Policies, Plans & Programs

30 *in perspective* YEARS

Urban & Regional Information Systems Association

1992 Annual Conference Proceedings • Volume V

IS/GIS/LIS
AND
PUBLIC POLICIES, PLANS, AND PROGRAMS: THIRTY YEARS IN PERSPECTIVE

Papers from the annual conference of the

URBAN AND REGIONAL INFORMATION SYSTEMS ASSOCIATION

July 12–16, 1992

Washington, D.C.

Volume V

Invited Papers Prepared for the "Perspectives Track" of URISA '92

ISBN: 978-0-916848-26-2

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PREFACE

The Urban and Regional Information Systems Association (URISA) is a professional society which serves to bridge the gap between users and providers of information for public decision-making. Founded in 1966, URISA draws most of its membership from the United States and Canada. The membership is composed primarily of administrators and technical staff in municipal, county, and regional governments. Many URISA members serve in federal, state, and provincial agencies. The remaining Association members include university faculty and students, employees of computer vendor and service companies, consultants, and elected officials.

This year's conference theme is "Making Connections." The 1992 conference is the thirtieth annual gathering of the Association and its predecessor conferences. The conference program includes papers on how technologies such as geographic information systems, microcomputers, and artificial intelligence systems are used in applications in land use planning, economic development, infrastructure and facilities management, transportation, public safety, demographic analysis, and natural resources management.

As in years past, all conference participants have been invited to submit camera-ready papers for possible inclusion in the URISA **Proceedings.** All papers have been subjected to review by an editorial board. Because of the large number of quality papers submitted, the 1992 URISA **Proceedings** have been prepared in five volumes. Each paper is presented in its submitted or revised form. A sixth volume provides abstracts of all papers accepted for the conference. The fifth of these volumes has been produced this year as a special perspective on the use of information systems since the first conference thirty years ago.

The six volumes are:

- I: Infrastructure Management • Transportation • Public Safety • Land Records Modernization • Environment and Natural Resource Management
- II: Geographic Information Systems
- III: Artificial Intelligence/Knowledge-Based Systems • Education/Technology Transfer • Integrated Systems • New Technology • Spatial Decision Support Systems
- IV: Urban and Regional Analysis • Regional Agencies • Public Information • State/Province
- V: IS/GIS/LIS and Policies, Plans, and Programs: Thirty Years in Perspective
- VI: Abstracts: All Papers Accepted for the 1992 Annual Conference

The six volumes are provided free of charge to the URISA membership as a member service. Others may purchase the URISA **Proceedings** individually or as a six-volume set by contacting the:

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FOREWORD

Anniversary conferences offer a convenient opportunity to reflect on past accomplishments and focus attention on key events and issues important to an association. URISA '77 in Kansas City was the association's fifteenth annual conference, but only my first. Fifteen years later, I am Conference Chair. Again our challenge is to evaluate our progress—what has been learned, what has been accomplished—on URISA's 30th Anniversary.

There is another reason for remembering URISA '77, however, and it involves our development as a progressive, dynamic Association. Unlike prior URISA conferences, or those of many other organizations, URISA '77 was designed to take stock. Leaders in the field were invited to review what had been said or written over the previous years, and to draw conclusions, and make projections about what might lie ahead.

That model is even more pertinent and necessary in 1992. The flood of papers and reports in proceedings and journals threatens to overwhelm us. We scarcely have time to digest their contents. As Conference Chairman for URISA '92, I am pleased that the URISA '77 model has a central role at our thirtieth anniversary conference. I refer of course to our **Perspectives Track**, which received a great deal of deserved attention from URISA members, academia, the information systems industry, and the public sector at all levels.

On behalf of URISA, I want to express our gratitude to Dr. Barry Wellar and Mr. Daniel Parr. As the 1977 Conference Chair, and a long-standing leader in both the information systems and public sector fields, Professor Wellar called on a wealth of experience and contacts, in defining and organizing the text, and selecting the contributors to the Perspectives Track. His collaborator, Dan Parr, initiated the effort by recruiting Barry and was instrumental in ensuring that the terms of reference, and promises, were turned into action and this text. Through their vision and efforts this volume became a reality for URISA '92.

To Barry Wellar and Dan Parr, I say "Thank You" for organizing the Perspectives Track at URISA '92, and for producing this very important text. The papers summarize where we've been, where we are, and where we might be going. They are, and will continue to be invaluable to anyone with responsibilities for IS/GIS/LIS, and public policies, plans, and programs.

D. Edward Crane
Conference Chair, URISA '92
Edwardsville, Kansas
May 1992

INTRODUCTION

by

Barry Wellar and Daniel Parr

In recognition and celebration of URISA's 30th anniversary conference, a **Perspectives Track** was adopted as a central aspect of URISA '92. Beginning with the Opening Plenary, and followed by five sessions featuring invited presentations, **Perspectives** are highlighted on a daily basis throughout the 1992 conference. The full details regarding topics and participants are contained in the Conference Program, **Making Connections**.

The papers contained in this volume are the written record of the contributions to the Track. We make this point only to emphasize and acknowledge that we cannot provide readers with two other valuable elements of the Perspective sessions. That is, and of necessity, we cannot report on discussions from the Q and A parts of sessions. Nor, most regrettably, can we report on remarks made during the Track's wrap-up session, "What Was Said, What Does It Mean?" We are optimistic, however, that articles in those respects will soon find their way into the literature.

In the lead article, "IS/GIS in Perspective: The Rationale and Terms of References for a Major Bench-Marking," Wellar and Parr set out the objectives and processes, as well as constraints, of the Perspectives Track initiative. We urge readers to examine that article in order to put the other papers in context, and to better appreciate the nature and difficulty of the tasks taken on by the contributors.

Contrary to URISA's tradition, it is not our intention to use the Introduction to preview the papers, nor to provide overviews. Generally speaking, the contributions are too rich in subject matter, ideas, interpretations, etc. to lend themselves to one-sentence or even one-paragraph summations.

Instead, as the organizers of the Perspective Track, and Editors of the volume, we believe it's appropriate to acknowledge the **collective** skill, energy, and effort that went into the preparation of materials. On behalf of all readers, we thank the authors for their contributions to **Making Connections** in 1992, and for laying a foundation that will enable us to continue to make and benefit from connections in the years ahead.

TABLE OF CONTENTS

IV. Information System Inputs to Plans

V. Information System Inputs to Programs

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IS/GIS PROGRESS IN PERSPECTIVE: THE RATIONALE AND TERMS OF REFERENCE FOR A MAJOR BENCH-MARKING

ABSTRACT: The reviews and previews prepared for the Perspectives Track at URISA '92 represent a major undertaking, with profound implications for measuring and assessing what has been done to date in the name of IS/GIS, and for making decisions about IS/GIS initiatives and activities over the next decade. This paper reports on the rationale, and the terms of reference, which served as the guidelines for selecting and advising the many contributors who participated in the Perspectives sessions.

The purpose of the paper is three-fold: first to establish the context and challenge provided for the Perspectives Track by the 1992 Conference theme, "**Making Connections**"; second, to put the rationale and terms of reference on record in the event of future bench-marking(s); and third, to make explicit the directions and constraints attached to the Perspectives papers.

INTRODUCTION: CONTEXT AND CHALLENGE

Over the past thirty (30) years URISA has evolved to become a central and often leading-edge player in the development, implementation, and use of information systems (IS) in general, and geographic information systems (GIS) in particular. As such it is appropriate, and may even be a matter of duty, for URISA to undertake a periodic, comprehensive bench-marking to confirm IS/GIS progress and shortcomings, and to provide an informed forecast on emerging IS/GIS problems, prospects and outcomes.

URISA previously undertook the bench-marking challenge in "big-time" fashion fifteen (15) years ago at URISA '77 in Kansas City. The '77 theme was "**Information System Inputs to Policies, Plans, and Programs.**" This extract from the Preface in the **Proceedings** contains the preamble to that earlier "progress report" (Wellar, 1977):

> "Areas of interest to URISA and its members include the full range of government functions—management, planning, operations, research; all areas of public sector activity—finance, engineering, human services, land use, assessment, transportation, housing/building, criminal justice, evaluation, welfare, libraries, etc.; the full range of

considerations related to hardware/software configurations - minis, programming, display systems, remote sensing, vendor services, implementing low cost technologies, to name a few; and all aspects of data base development—standards, compatibility, data directories, geoprocessing, cadastre, confidentiality, data dissemination, and so on.

In addition, URISA is developing a strong, international reputation as a result of its important contributions to topics dealing with intergovernmental relations, including support for R&D, data interchange, user access, development of census statistics, and transfer of hard and soft technologies. Further, it has assisted in the evolution of public sector - private sector developments which are mutually advantageous to both sectors in the marketing and use of hardware—and software—related goods and services.

The theme, Information System Inputs to Policies, Plans, and Programs, is most appropriate for a Fifteenth Anniversary Conference as it reflects the close ties between members' interests in information systems and the uses to which such systems are put by the members."

We suggest that this brief extract from the **1977 Proceedings** is sufficient to reveal two important messages for the 1992 conference, and this Track. First, there are **many similarities** between the topics referred to in the 1977 preamble, and those addressed at subsequent URISA (and related) conferences over the intervening years. And, second, the reference to "**close ties between members' interests in information systems and the uses to which such systems are put by the members**" is another and more explicit way of emphasizing the relevance and value of "**Making Connections**", the 1992 theme.

It would, of course, be most gratifying to be able to claim that the groundwork done in 1977 caused the 1992 Perspectives Track to be a logical, inevitable outcome. Regrettably, however, and in all candor, the decisions to propose and approve the Track were not the results of such beneficence of forethought, in principle or practice. That is, the timing (a 15-year cycle) is sheer coincidence, and the structure is dependent on the ready agreement of a number of key contributors to take on the responsibility to define sessions and prepare papers.

As further good fortune would have it, however, the Perspectives Track could not have been given a better theme within which to organize Perspectives topics and contributors. Although it is (apparently) due more to accident than design, **Making Connections** flows directly from the earlier bench-marking.[1] Moreover, given the '92 theme, it is reasonable to expect the entire conference to logically and consciously draw on and build upon all preceding conferences, and especially the 1977 "progress report". Anything less could cause us to miss a golden opportunity of affirming URISA's pre-eminence in the field, and do injury to **INFORMATION**, our good middle name.

To complete the Introduction, it is appropriate to acknowledge and briefly comment on other bench-markings or reviews undertaken under the auspices of, or precipitated by URISA. We do so to give credit where credit is due, but also to clearly establish the orders of magnitude difference between those initiatives and the URISA '77 - URISA '92 efforts reported on in this paper.

In brief, and for institutional as well as professional reasons, URISA members have long been involved in activities that require taking account of the literature (and the non-literature record). They did so, and do so, in recognition that knowledge of the literature bears significantly on whether, and the degree to which findings or conclusions are credible. Some of the more recent program activities which involve(d) literature reviews include the NSF-NCGIA project, the GIS/LIS Consortium program, the Spatial Data Transfer Standards dialogue, and the URISA Research Agenda Group (RAG) project.

The following short list of published materials illustrates the topics/authors of some recent overview or review-type reports produced under the auspices of URISA:

- GIS for science and society/ Borchert (1990)-Wellar (1990)
- URISA's research objectives, needs, means/Craig (1989)
- Lessons learned re GIS implementation/Croswell (1991)
- Models for policy analysis-decision support/Enache (1991)
- GIS, plans, planners and planning: tendencies/Harris (1989)
- Planning support systems/Kindleberger (1988)
- Standards and standardization issues/Moyer-Neimann (1991)
- Information valuation framework/Steger (1991)
- Institutional "musts" of IS/GIS development/Wellar (1988)
- Measuring use and impact of LIS/Zwart (1991)

The list serves to indicate the kinds or types of topics that have lent themselves to a Perspectives dimension. On the evidence, we suggest that the professional, attitudinal, or research inclination of the author(s) is the primary reason that such papers get written. And, again looking at the record, most such offerings are "narrowly-defined," either by issue, situation, experience of the contributor, time interval, etc.

By comparison (and we acknowledge that we could have done better, time and resources permitting), the Perspectives Track is relatively broadly-defined in terms of subject matter coverage, situations and points of view represented, and the span of time over which the reviews extend. It occurs, therefore, that a measure of the Track's long-term success may rest on how well it provides a context or basis for the occasional, subsequent, review-type papers that our more dedicated members enter into the literature.

RATIONALE AND TERMS OF REFERENCE

For the record, and the information of present and future readers, including those who might consider a similar undertaking years hence, the following sections from the proposal statement summarize the intent of the 1992 Perspectives Track (Parr and Wellar, 1991):

"**SESSION DESCRIPTION**: On our 30th anniversary, and 15 years after the first rigorous examination (1977) of URISA's impact on urban and regional policies, plans, and programs, it is appropriate to again broadly examine what has and has not been accomplished. A particular value of this kind of Track is the context which such an overview provides for assessing progress, and especially for taking a reflective look at "hot items and trends".

Consider the GIS phenomenon, as part of the IS family. It could be argued that, driven by rapid and far-reaching advances in hardware and software, GIS enthusiasm has obscured URISA's broader origins, and detracted from its greater potential for impact on the functioning of government and other urban and regional organizations. As a result, in that respect, we may be failing to communicate our rich history and wide range of interests to the current and future members who see us as a GIS organization and trade show.

To summarize, the objective of the Track is to communicate the knowledge and experiences of the past 30 years effectively, and to thereby help our members to: a) lessen the start-up costs; and b) realize more of the benefits of information system development.

SESSION ORGANIZATION: The four Track Sessions (Perspectives, Policies, Plans, Programs), following the '77 format, would combine to serve the following important functions:

1. Assess the current state of IS in urban & regional institutions through a comparison with past reality and expectations.

2. Identify the major accomplishments and failures of the IS/GIS/LIS/MIS/etc. field **in URISA terms**.

3. State and document our present understanding of "the knowledge base" (lessons learned from experience, research, etc.) regarding what is known and needs to be known about information system inputs to urban and regional policies, plans and programs.

4. Make recommendations about lessons we believe deserve to be passed on to the future, and on how URISA can best contribute to the next 15 years of the Association's development.

The intent is to provide quality speakers to overview and stimulate discussion of these important topics during the sessions, and to provide a theme for discussion <u>throughout</u> the '92 Conference. Clearly, these sessions tie into the Research Agenda and the education role of URISA, and could be a starting point for a longer-term URISA initiative to summarize and disseminate the knowledge we are producing. We expect the Track to have significant implications for the **Journal** and future conference programs."

As readers of the final Conference Program may have noted, there was a session change between Track approval and the annual meeting. That is, a wrap-up session, "What Was Said, What Does It Mean?" was added to provide feed-back on, and a focal point for discussion of Track papers and presentations.

The next section of this report deals with several considerations which, although often accorded nods of acknowledgement, tend to receive due regard in only the most disciplined circumstances. However, respect for each is crucial if **real progress** is to be made in **Making Connections**. The following extract, or terms of reference, is from the "Guide to Context of Sessions and Papers" (Wellar, 1991):

> "There are several common elements to **ALL** the sessions and papers.
>
> 1) We are seeking to cover off 30 years of history, and to look forward 10-15 years.
>
> 2) The URISA literature — Proceedings, Journal, etc. are part of the history, and **must** be the basis of remarks. It is expected that the **1977 Proceedings** will be a major part of the reviews, and will serve as a key point of departure in marking our progress.
>
> 3) Following from the word "themes", in Structure and Themes, papers should not be merely descriptive — who, what, where, when, stuff — but should strive to draw out **generalizations** along the lines of propositions, central concepts, theories, maxims, principles, etc.. In other words, let us try and extricate "the signals from the noise", and thereby seek to present attendees with essentials as opposed to incidentals (which, after a while, tend to overwhelm rather than inform!)"

At the risk of belabouring the obvious, the three elements are regarded as crucial to documenting and elaborating **real IS/GIS progress** for the following respective and illustrative reasons:

1) The explicit reference to **time** is a reminder of how long URISA has been in operation, and of the dynamic, connected aspects of IS/GIS evolution. In the interests of reaping the benefits that accrue by learning from past and present successes and mistakes, and taking advantage of these lessons learned, we believe it is necessary to begin at the beginning to the extent permitted or required. For some papers, it may be sufficient to proceed from the 1977 review; for others, getting back to basics (as roots or origins) may mean a 30 year span.

2) As for the **review** of URISA-based **literature** being a **required** part of the papers, it is an appropriate condition on several counts. First, that literature is widely regarded as, or held to be leading edge, so it follows that the Perspectives papers must review that material, as a minimum. Second, and as a matter of pragmatics, the formal URISA literature warrants reviewing because it

was deemed acceptable to be published. This kind of "calling to account" of our own works is a professional and responsible approach to association development, a matter noted by Horwood (1977), Wellar (1977, 1988, 1990) and Craig (1989) among other URISA writers. And,

3) The progress of a discipline, or professional/technical association, and the respect or attention it generates, obviously depends upon many things. We believe that key measures or indicators of progress include the degree and extent to which **lessons learned** — from both research projects and day-to-day, real-world action — are defined, documented, and incorporated as part of an IS/GIS knowledge base.

In this respect **Making Connections** means a cumulative, building-block approach whereby we seek to derive information from data, and universals from particulars, incidentals, or individual cases. As a result, the challenge placed on Perspectives Track papers is to get beyond the widespread tendency to merely add to the IS/GIS pile of bits-and-pieces reports. That is, what we seek, at a higher order, are reports that offer for consideration any and all manner of generalization, whether as "rules of thumb," principles, laws, etc., around which the field can be productively organized.

An additional feature of the Track that is pertinent to the Terms of Reference section, is the composition of the group of contributors. In respect of URISA's make-up, it was intended that the contributors selected for the Track be as representative of the membership as conditions (and offers to participate) would permit.

DIRECTIONS ON TRACKS AND SESSION CONTENT

This is a volunteer effort in every respect. As a result, there are limits on how much direction one can advisedly attempt to give to participants. And, there are other factors related to initiative, imagination, spontaneity, etc. that are affected by the type and level of direction exercised by organizers. On the other hand, however, all parties appear to be aware that we cannot lapse into a full *laissez-faire* approach, as that would undermine the initial petition to the Conference Committee for a (coherent) Perspectives Track (Parr and Wellar, 1991).

The approach adopted for the 1992 bench-marking, therefore, was to base directions on feed-back over the years about the 1977 sessions and **Proceedings**, and on a preliminary round of discussions with key participants about what should, and could be done in a Track format for URISA '92. As the 1977 Conference Chair and **Proceedings** editor, it fell to Wellar to take the lead for the content component of the Track, and to work out session and paper details with the contributors. The Structure and Themes presented in Figure 1 is the product derived from the reviews and consultations, and was proposed as the framework for the Track.

FIGURE 1: Information System Inputs to Policies, Plans, and Programs: 30 Years in Perspective*

STRUCTURE AND THEMES

I. Policies, Plans and Programs in Perspectives: The Big IS/GIS Picture
   1. Tracking Topics: Identifying and Interpreting the Information Issues and Initiatives at the Heart of IS/GIS Applications
   2. IS/GIS Hardware/Software/Data Features and Capabilities: What's Done, What's On, What's Next
   3. Philosophical and Methodological Progress Towards an IS/GIS Knowledge Base

II. Information Systems Inputs to Policies
   1. Role and Use of IS/GIS in Public Policy Formation Process
   2. Role and Use of IS/GIS in Realizing Public Policy Objectives
   3. Policies on the Development and Use of IS/GIS

III. Information System Inputs to Plans
   1. Role and Use of IS/GIS in the Planning Process
   2. Role and Use of IS/GIS in Realizing Plan Objectives
   3. Impact of IS/GIS on Planning Education and Training

IV. Information System Inputs to Programs
   1. Applications of IS/GIS: Government
   2. Applications of IS/GIS: Business
   3. Application of IS/GIS: Science and Education
   4. Building the IS/GIS Capability to Support Programs, Plans and Policies

*After the outline drafted for Conference Committee (Parr and Wellar, 1991)

In a widely-circulated memorandum sent to the Conference Committee, Board members, SIG chairs, and other notables, the general, proposed content of the sessions was put out for consideration. Since no modifications were proposed, we enter that part of the "Guide to Content of Sessions and Papers" directly into the record, session by session (Wellar, 1991):

> "I. This is a synthesis-type session which addresses three core aspects of URISA. In Paper 1 reference is to the subject matter topics which have come and gone, or stayed with us. They may be institutional, organizational, political, procedural, sectoral (land use, housing, transportation, wetlands, etc.), spatial, research-oriented, etc.. In other words, this paper reports on what we have been doing with and about IS/GIS, and has a special interest in trends. There will be an **applications/operations focus** to this paper.
>
> Paper 2 will address the numerous technological and technical changes to the hardware/software/data (H/S/D) composition and configuration of IS/GIS, with many bumps, detours and shortcuts in the road we have travelled. And we still have many "miles" to go. A synthesis of our H/S/D "progress", and a preview of what lies ahead will be a daunting task, but its benefits could be huge, and especially

for those who may not be aware of the **"generations"** aspect of H/S/D evolution or revolution.

Paper 3 has as its focus the conceptual and intellectual underpinnings of the information systems field, and will build directly on Horwood's **1977** Proceedings paper. Of direct concern here is our progress towards more effective and efficient means of inquiry via IS/GIS, and towards establishing **a robust knowledge base** about the use and significance of IS/GIS in terms of applications. A major task of this paper is to document and advance the **science aspect** of IS/GIS research and applications, which includes the philosophies, theories and methods — the whys behind the hows — of what is done in the name of IS/GIS.

II. This session, with its policy orientation, is more narrowly and specifically defined than I. The content of the three papers flows from their titles, and the 1977 Policy Sessions. In Paper 1, the emphasis is on the public policy formation **process**. There are many factors which come into play during the policy process, and this paper presents an overview of situations, circumstances, etc. where information system inputs were, and were not, a factor in policy outcomes. Of particular value will be an assessment of whether, and in what circumstances, information system inputs have been a larger player in the process since the 1977 review. And, we suspect there will be great interest in a prognosis of what the future holds for the role of information in the policy process, from the local, regional, etc. levels of government to the global aspect.

Paper 2 is intended to document **policy outcomes** that have actually been affected by the presence or absence of information system inputs. What we are seeking here is documentation of the **difference** that information system inputs made, make, and could make to realizing policy outcomes, or to seeing them lost.

Paper 3 is similar to Paper 2 in this series, in that it documents the policies which have been adopted to direct the design, development, implementation and use of information systems. Of particular value will be lessons learned about the formation, adoption and "enforcement" of **IS/GIS policies**, and any associated policies such as those related to standards, procurement, staff training, etc..

III. The papers in this session parallel those of II, and will also draw on and build on the **1977** Proceedings. Our **focus** here is **on plans and planning** related to land use, transportation, regional, rural, etc., which are represented in Comprehensive Plans, General Plans, Official Plans, etc. at the local, regional, state/provincial levels, or by plans for agriculture lands, wetlands, drainage basins, etc., at all levels.

Paper 1 will address the **process** aspect, and the role and use of IS/GIS in the formulation, testing, review etc. of plans. Paper 2 will focus on the **results** that have occurred, that is, **plan objectives realized** as a result of, in spite of, etc. information system inputs. As in Paper 2 of II, we are looking for real-world evidence of the **difference** that IS/GIS made to plan outcomes.

Paper 3 will address the presence and impact of **IS/GIS** on **education and training** (curricula, thesis topics, etc.) in the planning profession, and in government and private sector planning departments. Explicitly, this paper will examine **both** the academic and practice aspects of planning.

IV. Programs are what **taxpayer dollars** are spent on, a topic of vital importance at any time. The efficacy of programs — getting the biggest or best bang for the buck, doing more with less, selecting the right programs, preventing disasters, etc. — is the final measure of success for urban and regional organizations, and for state/provincial and federal agencies and governments as well.

This session is designed to take that measure of IS/GIS progress. It will be done through an examination of programs in the three major URISA constituencies — **Government, Business,** and **Science and Education** — and discuss the reality of IS/GIS effects on programs. The basis of comparison or evaluation is the expectations of 30, and 15 years ago, when this topic was last examined at URISA '77.

These examinations will identify the major accomplishments and failures of IS/GIS in the implementation of programs. Each paper will then **document our present understanding of the knowledge** (lessons learned from experience, research, and observation) which deserves to be passed on to the URISA membership regarding what is known, and needs to be known, about information system inputs to urban and regional programs. Each paper will conclude with recommendations on how URISA can best contribute to the next 10-15 years of employing IS/GIS in the formulation, implementation and delivery of programs.

The final paper of the session will examine the **trends of IS/GIS** in these programs from a broader point-of-view. It will summarize how — means and reasons — the building of IS/GIS capabilities into programs of all types has evolved over 30 years. What have been the fundamental themes behind the spending of billions of dollars on IS/GIS? How did we justify or rationalize our decisions? What conclusions can be drawn from this knowledge?

In conclusion, and again, **ALL** of the papers will require a rigorous and vigorous examination of 30 years of literature [at least URISA's] aimed not at historical reporting, but at **discovery of knowledge** developed by our URISA discipline. We are looking for derived, tenable conclusions and not just descriptions and casual opinions. If the Track goes as intended, we will stimulate a discussion that will begin at URISA '92 and will continue, productively, for many years to follow.

Barry Wellar
Editor of Paper Content"

Circulation of the proposal yielded a number of comments. However, the only substantive inquiries or observations that were received during the formative stages of the Track involved correspondence with Professor Clark Rogers, University of Pittsburgh. The points raised are at the heart of the Track, and were copied to all leaders of papers. Several observations and replies are repeated here, for the information of readers (Rogers and Wellar, 1992):

Rogers observed:

"There seems to be a mixed message in the proposal that need not be carried over to the sessions. Does IS/GIS mean IS or GIS, or IS/GIS as its own entity, or GIS as a sub set of IS? It's important for the integrity of the track that prospective presenters know the difference and that the audience know where they are coming from. It's also valuable to have a definition for purposes of leading into any discussion for the future of URISA.

Wellar replied:

"Our interest in posing the IS/GIS combo is deliberate, in that by doing so we are drawing attention to the very good questions that you raise. In my opinion, the IS represents the heart of URISA but, as Dan Parr and I noted in our proposal to the 1992 Conference Committee, much of the membership seems to regard GIS independently of IS. Indeed, a review of the volumes for any year indicates, I suggest, that for many contributors IS and GIS are worlds apart. It was our intention, via the IS/GIS combo, to explicitly relate them such that the Track's overall concern is with IS in general, and the GIS aspect gives due regard to an important member of the IS family."

Rogers observed:

"The title of the track, "Information System Inputs to Policies, Plans and Programs: 30 Years of URISA Progress in Perspective." There is a bold assumption there that URISA is responsible for IS inputs. Is it thirty years of URISA progress, IS progress during thirty years of URISA, or thirty years of URISA impact, or lack thereof, on IS? The title might have more appeal if it included the word 'future'."

Wellar replied:

"Our primary focus is on the documented URISA record, as expressed by writings in the **Proceedings, JURISA**, and **GIS/LIS Proceedings**. The overriding collective task is to derive from that record the contributions which "URISA" has made (1963-1992), and could make over the next decade or so, to policy, plan, program and research progress via IS/GIS progress. And vice versa. We do not, however, intend or wish to preclude reference to other pertinent literature."

In addition to circulating the proposal for discussion and feedback, several other "means of direction" were employed to help ensure that contributors actually addressed the topic and task which they had accepted. And, we hasten to add, in the interest of time the means were employed during the completion of the roster of leaders, and the setting up of representative teams to prepare papers.

First, and being well aware of how difficult and time-consuming it is to review, and recommend changes, and work out amendments to abstracts and papers, we produced "A Checklist for Self-Critiquing Perspective Track Papers" (Wellar and Parr, 1992). The checklist was distributed to leaders of papers with a package of material dated January 14, 1992. It is reproduced here for interested, present readers, and for the possible benefit of future organizers of non-trivial Tracks or sessions.

Second, a schedule was established that was intended to allow for the preview of abstracts and papers. To the extent that abstracts and papers were submitted in a timely manner, we were able to exercise a measure of direction and control. That is, we were able to suggest changes **before** options were foreclosed, ideas got set, domains got blurred or invaded, etc. Due to the volunteer aspect noted above, and numerous other twists that bedevil these kinds of efforts, we were not fully successful (as one might expect) in reviewing abstracts or papers.

CONSTRAINTS

There are obvious constraints to any joint effort, and especially one of this nature. For the record, "difficulties" which affected this bench-marking project included: limited time; limited resources; lack of access to source materials; bad logistics (the "miracle of fax" notwithstanding); changing circumstances of contributors (budget cuts, job re-definitions); differences of opinion about how to proceed and what to cover; and, of course, "murky" instructions and communications. Each such constraint affects the amount and quality of reading, listening, interpreting and writing that goes into papers. And, although we have no evidence on the volunteers versus paid-help relationship, there are definite limits on what volunteers can be "instructed" to do or when to do it!.

It also warrants noting that with so many participants, constraints are imposed on the amount and nature of interaction between and among the organizers and contributors. That is, in our situation, and upon reflection, one review round of abstracting and paper drafting is about the most that can be done reasonably in terms of checking out what the contributors are doing as a group. Additional exchanges of views are limited to the most active types, who seek out opportunities to strengthen their products. Other contributors and the organizers may lack the time or support resources to go through such a refinement process.

Therefore, to those who raise legitimate concerns about proceedings or journal papers not read, topics not considered, relationships not specified, interests not represented, etc. we have no counter-argument nor quarrel. Indeed, what you seek is totally **consistent with the essence of inquiry,** and the **search for excellence** that should be part and parcel of our involvement in measuring and assessing IS/GIS progress. In fairness, however, it is appropriate that the "realities" noted above are born in mind when compiling the list of sins of omission or commission on the parts of either contributors or organizers/editors.

FIGURE 2: A Checklist for Critiquing Perspective Track Papers*

1. Is the Abstract/Paper consistent with the terms of reference provided in the "Guide to Content of Sessions and Papers"? (Memo of 11 November 1991). We especially call your attention to common elements 1), 2), and 3).

2. In the event of perceived "boundary problems", have you consulted with other Leaders in your session to work out an accommodation?

3. In view of our universal proclivity to opine, have you taken steps to ensure that <u>all the relevant literature has been given due regard</u>?

4. In the interests of effective communication, and in view of page limitations — maximum of 20 pages —, does your paper contain tables, graphs, etc. as the basis of narrative?

5. URISA has many constituents, including numerous agencies in <u>all levels of government</u>, a number of academic disciplines and professional groups, the vendor and larger business community, and so on. Is your paper sensitive to the needs and expectations of URISA's diverse (and demanding) body of interests?

6. And most important, does your paper build on the propitious 1992 conference theme, "Making Connections"? Indeed, from a temporal perspective alone, we could hardly have a better term of reference for the Track.

We thank you for consideration of the concerns that we note in the checklist. Be assured that we will provide whatever assistance we can to help you produce your paper, so please call on us at your convenience.

Barry Wellar and Dan Parr, Perspectives Track Organizers

*Note: It was originally intended that the Track focus on URISA's progress, as it seemed overly ambitions to even contemplate dealing with a topic as large as "URIS Progress." We were persuaded, however, by Conference Chairman, Ed Crane, and upon consideration of the high-quality track team that had been assembled, to "open the window." As a result of the mid-course correction (in March), the Track's scope was broadened to encompass URIS progress in general, with the Association's contribution to be a topic of particular attention. There was, therefore, an enlargement of the terms of reference contained in the "Guide to Content of Sessions and Papers".

CONCLUSION

This paper establishes the rationale for the Perspectives Track, and puts the various sessions and papers in context. That background information is provided for both current and future readers, including potential bench-markers.

It is our summary conclusion that while there are other ways to proceed, other topics to be addressed, other reports to be read, other experiences to be covered, etc., those "others" do not diminish either bench-marking as a vital URISA responsibility, nor the papers which have been prepared for this **Proceedings** of the 1992 URISA Conference. Therefore, on behalf of those who seek analyses, syntheses and interpretations of IS/GIS progress — the essence of **Making Connections** — we acknowledge and thank the contributors who made this volume possible.

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[1]We note that the 1992 URISA Conference theme also flows directly from "Making Connections with Geographic Information Systems," which was the theme of a Symposium sponsored by the National Capital Chapter of URISA and held in Ottawa, October 15, 1987.

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PERSPECTIVES ON URISA'S ORIGIN AND ON THE EMERGENCE OF A THEORY OF URBAN AND REGIONAL INFORMATION SYSTEMS[1]

Abstract. The incident of conception of URISA and the circumstances which brought the organization into being are recounted. Definitions of the field are presented and discussed. The association is viewed through the nature and type of its literature. Speculation is made on the disciplines of urban and regional information systems and the future of URISA.

INTRODUCTION

I have been asked as the first president of URISA and as one involved during its pre-organizational period to sketch the early background of URISA today, and coincidentally to make some comments that may give relevance to its present being and its emerging role. It has been several years since our last exercise in this respect, wherein we introduced the decades of the Seventies by a session on the examination of the past, present and future of our field (URISA, 1970). We have been an organization of substantial turnover, according to one of our historians (Kraemer, 1977), and there are only about 100 of us who have maintained continuous association with URISA for more than a decade. Perhaps it is also a sign of my advancing years that I am asked to recount the history of URISA and record early events and decision points before they are forgotten. History is only significant in that it can be related to current events and emergent prospects, therefore I will try to be more than just an historian in this role.

THE ORIGINS OF URISA, 1962-1966

The concept of URISA got its start unbeknowingly in the fall of 1961 with the attempt of a few people to get information from the then new tape technology of the United States Census Bureau regarding the Census of Population and Housing of 1960. If I could point to one single incident, it would be a telephone discussion I had with Jack Beresford, a subsequent URISA president, who was then a member of the staff of the U.S. Bureau of the Census involved in handling requests regarding access to Census data. The conversation went something like this:

Ed. Horwood — "Jack, how can I get Seattle's block data without waiting for its hard copy publication in a couple of years?"

Jack Beresford—"Well, you can't, Ed, that information is only yet on computer tape."

Ed Horwood— "Well, why don't you send us a copy of the tape and a write-up of what's on it?"

Jack Beresford—(deep pause) "Well, there's nothing I know of that tells me I can't. Providing there is appropriate suppression to avoid disclosure on small entries. I'll send it on out to you at cost."

The current generation of Census tape users should realize that there was no apparatus in 1960 for the dissemination of Census tapes. They were essentially an internal artifact of the Census Bureau. With the receipt of the tape at the University of Washington sometime in November a new world opened. For one thing, with the advent of the relatively new automatic digitizer the block centroids could be digitized from maps, merged with the tapes from Census, and Census data or symbols representing data could be printed out in the mapped format.[2] Further, computer printer graphics could be developed to show rank order arrays and distributions of data. The only thing Jack Beresford did not tell us was that there was a dummy word on the tape at the beginning and it took us several months to get a useful product.

The use of the first United States Census tapes came shortly after the advent of the first general computer programming language, FORTRAN, and with the assistance of Arnold Rom, of the Boeing Company, who had considerable experience with the then new IBM 709 computer, my colleagues[3] and I developed a macro-compiler which produced ROMTRAN, the first known user's language for Census tape processing.

During the winter of 1962 we had a number of inquiries from people Jack Beresford referred to us, and decided under the demands of efficiency to produce a two-week workshop for a national audience, which included the then Chief of the Geography Branch of the Census, William T. Fay. Two weeks were required for a short course then because we also felt the need to teach the elements of data processing and general computer programming, insofar as the user language we developed included FORTRAN-type arithmetic capabilities. In retrospect, the main thing I learned from this experience was the 15 years ago people could leave their offices for two weeks without having them fall apart, whereas today that time has diminished to two days.

At the end of the first course we distributed object decks of the ROMTRAN programs as graduation gifts, and expected to go back to our research. However, a fraternity seems to have been formed that did not dissolve. A number of the graduates began using the new-found knowledge and kept us busy on the telephone lines and in visits to help them out with problems. And so we planned additional short courses, and by 1965 had given 11 at major universities in the United States and one in Europe. The faculty for these courses included names long active in URISA— Clark D. Rogers, Kenneth J. Dueker, and William L. Clark.

To return to the chronology, by mid-1963 there seemed to be a genuine interest of the users of the ROMTRAN language and some of the more active graduates of the courses to get together to discuss applications and on August 28, 1963, 48 people met on the University of Southern California campus to trade information on developments in "urban and regional information systems." This was billed as the "First Annual Conference on Urban Information Planning Systems and Program." In a sense, the organization founded itself.

No proceedings were issued form the first conference, which was essentially of a seminar nature, structured around a few topics of interest. Two things stand out in my mind from that first meeting. One is the demonstration of interactive computer graphics given after the meeting by Weldon Clarke, then of the Los Angeles Office of Bolt, Beranek, and Newman, and the other was the luncheon address given by Robert Goe, a chief aid to the then recently elected Mayor of Los Angeles, Sam Yorty.

The demonstration of interactive computer graphics, using a light pen and vector generating cathode ray tube operating from a small-scale computer, opened a new horizon of thought in the minds of the viewers toward the on-line editing of networks in connection with geocoding. In retrospect this causes one to consider how quickly the hardware systems' technology outdistances our capabilities to adapt to it, because it took us five years to gain this competence at my university and few metropolitan area DIME[4] files are yet interactively edited.

The lunchtime talk by Robert Goe is memorable in the light of the 12-year history of the Yorty administration of Los Angeles. Mr. Goe personified the newly emerging style of public administrator dedicated to the incorporation of information systems into the fabric of the administrative process. With the computer now firmly incorporated in public management thinking, we were, according to Goe, at a new threshold of governmental efficiency and improved executive capabilities via harnessing of the new information automation capabilities. Los Angeles, situated in the center of a vast sea of competency in information processing technology related to the Southern California aerospace industry, was obviously well located to accommodate the transfer of the new technology for the betterment of the citizens of the region. Needless to say, the visions of Robert Goe were slow in materializing. Bunker Hill, the oldest unfinished urban renewal project in the country, was then entering its second decade of planning and is now, for all I know, in its fourth. In the interval, smog, riots, traffic, and the civil service did not show any signs of diminishing.

We see from the foregoing that URISA emerged from the need for communication among professionals in a new field and from their need to learn skills, outlooks and philosophies that had not been included in their formal scholastic background.

THE FORMATION OF URISA 1966-1967

Returning to this brief history of URISA, conferences on urban and regional planning information systems and programs —note emphasis on planning—were held in Pittsburgh, Chicago and Berkeley in the successive three years, with attendance increasing and the inexorable movement toward an association. An *ad hoc* committee to study formal incorporation was impaneled in 1964 at Pittsburgh. The Chicago meeting of the informal group in 1965 called for the drawing up of a constitution, which was adopted the following year at Berkeley. The first formal annual meeting of URISA as an organization was held in 1967 in Garden City, New York, and the initial by-laws were adopted in 1968 at the second annual meeting in Clayton, Missouri.

THE ORGANIZATIONAL MODEL FOR URISA

It might be interesting to dwell for a moment on how URISA got its present organizational structure. As secretary and chairman of the constitutional drafting committee, Kenneth Dueker and I, respectively, looked for organizational models. We reflected on the organizations we belonged to at the time. I was then on the Board of the American Institute of Planners, which was again in the throes of searching for its identity and reestablishing criteria as the basis of membership. I had reluctantly come to the conclusion as a result of that experience that guild-type organizations, such as the AIP, spend about 80 per cent of their resources in determining who may or may not become members and by what process, On the other hand, the relatively new Regional Science Association, linking aspects of economics and geography, which Kenneth Dueker and I were also members of, spent no resources on screening membership and seemed never to have had the problem of either disinterested members or having members without learned credentials. It also had the excitement of being a new field and one catering to people trained in a range of disciplines and belonging to traditional societies like the American Economics Association and the American Society of Geographers.

We were impressed by the fact that a guild organization would be inappropriate for our colleagues in search of an association. We were trained in many different disciplines and involved in a wide range of job functions that could not be readily classified under guild criteria. Guild organizations, like the American Institute of Architects, the American society of Civil Engineers, and the American Bar Association, are associations based on the historical needs of members who serve clients in formalized commissioned or contractual roles, even though they have broadened out somewhat. They are geared essentially to promote the consultant-client relationship. Guild organizations have strong interests in licensing criteria, fee schedules (and now advertising) and to a substantial extent the exercising of a quality control (read constraint) on the professional intake process. Not only does the guild-type organization become unduly involved in membership selection and the protection of its professional territory, but in my own view appears to be somewhat anachronistic for organizations that have not fairly structured client relationship and licensing requirements.

Other types of professional associations are based on specific role functions, rather than client service or broad intellectual interests. These include organizations relating to such role functions as municipal finance officers, chiefs of police, right-of-way agents, and so forth. In viewing the make-up of the *cognoscenti* in our filed of interest in the four years prior to formal organization, it occurred to those of us drawing up the constitution that the interest area encompassed those whose positions and backgrounds were widely varied, and who were not exclusively in any characteristic type of public service or private enterprise. Hence, we arrived at the "open membership" model characterized by the Regional Science Association rather than the guild or role function organizations types just discussed. The URISA constitution welcomes all comers to membership who have an interest in the intellectual field or urban and regional information system, whatever it may be as determined by how its members define it in the totality of their respective interests and contributions. It then becomes necessary for the membership to continually test its interests against different views of what it perceives the field to be, which has essentially happened in the formation of the special interest groups and in the changing themes of its conferences. The URISA Constitutional Convention provided for the advancement of an interdisciplinary and multi-disciplinary approach to meeting the interests of the founding members, and subsequently these who would follow.

INTERDISCIPLINARY & MULTI-DISCIPLINARY BASIS OF URISA

We recognized from the outset that most of the members-to-be of our organization were also members of other associations, organized on either the guild or functional role basis. Thus, the original need for URISA catered to some common interests, the depth of which was not probed in any one of the guild or role organization associations to which the early advocates of URISA belonged. We seem therefore to have been performing from the beginning a synergistic role. the excitement of the early meetings arose out of our discovery of each other coincidentally with the emergent field. It was as if we had discovered the computer along with each other. The admixture of people with interest in computer science, the management sciences, the social sciences and other fields, as well as the mix of organizations represented in the membership and roles within organizations, was a very interesting matrix indeed. our early conventions, at least, were like a weekend away from our families of orientation—they expressed the freshness of a new coupling. How did this come about? I will describe three reasons in my view.

First, at the beginning of the Sixties we had truly embarked on the era of computerization. Whereas commercial computers had been around for just about a decade, their use had been mystical and difficult. Before the advent of the general purpose programming languages use of the computer was by machine language or codes that were difficult to remember. The first general programming language, FORTRAN came into widespread use only at the beginning of the Sixties. It opened the door to both a much wider group of users as well as to the introduction of computing capability to non-computer experts.

Secondly, the era of the early Sixties was a period of great infusion of federal money into urban and regional planning activities, stemming mainly from the housing and highway agencies. on the transportation side dozens of urban area transportation studies were coming into existence, presenting the first major thrust in large-scale data gathering and information production activities dealing with metropolitan areas. On the housing side we had expectations of large-scale urban renewal and housing rehabilitation in the community Renewal Program of the Housing and Home Finance Agency later to become the Department of Housing and Urban Development. There was a great demand for people who could work on the relationship of information to policy issues.

Thirdly, not only were there great deficiencies in the classical academic background of the new information systems specialists, based on their programs of origin having been within the conventional wisdom of pre-computer education, but the newly emergent graduate specialties such as public affairs, urban planning, business administration and a few other areas did not package the needed educational equipment for the new demands. This still appears to be the case, and provide probably the greatest *raison d'être* for the continued existence of URISA.

DEFINITION OF THE FIELD

It is interesting to note that in the 15 years or so that we have been meeting we do not have in any of our organizational papers—constitution, bylaws, invitations to take out membership—any formal definition of urban and regional information systems. I have defined the field from time to time in papers and lecture notes and I have searched the early literature at some length as well as perused the later looking for definitions. I find yet only three, all of which I have been at least co-author of, and I have brought them together here as a start in the review of definitions of this field (see Table 1).

TABLE 1
Early Definitions of Urban and Regional Information Systems

1. An urban and regional information system is one involving the sequence of steps in the synthesis of information from broad data inputs by the use of automated methods to bear on the solution of particular problems involving management <u>decisions</u> relating to the functions which control, shape or anticipate change in the urban and regional environment. (Horwood, 1965)

2. An urban and regional information system is one involving the sequence of steps in the synthesis of information from diverse data inputs by the use of automation to bear on the definition display and solution of a set of problems relating to planning, political and management <u>decisions</u> in urban affairs. (Horwood and Calkins, 1970)

3. An (urban and regional) information system is a collection of people procedures, computer hardware, computer software, and a data base organized to develop the information required to support a particular <u>mission.</u> (U.S. Department of Housing and Urban Development, 1968)

Note: Underlining added for emphasis in discussion.

I do note in the literature of our field that there are often attempts made to define the field by its properties, impacts or outcomes. This has been done by my esteemed colleague, Professor Kenneth L. Kraemer, of the University of California at Irvine, in a recent salient paper entitled: "Present Status of Urban Information Systems in the United States"—a paper he delivered at the Sixth European Symposium on Data Management at Liege this spring. While no specific definition is given in the entire 50 pages, he does put together the basis of a definition, which in his view is the adoption of computing by urban management—a somewhat more constrained view than I have myself.

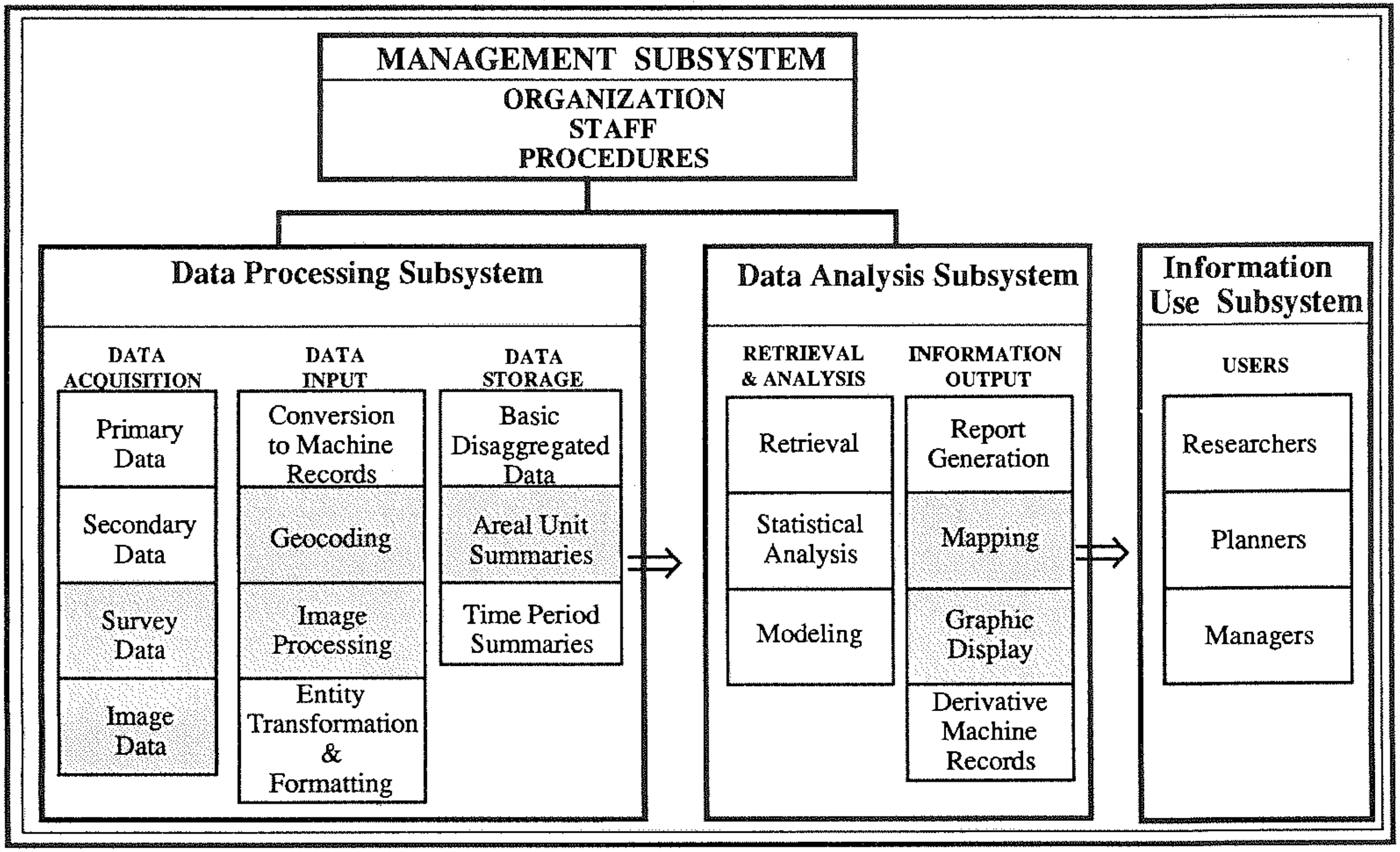
The definitions in Table 1 appear to me at least to be intuitively accurate, although all are cast in terms of relatively discrete events such as missions and decisions, rather than processes, which may note specifically oriented to event-related goals. I am sure the thinking behind these definitions reflects the atmosphere of the early and mid-sixties in which information was collected more for *ad hoc* tasks than for continuous flow processes. A philosophy behind these definitions is that as the result of an information system a decision would be made or a mission completed based on information supplied. It is almost as if we thought in terms of a series of discrete information systems projects, even though many of us at the time were also looking at the continuous development of data bases for multi-purposes. We also note reference to the solution of problems in the early definitions, creating the impression that an information system stems from a specific effort to solve a problem. In retrospect, I feel that the third definition is most reasonable if the word "mission" would be substituted by missions or processes." I believe that this would bring the management side of information systems needs into the definitional picture.

The best visual representation of the field definition I could find was a diagram by Calkins (1972) which puts the various parts of the information system complex together, leaving only the subject of the system to be supplied. I submit that the interrelation of the boxes of Figure 1 are the general field of the information systems specialist, as it may be applied to the substantive area. Some of the boxes may be the exclusive turf of associated specialists, who may or may not be interested in the larger system A central theme of URISA interests has been in my view the interrelationships of the elements of Figure 1 applied to substantive issues and process in the urban region context, as well as both the problems of organizing for this process in a very imperfect political environment and looking at the system outcomes. The diagram becomes a form of definition of functional activities in the field and you may test yourself by seeing which box or boxes come closest to containing your interests.

As an educator I cannot help but reflect on the fact that it is the comprehensive view of this relationship system that escapes most of the formal training in academic programs. As an example, we teach statistical analysis, modeling and mapping in respective courses. It is only the occasional student who puts the system together in a thesis study. Perhaps this is one reason that we assemble here to view the parts of an information system in a holistic context.

In all of this definitional discussion I am struck with the thought that the same definitions and diagrams with a few words changed might apply to any field. With the exception of the interest in spatial definitions in urban and regional information systems, disclosed in the shaded boxes of Figure 1, the major difference between information systems in various fields is the environment of actors, institutions, programs, politics and substantive background of the information system builders, clients, managers and analysts. What we are looking at in Figure 1 is the substantive and procedural field of information systems, urban and regional in our case.

FIGURE 1
Elements of an Information System (Calkins, 1972)



WHAT IS THE PHILOSOPHICAL BASIS OF URISA?

With this background of organizational structure and definition we might now pass to thoughts about the philosophical role established by the founding members of URISA. Here I shall have to draw on the record of the pre-organization contributions of our leading members between 1962 and 1966, as well as their general philosophies as best as I can construct them from memory. First let us reflect on the themes of our annual conferences.

It is interesting to note from the record of Table 2 that in four of the first five conferences (all but 1962 being recorded in proceedings of the conferences) the word "urban planning" is included as a modifier to the term "information systems." This reflects the facts already alluded to, that the first field of general interest of the URISA stemmed from the involvements of its founding cadre in the information support area for physical planning, predominantly transportation and

TABLE 2
Themes of URISA Annual Conferences

YEAR	CONFERENCE THEME
1962	Urban Planning Information Systems and Programs
1963	Urban Planning Information Systems and Programs
1964	Urban Information and Policy Decision
1965	Urban Planning Information Systems and Programs
1966	Urban Planning Information Systems and Programs
1967	Urban and Regional Information Systems(URIS) for Special Programs
1968	URIS: Federal Activities and specialized Systems
1969	URIS: Service Systems for Cities
1970	URIS: Past, Present, and Future
1971	URIS: Information systems and Political Systems
1972	URIS: Information Research for an Urban Society
1973	URIS: Perspectives on Information Systems
1974	URIS: Resources and Results
1975	URIS: Computers, Local Government and Productivity
1976	URIS: Information Systems as Services to Citizens
1977	URIS: Information System Inputs to Policies, Plans, and Programs

housing. While this founding cadre was not usually involved in front-line operational planning at the local level, from their vantage point of specialists in geography, urban land economics, computer use, etc., they stood at sufficient distance from the operational field to examine some of the emergent and fundamental issues and roles of information systems in those activities.

An examination of the authors through 1966 reveals participation of substantially those appended to, or consulting for, large regional studies arising out of the urban transportation planning process. It is only natural that the initial direction of URISA reflected the prominent application interests of the time. It was the area of yet still great suburban expansion. Urban region modeling studies were at the height of their expectations as a new scientific base for urban and regional planning. The cities had not yet burned up and the words of Martin Luther King were not yet in the foreground of the national conscience.

It is interesting to note that a marked departure took place in 1967 with concerns for social programs and the subsequent URISA conferences dealt with a broad variety of topics. Both understandably and fortunately the initial focus of urban region planning information systems was put aside as our attentions were taken by emerging problems. Thus, the substantive fabric that brought the organization together initially is now only one of the many concerns of its members. I believe it is a credit to the organization that it has not stuck to any one focus but has clearly recognized changes in the national mood and adjusted its sights accordingly.

In reviewing the literature of the organization between 1964 and 1967 inclusive, of the 60 articles published I note that approximately 20 per cent were authored by academicians, 20 per cent by independent consultants or members of consulting firms, and approximately 60 per cent of the titles were authored by governmental agency people, including a good representation from the U.S. Bureau of the Census. Consequently, it is not a fact that the organization has ever been an extension of the academic establishment, even though its first board had a majority of academicians. Obviously, academicians have figured prominently in its institutionalization because they have generally had freer lifestyles in regard to selection of their own long-term interests and in regard to their release from operational tasks.

The breakdown of titles of early contributions into a few classifications (Table 3) also reveals an interesting breadth as well as attention to the problems of the time. An interesting mix is noted here which again tells us something about the background and nature of our organization via the interest of its members and the prominent issues of the period.

The excellent literature compendium of Matthews and Kraemer (1975) gives another view of our interests. The big three areas (Table 4) show up as contributions of information systems to physical planning, management and census-related activities over a ten-year period of time frame. I suspect that management concerns have been on the increase and physical planning on the wane.

Now let us look beyond the literature itself for clues as to our identity. As the introductory words of this discussion imply, URISA has always been closely associated with certain activities of the U.S. Census Bureau, particularly those relating to its Geographical Branch. From the earliest days of its pre-organizational period the pre-members , and later the members, have had a strong involvement with small-area Census data and particularly its automated mapped representation. While I do not like to think of URISA as being beholden to any one branch of government, I believe that its linkage with the Geography and

TABLE 3
Classification of Published Papers—URISA, 1963-1967
From Annual Proceedings

Theme	**Approximate % of Total**[a]
Organization and Management [b]	25%
Technical Operations in General[c]	25%
Applications[d]	25%
Modeling[e]	15%
Geocoding	10%

Notes:
a. Universe of 60 papers
b. Institutional and organizational issues of information systems. Data base development and management. Computer use issues, etc.
c. Software and hardware. Automated mapping and graphics. Remote sensing, network analysis, query languages, etc.
d. To planning, social services, housing, etc.
e. General modeling theory and applications of modeling. Information requirements for modeling.

TABLE 4
Subject Area Breakdown of URISA Literature, 1963-1973
From Matthews and Kraemer (1975)

KEYWORDS	**ENTRIES**	**RANK**
Physical Planning	96	1
Management Information Systems—31 Public Finance—8 Public Safety—11 Program Development—29	79	2
Census	54	3
Decision Making	23	4
USAC (Federal Interagency Effort)	18	5
Privacy	11	6
Housing and Transportation	10	7
Implementation	10	7
Transferability	9	9
Data Base Management	7	10
State and Regional	7	10
Federal Role	5	12
Miscellaneous	52	—

Census Uses Branches of the U.S. Census Bureau has been important as it has been long lasting. This relationship has grown out of the fact that the specialized technical nature of using Census tapes and merging them with mapping codes falls through the cracks of the platforms of other organizations. Apart from this symbiosis, the Census Bureau has materially assisted URISA through the participation of its staff in URISA activities. Likewise, URISA, I am sure, has helped Census in the relation of its members to various organizations that make use of small-area Census data in a spatial context. Many URISA members serve as this interface.

Secondly, since the early Sixties the pre-association devotees have been interested in geoprocessing. This interest pre-dates the advent of the Census DIME Files through the work of such people as Robert B. Dial (1964) and Hugh W. Calkins (1965) in the National Science Foundation funded research of the early Sixties. The advent of GEOSIG attests to the continuing interest of the members in this activity insofar as GEOSIG has been one of the largest special interest groups, and a dissertation of considerable interest to Geoprocessing is that of Charles E. Barb (1974).

Thirdly, as I have alluded to earlier, the members of the founding cadre were interested in studying the uses, successes and failures of general purpose information systems in regard to questions of planning and management and decision making. This I believe is probably one of the most important activities for URISA to carry on as I see that no other organization seems to be as involved in this activity. This philosophical thrust has been concerned with the nature of data base organization in mutli-governmental activities, the use of information in the feed back analysis of public policy, the role and limits of information in public decision-making, and the organization of information support centers both within organizations and as separate entities.

This stream of interest probably starts with the work of one of our early presidents, Edward F. R. Hearle, in his contribution with Raymond J. Mason. in A Data Base Processing System for State and Local Governments. Although that work dealt with the organization of information in state government, it stands as philosophical forerunner to the subsequent USAC[5] work which brought a number of federal departments of government together to commonly pursue the development of multi-purpose information systems for local government.

The role of information systems in the feedback analysis of public planning policy, or the concept of an information systems monitor, was substantially the theme of the Second Annual Conference on Urban Planning Information Systems and Program, held in Pittsburgh in 1964, producing a proceedings entitled, Urban Information and Policy Decisions. Interest in this area of information systems has been pioneered by Clark D. Rogers, still at Pittsburgh University, and Hugh W. Calkins, now at State University of New York, Buffalo. A landmark piece of literature in this respect is the doctoral dissertation of Calkins (1972), who traced down by direct contact or visitation every known planning information system in the country in the years approximately between 1965 and 1970. Calkins was able to document fateful flaws in the basic fabric of urban planning activities in the lack of a feedback monitor system which is well documented in both his dissertation and subsequent works.

TOWARD A DISCIPLINE OF URBAN AND REGIONAL INFORMATION SYSTEMS

Is there any theory of urban and regional information systems? Does there, in fact, have to be a theory base to sustain an organization? Is there in fact a theory of information systems, and if so is it different from that of urban and regional information systems? Questions like these are asked by most professional and scientific societies. As an example, in searching its soul along similar lines the president of the Regional Science Association—which is now a very well-founded international organization and publishes a journal—asked recently if the theories of regional science were any different from the theories of the disciplines it drew on. In that discussion Czamanski (1976) sets forth the following criteria for a discipline:

1. The set of objects with which a discipline is concerned;
2. The point of view from which the set of objects is viewed;
3. The level of theoretical integration, or theory construction;
4. The methods of transforming observables into data;
5. The analytical tools;
6. The practical applications; and
7. The historical circumstances of the discipline's origin and development

If we accept this as an operational definition of a discipline we see that different disciplines may share some of the same theory provided there is a difference in their sets of objects, points of view from which the objects are viewed, or practical applications and analytical tools. Thus, urban and regional information systems, medical information systems, legal systems, and so forth may have some theory in common and yet have differentiation of the other elements of the definition of discipline.

I submit that any field claiming to be one of "information systems" shares a common information systems theory which I will allude to in greater detail shortly. I believe it is the intellectual content of information systems theory that is the basic glue that holds any information system group together and that the differences are mainly the sets of objects, the points of view from which the objects are viewed, the tools, the practical applications and the historical circumstances of a discipline's origin and development. From these seven elements let me present my view of the discipline of urban and regional information systems.

1. <u>The Set of Objects with which URISA is Concerned</u>

Our object field consists mainly of the U.S. Census data bases, the operational records of local government, the survey data of metropolitan planning organizations, the land cadastral files, the object entities of health, welfare and social service organizations, the data inputs to trade area analysis and special survey data relating to any of these areas of records or concerns.

2. <u>Orientation of the Set of Objects</u>

We view the objects mainly within the relationships of the activities of Figure 1, and in support of research, planning, programming and management functions. in addition we have the orientation of the market use of information, in either an economic or political context. The latter may be outside of the sphere of a formally commissioned or supported information system.

3. <u>The Level of Theoretical Integration</u>

Theory is defined in a number of ways, but I think the most germane one from our point of view today is: "A set of theorems forming a connected system" (Oxford Universal Dictionary). A theorem is defined by the same source as: "A universal or general proposition or statement, not self-evident, but demonstrable by argument or necessary reasoning." Information is defined, again by the same source, as: "That of which one is appraised or told." The "one" may refer to an individual who receives information by design or accident, or an actor who commissions information for a particular function or purpose.

I am not surprised to see a rich background of thinking on the subject of information and its role in human interaction and feel frustrated in treating this subject in a few hundred words. The literature has its roots in sociology and social psychology (Parsons and Shils, 1959), political economy (Dahl and Lindblom, 1953) and even some of our own URISA authors (Webber, 1964 and Grundstein, 1970). I have assembled a handful of theorems which I believe constitute the field of information systems and are the philosophical base of the subject that we are concerned with. These theorems are not unique to urban and regional information systems, but the definition of a discipline that I have taken from Czamanski does not suggest that all elements of it are unique to any one discipline. Recall that it is the subject area or application of these theorems that gives us the common discipline of interest when juxtaposed with the intellectual content of this general information theory.

Theorem 1— Information is an Independent Force for Change

Broadly disseminated in its area or function of appropriate inclusion, information is an independent force of change operating on the fields of both leaders and non-leaders. Its raw impact on outcomes rivals decisions arising out of formal policy-making processes. In other words, information availability by non-leaders challenges leaders. the extent to which information systems design disseminates information or facilitates information dissemination thereby plays an important role on the shaping of public policy. The knowledge of A, the leader, that B, the non-leader, has access to the same information base constrains or modifies A's action.

Theorem 2—The Institutionalization of Information Systems Increases Social Overhead

Whether automated or not, the institutionalization of information systems creates new roles, new interactions among organizational parts, user expectations and the inertia of both personal and organizational tenure. These costs overwhelm the cost of automation itself. The increasing social entropy of the system has to be viewed in balance with its achievements.

Theorem 3—Information Systems Lead to Organizational Change

If at all successful, the institutionalization of information systems redefines roles and relationships, changing organizational structure to the detriment of some and advantage of others. There are some significant socio-political impacts as a consequence. The span of control of officials and decision makers changes.

Theorem 4—Information Systems Tend to Make Decision-making More Difficult.

Information *per se* does not lead to better or easier decision-making. Again, if relatively successful, information systems tend to introduce more variables, knowledge of impact, checks and balances, opportunities for alternative actions and disseminated knowledge of the information base in regard to which decisions are made.

Theorem 5—Information Systems Expose the Frailties of Goals

Goals tend to be expressed in generalities sufficiently broad that the systems design to effectuate them soon discloses the unavailability of information, difficulties of monitoring policy outcomes, or externalities that obscure the measure of goal realization.

Theorem 6—Doctrine Eschews Facts

Much of our governmental fabric is based on doctrine. Governance has tended to be as much a function of intuitive reasoning as in attempts to arrive at rationality through the use of information. Information obfuscates (i.e., the don't-bother-me-with-the-facts outlook).

Theorem 7—Information Systems Contribute to an Understanding of System Complexities

Information system development assists in the understanding of system complexities and the gaining of a more fundamental view of the problem addressed. Many information systems that fail in their design missions are successful in this regard.

Theorem 8—To Be Credible, Planning Must Be Cast in an Information System Context

It is only by the development and acceptance of monitors relying upon information flows that we can judge accomplishment.

4. Methods of Transforming Observables into Data

Here we share a methodology with the social services, management and geography. It includes field survey, survey sampling, the administrative processes, remote sensing and digitizing.

5. The Analytical Tools

I shall refer here to the work of Tomlinson, Marble and Calkins (1975) arising out of previous work of Calkins (1972) in the development of an information system design and evaluation model. It is now undergoing further refinement in subsequent work being undertaken by Calkins (1977). [see Figure 2] What we have in Figure 2 is a model of how the different parts of an information system fit together and how they tend to be accomplished in sequence. This is actually an adaptation of the general systems model, but cast in the specifics of the activities of the information systems specialist, designer or analyst. Each box of this model is described in the references cited, but unfortunately it is not possible here to dwell on the details of this model. My students and I have found the model to be of fundamental importance, particularly in the analysis of information systems and their failures.

6. Practical Applications of URISA

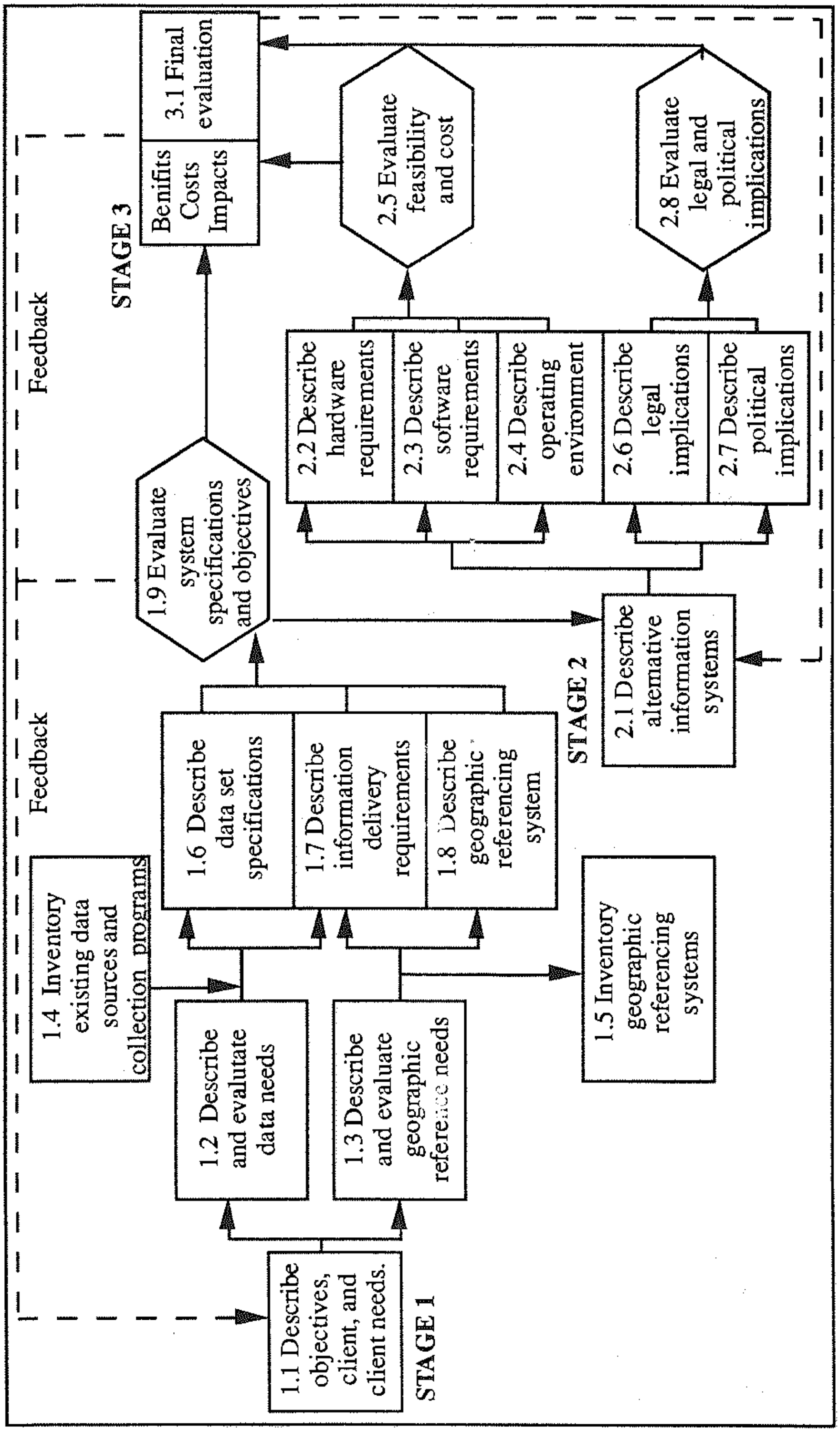
The practical applications areas of our field may be best viewed in the literature to which I have referred earlier. Generically , they relate to urban and regional planning; city management; social, health and transportation services; market analysis; the use of census products; etc.

7. The Historical Circumstances of URISA's Origins

I have dealt with this in length; it might be opportune to conclude on this point. Let me quote from Czmanski (1976):

> *"The achievements giving rise to new disciplines share two characteristics: (1) they are sufficiently unprecedented so as to attract an enduring group of adherents from competing modes of scientific activity; and (2) they are sufficiently open-ended so as to leave all sorts of problems to resolve."*

FIGURE 2: Information Systems Design And Evalutation Model (Calkins, Tomlinson and Marble, 1975)



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[1] This paper is reprinted from Information System Inputs to Policies, Plans, and Programs, Papers of the 15th Annual Conference of the Urban and Regional Information Systems Association, Vol. 1, pages 2-19, Chicago, 1977.

[2] The prototypical SYMAP software, also intially related to Census tape use, was under development by Howard T. Fisher at Northwestern University by 1963.

[3] Clark D. Rogers and William L. Clark

[4] Dual Independent Map Encoding, introduced by the New Haven Census Use Study in 1967.

[5] Federal Urban Information InterAgency Committee

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EVOLUTION OF INFORMATION SYSTEMS AS ESSENTIAL INFRASTRUCTURE IN URBAN AND REGIONAL GOVERNMENTS[1]

Abstract During a short, eclectic, and dynamic history, URISA and its members have made significant contributions to the rational evolution of information systems in all levels of government, but most notably at the urban and regional level. Paramount among our contributions are the following: 1) improved appreciation of the perceived, actual and preferred roles of management, planning, operations and information technology functions in effecting program, plan, and occasionally policy changes via the technology; and 2) dramatic upgrading of the ways, extent, and purposes whereby information system hardware and software are used in the public sector.

INTRODUCTION

As anyone who has read the preceding paper (Horwood, 1977) in this volume will readily attest, Professor Ed Horwood has admirably dealt with much of the sum and substance of URISA's evolution. The purpose of this brief paper is to:

a) offer alternative perspectives in two major areas; and

b) further develop several topics which Professor Horwood may not have taken full circle

ALTERNATIVE PERSPECTIVES

In my view legitimate and necessary exception to Professor Horwood's view of URISA's unfolding needs to be taken in a very important regard: URISA as an educational forum.

The section of his paper entitled "The Interdisciplinary and Multi-Disciplinary Basis of URISA" concludes, in effect, that the *raison d'être* of URISA resides very largely in its capacity to assist in the packaging of needed educational equipment. While I subscribe to the view advanced, that a primary basis of URISA's continued existence resides in its educational component, I do not share the perception that the most consequential teaching and learning about urban and regional information systems takes place in a university environment.

I submit, supported in large measure by the contents of Final Programs, Proceedings, and assessments of after-session, in-the-hall conversations, that the most consequential lessons taught and learned are associated with "the true school of hard knocks," the WORKPLACE. I would further argue, schools of public admin., bus ad, planning, geography, etc., notwithstanding, that the WORKPLACE, brought into URISA as a teaching and learning device, is in fact the root basis of our enhanced capabilities to bring information system technology to bear in all elements of governance (management, planning, operations). Finally, I would observe that the WORKPLACE (rather than the university environment) must be credited with the vast majority of changes which have accrued to data processing centers, or what might be called information system machine shops.

Still in this vein, it is difficult to overlook the academic orientation of the references in Professor Horwood's paper.

We do not disagree that information systems, automated and otherwise, are essential infrastructure in all levels of government. In fact, it could very probably be successfully argued that relative to traditional infrastructure (roads, sewers, etc.), information systems are critical infrastructure in most city, state/provincial and federal governments in every technologically advanced country in the world. However, if references are indicators as to how this end was achieved, then I offer an alternative view: namely, that the key works in this regard are those advanced by practitioners who are responsible for the conceptualization, design, development, and implementation of information systems which provide needed, usable inputs to policies, plans, and programs.

I appreciate that the text of Professor Horwood's paper acknowledges a strong non-academic presence in URISA; I would prefer, however, to have seen such acknowledgment manifest itself in an explicit, referenced recognition of that presence. Let me immediately and explicitly admit, however, that this is much more readily said than done. It is with considerable relief that I am able to advise the reader that this task is covered off by URISA members who took on the onerous assignment of preparing benchmark papers which are to appear in companion volumes (URISA, 1977a, 1977b).

The second area of departure from Professor Horwood's recounting of URISA's evolution is tied to Figure 1 in his paper. The Operations component of governance, a fundamental element of urban and regional information systems, is not represented; further, and although Figure 2 of his paper could be interpreted to so read, he does not appear to make explicit the very important distinction between users (managers, planners, operator, researchers) and usages (management, planning, operations, research) of information systems, and their outputs.

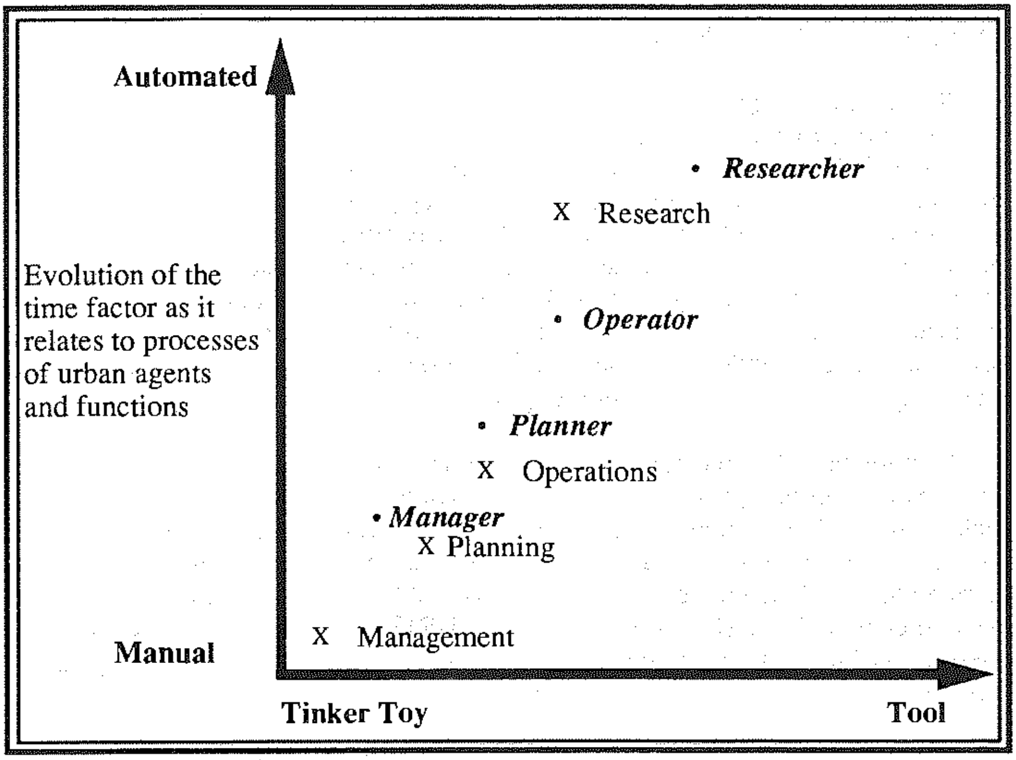
So as to not break with the URISA tradition of counter-offering a "model" at every opportunity, Figure A is offered to further elaborate several fundamental information system considerations. As suggested in Figure A

1) the essence of information systems is perceived as boiling down to one cost factor, time;

2) computer-assisted information systems range between tinker toys and tools in terms of the extent, purposes, and ways that users and usage exploit them; and

3) we must be careful to distinguish between the agent, and the function that agent performs *vis-à-vis* the extent, purposes, and ways that (computer-assisted) information systems are engaged in the processes and practices of governance.

FIGURE A: Relationships Between Urban Users and Usages of Computer-Assisted Information Systems



Source: Wellar, 1975

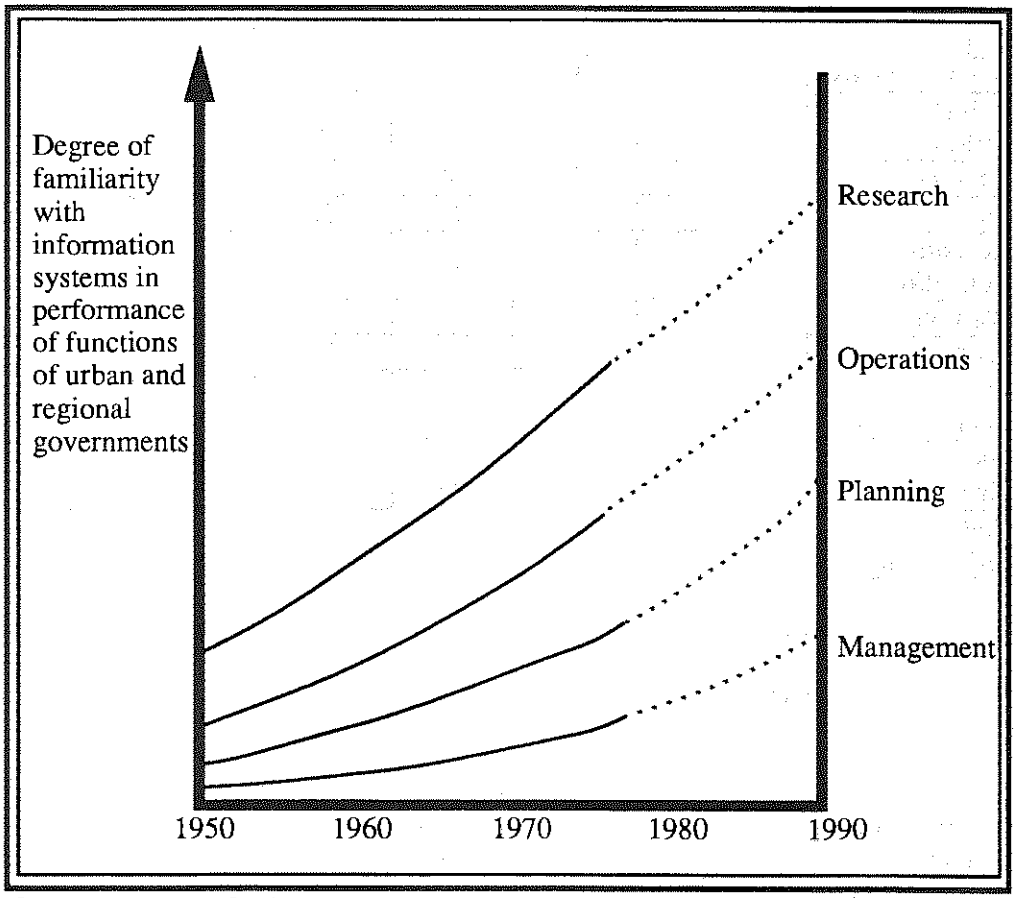
In view of the magnitude of Professor Horwood's undertaking, the differences of opinion noted above are minor indeed. However, they are of a fundamental nature, and as such warrant being flagged as we attempt to get handles on URISA's origin and future, and on theories of urban and regional information systems.

SELECTED ELABORATIONS

In terms of placing URISA's evolution in perspective and relating URISA to its several environments, it is most appropriate to attempt to document (or at least offer undocumented speculations) as to the Association's contributions to developments in the information systems field.

First, let us assume that the curves in Figure B are reasonable representation of the extent and rates of familiarity associated with information systems adoption in urban and regional governments. It is most surely not unreasonable to suggest that all curves would have to be shifted downward, and to the right, had URISA (or some comparable association) not existed. Similarly, the X's and O's in Figure A would most surely have to be relocated downward, and to the left, without URISA's contributions to the information systems field.

FIGURE B. Degree of Familiarity (use) with Information Systems in Performing Management, Planning, Operations, and Research Functions of Urban and Regional Governments, 1950—1990



(Source: Wellar, 1977)

Second, it may not have been particularly informative on my part to refer to extent, purposes, and ways of utilizing information systems outputs without elaborating on what the terms "extent," "purpose," and "ways" might mean. Further, the terms "management," "planning," "operations," and "research" leave much unsaid in terms of the activities which each entails. Figures C and D are intended to rectify in part these short-comings of my earlier remarks, and to suggest elaborations to components of Figures in Professor Horwood's paper.

FIGURE C. Purpose and Extent of Use of C-AIS for selected Activities of the OperationS Function

Purpose of C-AIS Use[1]	Legislation	Policies	Programs		Projects	
Activity[2]	Introduce	Introduce	Introduce	Manage & Administer	Introduce	Manage & Administer
Transportation		L	L	M	M	H
Engineering				M	M	H
Environmental Control			L	L	L	L
Building Inspection				M	M	M
Land Records		L	M	M	M	H
Public Utilities			L	M	L	M
Finance		L	M	H	M	H
Assessing		L	L	H		M
Revenue Collection			L	H	M	H
Welfare			M	H	L	H
Library				M		M
Voter Registration				M		M
Police			M	H	H	H
Fire		M	M	H	M	M
Code Enforcement						L

Notes:

1. L=Low, M=Medium, H=high. An empty cell conveys the impression of either trace of nil C-AIS use for the activity
2. The list of activities is illustrative rather than exhaustive.

The comment I make with regard to Figures C and D is that, without URISA, a number of the H's, M's, and L's would be downgraded for many activities in virtually every city which has had representation at URISA Conferences. Since the assessments are based on a literature overview which is largely based on URISA Proceedings, it would be unwise to generalize this comment across all cities; it may not be inappropriate to suggest, however, that non-URISA cities, if they could be identified and evaluated, would have "grades" lower than cities which are within the URISA "sphere of influence."

FIGURE D: Purpose and Extent of Use of C-AIS for Selected Activities of the Management, Planning, and Research Functions

Purpose of C-AIS Use[1]	Legislation	Policies	Programs		Projects	
Function[2] Activity	Introduce	Introduce	Introduce	Manage & Administer	Introduce	Manage & Administer
Management						
Interpret constituents' preferences and needs					L	
Analyse data	L	L	L	M	L	
Evaluate recommendations	L	L	L		L	
Allocate resources			L	L	L	
Evaluate operations			L	L	L	
Planning						
Collect data	L	M	L		M	M
Analyse data	L	M	M		H	H
Evaluate operations			L	M	M	
Prepare plans	L	M	L		L	
Prepare forecasts		M	M		M	
Research						
Collect data	M	H	H		H	H
Test hypotheses					H	H
Develop theories	M	H			H	H
Develop and calibrate models		H			H	H
Analyse trends	H	H	H		H	H
Prepare forecasts	M	H			H	

Notes:
1. L=Low, M=Medium, H=high. An empty cell conveys the impression of either trace of nil C-AIS use for the activity
2. The list of activities is illustrative rather than exhaustive.

The final elaborative remark in this particular context is based on an "insiders" view of the latest URISA contributions to the information systems field.

I have had occasion to review all Invited and Contributed Papers submitted for inclusion in URISA '77 documentation. The vast majority of papers, and the "Overview Papers" in particular, lead to two significant convergences of fact and opinion. First, URISA has indeed been a major contributor to the more effective and efficient formulation (fit) and implementation (delivery) of programs and projects in the public sector. Second, while planning and management breakthroughs are harder to come by, URISA contributions are serving to strengthen prospects and increase opportunities for information system-based inputs to policy and planning substance and processes in all levels of government.

The third elaborative deals with URISA's evolution in a forward context. URISA '77 not only involved producing benchmark papers which track the Association's efforts in many domains, but also yielded RECOMMENDATIONS in Invited Papers in a variety of contexts. This thrust, to set down in a formal sense recommended actions and activities, builds on the past to set out a series of preferred futures. When the RECOMMENDATIONS are examined in parallel with the "Theorems" set out by Professor Horwood, then one must conclude that URISA is moving in the direction of an organized body of practical, empirical, and theoretical knowledge, a surely to be desired state of affairs.

CONCLUSION

This paper emphasizes: the important role of <u>practitioners</u> in URISA; the necessity of considering the <u>extent</u>, <u>purpose</u>, and <u>ways</u> that information systems relate to users and usages; the advantages of explicitly distinguishing between <u>users</u> (agents) and <u>usages</u> (functions/activities); the very consequential contributions of URISA to an increasingly enhanced capability of effectively and efficiently bringing information system inputs to bear on policies, programs, and plans in government agencies at all levels; and the "arrival" of <u>information systems as essential infrastructure</u> of governments in general and of local governments in particular.

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[1]This paper is reprinted from Information System Inputs to Policies, Plans, and Programs, Papers of the 15th Annual Conference of the Urban and Regional Information Systems Association, Vol. 1, pages 20-28, Chicago, 1977.

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ISSUES AND TRENDS OF CONCERN TO THE URISA MEMBERSHIP: A THIRTY YEAR SURVEY OF URISA'S LITERATURE

Abstract: In its almost thirty years of existence, URISA has evolved from a small and rather loosely associated group of professionals with a common interest in urban planning information systems, into a major international organization boasting over 3500 members, with interest in a variety of topics related to development of effective management and geographic information systems (GIS). The evolution of the organization and the changing interests of its members is reflected in the topics that were addressed at the annual URISA Conferences from 1963-1991.

A review of the URISA literature from 1963-1991 reveals a number of discernible trends and patterns in the focus of the organization and the interests of its membership. These can be categorized as lost themes, redefined themes, new themes, and trends. Lost themes include concern with mainframe computers and concern with social change. Themes that have been redefined (same words, different meanings) include the terms "information system,", and "multi-participant." New themes include GIS as a profession, legal matters, and concern with the costs of data and data management. Significant trends include increasing use of geographic-based data, a shift from technology to institutional concerns, less conceptualization and more "doing," more analysis and less raw data retrieval, increasing demand for standards, establishment of GIS as a profession and a career in itself, and a shift toward decentralized computing.

INTRODUCTION

There are several ways in which this topic could be addressed. We have selected to take a high-level overview in an attempt to identify trends, if any, that are discernible based on the paper titles and abstracts that have been published by URISA during the past 30 years. Even that task is large, and in an attempt to maintain a broad perspective and avoid a descent into obscuring detail, we have purposefully not sought quotes from the "recognized leadership" of URISA. We have attempted to look at what the "pack" was doing rather than what the leadership was "saying". We recognize the fact that the literature itself is selective, i.e., most of the "pack" is not writing and speaking at the annual meetings, but rather listening and learning. So in reality we have attempted to analyze what the second level cadre of URISA professional (that level just below the leadership rank) was doing and saying.

To structure this review, we have decided to use four categories: 1) lost themes, 2) redefined themes, 3) new themes, and finally 4) trends. We conclude with our speculation on the future of our identified trends. We do not seek general agreement with our selected issues and trends; however, if in reading this paper you have been nudged to step aside from your daily activities and to think about the "long term", and perhaps to ask "Where are we going?", then we will be satisfied that our efforts have been rewarded.

LOST THEMES

Two themes are singled out as being lost. Given a longer period of history, it is conceivable that these themes may prove cyclical and reappear. Further, there may be readily explainable reasons why these themes have been lost or at least are temporarily in abeyance.

In the early part of URISA's thirty-year history, a significant segment of the literature was concerned with the use of mainframe computers. It appeared as though every governmental agency, local, state or national in scope, and every university setting and private concern was operating on a mainframe. The concerns thus expressed were the concerns of the sharing of this vital resource by a number of participants. Fagen observed in 1966 that "One of the most important trends in computer utilization today is the time sharing of a central computer or computer complex by a number of independent users who are on-line and in locations remote to the main computer center." We draw your attention to two items: the use of a centralized computer facility and the concern for multi-participants. Today we are still concerned with multi-participants but the use of that term, we suggest, is broader today. The literature itself does not put an overemphasis on the use of mainframes; rather, the use of mainframes is an underlying assumption. The fact of the time was that a centralized computer facility was the only available alternative.

By 1969 we see the realization that something other than a centralized mainframe system could yield benefits. Amsterdam (1969) observed in that year that "As a possible alternative to the massive centralized data bank, the data network concept should be considered for use by cities, regional organizations and other governmental groups considering the development of integrated information systems. In the data network only key elements are centralized and standardized; as much as possible is left to the option of the system users." Clearly the world was still awaiting the mini and then the micro computers yet to come. We all recognize that the microcomputer of today is probably the equivalent in capacity and exceeds in speed and capabilities the mainframe of the 1960's, and the mainframe is now, gratefully, a thing of the past.

Another lost theme (which we hope is only a suppressed theme) is a concern for social change. Around the beginning of the 1970's many papers appeared in the URISA literature dealing with social themes in the cities of the United States. Jaycox observed in 1969 that "If we can place a man on the moon, then certainly there should be something that can be done to solve the social and economic problems at home. Heading the list of domestic problems is 'Crime on our Streets' and what can be done to alleviate this cancerous condition that threatens to envelope us." In a similar vein, Jacoby observed in 1967 that "DEWS is a tool for physical and social city planning to evaluate and support programs for community renewal in relocation and housing programs. Its purpose is to record the amount and intensity of change on a block face level to show impact of programs on neighborhood conditions."

Undoubtedly, many of the studies in the social change genre at this time were the result of money being made available by the federal government through programs instituted in the 1960's. Two pertinent examples in the URISA literature are the 1972 papers by Cannup, Boumbulian, and McAllister, entitled "Systematic Profile Approach: A Case Study in Child Care Evaluation," and by DelaBarre (1972), entitled "Translating Research Results into Action Programs: Fresno's Example." The first example is an evaluation methodology for part of the Model Cities Program and the Appalachian Child Care Project. To quote the second example, "...the community profile identifies and quantifies specific community needs, as well as pinpoints where they exist. This identification of existing needs is necessary for the development of strategies or policies to satisfy the same. Such strategies are translated into action programs." Clearly these themes are as relevant today as they were in 1972. Most probably these topics resulted from the use of governmental monies no longer available to local agencies. This theme of social change may only represent the response of URISA members to the political realities of the time, but similar studies are not as numerous today to the same relative degree that they were present in the early 1970's.

REDEFINED THEMES (SAME WORDS, ALTERED MEANINGS)

Perhaps one of the more striking features of our survey of the literature is the evolution of the terms "information system," "urban information system," "regional information system," and more recently "geographic information system." The term "geographic information system" (or GIS), although mentioned as early as the late 1960's does not come into widespread use until the latter part of the 1980's. Even as late as 1982 and 1983 the references were to "geographic data file," "geocoding system," "geographic referencing system," etc. In 1984, the Proceedings included a separate section on GIS for the first time (Geographic Information Systems and Geoprocessing), but only a handful of papers had the term "GIS" in their titles. One example is the paper by Frank Cooper (1984), entitled "Geographic Information System for Transportation." In 1985, the year that the Proceedings were split into four volumes, Volume II was entitled "Geoprocessing." Volume II became "Geoprocessing and Geographic Information Systems" in 1986 and 1987, and in 1988 simply "Geographic Information Systems," the title that has remained through 1991. By 1987, more than 20 sessions were conducted with GIS in the session title, and GIS-related papers appeared in many other sessions. In 1991, more than 30 sessions were conducted with GIS in the session title; it seems likely that a GIS keyword search on the 1991 Proceedings would turn up almost every published title. Pertinent sessions conducted in 1991 included: (A2-A) GIS as a Decision Support System for Economic Development, (A1-B) GIS in Developing Countries, (M1-B) Organizational Policy and GISs, and (A1-E) GIS Application and Information to Climate and Weather.

Clearly, the use of terminology parallels what was actually happening. Early in this thirty year period we were talking about information systems that often did not include a spatial component. As information systems became greater in number, it became useful to differentiate with prefacing adjectives, e.g., urban, regional, integrated public, municipal. Other types of specialized information systems of the period included criminal information system, traffic records information system, and land information system.

Truly remarkable has been the increase in the use of the term "geographic information system." And we believe that GIS is subtly different in meaning from the earlier systems. We posit that the various adjectives used earlier to modify "information systems" referred to systems much more closely tied to data bases than is the case with the modern systems described as GIS. Twenty to thirty years ago, an information system was in essence a data retrieval system. Numerous functions that are now integral parts of any GIS were typically separate and distinct programs that individually accessed a computer data base to answer very repetitive, unvarying questions. Today, GIS is more often applied simply to the set of processing and analytical tools which we wish to use. It is more independent of the data; a given GIS may be applied to a variety of data bases. However, the overall combination of a GIS and data bases still constitutes an information system. We feel that this evolution of the use of variations in "information systems" terminology and concepts is particularly important to highlight.

The concept of multi-participants is also used in a somewhat broader or looser context today. Thirty years ago the concept of multi-participants was typically applied to a group of offices that were tied together by the use of common computer hardware and software configurations. This is best illustrated in the example of a large mainframe computer and access to it by a number of different agencies or offices in a municipal government, most often collocated in the same building. Today the term multi-participant is still applied to agencies or offices, but not necessarily in one municipal government or collocated in one building, and spread among different levels of government, which have similar objectives and needs. Therefore, from a beginning attempt to integrate urban agencies that needed to combine social, economic and property information for a city through a centralized computer system, we are now seeing widely disparate agencies (e.g., city property deeds office, state taxation offices, and federal land management agencies) working together to access similar data needs from decentralized computer systems. Both are multi-participant, but today the ties amongst the participants are looser.

Another change is the broadening of the use of the basic term "information management." Today, quite simply, the data bases and access to them have expanded the number of tasks that information management includes. Consider the role of computer viruses in the 1960's; how many different media were readily available for computer data storage? As options and considerations have increased, the role of information management has become more complex. We must accept the fact that information management is vastly more complex and difficult today than it was thirty years ago and it is also more important to individuals involved in our profession.

A final comment on the information management issue is that whereas in the early 1960's most access to computerized data was for specific data retrieval, access and retrieval today is usually for the purposes of performing analyses on the data. This change is actually a trend which we will address in more detail in a later section of this paper.

NEW THEMES

Not surprisingly, several new themes have entered the URISA province of concern during the past thirty years. We will highlight three of these.

Evidence of concern in the URISA literature for GIS education and careers is limited to recent years. The 1989 conference included for the first time a session on GIS education (University-Based GIS Educational Models), containing three papers, presented by educators from Canada, Australia and the United States. This conference also included a session entitled "GIS Employment" containing three papers. An illustrative title from this session is the paper by Anderson and Preecs (1989) entitled "Beyond the Ad Hoc Approach to Staffing a GIS."

Volume IV of the Proceedings in 1989 included a separate section on "Education." The 1990 conference included a session on "Training and Career Paths in GIS and Information Management," containing three papers, and three separate sessions dealing with the role of the "info professional."

In 1991, the evidence of emphasis on education and career concerns continued to grow, with sessions on "University GIS Education Perspectives," "GIS Education from the Workshop, Short Course and Vendor Perspectives," "The Roles of Education in Supporting GIS Professional Development," "The Human Side of GIS," "The Human Resource Shortage," and "The Role of the Computer Science Professional in the Implementation of a GIS." There was also a separate section in Volume II (Geographic Information Systems) on "Operations and Personnel" containing two papers. A illustrative title from this section is the paper by Huxhold (1991) entitled "The GIS Profession."

We feel that the introduction in these past three years of papers concerned with the education and the professional development of GIS personnel represents a new theme in the URISA literature, and one that is likely to continue. Other nations, notably the United Kingdom, have established professional societies for GIS professionals. In the United States, we have seen the joining together of ACSM, ASPRS, AAG, and AM/FM International with URISA in the sponsoring of the annual GIS/LIS conference. If a separate society is not formed for GIS personnel in the United States, it is reasonable to expect the GIS education theme within URISA to continue and to grow.

A second new theme introduces URISA to the legal profession. It appears that concern with legal implications during the first ten years of URISA was largely confined to issues of privacy and confidentiality of the data resident in a data base. (Eleven papers surface under PRIVACY in the keyword index from this period.) The Proceedings from 1978, and 1982-85 are apparently without direct reference to legal or privacy concerns. The first time a separate heading appears on legal issues in the Proceedings is in 1986. It contains two papers.

In 1987, concern with legal matters suddenly appeared as a prominent theme. In that year, the conference included three sessions related to legal matters: (7.4) Public Information: Legal Issues, (8.4) Public Information: Privatization of Public Data and Legal Reform, and (9.4) Public Information: Access to Public Information. The 1988 conference included two related sessions: (1.8) Legal Issues in Public Information, and (2.8) Marketing Public Information: Legal Theory and Project Applications. In 1989, three sessions dealt with legal and information access issues: (01A) Access to Public Information, (02A) Public Information Issues in Canada, and (03A) Intergovernmental and Public Access to Information and Products of GIS. The conference in 1990 included the session: (6A) Addressing Legal Issues in the '90's: What are Your Responsibilities?

The 1991 Proceedings included in Volume IV a section on Legal Issues (under the heading of Public Information). One paper from this section entitled "Open Records Law, GIS, and Copyright Protection; Life after Feist," by Lori Dando (1991), was cited in the introduction to Volume II as breaking new ground because it represented the first attempt to reconcile the provisions of copyright and open record laws. It should also be noted that Dando is an attorney. The program of the 1991 conference included three related sessions: (RD-C) The Legal Challenge: Developing and Defending a Redistricting Plan, (M1-H) Legislation and Open Records, and (T2-M) Applying AI to Residential Building Permit Applications.

Clearly this infusion of concern with legal matters is indicative of U.S. society today, but it also represents a new theme in the URISA literature, and the fact that URISA conferences now are attracting lawyers as presenters must be noted. Given our litigious society, it is reasonable to expect that this new theme will grow in the coming years.

A final new theme is more a realization of an evolution than it is a new theme. It is a new and costly concern. During the first ten years, little was stated about the relative costs of hardware, software and data, although certainly computing was expensive during the period. Most of the attention was directed at conceptual discussion (i.e., Is it theoretically possible to make it work?), and discussions of initial attempts at implementation and the programming of single functions. Most implementations were pilot projects with some being successful and many not. The focus was on getting the first urban information systems started. People were building their own in-house software systems piece meal, i.e. function by function, and accessing the local mainframe computer. They apparently did not have good oversight on the total costs. The U. S. Bureau of the Census was the primary data source. As one remembers, the 1960's mainframes were expensive, and desired functionality in software was, by today's standards, extremely limited. Time used on mainframes was cost-accounted and the professional worried about how to get enough funds to access the information system, i.e., the hardware/software/available data combination.

In 1978, the theme of the URISA conference was "Data Resources and Requirements: Federal and Local Perspectives". One section of the Proceedings was entitled "Designing Information Systems: Requirements, Costs, and Benefits", but "costs" were not an apparent focus of the presented papers with the single exception of the paper "Developing a Low Cost, High Technology Geographic Information System", by A.F. Downard (1978). PC's and inexpensive workstations still were not available, and although more software functionality was available, the costs remained high.

Today's concerns are dramatically different. Hardware over the past decade has decreased substantially in price and today is readily accessible to most potential users. Mainframes have yielded to networked microcomputers and versatile graphics workstations. Extensive software functionality has been bundled into GIS packages, and is generally available at a lower cost today than as the separate programs of the past. (For example, the public domain GIS package GRASS is available for $25). What seems to be missing today is large amounts of accurate digital data that are easily digested into the available hardware platforms. As a result, data costs are now the most expensive part of an information system. New hardware and software technology built to cut these costs are discussed in the 1991 Proceedings in the separate section in Volume II (GIS) on Data Conversion. A representative title is "Scanning for GIS Data Conversion; Perils, Pitfalls, and Potentials," by Konty and Gross (1991). Six sessions at the 1991 conference gave evidence to the high costs of data relative to the costs of hardware and software today: (T1-I) Integrating Disparate Data Types, (M2-N) Technical Options for the Delivery of Data, (T2-N) Scanning vs. Digitizing: Techniques for Evaluating the Costs and Benefits, (T3-N) Distributed Databases: Designing Database Systems for Accuracy and Security, (M2-B)

Assessing Database Costs in GIS Applications, and (M2-E) Data Conversion: Procurement and Cost Control.

A final point in this section is related to the trends discussed next. Added emphasis for data standards and data exchange is largely being driven by the high cost of data today. The capability to process data on relatively inexpensive hardware with public domain software tools drives home the realization that data costs are now among the GIS professional's primary concerns. Ways to lessen that cost are a new theme in the URISA literature.

TRENDS

This section is really a combination of trends that we have observed during our review of the past thirty years of URISA's literature and continuations of the new themes which we have just discussed. There are seven trends that we wish to identify.

Increasing Use of Geographic-Based Data:

This trend was alluded to in our discussion of the redefinition of terms and the specification of information systems as geographic or urban. Clearly the geographic or "place" component is now a necessary part of our analytical tools and of the data in our data bases. Most data models have defined geographic features and attach attributes with values to these features. Therefore, the ability to link "place" with the "characteristics of place", and to have descriptors of features tied to place, something that we have long wanted, will continue to be required of our information systems. Many other topics are entwined with this trend, including standards, the need for data, and its high cost.

During the first ten years, Census DIME files were the most common data source that included some geography. The compilation of abstracts during that period includes more than fifty papers associated with the utilization of Census data. Geography based systems and data began to become more prevalent during the late 70's and early 80's. The 1982 Proceedings included a section on "Geoprocessing and Interactive Graphics," containing ten papers. An illustrative example from this section is the paper by Coan (1982), entitled "The Installation and Management of an Interactive Computer Mapping System." The 1984 Proceedings included a section on "GIS and Geoprocessing", containing 11 papers. An illustrative example from this section is the paper by Lam (1984), entitled "Geographic Information Systems and Spatial Analysis in Microcomputers." In 1985, the proceedings were divided into four volumes, one of which was devoted to Geoprocessing (Volume II); it contained 25 papers. In 1986, Volume II was retitled "Geoprocessing and Geographic Information Systems".

In the last few years, geography-based concerns (particularly GIS) have become almost dominant. The 1988 conference included more than 25 sessions dealing with GIS, cartography, or spatially referenced data. This emphasis continued through the conferences in 1989-1991. An illustrative title from 1991 is "Geography as Systems Integrator in Local Government Data Processing," presented by Daniel Parr (1991) in the session "Integration and GIS."

The importance of this trend cannot be overemphasized. It represents the realization of the capability to use analytical procedures on data in a spatial context, a capability that professionals have yearned to accomplish for hundreds of years. The availability of inexpensive hardware and software allows the professional to turn attention to the creation of data sets that include geography and that can be analyzed by GIS functions. It is incumbent upon our profession to join together in the creation and use of accurate, current, geographically tagged data for entry into versatile and easily accessible data bases.

From Technology Concerns to Institutional Concerns:

The earliest literature (first ten years) focuses largely on the technological limitations (and ideas to overcome or circumvent them), and on discussion of how to best utilize the emerging and expanding technological capabilities. There were many papers describing pilot projects and fledgling implementations.

During the late 70's and through much of the 80's, as GIS technology was maturing, the focus on utilization of the emerging and expanding technology intensified. Much effort was devoted during this period to examining the technological state of the art, and reflecting on the lessons to be learned from the experiences of the formative years. Many of the papers during this period focused on efforts to expand the technical capabilities of GIS, and on strategies to solve technical problems. The five sections of the 1978 Proceedings dealt with 1) requirements, costs, and benefits to be considered in designing an information system, 2) approaches to designing information systems and pitfalls to be avoided, 3) available hardware and software resources, 4) experiences with existing information systems, and 5) results of research using information systems. Two representative examples of this continuing focus during the mid 1980's are the papers published in the 1984 Proceedings by Kevany entitled "How Well Are Automated Mapping Systems Working?" and in the 1985 Proceedings by Jacobs, Kickhut, and Moyer entitled "Building a National Rural Land Transfer Data Base: Difficulties in Merging Existing State Data Systems and Recommendations for Change."

There is also evidence of effort devoted during the mid 1980's to developing basic theory and principles to guide implementation of the technology. Two good examples of this effort are the papers published in the 1986 Proceedings by Antenucci entitled "Timing the Acquisition and Implementation of a GIS Computer System and Its Database," and in the 1987 Proceedings by Saarinen entitled "Improving Information Systems Development Success Under Different Organizational Conditions."

In the 1990 introduction to Volume II of the URISA Proceedings, Gene Trobia and William Bamberger stated "GIS technology has matured and become a usable reality. In the past, many papers presented in the GIS volume of the URISA Proceedings have concentrated on documenting GIS uses and capabilities. Now that GIS has proven effective and feasible, the major concern has shifted to how to invest in a GIS and make it pay off for an organization." In fact, the shift of emphasis from technological concerns to institutional, organizational, and information management issues was clearly well underway in 1989. Volume II (GIS) of the 1989 Proceedings included a separate section on "GIS - Planning and Management," containing 12 papers. An illustrative example of this section is the paper by Somers (1989) entitled "Organizational Change for Successful GIS Implementation."

Volume II of the 1990 Proceedings followed along these lines with a section on "Organizing, Planning, and Managing a GIS," containing 9 papers. An illustrative example of this section is the paper by Joffe (1990) entitled "Managing GIS Effectively: Real Experiences from Mature Systems."

In 1991, the successor section in Volume II of the Proceedings was titled "Management, Organization, and Funding," containing 6 papers. There was also a new section on "Operations and Personnel." The session structure at the 1991 conference also serves to illustrate the current emphasis on management and organizational issues in information systems. Some example sessions devoted to these topics include: (M1-A) Information Technology and Organizational Issues, (M1-B) Organizational Policy and GISs, (A2-G) Deteriorating Infrastructure, Depleting Resources, (M1-M) Information Technology and It's applications to Management, (M1-K) Strategies for Policy and Pricing Information Systems, and (M1-N) Public/Private Sector Cooperation.

We see in the literature a trend away from the "how to" to the "what is the effect of." The central issue is no longer the technology itself, but rather the organizational change required to accommodate the results of technological advances. We foresee this to be a trend that will intensify during the next decade.

Less Conceptualization/More Doing:

Stated simply, this trend captures the fact that over the surveyed thirty year period we find less discussion and speculation on how to build and implement information systems and more actual case examples of using the information systems for analyses and subsequent decision making. Representative examples are Ruff (1967), in which the author establishes criteria for developing a mathematical model for a social management system allocating resources to needs according to a set of maximizing programs; and French and Belknap (1991), in which the determination of the best use and the shaping of communities for the next fifty years requires analyzing data and receiving input from the public.

This trend is welcomed and demonstrates the maturation of the technology and the use with which the current day URISA professional employs the technology. Conceptualization is still taking place, but our belief is that a better balance between conceptualization and actual use exists today than existed in the 1960's. This is easily explainable, and, in fact, if it were not observable we would question the current priorities and viability of the URISA membership to continue to exist in the future.

Increasing Analyses/Decreasing Retrieval:

This trend is evidenced by emphasis during the early years on research to enable encoding of data into a computerized data base so that it could be retrieved intact when necessary, and by today's emphasis on encoding data to facilitate retrieval into analysis packages in order to present synthesized information upon which decision makers can base decisions. Two illustrative examples from the earlier time period are papers published in the 1965 Proceedings by Ahnell entitled "Information Retrieval and Digital Display", and in the 1970 Proceedings by Wormeli entitled "Project Search: System for Electronic Analysis and Retrieval of Criminal Histories." In contrast to these papers, we cite in the 1991 Proceedings the papers by O'Neill and Grenney entitled "Prototype Knowledge-Based Model for Matching Non-Graphic Road Inventory Files with Existing Digital Cartographic Databases," and by Morgan and Thorn (1991) entitled "Geographic Knowledge Structures for Harbor Management." Clearly, the profession has passed the point in which mere retrieval of data is satisfactory. We expect more and we expect to be able to analyze data by combining it with other relevant data sets.

Increasing Demand for Standards:

In 1967 Todd observed that "Data must be gathered from a wide range of sources... One of the most important objectives is to keep data in a form which will permit it to be most efficiently merged with existing or potential urban data systems in the future." However, there is little evidence of data standards research in the 1960's and early 1970's. During the first ten years, standards concerns showed up under the keyword "transferability", with nine proceedings entries. These papers dealt primarily with system transferability rather than data standards. There was also a pertinent reference in 1972 by Barry Wellar that states that there were three sessions at the 1972 URISA meeting hosted to talk to and about standards and standardization issues.

By 1982 the terms "Data Sharing" and "Data Standardization" appeared with some frequency in the URISA literature, as in the papers by Gilbert (1982) entitled "Data Sharing as Politics: Policy, Tools, and Access," and by Eichelberger (1982) entitled "Land Use and Space Use - Data Standardization Issues in Data Base Management." During the last few years, standardization has become a prime topic. The 1990 conference included two sessions on standards: (1J) Database Standards and Design, and (3L) Standards: Standards a Must. An illustrative example from the latter session is the paper by Croswell and Ahner

(1990) entitled "Computing Standards and GIS: A Tutorial." The 1991 conference included six sessions directly dealing with standards and standards issues: (T2-D) Accuracy, Quality, and Standards - Important Components of Land Records Systems, (M2-G) Issues in Digital Spatial Data Exchange, (ST-1) Governmental Development of Standards, (ST-K) What Do We Standardize?, (ST-L) What is URISA's Role in Standards?, and (ST-H) Pros and Cons of Standards: A Reflective Discussion.

This trend toward the recognition of the need for more standards within the information system world parallels similar trends observable in other professions. Whether we like it or not we must adopt standards to make the utilization of our increasingly complex information systems efficient.

GIS a Profession and Career in Itself:

We have already discussed under new themes the fact that since 1989 a tremendous number of papers reflect a concern on the part of the membership of URISA for education and recognition of GIS personnel as professionals. We do not intend to reiterate the documentation of that new theme here. We simply recognize it as a trend in the literature that we expect will continue.

Centralized Mainframes to Decentralized Personal Computers:

We have already discussed that in the 1960's it was assumed that URISA professionals were working with centralized mainframe computers, mainly because there were few alternatives. Concern by URISA with microcomputers became evident in the early 1980's, with the advent of separate sessions on microcomputers at the URISA conference. By 1986, the Proceedings included a separate volume (Volume III) on "Data Processing and Microcomputers"; the editor's introduction to this volume was entitled "Data Processing and Microcomputer Applications: Where to Compute?" At this point in time, information professionals were having to make choices among micro, mini, and mainframe computing platforms. By 1987, Volume III had evolved to "Microcomputers/Information Resources Management/Systems Integration/New Technology." There was a Microcomputers Track at the 1987 conference, and two related sessions: (7.5) Microcomputers: Micro-Based Planning and Management in Developing Countries, and (8.5) Microcomputers: Local Area Networking and GIS Packages. By 1988, the program had expanded to three sessions focused on microcomputers. In addition, networking and distributed processing appeared as popular topics. There was a session in 1988 on "Networked GIS," and one on "Making GIS Technologies More Accessible," and papers dealing with microcomputer applications began to appear throughout the conference schedule and proceedings.

In 1991, the title of Volume III became "Artificial Intelligence/Knowledge-Based Systems, Integrated Systems, Microcomputers, New Technology, Education/Technology Transfer, Research Agenda." There were sessions on (T3-E) Networked Systems: Access to Distributed Databases, (T2-G) Problems and

Solutions in Using the Microcomputer-Based Platform: The Experts Speak, (T2-E) Sophisticated Microcomputer User's Issues, and (T3-N) Distributed Databases: Designing Database Systems for Accuracy and Security. Two papers from the 1991 Proceedings clearly expose the trend: by Edmondson (1991) entitled "Addressing Organizational Impacts Affected by the Transition from a Centralized GIS to a Distributed GIS," and by Ingoldsby (1991) entitled "Transparent Access to Geographically Related Data from Heterogeneous Networked Systems."

It would be difficult to overemphasize the impact which microcomputers have had on our profession. We are not through this transition as yet but at least we are looking at a future that holds promises of things which we sincerely want to do and things that we sense are the "right" thing to do.

In summary, we have identified seven trends that we feel are evident in the URISA literature of the past thirty years. Undoubtedly there are more, and some very subtle changes that we may have missed. We do think that we need to conclude this paper with a statement of the future as we expect it will unfold given the new themes and the seven trends which we have indicated.

FUTURE

We certainly expect the trend toward decentralization to continue. The days of the mainframe centralized computing facility and data base are over. We will be working with distributed computing facilities and distributed data bases in the future. To do this effectively and efficiently, we will have to adopt standard protocols for computer processing, standard formats for the exchange of information, and an increased overhead in the form of metadata as adjuncts to our data bases. We also foresee continuation of the trend toward the increased identification of GIS as a discipline and the need for education and training of professionals in GIS.

Barring a new and revolutionary breakthrough in technology, we expect that there will be a continuing decrease of emphasis on technological concerns and an increasing concern with the institutional aspects of information systems. However, we do not rule out the prospect that a new wave of intelligent technology will appear and that it will revolutionize our day-to-day operations just as much as the previous wave of technological advances. If and when the new wave of technological advances occur, undoubtedly we will return momentarily to a concern for technology. However, revolution or no, we feel that the organizational change that the complete integration of computer technology will force in our profession will remain a central and growing concern. We are only now beginning to see the effects of this and the greatest changes are yet to come.

We are all hopeful that the establishment and adoption of standards will reduce data collection and management costs, following the examples set by hardware and software costs; concern with reducing data costs certainly will remain strong in the short-term. Legal concerns also are certain to increase in the short-term. We are fortunate in the United States that (to date) we are not burdened by copyrighted digital data and that liability is not assumed by data producers for the validity of each data entry.

In light of the events in Los Angeles during May of this year, we feel that there is a chance for an increased emphasis on the use of information systems to aid in the processes of social change and the rebuilding of the inner cities in the United States. Whether monies will be available for the necessary programs is uncertain, but the alternative seems bleak indeed. This nation desperately needs a National Spatial Data Infrastructure. Such an infrastructure would constitute the necessary foundation to allow for the planning and the intelligent and efficient decision making that is so desperately needed today. Without the establishment of such an infrastructure this country could conceivably slip toward third world status. It would be unconscionable for the professionals in URISA not to make use of the technology that is today available to them to prevent this from happening. We have the knowledge and the capability to make a difference. Help URISA to do so in the next thirty years.

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IS/GIS HARDWARE/SOFTWARE/DATA FEATURES AND CAPABILITIES: WHAT'S DONE, WHAT'S ON, WHAT'S NEXT?

Abstract: URISA is now nearly 30 years old. These have been decades of extensive changes in computer hardware technology, IS/GIS software technology, and in the digital data that we create and use. For this paper we were charged to write a history (over the past 30 years) of IS/GIS hardware, software, and data. We first describe the classic roles that URISA members have taken as users of data. Next, we summarize some of the highpoints of hardware development over the past 30 years, including improvements in data processing and analysis, data capture, data storage. After considering these hardware innovations, we turn to a summary of progress in database management software. At that point, we have discussed capturing, storing, and managing our digital data, and we turn to some of the technology improvements directly impacting the development and use of GIS. These improvements include enhancements to our graphic presentation capabilities, our displays and output devices, and human interfaces. This discussion leads us directly to a brief history of GIS software technology. As one of the technical challenges to GIS in the 1990s, we next examine communications and the evolution of computing environments. Finally, we return to where we started, with a discussion of federal data sources and data sharing issues. We conclude with our recommendations for areas of URISA action and concern in the 1990s.

INTRODUCTION

URISA is now nearly 30 years old. These have been decades of extensive changes in computer hardware technology, IS/GIS software technology, and in the digital data that we create and use. For this paper, we were charged to write a history (over the past 30 years) of IS/GIS hardware, software, and data. We have found this to be a large task, but it meant that we learned new facts and had fun dredging up old memories.

There are other aspects of IS/GIS hardware, software, and data that this paper ignores, particularly those dealing with organizational and institutional issues. We do not address issues of confidentiality or open-records laws or pricing, although we view these as crucial to the expanded use and diffusion of these technologies. We have been given a charge to deal with perspectives on the technology. Although organizational and institutional issues will be at the heart of IS/GIS use and diffusion in the 1990s, we leave these issues to others.

In this paper, we first describe the classic roles that URISA members have taken as users of data. Next, we summarize some of the highpoints of hardware development over the past 30 years, including improvements in data processing and analysis, data capture, data storage. After considering these hardware innovations, we turn to a summary of progress in database management software. At that point, we have discussed capturing, storing, and managing our digital data, and we turn to some of the technology improvements directly impacting the development and use of GIS. These improvements include enhancements to our graphic presentation capabilities, our displays and output devices, and human interfaces. This discussion leads us directly to a brief history of GIS software technology. As one of the technical challenges to GIS in the 1990s, we next examine communications and the evolution of computing environments. Finally, we return to where we started, with a discussion of federal data sources and data sharing issues.

DATA USERS

To understand how URISA members have viewed data over the past three decades, it is instructive to begin with a history of URISA members as users of data. URISA began with a membership of people looking for better data for policy making. Our search for data has led us deep into operations and technology, and we now see ourselves on the verge of returning to our original mission.

Our founder, Edgar Horwood, traced URISA's origins back to a phone conversation he had with the Census Bureau in 1961, when the Bureau agreed to give him a computer tape of census block data (Horwood, 1977). Up to that point census data was available in printed form only; the only reason the Bureau had the data on tape was to assist their internal work. In fact, it was not until the 1970 Census that summary tapes contained more detail than the printed reports and the Bureau established a formal program for dissemination.

FORTRAN and digitizers were just becoming available (see sections on hardware, below) and Horwood's Urban Data Center began producing useful maps of these census data. The word spread, people began bugging Horwood, and he decided to pull these people together for a meeting on August 28, 1963. They called the meeting "The First Annual Conference on Urban Planning Information Systems and Programs." The Association was incorporated at the 1966 conference in Berkeley and Horwood was elected the first president. The emphasis on *planning* carried through the titles of the conferences until 1967. Our founders were interested in questions of urban and regional planning and management, as well as in decision making. For them, block level data was of sufficient detail for their policy needs.

There are two obvious problems of census data: it is current only once per decade and it does not include much data that is critical for urban and regional decision making. People began to focus on the use of the operational records of government as another approach for gathering data for planning, management and decision making (HUD, c1967). The Census Bureau developed techniques to geocode addresses to blocks in order to conduct the 1970 Census by mail and URISA members saw this as a tool with broader use (Cooke and Maxfield, 1967). At roughly the same time, cities were beginning to computerize their operational records and the federal government saw an opportunity to develop prototype urban information systems. The USAC project was started in 1971 and eventually spent $26 million (unadjusted) in six cities over seven years (Kraemer and King, 1979). Discussion about USAC and records automation was frequent at URISA meetings in the early 1970s.

City and county records are most often about parcels of land and URISA formed its Land Records Special Interest Group (SIG) in 1977 at the Kansas City meeting. At this point people were still awed by the amount of data this might represent and were willing to settle for a parcel centroid as the major geographic indicator for each parcel (Moyer and Fisher, 1973). This was insufficient for the operational needs of local government surveyors and assessors and soon technology allowed the enhancement of these files to include parcel boundaries. URISA's Land Records SIG was reborn in 1983 at the first Atlanta conference and a compendium of the papers presented there formed the core of a special issue of the journal *Computers, Environment, and Urban Systems* (Barr and Moyer, 1984).

Meanwhile, natural resource activities, outside the urban area, were being added to URISA's lists of interests. At the Atlantic City meeting in 1973, SIG-GEO was renamed SIG-GBF (Geographic Base File, used for urban geocoding) in order to allow those with non-urban interests to have their own SIG. A vital SIG was established in 1980 in Toronto, called "Natural Resources and Environmental Assessment." Papers from that conference and the 1981 conference were published in another special issue of *Computers, Environment and Urban Systems* (Craig, 1982). Initially, the data sources for the natural resource group initially were existing maps and aerial photography, but they have grown to include such operational records as permits and harvesting information.

The above URISA activities are aimed at improving the use of technology for a specific governmental function or operation. But the goals of our founders were to get better data for planning and management and decision-making. These goals are reappearing in the newer URISA SIGs of Regional Agencies and Urban and Regional Analysis. For these people it is critical to combine data from various sources, and the increased geographic accuracy of newer data sets makes for better combined data. The remaining problems for data sharing are institutional and include the lack of standards and barriers to willingness to cooperate.

URISA's focus since 1977 has been on land, and the technology interests have centered on both GIS and LIS. There are other important community issues that we have ignored. For a time we dealt with municipal finance (in fact, for a brief period in the late 1970s we used the Municipal Finance Officers Association as a Secretariat), but either those issues have been solved or those people have gone elsewhere. Periodically we see visitors interested in the health or social services aspects of our technology, but we show little interest in their needs or contributions. People have addresses and our technology could be of some assistance to the health and social service providers, but we cannot currently help them solve their major policy issues. In fact, whose problems are we solving? We have been solving technical problems — as well as the institutional problems that get in the way of our technology. We are on the verge of having all the data we want, but we have done very little to develop the use of these data for better planning, management and decision-making. We will return to these issues at the end of this paper. In the next sections we provide a perspective on the progress of technology over the past 30 years. We focus here on GIS/LIS and related technology, as a continuing focus of URISA activities and member interest.

DATA PROCESSING AND ANALYSIS

It is not a coincidence that as digital computers were becoming commercially available, GIS emerged as a field. Roger Tomlinson, in recounting his early work on GIS at the beginning of the 1960s, notes that, "Computers still had small storage capacities and slow processing speeds by today's standards. The largest machine available for early work on GIS was the IBM 1401 with 16K of BCD [binary coded decimal] memory; it processed approximately 1,000 instructions per second, cost $600,000 ($2 million in 1984 dollars), and weighed more than 8,000 pounds (Peuquet and Marble, p. 20). In 1964, the IBM 360 was announced. Table 1 shows the evolution of IBM mainframe computers, a reasonable depiction of improvements in computer processing speed from 1960 to the mid-1980's.

In 1971, Intel announced the 4004, the first microprocessor, or "computer on a chip". In the fall of 1976, Steve Wozniak proposed that Hewlett-Packard Co., create a personal computer. Steve Jobs proposed the same to Atari. Both were rejected. In June of the following year they ran their first ad in *Byte* magazine for the Apple computer. Four years later, in August 1981, IBM introduced the IBM Personal Computer, legitimating a market that then grew explosively in the 1980's. By the mid-1980s, personal computers had far surpassed the capabilities of the first mainframe computers used in the early days of GIS. In 1992, you could buy a desktop PC with an Intel 486 processor, 8 megabytes of RAM, and 200 megabyte hard drive for under $3000. This personal computer could process 12 to 15 million instructions per second—more that 100 times the speed of the IBM 1401, and at less than 1/100th the cost. Workstations are now available that are even faster and have better price/performance ratios. Table 2 shows the evolution of the microprocessor as represented by the Intel family of chips. As this is being written, Digital Equipment Corporation has just announced a new microprocessor, the Alpha chip, that has been demonstrated at 400 MIPS.

TABLE 1
IBM Major Large System Announcements

Model	Announced	Delivered	MIPS	Price	$/MIPS	Average $/MIPS
360/50	Apr '64	Aug '65	0.2	1,200,000	7,018,000	6,150,000
360/65	Apr '65	Nov '65	0.6	3,000,000	5,282,000	-
370/155	Jun '70	Jan '71	0.6	1,600,000	2,667,000	2,386,000
370/165	Jun '70	Apr '71	1.9	4,000,000	2,105,000	-
370/158	Aug '72	Apr '73	0.9	1,400,000	1,628,000	1,689,000
370/168	Aug '72	May '73	2.4	4,200,000	1,750,000	-
370/158-3	Mar '75	Sep '76	1.0	1,600,000	1,684,000	1,745,000
370/168-3	Mar '75	Jun '76	2.5	4,514,700	1,806,000	-
3031	Oct '77	Mar '78	1.1	1,000,000	909,000	-
3032	Oct '77	Mar '78	2.5	1,900,000	760,000	782,000
3033	Mar '77	Mar '78	5.0	3,380,000	676,000	-
3033S4	Nov '80	Jan '81	2.4	1,190,000	492,000	-
3033N4	Nov '79	Jan '80	4.0	1,800,000	450,000	447,000
3081-D	Nov '80	Oct '81	10.0	4,003,000	400,000	-
3083-E	Mar '82	Apr '83	4.0	1,400,000	354,000	-
3083-B	Mar '82	Oct '82	5.7	2,100,000	367,000	-
3083-J	Nov '81	Oct '82	7.5	2,700,000	360,000	-
3081-G	Nov '81	Sept '82	10.5	3,543,000	337,000	345,000
3081-K	Nov '81	Apr '82	13.5	4,603,000	341,000	-
3084-Q	Nov '81	Oct '83	25.7	7,982,000	311,000	-
3083-CXO	Oct '84	Jun '85	3.2	871,000	277,000	-
3083-EXO	Feb '84	Jun '84	4.2	1,400,000	333,000	-
3083-BXO	Feb '84	Jun '84	6.1	2,100,000	344,000	-
3083-JXO	Feb '84	Jun '84	8.0	2,700,000	338,000	-
3081-GX1	Feb '84	Jun '84	11.4	3,543,000	312,000	315,000
3081-KX1	Feb '84	Jun '84	14.9	4,603,000	310,000	-
3084-QX3	Feb '84	Jun '84	27.8	7,982,000	288,000	-
3090-200	Feb '85	Nov '85	28.0	5,085,000	182,000	186,000
3090-400	Feb '85	Apr '87	50.0	9,468,000	189,000	-

Source: Datamation, 1991, p. 90.

TABLE 2
Technology Changes: INTEL CPUs

System Component Performance Measure	1982	1985	1990		1995	2000
CPU (Intel)						
Year Introduced	1982	1985	1989	1992-93	1995-96	2000
Device	80286	80386	80486	80586	80666	80786
Circuits/chip	134K	275K	1M	4M	22M	50-100M
MIPS	2	4	10-12			2000

Source: Forecasts and data from Cutaia (1990).

In reality, processing power is increased not only by increased CPU speed, but also by improvements in computer architecture and algorithms. Algorithm improvements have been constant throughout the short history of GIS. In the next decade multiprocessor architecture will greatly speed up computing. The Intel microprocessor planned for the year 2000, the 80786 chips, will have four CPUs on a single chip. PC operation systems, OS/2 and Windows NT, will have multiprocessor extensions, as do operating systems for larger computers. The next generation super computers are likely to be built from large numbers of microprocessors. Thinking Machines has already clearly demonstrated the capability with a commercial product, and Cray has such a design under development.

From the standpoint of the GIS user, in the early years processing power was a constraint that required careful consideration in all aspects of data management and analysis. The lack of graphics input and output devices, fortunately, spared the computers of the computational overhead that would have been required to support such graphics. They would not have been up to the task. By the 1970s, computing speeds had increased to the point where most GIS tasks could be undertaken, at least in batch mode, relatively unconstrained by computing speed. Through the 1980s, as processing power increased and prices declined, more ambitious use of graphics was possible, and more interactive computing was undertaken. Nevertheless, by the end of the 1980s, computing power was still often not adequate to realistically run significant GIS analysis interactively, at least without a few coffee breaks.

In the 1990s ever more ambitious analysis tasks may be undertaken within an interactive environment. To the extent that GIS gains more widespread acceptance for policy analysis, this ability to interactively explore policy alternatives will become increasingly significant. In order to implement GIS for such policy analysis, both graphic and attribute data must be captured. This has been a bottleneck for GIS/LIS development, and is the topic of the next section.

DATA CAPTURE

The primary source of operational text-records has been key-entered data collected during operations. Examples include records of building permits applied for and granted. Depending on the nature of the task, data has been entered as part of the operations process or shipped off to a separate data entry operation. Breakthroughs occurred during the 1980s and 1990s with utilization of hand-held portable collection devices (Casebolt, 1985), telephone keypad entry (Antelo, 1985), and now pen-based systems (Wilson, 1991).

Sinton (1992, p. 4) provides a concise history of data acquisition in GIS:

> In the early days of GIS, data acquisition was an extremely cumbersome and mostly manual operation. Because it was so expensive and so slow, the data acquisition process included

considerable abstraction of the data during the actual data capture. Thematic grid cell data models flourished during this time because they were effective for abstracting the data during the acquisition process. The dream for the GIS industry 25 years ago was automatic, low-cost data acquisition. Since then, we have gone from manual coordinate coding on SYMAP forms to mechanical digitizers to automated raster scanners for capturing existing data from secondary sources. We have also fully developed our remote sensing technology to capture digital images that provide an abstract model of Earth's surface. Even more exciting has been the development of automatic primary data capture by multifunction surveying instruments, now enhanced by the global positioning system, which has been adapted to capture real-time coordinate data from moving vehicles.

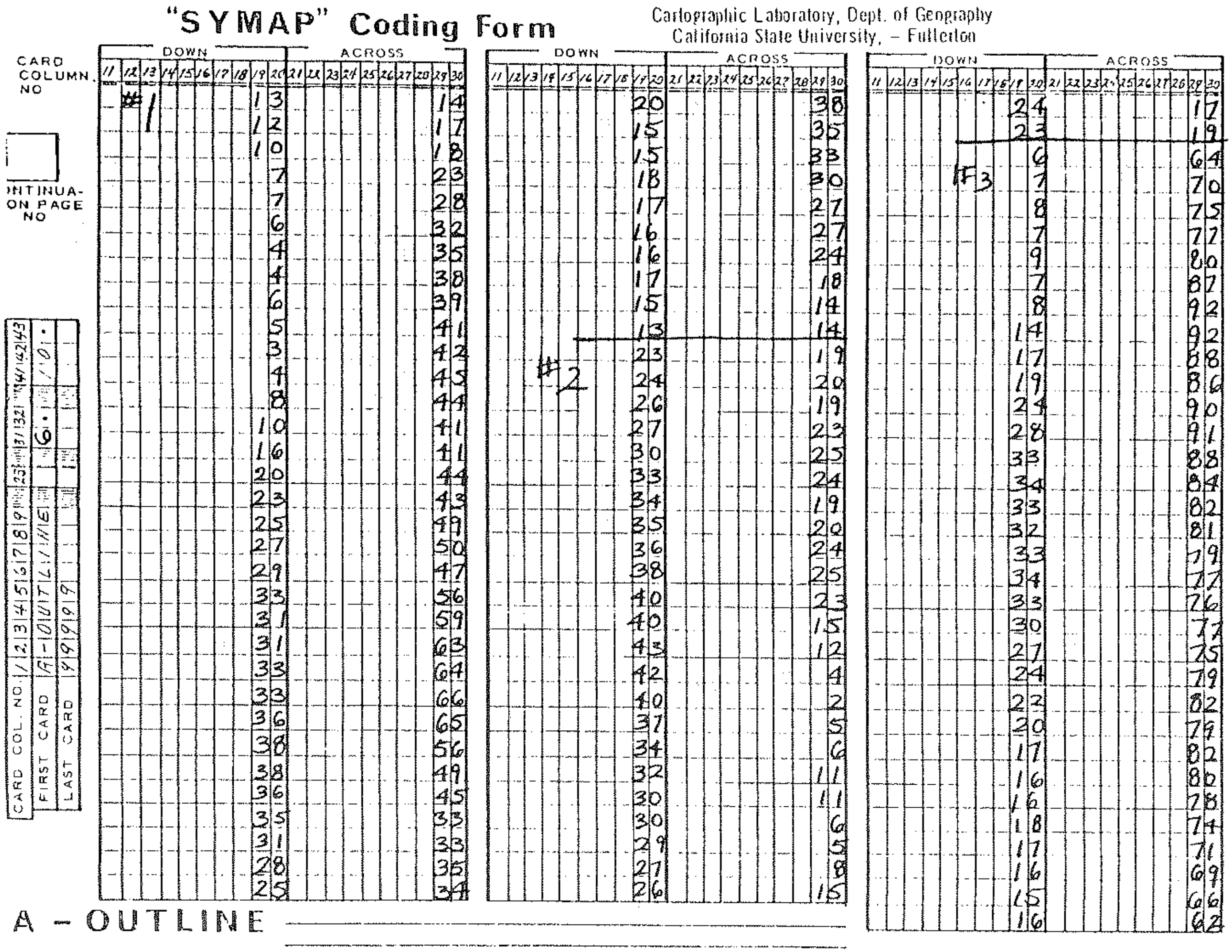
To remind us of this early data entry procedures, Figure 1 shows a classic SYMAP data entry form. By the late 1960s significant progress was achieved in digitizing map data. For efficiency, attribute data were keyed in from lists separated from map data. Large surface, 48" x 48" digitizing tables were built. Later, a large format, 48" x 48" cartographic quality drum scanner was invented for the optical scanning of maps, replacing manual line tracing. Raster to vector conversion techniques were invented.

In the 1970s, data acquisition technology changed little and data entry remained a major bottleneck for GIS systems. Nevertheless, digitizer and scanner technology improved during this period, and costs declined. All maps are best captured in vector format whether or not the software is grid-based. This fact was debated well into the 1980s (for example, see Heidlebaugh, 1982). Digitizing is the normal way to capture such data, but it is tedious and expensive. Electronic scanning was long thought to be the solution, but it wasn't until the 1990 Edmonton conference that we saw sufficient breakthroughs had been achieved to make this process viable (for example, see O'Connor and Sidebottom, 1990). At the 1992 URISA conference we will hear papers about new digital orthophotos that can be used as a background for heads-up digitizing.

Geographic detail and coordinate control on computerized maps has also seen considerable discussion at URISA meetings. The more detail and accuracy, the more expensive the system. In many cases a street center-line (e.g., block-level TIGER) approach will meet many planning and decision making needs. Those who do need accurate parcel-level data will find great help in COGO and GPS technologies (for example, see Claypool and Stevenson, 1989). Many will want to computerize the maps they have so they can start with applications immediately. Often these people intend to improve their spatial accuracy later; care must be taken to relocate all data referenced to the altered base map (Kjerne and Dueker, 1990).

Also during our review period much progress has been made on avoiding the problem of conversion through initial collection of data in digital form. Satellite remote sensing allows us to capture information as an array of digital data. Early

FIGURE 1



SOURCE: Authors (Wiggins) Files, Circa 1971.

satellite sensing in the 1960s used relatively primitive cameras and sensors, though significant developments in weather satellites occurred during this period. The milestone in satellite remote sensing, from the GIS perspective, was the launching of the first Landsat satellite in 1972. Unfortunately, in the mid-1980s the Landsat program declined and the U.S. Government transferred it to private ownership. Fortunately, at that time, the first French SPOT satellite was launched. The history of satellite imagery has been one of larger area coverage, higher spatial resolution, using more of the electromagnetic spectrum, and with more frequent updates. The good news is that this has provided a vast amount of relatively current and continuous information covering virtually all of the earth. The bad news is that this presents a near-overwhelming amount of data. Even worse, the resolution of these data are generally considered adequate for many natural resource and scientific applications, but not for most urban planning uses.

Because of these scale issues, digital remote sensing has received little attention at URISA meetings, but that is beginning to change. URISA's large scale (mostly urban) focus and the inability of satellite data manipulators to deliver a reliable, cost-effective product, have kept Landsat and SPOT from regular use by our members. Only now is multi-temporal analysis of these data showing its value for reliable land-use classification (Sturdevant et al., 1991).

After we capture our attribute and graphic data, it must be stored and maintained. In the following section, we examine our progress in storing the increasingly large amounts of digital data.

STORAGE

We can think of storage devices as hierarchically arranged. At the top is primary storage, typically RAM, which is very fast, but also relatively expensive. At the bottom is archival storage, typically much slower but also much less costly. In between are various other levels that achieve varying balances between cost and speed. The upper reaches of the storage hierarchy are of interest because they effect the size of problems that can be efficiently handled and the speed of processing for those problems. The lower levels are of interest because they determine the cost and availability of information.

The IBM 1401 that Tomlinson used in his early work had 16K of primary memory. In the intervening years primary memory has rapidly declined in size, increased in storage density, increased in speed, and decreased in cost. Today, a single memory chip may store 4 million bits of information and working prototypes for 64 million bit chips have already been demonstrated. By the end of this decade 256 megabit chips should be readily available. These chips continue to increase in speed and decline in cost per unit of storage. These advances are depicted in Table 3.

Secondary storage devices also continue to show remarkable increases in storage density, capacity, and access times, and to decreases in cost. In the early years, because of the high costs of storage, geographic information was typically stored on tape. Access time was often measured in minutes. Declining storage costs allow more data to be stored higher up on the storage hierarchy, frequently on hard disks where access times are measure in milliseconds. New technologies continue to emerge, with optical storage likely to be the most significant for the next few years. Table 4 portrays this evolution.

Table 3
Technology Changes: RAM

System Component Performance Measure	**1982**	**1985**	**1990**		**1995**	**2000**
RAM						
Mb/chip	16K	256K	1	16	64	256
Speed (ns/cycle)		80386	120	30	10	1-2
$/Mb			250	75	15	3

Source: This table is based on data and forecasts provided by Cutaia (1990).

Table 4
Technology Changes: Storage

System Component Performance Measure	**1982**	**1985**	**1990**		**1995**	**2000**
Magnetic Storage						
Mas. GB/arm						
5 1/4"		0.4		1		
3 1/2"		NA		1	2.4	4.5
2"		NA		0.2	1.5	4.5
Access time (MS)		20		11	5	2.5
$/MB		5.5		0.5	0.07	0.03
Optical Disk						
Max. GB/arm		NA		1	3	6
Access time (MS)				18	11	8
$/MB						
Read Only				0.18	0.04	0.01
Write Only				0.38	0.09	0.03
Fiber Optic Link						
Data Rate (GB/Sec)		75		200	500	10,000

Source: Data and forecasts from Cutaia (1990).

More sophisticated computer architectures are also evolving, particularly for microcomputers. The early microcomputers typically had primary storage

(RAM), and secondary storage — a Winchester hard drive and a floppy disk. The higher end personal computers and workstations today have cache memories for the CPU and hard disk caches or RAM caches for hard disks to speed up processing. Optical disks may utilize Winchester disks as caches. These more complicated computer architectures speed up processing of large data sets while keeping costs reasonable.

Communications capabilities also are relevant in any contemporary consideration of secondary storage. Communication allows remote storage. This will be discussed more fully in a later section.

After our graphic and attribute data is captured and stored, we need database management software in order to access, query and manage it. Our progress in this area is traced in the following section.

DATABASE MANAGEMENT SOFTWARE

A good summary of the progress in GIS database technology can be found in Garth (1990). Here we consider database management software (DBMS) more broadly. We remind our readers that in the 1960s, the users of DBMS were programmers (Trimble and Chappell, 1989). To access our data, programs had to be written in some programming language (often COBOL), and the access of users depended on their relationship to a knowledgeable programmer. As database usage increased, more and more users wanted greater direct access to their data. The languages developed to allow such easy user access are called query languages, the most widely used today being the Structure Query Language (SQL) developed by IBM.

Some authors have called the older hierarchical and network database management systems the "first generation" (The Committee for Advanced DBMS Function 1990). They typify the first generation with CODASYL systems and IMS. They then call the current relational systems the "second generation," as represented by DB2, INGRES, NON-STOP SQL, ORACLE and rdb/VMS. It is these relational systems that URISA members are currently using for their IS/GIS applications. What, then, are some of the desirable characteristics of the "third generation?" The Committee for Advanced DBMS Function suggests three characteristics: (1) support for richer object structures and rules; (2) continuation of the two strongest areas of the second generation (non-procedural access and data independence); and (3) openness to other systems (including a fourth generation language (4GL), various decision support tools, and easy access to such common software as spreadsheets and graphics (The Committee for Advanced DBMS Function, 1990).

Now that we've discussed capturing, storing, and managing our digital data, we turn to viewing that data graphically. In the next section we examine the technology improvements over the past 30 years in graphic presentation, displays and other output devices.

GRAPHIC PRESENTATION: DISPLAYS AND OUTPUT DEVICES

Since the early 1960s. when computers first became commercially available, there has been an interest in using them to assist in making drawings. Initially, computers were connected to X-Y plotters used by scientists and engineers to plot numeric results. It would be many years, however, before these ideas would be translated into commercially available, affordable large plotters available for mapping and computer-aided design. Nevertheless, many of the early problems of "handling cartographic drawings were addressed and, to a great extent, solved in the sixties in such pioneering efforts as the Oxford Cartographic System (UK), AUTOMAP (Central Intelligence Agency, U.S.A.), and Canadian Hydrographic System (Government of Canada). However, the high cost of hardware made them less than cost-effective in comparison with well-established manual cartographic procedures (Tomlinson, 1990, p. 21)."

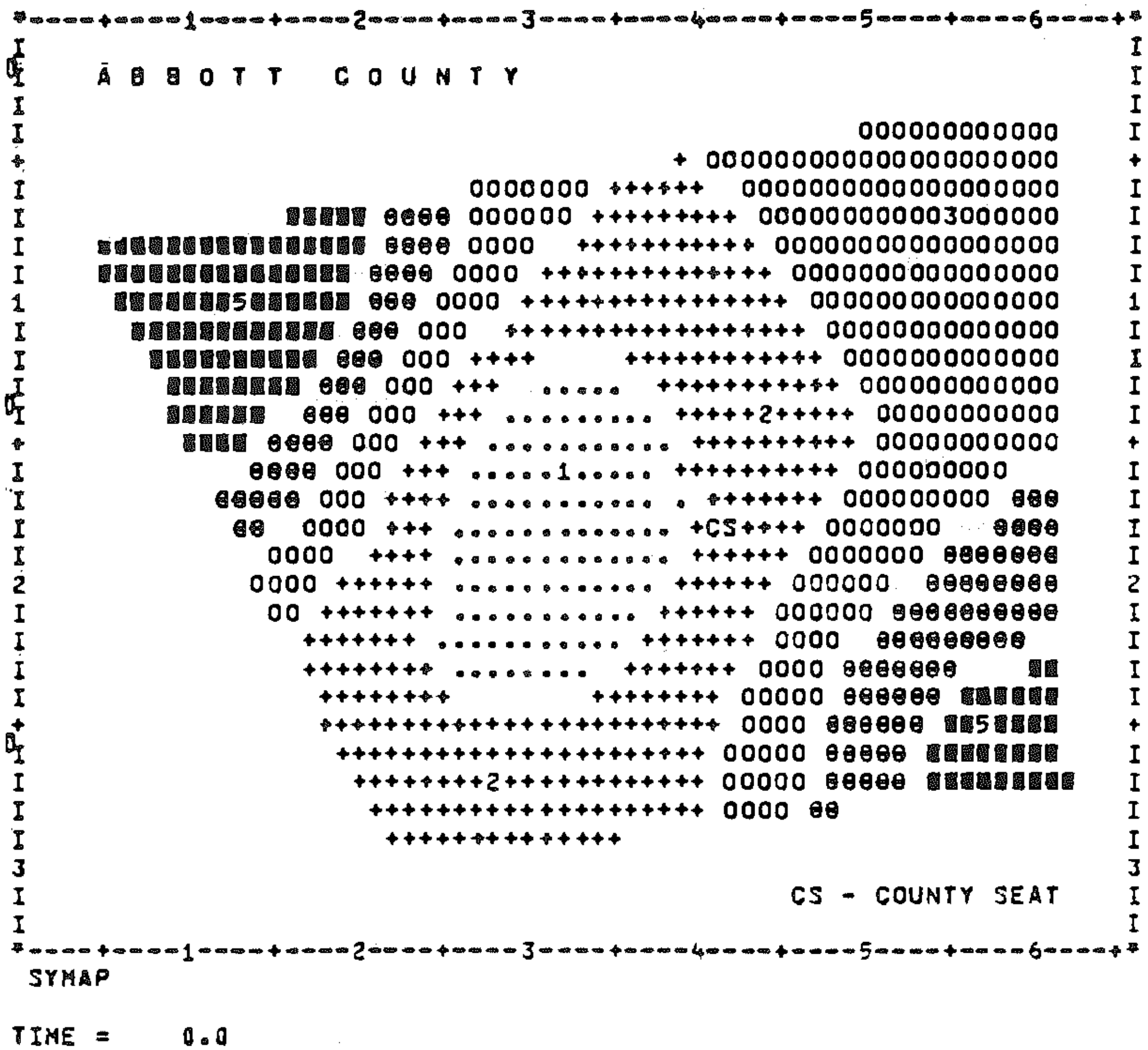
In the early years, particularly at such places as the Harvard Laboratory for Computer Graphics and Spatial Analysis, the major interest was in analysis, not attractive map drawing. There, as early as 1964, they had developed SYMAP, a general purpose mapping package. They developed algorithms for overstriking letters on a line printer to create different densities. Though SYMAP was the most widely known, many other grid cell manipulation programs were developed soon after. As a memory of that time, a SYMAP output is given in Figure 2.

Of particular importance would be the development of an interactive graphic display device that could be used for data entry, editing and presentation. A seminal development in this arena was the Sketchpad system, developed by Ivan E. Sutherland at MIT. Sketchpad was designed to allow an engineer to generate designs by sitting at an interactive graphics terminal, and manipulate drawings displayed on the screen by use of a light-pen and keyboard. At the same time, IBM developed a system known as DAC (Design Augmented by Computer) for use by General Motors in automobile design. This system was announced in 1964 and was to be a front-runner among the many interactive computer-aided design systems acquired by automobile and aerospace firms by the end of the 1960s (Mitchell, 1977, p. 15).

The early display devices, however, had many limitations. They produced vector graphics on what was called a storage tube display. These displays were monochromatic and static—that is, you could not erase a line without erasing the entire screen and redrawing the picture. They were also expensive. Tomlinson recalls that: "Graphic display screens cost $90,000 in 1967 and each needed a dedicated port to a mainframe. The sixties were the decade of batch processing and poor graphics (Tomlinson, 1990, p. 21)."

Actually, since the 1950s refresh vector display technology was available that, at least in theory, should facilitate editing (and the display of moving images, not of particular interest to GIS). However, this technology was even more expensive than storage tubes. Furthermore, refresh times increased with the complexity of drawings, so the technique was problematic for the drawing complexity frequently desired in GIS.

FIGURE 2



SOURCE: SYMAP Output.
Authors Files, Circa 1971.

Though costs declined and performance improved in display technology, it would be the 1980s before really significant progress would be evident. In the 1980s, raster graphics emerged as the leading display technology. It had the advantages of color, and sufficiently rapid refresh rates to allow interactive editing. In the early and middle 1980s, large, high resolution displays required special hardware and added display memory, and therefore were relatively expensive. However, screen resolution continues to increase and costs have declined dramatically. Even on personal computers, it is increasingly common to find displays capable of full color 768 by 1024 resolution for under $1500. Larger displays and higher resolutions of course cost more. The 1990s should be the decade when large screen, high resolution color displays become commonplace.

The advances in the raster color displays in the 1980s were important to GIS for another reason. Previously, graphic terminals were optimized for either vector or raster data. Mixing these data models on a graphics terminal degraded performance. The current generation of displays support both data models with little performance impact, and are thus capable of supporting a GIS that fully integrates vector and raster data models. Graphic displays no longer present a technical constraint to GIS data models, and we are seeing more systems that integrate raster and vector GIS in the URISA vendor displays each year.

Concerning physical output devices, through the 1970s and 1980s large format pen plotters have been available, and their cost has steadily declined. Electrostatic color printers have become widely available. High quality film recorders have declined in price to the point where at least some models are now considered as a personal computer peripheral.

In 1985, the convergence of three technologies — the Apple Macintosh, the Apple Laserwriter, and the Aldus Pagemaker program — gave birth to desktop publishing. In the past few years the emergence of Postscript as a standard page description language and the increasing availability of color postscript printers are making color desktop publishing a reality for personal computer and larger system users. The provides additional significant additional output options for GIS users.

In summary, from the standpoint of GIS, in the first years in the 1960s graphic output was of very low quality, adequate for geographic analysis, but not up to the standards of cartographers. In the 1970s the quality of output improved to a point considered adequate by most cartographers. However, the cost of high quality and large format output devices remained high. In the 1980s, the quality continued to improve and the costs declined dramatically. By the end of the decade costs had declined to the point where high quality output was affordable for most GIS users, although the color options still remained pricey. The 1990s will see continuing improvements in quality and declines in price, with high quality color output likely to become the norm. The emergence of desktop publishing will also provide a better integrated and useful computing environment for many GIS users.

The 1990s will also be the decade where high resolution color displays become commonplace. This will not only facilitate data entry and display, but also presentation. GIS will become better integrated and contribute to more effective utilization of GIS through presentations using desktop presentation and desktop publishing technologies. Large screen, high resolution, color graphic displays will also speed the use of graphical user interfaces. This in turn will broaden the community of GIS practitioners and consumers. This will be further discussed in the following section on the Human Interface.

HUMAN INTERFACE

In the early years, users interfaced with GIS through punched cards and FORTRAN code. In the 1960s, this was characteristic not only of GIS, but throughout the computer industry—except that languages other than FORTRAN might have been used.

In the 1970s, applications programs arrived. So did teletype machines and then character-based terminals and interactive computing. Application programs packaged functions, and it was considerably easier for the user to type simplified commands which would invoke the appropriate segments of code.

In the 1980s, graphical displays gained widespread acceptance. The rapid growth of the personal computer forced the development of an easier to use interface if computing was to be adopted by ever increasing numbers of users. The graphic user interface (GUI), first developed at XEROX Parc in the 1970s, entered mainstream computing when the Apple Macintosh was introduced in 1984. Developments in the UNIX environment, and with Windows on the IBM and compatible personal computers assure that this will be the dominant user interface of the 1990s. The many advantages of GUI are compelling—easier to learn and use, increased ability to integrate information from diverse sources, and better tools for task integration and interprocess communication.

These improvements in the design of the Human Interface have many implications for the future of GIS. First, GIS is likely to become more accessible to a larger community of users, extending the potential impact of GIS, but also requiring changes in GIS to facilitate use. Second, as the potential for integrating data from multiple sources is realized, GIS will need to be adapted to both facilitate integration with other programs, and to serve as a potential framework for integrating diverse data (Langendorf, 1991). Thus, improvements in the design of the Human Interface are likely not only to change the "face" of GIS, but also profoundly influence its use and underlying architecture.

To this point, we have discussed the rapid improvements in hardware capabilities; innovations in data capture, storage, and management; and the advances in graphic presentation, output devices, and the human interface. Together, these technology advances have impacted the software technology of GIS. During the rapid diffusion of GIS technology during the past 5 years, an increasing proportion of the URISA program has focused on GIS software development and use. In the next section, we briefly trace the history of GIS.

GIS SOFTWARE TECHNOLOGY

David Sinton recently reflected on 25 years of GIS:

> "The pioneers in the GIS field were not GIS professionals; they were experts in a wide variety of disciplines—experts who needed tools and procedures to use geographic data to solve problems within their disciplines. Geographic data was only useful if it contributed to solving real problems for real people (Sinton, p. 1)."

The early work focused upon spatial analysis. The 1959 report *Studies of Highway Development and Geographic Change,* laid a foundation for the first automated geographical analysis systems with statistical capabilities. The authors included William Garrison, Brian Berry, Duane Marble, Richard Morrill, and John Nystuen. They had formed an early academic center for computer-assisted geographic analysis at the University of Washington at Seattle (Ripple, 1989, p. 12; Johnson, 1983, pp. 62-66). Shortly thereafter Howard Fisher moved from Chicago to Harvard to establish the Harvard Laboratory for Computer Graphics and Spatial Analysis. At about the same time, the Forest Service was developing a land management system, MAIDS, at Berkeley. MAIDS may be the first U.S. operational GIS in the natural resource environment. Technology limited the size of the databases and the quality of the graphics, but these limitations nevertheless allowed useful analysis of urban and regional problems.

The CGIS (Canada Geographic Information System), also started in the mid-60s, began with an applied goal—"to analyze the data collected by the Canada Land Inventory and to produce statistics to be used in development land management plans for large areas of rural Canada (Goodchild and Kemp, 1990, pp. 23-25). To accomplish this, massive amounts of data needed to be input into the system. Major advances in data acquisition technology resulted. Nevertheless, data acquisition imposed high costs for both technical development and data input, and little remained for analysis.

In the 1970s, there was in the U.S. and elsewhere a growing environmental awareness and a parallel increase in governmental involvement in natural resource and environmental management. During this same period there were rapid advanced in computer technology—increases in memory size and processing speed, decreasing costs, and increasing interactive capability. Interactive graphics allowed immediate feedback and error correction as data was being digitized. It also had the potential for spatial query and graphic display of the results of analysis. However, the principal impact of these developments was not in GIS analytic capability, but rather faster and more accurate data entry.

The 1970s were also the era of the emergence of commercial applications programs. Off-the-shelf GIS software were developed and marketed by companies like ESRI, GIMMS, Synercom, Intergraph, Calma, Comarc and others.

The experience of many agencies acquiring these systems throughout the 1970s and the 1980s was similar to CGIS. That is, most of the resources went into data acquisition, and little effort was applied to analysis. Many of these systems functioned as large accounting systems for spatial and spatially related information.

The 1980s were boom years for GIS software technology diffusion. We note several important developments. First, during this period many new software firms entered the market. In fact, rather than leave any out here, we simply refer you to the 1992 URISA corporate member list. Second, these products became increasingly easier to use through improved human interface, the graphic quality and speed increased dramatically, and more and more functionality was added to the software. Third, low-cost "desktop GIS" products for microcomputers provided many more users with more GIS options (Van DeMark, 1991). Fourth, even lower-cost "desktop mapping" products provided users in business, real estate and other areas with a taste of the power of spatial data (Wiggins, 1986, Wiggins and French, 1990). Fifth, all of the above activity led to many more government agencies in the U.S. to adopting, or thinking about adopting GIS technology (French and Wiggins, 1989, 1990; Wiggins and French, 1991, Wiggins, 1992).

No GIS software history is complete without a specific mention of the role of ESRI (Environmental Systems Research Institute), founded by Jack Dangermond in 1969. Dangermond had been a student at the Harvard Lab where he was studying landscape architecture. In the 1970s, ESRI grew slowly, as did other commercial GIS vendors. In the early 1980s, Arc/Info was released. Towards the end of the decade PC Arc/Info was released. It was the first GIS to take advantage of new super-mini computer hardware, and the first of the large GIS systems to port to the PC. In the later part of the 1980s, GIS has enjoyed explosive growth, and Arc/Info has been a leader in that growth. Today, Arc/Info, on a variety of hardware platforms, has the largest market share among URISA members in the government sector (Wiggins, 1992).

In many ways GIS stands at a crossroads today. Technology advances provide many choices for how GIS can evolve. It can continue the emphasis on centralized large scale data acquisition and minimal analysis. But these GIS data repositories are so rich in promise, that one might hope there will be increased analysis. Increasing computing power, decreasing price, distributed computing environments, human interface design that makes GIS and other information and analysis capabilities more widely accessible—all pose the promise and challenge to better utilize information for improved policy analysis and decision making. Here we note, and encourage the reader to enjoy, the thoughtful comments on adding or linking modeling capabilities to GIS provided by Martin Clark (1990) and Britton Harris (1989). We also note the research initiative in this area at the National Center for Geographic Information and Analysis (NCGIA): Initiative-6, "Spatial Decision Support Systems").

In several places in this paper we have mentioned one of the most significant challenges for IS/GIS in the 1990s is in the area of distributed computing environments. We devote the next section to our view of this technology challenge.

COMMUNICATIONS

To understand the importance of communications is to understand the evolution in computing environments. In the 1960s, computing was mainframe computing. In the 1970s several developments contributed to a more distributed computing environment: the emergence of minicomputers, multitasking-timesharing operating systems, modems and wide area networks. The 1980s, in many respects, could be considered the decade of the personal computer and standalone systems. But in the mid-1980s, local area networks began to provide a more connected computing environment, linking personal computers together and to mini and mainframe computers on- and off-site. More truly distributed computing environments will gain in importance throughout the 1990s. Whereas in the timesharing environments of the 1970s computer users could be distributed, they shared a single CPU. In the computing environments of the 1990s, processing and data storage will also be distributed across the network.

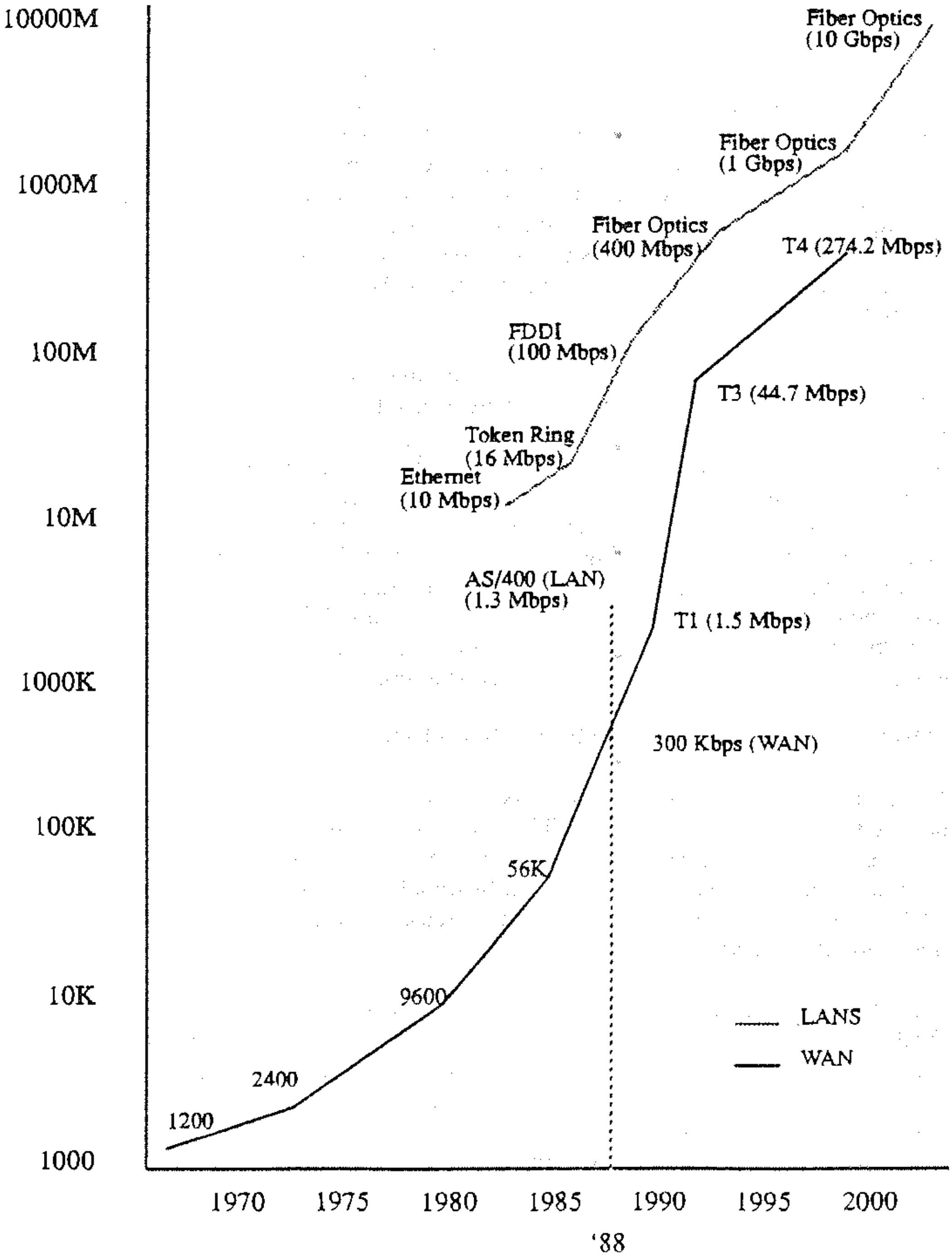
GIS files are large, and may be getting larger as more and more digital data become available. This is resulting not only from the accumulation of satellite imagery, but also the ready availability of the TIGER files for the entire nation. These open up entire new areas for analysis of national or multi-site data. One industry participant has observed that, "I perceive the operational requirement to move large volumes of data between nodes on a GIS network as the most serious technical issue the (GIS) industry faces. This technical constraint is likely to be addressed on at least three fronts: increasing data transmission rates, data compression, and distributed storage and processing (Sinton, 1992, p. 5)." It is worth expanding on Sinton's three points.

First, data transmission rates have increased dramatically, and are likely to continue to increase. In the mid-1960s, data was transmitted over phone lines at a maximum rate of 1200 bits per second. T1 connectors today transmit data at 1.5 Mbps (million bits per second) and by the year 2000 are projected to be transmitting at 274 Mbps. In the mid 1980s, Ethernet was the fastest local area network, transmitting at 10 Mbps. Fiber optics, relatively expensive and not in widespread use yet, can now transmit at 100 Mbps and are projected, by the year 2000, to be capable of transmission rates of 10 Gbps (gigabits per second). These historic and forecast data transmission rates are portrayed in Figure 3.

The second consideration mentioned by Sinton is data compression. Data compression can reduce storage and transmission requirements. Improved data compression algorithms have received much attention recently, and are likely to gain in importance in the next few years.

Finally, the distribution of functions among nodes on a network is an important factor that has not received much attention in the GIS community to date, but is likely to grown in importance in the 1990s. More questions about how data should be distributed across the network will be asked. The answers to these questions could have a profound impact upon the architecture of GIS in the 1990s. Here we give only an extremely brief introduction to these issues.

FIGURE 3



SOURCE: Cutaia (1990), p.196.

Our data for IS/GIS may be distributed among multiple databases, stored on a single computer system, or on multiple computer systems in multiple locations. Also, our data may be distributed in multiple databases, using multiple database management systems. All of these possibilities mean that we can have many types of heterogeneity: differences in hardware technology, differences in system software and communication protocols, differences in DBM software (and query languages), and differences in data structures. The technical complexity is considerable. Yet we recognize the benefits of data distribution, including increased availability and reliability. We also note the organizational advantage of having separate databases residing in separate departments in separate locations (for example, in planning, public works and assessing departments in a municipality). Interesting discussions of these issues can be found in the literature on "federated database systems" (for example, see Webster, 1988, Sheth and Larson, 1990).

We have now almost completed our passage through the variety of technology changes that are of particular interest to URISA members. We have described changes in hardware and software. Now, as we promised earlier, we wish to return once again to the question of data. Acquiring the needed data has been one important focus of our meetings and significant changes have been made over the past three decades. As we saw in an earlier section of this paper, data capture has been seen as representing 60 to 80 percent of the cost of developing a useful GIS, and significant breakthroughs have been made to allow us to do this job better and cheaper. It is also our hope that more data will be available to us in digital form from government sources. In the next section we consider the existing and potential national spatial data infrastructure.

NATIONAL SPATIAL DATA INFRASTRUCTURE

At the beginning of URISA the only national digital database was the summary data from the U.S. Census. Thirty years later, only the Census TIGER files and the USGS Digital Elevation Model (DEMs) have been added to this list. There is hope that other federal agencies will begin adding to this spatial database, but URISA may wish to develop policies to increase the pressure to ensure that tentative commitments are met.

The USGS requested a review of its products and services in the context of GIS (NRC 1990). The review recommended that USGS convert its map products to digital form by the year 2000. This would give us topography, transportation, hydrography, and (limited) land-use data. There is little evidence that the USGS is committed to meeting this recommendation in the 1:24,000 series. This should distress URISA members, who make little use of 1:100,000 or 1:2,000,000 scale maps.

The Department of Agriculture is also beginning to look more seriously at using GIS technology, especially in light of mandates imposed by the 1985 and 1990 farm bills (Price, 1991). Roughly five percent of the nation's soils have been digitized to the standards of the Soil Conservation Service (SCS). Virtually none of the ASCS (Agricultural Stabilization and Conservation Service) farm field data has been digitized, and this data would be useful for environmental, modeling and monitoring land-use change. Both groups know the advantages of implementing GIS technology. The SCS has an implementation strategy using GRASS. The ASCS, to our knowledge, has yet to make the commitment, but should do so.

Other federal agencies are delivering data for the national spatial data infrastructure. Land-owning agencies such as the U.S. Forest Service and the Bureau of Land Management are moving towards digitizing their own land resources. The U.S. Fish and Wildlife Service is developing the National Wetlands Inventory. The Environmental Protection Agency's Toxic Release Inventory provides an increasingly complete list of industrial polluters and has mapped these at the ZIP code level.

In addition to federal data sources, URISA members will increasingly share data in the 1990s. As we described in the section on communication technology, above, this data sharing is likely to take place over more complex networks. In the next section, we consider other data sharing issues.

DATA SHARING

The USAC project participants saw the value of data synergism. They envisioned an Integrated Municipal Information System. Problems would be solved through centralized computing and extensive documentation (Kraemer and King, 1979). The mainframe batch computing of the day was so limiting that people broke to stand-alone minicomputers as they became available. USAC's documentation requirements were so substantial that they significantly reduced the amount of useful work that could be delivered.

Of course, it made sense for different databases to be designed and built to suit their own individual purposes rather than forcing them into a single mold. The question was how to connect them when necessary to answer management or decision-making questions. One answer came from Ann Arbor, which reported one of the first uses of relational databases (Bohl, 1978).

We now have a Spatial Data Transfer Standard to facilitate the transfer of the digitized data from one system to another, but the real problem is that people have cut corners in their original digitizing in meeting their own needs, but not the needs of others. The new data is often useless for the new system (Craig, Tessar and Khan, 1991).

This problem of domain specific fragility was articulated by Vince Robinson in URISA's Research Agenda and goes well beyond the digitized data (Craig, 1989). We have precious few standards to follow for our classifications of things like parcels or people. It is no wonder that it is impossible to build a regional database by gathering data from the counties across a large geographic area to answer the question, "Whose property was flooded by Hurricane Bob?" (Sinton, 1992). This is the major technical challenge facing the GIS community — and especially the LIS community — to develop standards that meet local needs while facilitating sharing. If not URISA, who else will rise to this challenge?

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INFORMATION AND KNOWLEDGE BASES FOR DECISION-MAKING: A PROGRESS REPORT[1]

Abstract: The founders of URISA recognized that information is not an end in itself but is, instead, an essential element in seeking a better life through better decisions. Decisions in turn are based on values, attitudes and knowledge, and succeed according to their ability to predict the outcomes of present choices as embodied in policies, plans, programs, and activities. And, our predictive ability depends upon and is derived from both research and action: research develops laws, principles, theories, methods and techniques as a logic base for decision-making, and "real-world" action tests and confirms or modifies that base.

Both research and action therefore need and create information, and generate associated challenges. Moreover, for urban and regional concerns, there is the challenge of an inherent and complex geographic dimension to address. In this paper we assess the success of the field in meeting some of the numerous challenges to information system "pay-offs." Our report draws on the URISA '77 "perspective" papers of Horwood and Wellar for context and direction, and emphasizes the importance of the philosophical, conceptual, and methodological underpinnings of information and knowledge base development and use.

INTRODUCTION: PUTTING "PROGRESS" IN CONTEXT

Interest in the general subject of information and knowledge bases for decision-making is both long and broad. If fact, this topic has been a salient matter of practical and intellectual concern since the dawning of civilization. As such, we explicitly note that while the object of our present concern is demonstrably recent, and ***avant-garde***, this report deals with only a very limited slice of the information, knowledge, and decision-making relationship that has evolved over time.

The focus of this paper, to be explicit, is on the emergence and seeming omnipresence of electronic computing or information technology (IT). Our task is to "make connections" with the data base, information base, knowledge base, and decision-making relationship that exists in governments, business, academia, and throughout the larger society. Before proceeding further, however, it may be useful to briefly explain why we make the point that the advent of IT in the plan, and program domains. Our task, by contrast, is to report on progress towards building information and knowledge bases, including decision support systems, planning support systems, etc. They are the foundations or pivotal points of rational, logical and informed decision processes and outcomes, and represent the upper limit of what we can examine in this preliminary paper on a complex topic.

INFORMATION AND KNOWLEDGE BASES: FOUNDATIONS OF REASONED DECISIONS

This section contains a brief but important reference to the philosophical, conceptual and methodological underpinnings of information and knowledge base development and use.[3] Of particular relevance here is the matter of appreciating and **Making Connections** between:

1. what **exists** in the real world;

2. our ability to **represent** the real world through data and information;

3. our ability to **interpret** and **explain** the whys and hows of real world **situations** and **relationships**; and,

4. our ability to **predict** the **outcomes** of public and private decisions to intervene or not intervene in local, regional or global events, processes, or states of affairs.

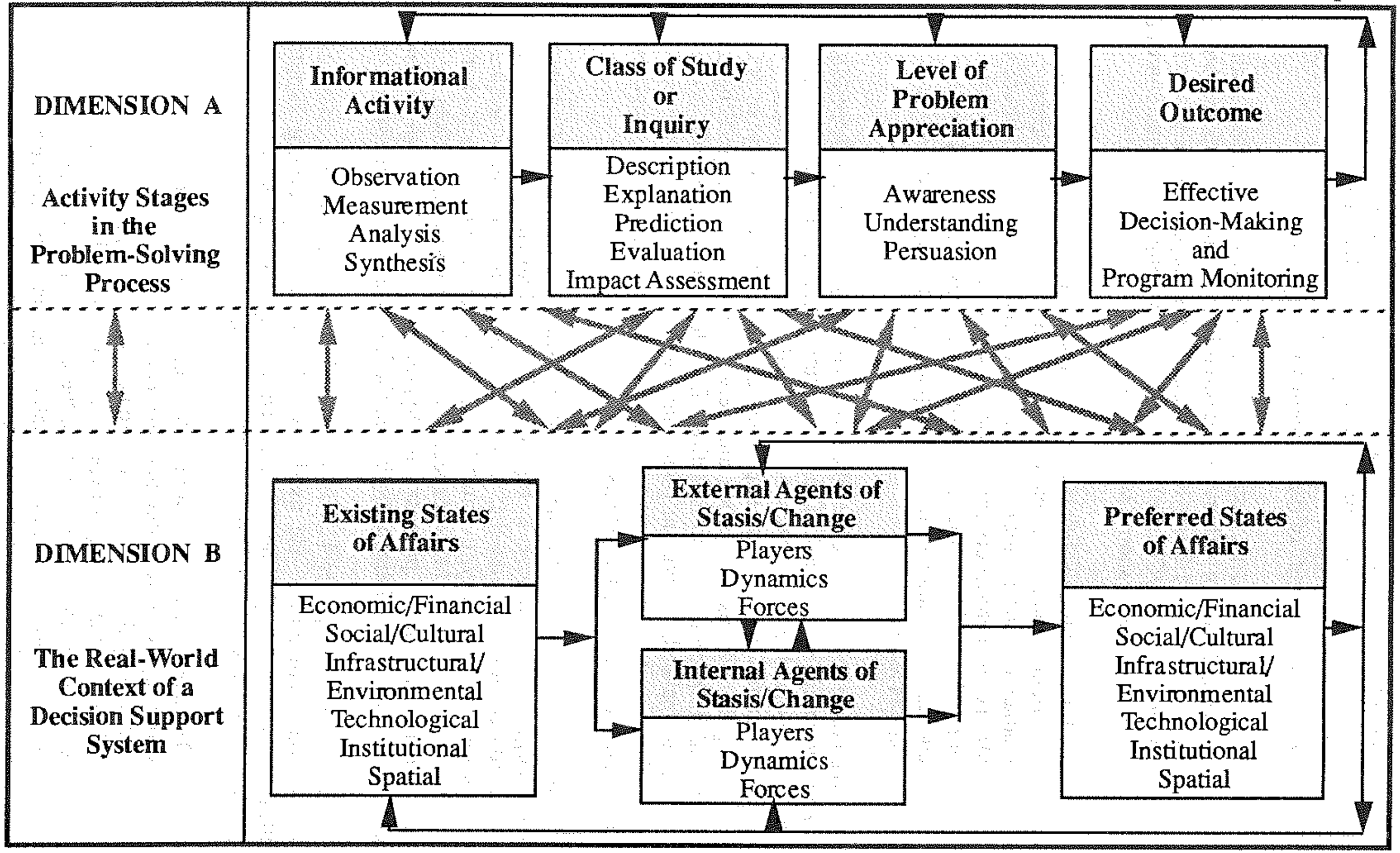
We observe at the outset that decisions may be based on conscious reference to established facts or values, to theories or laws, and to methodologically designed problem-solving processes. That is termed the rational approach. Decisions may be also based, however, on intuition, revelation, whim, "gut reaction", common sense, myth, personal experience, and other "non-robust" ways of knowing and deciding. That is termed the non-rational or extra-rational approach. And, indeed, one approach can be instituted early on the decision-making process, with the other taking over when actual choices must be made.

We acknowledge therefore, that there are different ways of "learning" and "knowing", and we advise that to ignore them is to make an unwarranted assumption about why and how decisions are made. In this paper, however, we adopt the rational model as appropriate for our task, so we briefly set out the fundamentals for robustly making connections between information bases, knowledge bases, and decisions.

Figure 1 with its decision support system theme provides a framework for presenting selected comments on a robust information/knowledge/decision relationship (Wellar, 1990, a & b). The key elements are summarized as follows

- Dimension A illustrates the process of building and moving from data and information base development (Informational Activity) to knowledge

Figure 1: Rudiments of a Decision Support System (DSS): Substance, Process, Context Source: Wellar 1984,1990, p.864



development (Inquiry or Study) to achieving the necessary comprehension of the matter at issue (Problem Appreciation). Ultimately, if the decision support system is effective, the yield is a decision leading to the Outcome Desired at the "end" of the problem-solving process.

- Dimension B, in turn, depicts the relationship between current reality (Existing States of Affairs), the desired future to result from problem-solving (Preferred States of Affairs), and the players, dynamics and forces (Agents of Stasis/Change) which promote or inhibit movement between what is and what should be or will be.

- As for the "broken" lines between A and B, they illustrate the inherent uncertainty and incompleteness which (for non-trivial problems) characterize information and knowledge about: current and future state of affairs; the behaviours and actions of agents that affect both what is done or not done with regard to the problem-solving process (Dimension A); and, the application of decision support system inputs and outputs to the matters at issue.

We note and emphasize that the term "**rudiments**" in the title of Figure 1 is both appropriate and advised. The Informational Activity box, for example, could easily be expanded to a dozen or so related activities. Also, there are many desired outcomes that could be expressed, and there are many ways of combining or relating the various within-box and between-box entries, depending upon the real world situation under consideration. By reference to rudiments, however, we are able to make the important point that, even at this elementary and overview level, there is little which is simple or easy about defining and elaborating the "foundations of reasoned decisions."

And, we hasten to add, the task of transforming data and information into knowledge is only hinted at in Figure 1. That is, knowledge as a foundation of reasoned decisions requires that it be methodologically derived, and that it pass tests such as verifiability, evaluability, generalization, etc., which characterize scientific knowledge. In this respect, the quest for knowledge takes us into the realm of theories, laws, propositions, hypotheses and models which pertain to both Dimension A and Dimension B, and the linkages between them.

In a previous paper Harris examined the nature of the data-scientific knowledge connection. He used several real world planning situations to illustrate why, although "the data may come easy", it is quite something else to produce rational, scientific bases for action (Clapp, 1985, p. 4):

> "The use of data to support the development of scientific knowledge calls for more than the data itself. At least a preliminary theory is in each case necessary to organize the data, and permit the testing of hypotheses. This necessity extends even to the collection of data—but the theory must be more general (even vague) or we would be unable to accumulate time series and thus to make comparisons and draw conclusions over time.

The need for theory to organize data is somewhat obscured by the technology of statistics based on mathematics and computer power. Statistical models contain oversimplified and possibly incorrect scientific assumptions, but they do provide a vantage point for gaining insight into the meaning of data.

Examples of theories providing a start in understanding data (and vice versa) are abundant in planning. Economic theories underlie many early studies of housing and industrial location. These theories failed to explain transportation demand, however, because behaviour appeared more diverse and less uniform than called for by economic theory. This contradiction led to the gravity model and ultimately to models of discrete choice, which in turn were applied to the housing market. The presence of urban congestion was widely documented but its analysis required a theory about trip distributions and the ability to simulate a network by tracing least-cost paths and assigning trips."

To complete laying the foundation of this section, we need to distinguish between research (the problem-solving process) in the scientific domain on the one hand, and in the public sector domain or the other.

In science, inquiries are undertaken to: 1) add to knowledge of a subject matter nature; and 2) to add to ways and means of continuing to add to knowledge, through new or different research methods, research techniques or research operations. The three types of such study are description, explanation and prediction (Figure 1, Dimension A).

In the public sector, in a rational setting, those three types of study are also present. The public sector embraces two additional study types, however, evaluation and impact assessment (Figure 1, Dimension A). They are used to determine the effectiveness, efficiency, economy, etc. of policies, plans, programs and projects, and provide a basis for deciding whether to maintain or modify them, or to engage in new or different initiatives.

At an indicative level, then, our perspective on progress towards building better information and knowledge bases for better decision-making takes into consideration the degree, extent and rigour to which the field has engaged in:

1. Information-building, IS/GIS-supported activities, and especially high-order endeavours involving analysis and synthesis;
2. Knowledge-building, IS/GIS-supported inquiries which employ hypotheses, models, propositions, etc. in the pursuit of generalizations expressed as theories and laws; and,
3. Methodologically designed studies which, in the public sector (our focus here) means that evaluation and impact assessment studies (of policies, plans, programs) incorporate elements of explanation and prediction in the research design.

BASES FOR DEFINING AND MEASURING REAL "PROGRESS"

It is tempting (and especially in view of the huge and rapidly growing body of related documentation) to limit perspectives to a cursory overview of the most recent or most popular contributions to the literature. Frequently, however, such short-circuiting leads to superficial "quick reads" that confuse symptoms and causes, tangents and central issues, or appearances and realities. Such quick-and-dirty missions of discovery often result in "quick fixes" that fail to address fundamental problems. In addition, they often produce sour if not bitter decision-making environments because expectations of easy solutions are dashed.

We believe it necessary, and perhaps usefully humbling, to briefly review two early and important large-scale endeavours which addressed a range of urban and regional issues. We suggest that they provide a very appropriate term of reference for defining and measuring progress towards integrating information, knowledge, policy, planning, and geography through IS/GIS.

In **1929**, when the first New York Regional Plan was in preparation under private auspices, Columbia University economist Robert Murray Haig proposed a new scientific approach to urban planning. Although Haig's bold initiative was not fully adopted, he succeeded in part by producing maps of the locations of selected industries at successive dates, to demonstrate the nature of urban change and industry patterns. What could be termed a primitive, and perhaps unintended exercise in "GIS", ultimately contributed substantially to the process of future-oriented decision-making, such as occurs in the 1990s. We explain as follows.

Haig's locational maps for industries were used to try to learn how their locations had changed in the past in order to study how they might be influenced in the future by pending decisions. For instance, the fur industry was very tightly clustered (probably in a single building) at each of two dates, but the locations differed somewhat. Such a change would have been thought difficult to make for business reasons; in point of fact, it was caused by a fire in the earlier location. Similar location-related observations applied to the garment industry, which was more dispersed but still tightly clustered.

The conclusion for policy was that based on observations, efforts to relocate these industries over time would be difficult and costly. Such conclusions are based on ideas which may be called to the attention of the analyst by geographic information, but which can usually be elaborated and made into useful "models", or explanations **only** with further investigation, and with the use of concepts and data which are not ordinarily found in an information system.

Hence, although Haig's endeavour had its shortcomings, it did contain many of the fundamental considerations with which we are still grappling in the 1990's, some 55-60 years later.

Moving from New York in the 1920s to Chicago in the **1950s**, we encounter the Chicago Area Transportation Study (CATS), under the direction of J. Douglas Carroll, Jr. The CATS project collected finely (some no doubt said excruciatingly) detailed data on travel patterns, geographically considered, and found ways to project the impacts of various planned transportation changes on the demands of the users.

The CATS study rarely used computers more sophisticated then tabulators, and its maps were simple because the project used a fixed definition of areas, or zones. Yet in every sense CATS functioned as a purpose-built geographic information system, and it probably stored more data and manipulated them more effectively than all but a very few subsequent transportation-based GIS studies or projects.

The example of the CATS study is **extremely relevant** to this discussion, and the Perspectives Track. Hence, a brief account of its origins.

The U.S. Bureau of Public Roads in the early 1950s faced the problem of planning the urban parts of the impending Interstate Highway system. However, it lacked any established way of relating its plans to future needs. Several earlier metropolitan highway planning studies had tried, and failed, to find adequate methods for credibly projecting future demand. Nor could they figure out how to accommodate future demand, given what was known about transportation systems. These earlier studies had collected large amounts of household and industry location data and trip-making records, but lacked adequate means for using them.

CATS, and its immediate predecessor study in Detroit invented an analysis framework for trip generation, choice of mode of travel, choice of route, and system response to total demand, comprising a system of models which collectively provided such means. Using this system, they successively tested over forty different transportation plans for the region. The very same information which overwhelmed previous studies, and produced inadequate guidance to planning, was transformed by the research into operational knowledge of the system, and permitted analyzing its future state.

In our opinion it would not be exaggeration to say that CATS, with the force of its example and the effectiveness of methods which it introduced, began a revolution in land use and transport planning, of which URISA became an important part. Of particular value and importance were the ideas of:

1. the geographic structure of large regions;
2. the use of large-scale and data information bases;
3. the modelling of locational behaviour and transport demand;
4. and the importance of computers in planning and analysis.

As for CATS, it set the stage by introducing a potent blend of in-house information, research, forecasting and planning. And, if we may be allowed a further opinion, we believe that, technological and other progress notwithstanding, there is not today any integrated geographic information system which would readily replicate CATS from current information, or even given the Chicago data-base.

These two examples suggest, and enable us to ask a series of questions about the accomplishments of IS/GIS. The same questions then provide a basis for our estimation of progress which has been made and which still remains to be made in the design and "perfection" of IS/GIS. And, finally, they enable us to examine the role of information in the larger settings of URISA and of decision making generally.

(As an aside, we note that the questions might be raised in conjunction with almost any activity related to public and private decision making, and to an extent we provide some such implications. However, our focus is on information and on URISA—and thus on GIS because of the importance which this technology has, perhaps ***faute de mieux***, assumed in the field.)

Our suggestive questions for defining IS/GIS progress are:

- Is the change in our capabilities to store, map, and manipulate information, from 1929 and the 1950s to 1992, an accomplishment of geography, information theory, computers and electronics, or locational analysis?
- How well are we prepared to answer the questions originally asked by Haig, and by CATS, on the basis of our present capabilities to handle geographic information?
- What capabilities are needed to make "good" decisions with respect to large geographically distributed systems, and to what extent are these capabilities represented in the information systems currently at our disposal?
- To what extent, and how, does the hands-on experience of technical experts in the field of geographic decision-making—that is, analysts, managers, and planners—reflect the strengths and weaknesses of available information systems?
- Do the activities of these and other urban and regional users influence the direction of growth and change in information systems, and if so in what direction? To what extent is their intended influence successful or not?

Those kinds of timeless and very pointed questions are at the centre of defining and measuring IS/GIS progress as it pertains to creating better data, information and knowledge bases for better decisions and outcomes. As such, they and their "precipitators" (primarily Haig in New York, and Carroll at CATS, but other early research types and projects as well) provide a base line for our study.

Our second term of reference for tracking progress is provided by a limited selection of documents which are broadly accepted as **major benchmark statements** on the information/ knowledge/decision relationship. We admit our association and hence familiarly with the documents and/or related research activities, but assure readers that our involvement is only an incidental consideration in their selection. The documents, briefly described, are:

1. **Urban Development Models**, a Proceedings from a 1967 Conference of the same name (Hemmens, 1968). Included in the volume are such ever-timely and pertinent papers as: "Agency Expectations from Predictive Models" (Zwick); "Plan Evaluation Methodologies: Some Aspects of Decision Requirements and Analytical Response" (Steger and Lakshmanan); "The Quality of Data and the Choice and Design of Predictive Models" (Alonso); and "Survey of Planning Agency Experience with Urban Development Models, Data Processing and Computers" (Hemmens). Harris chaired the Advisory Committee responsible for the Conference, and prepared the "Conference Summary and Recommendations". Wellar has reviewed the text on a number of occasions, and used parts of it as a model while directing the urban information activities at Canada's Ministry of State for Urban Affairs in the 1970's.
2. **Urban and Regional Information Systems: Support for Planning in Metropolitan Areas** (U.S. Dept. of Housing and Urban Development, 1968); **Request for Proposals NO. 2-70 for Municipal Information Systems** (U.S. Dept. of Housing and Urban Development, 1970); **and Municipal Information Systems - The State of the Art in 1970** (U.S. Dept. of Housing and Urban Development, 1969). These late 1960s, early 1970s volumes were prepared in conjunction with the USAC Project. They were at the heart of the content and flow of the urban and regional information systems field for a number of years, and were frequently considered at URISA Conferences. Harris was on the Advisory Committee for the first of the three texts. Wellar was a member of the University of Kansas component of the Wichita Falls Consortium for the USAC Project, 1969-1972. He was responsible for several phases and projects on research and development of an Integrated Municipal Information System (IMIS), and most notably the review and evaluation of prior information system projects (Wellar, 1971).

Those texts, and numerous others which could be listed, are part of the body of literature—research and action—which both defines and reports on our progress. And, by the same token, that literature provides an open, common basis for making and assessing judgements about expectations and achievements in using IS/GIS to enhance the decision-making process. We therefore suggest that it is appropriate and necessary to refer to that literature when reporting on progress expected, and achieved, or when judging our report for that matter.

As our final term of reference, we use URISA's own stated record, as it appears in the literature.

The early leaders of URISA, many of whom were involved in the Urban Development Models Conference, and the USAC Project, clearly recognized the importance of better information as a support to better decision-making. We suggest that reference to 1977 and pre-1977 Conference themes, as pertinent today as they were then, provides a useful reminder of the ties that bind information, knowledge, and public policies, plans and programs (see Table 1). Indeed, Edgar Horwood in his 1977 paper, "Perspectives on URISA's Origin and On the Emergence of a Theory of Urban and Regional Information Systems", provided an outstanding overview of URISA's origins, central interests, and prospects for contributing to the increasingly important and complex task of effectively **Making Connections** among information, knowledge, and decision-making.

Themes of URISA Annual Conferences

YEAR	CONFERENCE THEME
1962	Urban Planning Information Systems and Programs
1963	Urban Planning Information Systems and Programs
1964	Urban Information and Policy Decision
1965	Urban Planning Information Systems and Programs
1966	Urban Planning Information Systems and Programs
1967	Urban and Regional Information Systems(URIS) for Special Programs
1968	URIS: Federal Activities and specialized Systems
1969	URIS: Service Systems for Cities
1970	URIS: Past, Present, and Future
1971	URIS: Information systems and Political Systems
1972	URIS: Information Research for an Urban Society
1973	URIS: Perspectives on Information Systems
1974	URIS: Resources and Results
1975	URIS: Computers, Local Government and Productivity
1976	URIS: Information Systems as Services to Citizens
1977	URIS: Information System Inputs to Policies, Plans, and Programs

In the remainder of the paper we examine the literature through the perspectives provided by the 1977 Horwood and Wellar papers. In addition, however, our judgements about progress on information and knowledge bases for decision-making are tempered by the early Haig-CATS efforts, and leading-edge documents such as those briefly examined as our second term of reference.

LITERATURE REVIEW: PROGRESS IN DEVELOPING (AND APPLYING) INFORMATION AND KNOWLEDGE BASES FOR DECISION-MAKING

Due to the vastness of the relevant literature, we make no claims nor pretexts about completeness. Rather this is, and is intended to be, an indicative treatment of the field's efforts to enrich the information and knowledge bases developed as inputs to decision-making. Our approach, therefore, is to select from the literature a representative mix of contributions which we believe warrant mention as methodologically designed studies, knowledge-building inquiries, or seminal reports on informational activities.

Our first entries are papers which have already been judged as exemplary, several of which we previously assessed while members of Horwood Prize Critique juries. These papers from the URISA Proceedings, are:

1. "Toward a Method for the Evaluation of Multipurpose Land Information Systems" by J. Clapp, J. McLaughlin, J. Sullivan and A. Vonderohe, (1985).

2. "Modelling Location for Cadastral Maps Using an Object- Oriented Computer Language" by D. Kjerne (1986).

3. "Legal Issues in Providing Public Access to an AMS: Case Studies and Variances" by H. Roitman (1987)

4. "Adopting and Applying Existing Urban Models: DRAM and EMPAL in the Seattle Region" by W. Watterson (1988) .

5. "Facing Reality in GIS Implementation: Lessons Learned and Obstacles to be Overcome" by P. Croswell (1989)

6. "A Geographic Systems Approach to Fiscal Analysis" by L. Tomaselli (1990).

7. "Real-Time Control of the Transportation of Hazardous Materials" by G. Beroggi and W. Wallace (1991);

   and

   "Open Records Law, GIS, and Copyright Protection: Life after Feist" by L. Peterson Dando (1991).

Each of those papers is a significant contribution to the literature, and each contains elements which "pass muster" when measured against the demanding terms of reference just presented. In the interests of being discriminating, however, and in respect of our decision-making focus, we suggest that the Watterson paper best respects the standards set by the Haig and CATS endeavours, and the Clapp *et al* paper best meets the methodological design condition which we proposed.

In Table 2 we present the URISA Proceedings articles which best satisfy and elaborate the terms of reference that appear in Figure 1, and the discussions in the preceeding sections. Following our remarks about the research—action relationship, there are three general types of papers which we culled from the literature:

1) Articles of a conceptual/philosophical/theoretical nature, with an emphasis on models, frameworks, research methods, and research design;

2) Articles of an applicatious/empirical nature, both exploratory and confirmatory in orientation, with an emphasis on testing hypotheses, and on drawing generalizations from experiences and patterns. These papers would typically be inquiries in search of maxims, rules, or consensus about what it is we (might) claim to know about the real-world relationship between IS/GIS and decision-making; And,

3) Hybrid-type papers with a conceptual-empirical mix, whereby theories/hypotheses/data are expressed as relationships among variables, and the intent of investigators is to search for generalizations that hold up in theory and empirically.

We believe that each type of article is a necessary element in the progress of information and knowledge bases for decision-making. As a result, we accord each "class" of paper equal recognition.

We also believe, however, that the "best" of the papers combine research-action elements. That is, special attention and regard is held for papers which are the result of, or result in, a real-world happening that enhances our information and knowledge bases for decision-making. (Our regret here is that we do not have documentation on the Exemplary Systems winners or competitors, as we consider them to be prime candidates in this category).

The results of our search of selected URISA Proceedings is shown in Table 2. By way of explanation of column 5, the challenge was, and is, to devise a "filter" that would catch all papers that should be caught, and only the papers that should be caught. We hold no illusions, however, that we succeeded, or even that our criteria would be deemed appropriate or sufficient by colleagues and readers. In our defense, we observe only that this is a first-cut at a tricky piece of business, and express the hope that with the help of readers we will do better next time.

On the positive side of what we drew from the Proceedings, we are confident that the articles selected are worthy of careful attention, and especially those papers which in our opinion satisfy several of the criteria. Our concern, of course, is that we missed a number of articles that meet or surpass the criteria that we adopted for our search.

And, as a final explanatory note, we believe that the articles are sufficiently identified in Table 2 that it is neither necessary nor prudent to repeat them all in the references section. Also, having to modify titles in order to meet space constraints is most regrettable. Apologies are extended to any author(s) offended by this license.

PRELIMINARY ASSESSMENT

For reasons of sheer size alone, to say nothing of its inherent complexity, Table 2 cannot be elaborated in this paper. Moreover, given the magnitude of Table 2, and the limited time and resources, it is deemed imprudent to proceed further at this writing.

Instead, it seems wise to await the reviews of our methodology, and the findings from our literature search, before proceeding to undertake a "deep" study of what we think we encountered.

TABLE 2 : FUNDAMENTAL CONTRIBUTIONS TO BUILDING INFORMATION/KNOWLEDGE BASES FOR DECISION-MAKING
(Source : URISA PROCEEDINGS).

Year	ID	Author	Title	Contribution
1965	1	Grundstein	Urban Info. Systems Decision/Control	P,F,M
	2	Rogers	Research Implications/Info. Systems	F,M,R
1966	3	Steger	Development... Management Info. Systems	P,F,M,E,R
	4	Foley	Systematic Approach/Analysis/Lessons	S,R
	5	Kokat	Economic... Regional... Model	F,M,X,S
	6	Siegel	Program Approach... Info. Systems	P,F
	7	Blatt	Keynote Address	P,M,R
	8	Gruen	The Role of Models in Setting Values	P,F,M
	9	Seidman	Urban Land Use Models	F,M,X,S,R
	10	Duke	M.E.T.R.O. Urban Game-Simulation	F,M,X,R
1967	11	Vincent	Cost-Benefit Analysis/Urban Info. Systems	P,F,M,R
1968	12	Shawn	Macro Design of Regional Info. Systems	P,F,M
	13	Savas	Heuristic - Opportunistic Incrementalism	P,F,M
	14	Wellar	Developments in Data Generation Techniques	F,M,S,R
	15	Kaufman	Management Information Systems	P,M
1969	16	Leyland	Cost-Benefit Analysis/Urban Info. Systems	F,M,S
1970	17	Hayes	Managing the Unmanageable	
	18	Miller	Project Performance Information System	P,E
	19	Langendorf	Plan - Evaluation Systems/Model Cities	P,E
	20	Farmer	PPBS and Management Information...	F,M,E
	21	Hoisington	A Methodology for Developing...	P,F,M
	22	Lucianovic	Analytic/Experimental Information	M,X
1971	23	Magraw	Information Systems/Inner City Problems	P
	24	Floyd	Management Reflection	P,E,R
	25	Hopkins	Real-Time Management	P,F,E
	26	Lyon	Integrated Systems Development	P,F
	27	Blair	Measurement for Management...	E,S
1972	28	Delabarre	From Research Results to Action	P,F,M,E,S,R
	29	Carlson	Methods for Evaluating Impact	P,F,E,R
	30	Campbell	Development Guide Model	F,E,S,R
	31	Flax	Urban Indicators/Knowledge/Decide	M,X,S,R
	32	Sellers	IMIS + Quantitative Methods	P,M,X,R

***KEY**: **T**=Theory; **P**=Principle/Maxim/Consensus/Rule; **F**=Framework/Model; **M**=Methodology/Methods(Research/Design/Development)/; **E**=Evaluation/Impact Assessment; **X**=Explanation-Prediction; **S**=Synthesis/Analysis; **R**=Research Agenda

Table 2 continued

Year	ID	Author	Title	Contribution
1977	33	Horwood	Perspectives on URIS Theory	T,P,F,R
I	34	Wellar	Info. Systems an Essential Infrastructure	P,F,M
	35	Cody	The Isolated Policy-Maker	P
	36	Dueker	Information System Inputs to Plans	F,M
	37	Pitt	Infor. Systems/Econ. Dev't Dec.-Making	F,M,E
	38	McGimsey	Info. Systems in Regional Planning	P,F,E,S
	39	Herchert	Information Systems Inputs/Programs	P
	40	Horwood	A Prospective/Transportation SIG	R
II	41	Grundstein	Information/Policy/Human Services	F,M,R
	42	Kevany	Review: 15 Years Geo-Processing	E,R
III	43	Cotton	Computer Technology and Policy	P,E,R
	44	Reed	Comparison/Operational Capabilities	P,F,E,R
	45	Rowe	Environmental Management Decision Support	F,E,R
	46	Phillips	Framework/Analyses Urban Dates Sets	F,M
1979	47	Hyman	Design/Mgt. Info./Evaluation Systems	F,M,E
	48	Peach	Qualitative ADP Decision Model	P,F,M
	49	Hunt	Organization/MIS Integration	T,P,F,M
	50	McLain	Cooperative Forecasting Process...	P,F,M,X
	51	Janossy	Alternative Futures Simulator	F,M,X,S
	52	Blumberg	Fiscal Impact Analysis/Strategic Plan	T,F,M,E,S
	53	Bodutch	CRIS Model: Cost/Revenue Impact System	F,M,E,X,S
	54	Tien	Evaluating the Impact/Framework	P,F,M,X,R
1981	55	Gilbert	Management Model...Data Sharing	P,F,R
	56	Montasser	Applications/Tradeoffs/Impact Analysis	M,E,X,S
	57	Dyer	Land Eval. Model/Concept, Design	F,E,S
	58	Bamberger	Development Qualification...System	F,M,E,X,S
	59	Berkun	Environmental Data Bases/Mgt. Decisions	P,F,M,E
1984	60	Steger	Private Sector, Trends	F,E,S
	61	Rodammer	Guidelines to Assist	F,E,X,S
1985	62	Robbins	Methodology/Spatial Data Techniques	T,M,E,R
I	63	Alexander	Design/Multi-User Land Data Base	P,M,R
II	64	Dakan	Data Mgt./Data Analysis/Geostatistics	M,X,S,R
III	65	Wellar	International Comparisons	P,F,E,R
	66	Fowler	Local Gov't Info. Systems/Australia	P,E
	67	Wellar	Local Gov't Info. Systems: Canada	P,F,E,R
	68	Brussaard	Local Gov't Info. Systems: The Netherlands	P,E
	69	Barnes	Overview of ADP/ United Kingdom	P,F,E
	70	Kevany	Local Gov't Info. Systems/U.S.A.	P,F,E,R
	71	Nuttall	Evolution of a Reg'l Info. System	M,X,S,R
IV	72	Mize	NOACA's Comm./Indus./Dev't System	F,X,S
	73	Wennlunds	Methods/Pop. Estimates-Projections	M,X,S
	74	Kriger	Travel Demand Forecasting Models	P,X,S

***KEY**:T=Theory; P=Principle/Maxim/Consensus/Rule; F=Framework/Model; M=Methodology/Methods(Research/Design/Development)/; E=Evaluation/Impact Assessment; X=Explanation-Prediction; S=Synthesis/Analysis; R=Research Agenda

Table 2 continued

Year	ID	Author	Title	Contribution
1986	75	Anderson	Simulation Modelling/Reg'l Scale	F,M,X
I	76	Onsrud	Land Information Research Needs	R
II	77	Kevany	Assessing Productivity Gains	E,R
III	78	Wei	Long Range Planning	T,F
	79	Djunaedi	PLAN-DDS/Micro-Based System	M,S
	80	Heseltine	Master Plan: A BASIC...	F,E,X,S
IV	81	Lam	Can Decision Theory Work/Planning?	T,F
	82	Tryggvi	Development Tracking: A Method	E,X,S
1987	83	Karimi	Strategies/Distributed LIS	P,F,M
I	84	Anderson	Methods/Calculating Land Cap./Suit	M,S
	85	Saarinen	Development Success/Org'l Cond's	T,F,R
II	86	O'Reagan	Geocoding Theory and Practice	T,R
III	87	Meulen	Microcomputer Aided...Planning	F
	88	Eichelberger	Expert Systems... Future Projects	M,R
	89	Barb	Development of an Expert System...	M,E,S,R
IV	90	Klosterman	Guidelines/Computer-Aided Models	P,M,R
	91	Quinn	GIS/Monitor Goals/Lessons	P,R
	92	Blowers	Quant. Methods/Comprehensive Dev't	F,E,X,S,R
	93	Steger	New Approaches/Forecasting Systems	F,M,E,X,S,R
	94	Crebari	Info. as Organizational Asset	P,M,R
	95	Weir	Land Management Tools...Strategy	F,M,R
	96	Joffe	Guidelines for Evaluating...	P,ME
1988	97	Niemann	Research Needs: LIS/GIS Technology	R
I	98	Williamson	Land Info. Systems Research Agenda	R
	99	Chowdhury	Land Data/Multipurpose LIS	T,P,R
	100	Zwart	Real Impact/Land Info. Systems	P,M,E,R
II	101	Brown	Assessing Org'l Preparedness/LIS/GIS	P,E
	102	Dangermond	Designing GIS for the Public	P
	103	Florence	Admin. Guidelines/GIS Management	P,M
	104	Ferreira	Distributing Spatial Analysis Tools	S,R
III	105	Wennlund	Socioeconomic Data Development...	F,M
	106	Steger	Improving the Use of Expert Systems	M,E,S,R
	107	Marshall	Approach to Developing Integrated IS	P,R
	108	Wellar	Institutional Maxims/Conditions...	P,R
	109	Wellar	A Framework for Research	P,F,M,R
1989	110	Ferguson	Choice Behavioral Modeling and GIS	F,M,R
I	111	Markow	Life-Cycle Cost Evaluations...	P,E
II	112	Wellar	In Truth, What Do We Know About GIS	P,M,E,X,R
	113	Williamson	Conceptual Modelling/Design/Systems	F,M
	114	Morgan	Guidelines for Specifying GIS	P,F,M

*KEY: T=Theory; P=Principle/Maxim/Consensus/Rule; F=Framework/Model; M=Methodology/Methods(Research/Design/Development)/; E=Evaluation/Impact Assessment; X=Explanation-Prediction; S=Synthesis/Analysis; R=Research Agenda

Table 2 continued

Year	ID	Author	Title	Contribution
1989				
II	115	Somers	Organ'l Change/GIS Implementation	P,R
	116	Rourk	GIS Implementation Pilot Project Studies	P,F,M,E
	117	Kramer	A GIS Application Design Methodology...	P,F,M,S
III	118	Chu	Zoning Administration by ExpertSystem	P,F,M,R
	119	Amer	Expert Systems/Urban Transport'n Planning	P,F,M,E,S,R
	120	Han	Knowledge Sources/Expert Systems	P,F,R
	121	Parr	Amorphism and Order/Plans Review	P,F,E
1990	122	Crichton	Agricultural Land Assessment Approach	M,E,S
I	123	Weber	Effective Use of GIST/Environmental Mgt.	E,S
	124	Johnson	Interactive Hydromet/Forecasting	F,X,S
	125	Yang	Integrated Info. Mgt. Simulation System	F,E,S
	126	Steger	Clean Air, Small Area Data...	E,S
	127	Patterson	A Dynamic Disaggregate Model...	F,M,X,S
	128	Freund	Vertical Integration/Possibility	M,X,S
II	129	Geertman	Design-Evaluate GIS Alternatives	P,F,E,S
III	130	Hoover	Concurrency Management...	F,M,E,X,S
	131	Akkerman	Procedure for Change Measurement	M,X,S
	132	Bohl	Demographic Database/Case Study	F,S
	133	Prosperi	Appraiser Files: Untapped Resource	F,M,S
	134	Patterson	Aggregate Transportation Demand Models	F,X,S
1991	135	French	Analysing Development Policies	F,M,E,S
I	136	Bright	The "ALLOT" Model/Demand Distribution	F,X,S
	137	Davies	Applying Expert System/Methodology	F,M,S
	138	Osborne	Improved Management and Analysis	F,S
	139	Steger	Global Warming Information/An Assessment	F,E,R
	140	Kulkarni	Replacement/Maintenance/Priorities	F,X,S
	141	Olson	Modelling Earthquake Casualties...	P,F,M
	142	French	Knowledge-Based Approach/Assessment	F,M,R
	143	Beroggi	Real-Time Control...	F,E,S
	144	Padgett	GIS/Risk Assessment Contamination...	F,S,R
	145	List	Exploring Multi-Objective Strategies	F,M,X,S
II	146	Alberti	Suitability Analysis/Impact Modelling	F,M,X,S
	147	Coleman	Three-Dimensional Modelling...	S,R
II	148	Helgeson	Expert Systems/Analysis of Applications	P
	149	Han	Integration/Prog. Models - Expert Systems	F,M,S,R
IV	150	Enache	Maximizing Information Value	T,M,R
	151	Zwart	Indicators to Measure Decision Impacts	P,X,R
	151	Klein	Evolutioning Comprehensive Planing Process	F,M,S,R

*KEY: T=Theory; P=Principle/Maxim/Consensus/Rule; F=Framework/Model; M=Methodology/Methods(Research/Design/Development)/; E=Evaluation/Impact Assessment; X=Explanation-Prediction; S=Synthesis/Analysis; R=Research Agenda

We offer an emphatic **caution** here, however, about Table 2. That is, readers are advised to avoid making hasty judgements about the individual and collective significance of contributions, or the perhaps seemingly disproportionate amounts of writing done for the various criteria. In brief, and to borrow a phrase, "one article on theory could be worth a thousand on analysis". And a similar relationship could hold among the other criteria as well.

It is our intention, therefore, to present our comments on what it all seems to mean, and where it all might be heading, at the URISA '92 Conference. Simply put, we wish to, and must, give this matter further, serious consideration before putting an interpretation to paper. That will occur in due course, when we go into the next phase of our inquiry into progress on building robust information and knowledge bases for decision-making.

CONCLUSION

In the paper, we first propose and outline a framework and methodology for reviewing the URISA Proceedings (and other) literature in terms of contributions made to information and knowledge bases for decision-making. We call on the scientific-methological literature, several exemplary research action projects, and our respective and collective experiences, in proposing what appears to be a sound framework for conducting this review.

Then, in Table 2, and using eight criteria as our filter, we present what we believe to be a reasonable first-cut at identifying some of the more pertinent contributions to the building of information and knowledge bases for decision-making.

We are persuaded, however, that it is premature to attempt to draw generalizations at this stage. Rather, it appears more appropriate to accept that we have gone as far as we should on this paper at this time.

NOTES

1. Soon after completing a draft of the historical and philosophical context for this paper, Harris was called to Indonesia on a World Bank assignment. Wellar therefore accepts total responsibility for what is and is not in the sections on "Literature Review," "Assessment," and the "Conclusion," and he accepts full responsibility for any errors of omission or commission that he introduced into the work of his esteemed colleague when completing the other sections.

2. We use IS/GIS or IS/GIS/LIS in the paper only as a handy reference to information systems; clearly, there is an extended **family** to be considered.

3. For additional and similar comments on the planet's health see, for example, the **State of the World Annual Reports,** and the **Worldwatch Papers,** prepared by the Worldwatch Institute, Washington, D.C.

4. There are many excellent texts on the general topics of methodological research, and decision processes. The following references are among those which shaped the content of the present paper: (Ackoff, 1953; Bertalanffy, 1968; Kaplan, 1964; Rapoport, 1967; Simon, 1969/78; Whitehead, 1926).

ACKNOWLEDGEMENTS

For their contribution, which went far beyond the requirements of a course, we acknowledge with gratitude the literature search assistance provided by John Blatherwick, Steve Dolan, Roy Ketcheson, and Phil Wilson, students in the Department of Geography, University of Ottawa. In addition, we are indebted to Nicole Boucher-Chabot, Secretary, Department of Geography, University of Ottawa, whose deciphering and typing skills made this paper possible.

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* The references listed are from the body of the text, and do not include those contained in Table 2. We believe that the latter are adequately identified to enable ready identification; regrettably, easy retrieval in some cases is another matter.

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INFORMATION SYSTEM INPUTS TO POLICIES: 1977 REVISITED

Abstract: The authors review the relative atrophy of URISA policy analysis interest during the intervening fifteen years — but are quite optimistic that, if URISANs pay more attention to the policy process and its linkage to GIS, they will be successful in having a significant impact on the policy analysis process. Increasing demand for their services will come about because: first and foremost the Federal level now dictates the use of sophisticated data bases and analytic techniques in public policy formulation; second, at all levels of government, the emergence of lesser-scale and more precise decision models and the personal computer have saved the "era of analysis" from extinction; third, the personal computer has brought the information implosion to user-friendly, PC-based centralized data bases; and fourth, there is now money for policy analysis and research, with a growing adversarial process in the case of analytic techniques. Counterparts to these trends at the state and local levels are investigated, indicating similarities and differences between these levels.

The authors believe that the URISAN has a great comparative advantage in these policy analysis matters — be he local, regional, national, international, or global. Essentially, all public policy — as politics — is "local". Where people are and how they fare is fair game for the URISAN. GIS and policy analysis are **not** an oxymoron.

INTRODUCTION

When Barry Wellar asked us to think about updating the 1977 review of where URISA had been since its inception, (Steger, 1977) regarding information systems inputs to policy analysis, policy development, and policy assessment, we figured to have a much easier time of it than the earlier article. Why? Because in the last decade, URISANs have turned their attention **away** from policy analysis and policy research — the "demand side" for many of their earlier services — and have focused, instead, on the "supply side," the geographic information system (GIS) and urban information system (UIS) technologies which have so clearly distinguished URISANs from other computer science disciplines and technologists.

However, simply put, we were wrong. Even though URISANs, by and large, became policy-averse during the 80s, the rest of the world did **not.** Even more importantly, new factors have come into play during this period which — we believe — **will substantially increase the use of GIS in the policy process** during this and succeeding decades. In a sense, our task, here, is more difficult: to convince URISANs that, notwithstanding the last decade, if URISANs **do** pay more attention to the policy process and its linkage to GIS, they will be successful. There will be an **increasing** demand for their services; they will successfully impact important policy decisions; and some of them will become rich and famous for so doing.

Why do we believe this? For several reasons:

- First and foremost, the Executive Branch has ordered, the Congress encourages, and the Judicial Branch expects the use of sophisticated data bases and analytic techniques in public policy formulation. Given the **requirement** that one use these tools, the question of whether they **should** be used or not is now moot.

- The emergence of lesser-scale and more precise decision models and the personal computer have saved the "era of analysis" from the extinction to which implementation and technical difficulties and disenchantment in and with the use of large-scale models had almost doomed it.

- The personal computer has brought the information implosion to earth: user-friendly, PC-based centralized data bases have begun to push us towards supporting a "new incrementalism" whereby individual analysts can provide robust and defensible analyses of the primary effects of many (if not all) policy issues and their options.

- There is now **money** for policy analysis and research, with a growing adversarial process in the case of analytic techniques — "my model vs. yours": datawars (Kraemer, 1987; Danzinger, 1982; House, 1977) **are** expensive but datawarriors **need** to play and be paid!

- While for the most part, "GIS/policy analysis" has been an oxymoron, the exceptions to this rule have become more frequent. We predict: GIS will become a very significant component to the information systems basis of policy analysis and research.

But first, a few definitions are in order: policy, policymaking, and policy analysis and research.

Today, we talk about federal (or state or local) **public policy**, connoting the general set of goals, objectives, missions, principles, resolutions, and pronouncements of the federal (and subnational) government(s). **Public policy** is created throughout the government, that is, Congress legislates policies, the

Executive Branch implements policies, and the courts fine-tune policies. Public policy, in general, represents the current amalgam of all these various actions. While most individual public policies have little direct effect on how the majority of us live, the direct and secondary impact of many other policies (and the **combined** impact of the multitudinous decisions made by all the public sector decision makers) have profound impacts on the way we approach daily living. Figure 1 portrays only the more prominent identifiable persons and institutions involved in the continuing federal policy review process (House, 1991).

MANDATED POLICY ANALYSIS

As we have said, by the 1980s, proponents of detailed quantitative methods and requirements for specific data had gained enough credibility with politicians that such methods were incorporated into laws and executive orders. The most famous of these and, indeed, the mandate for, and fundamental substantive requirements of, policy and regulatory analyses performed by most U.S. Federal agencies are defined in two directives promulgated by the executive branch of the Federal government. These directives are Executive Order 12291 and the Regulatory Impact Analysis Guidance developed by the Office of Management and Budget (OMB) to facilitate implementation of the Executive Order.

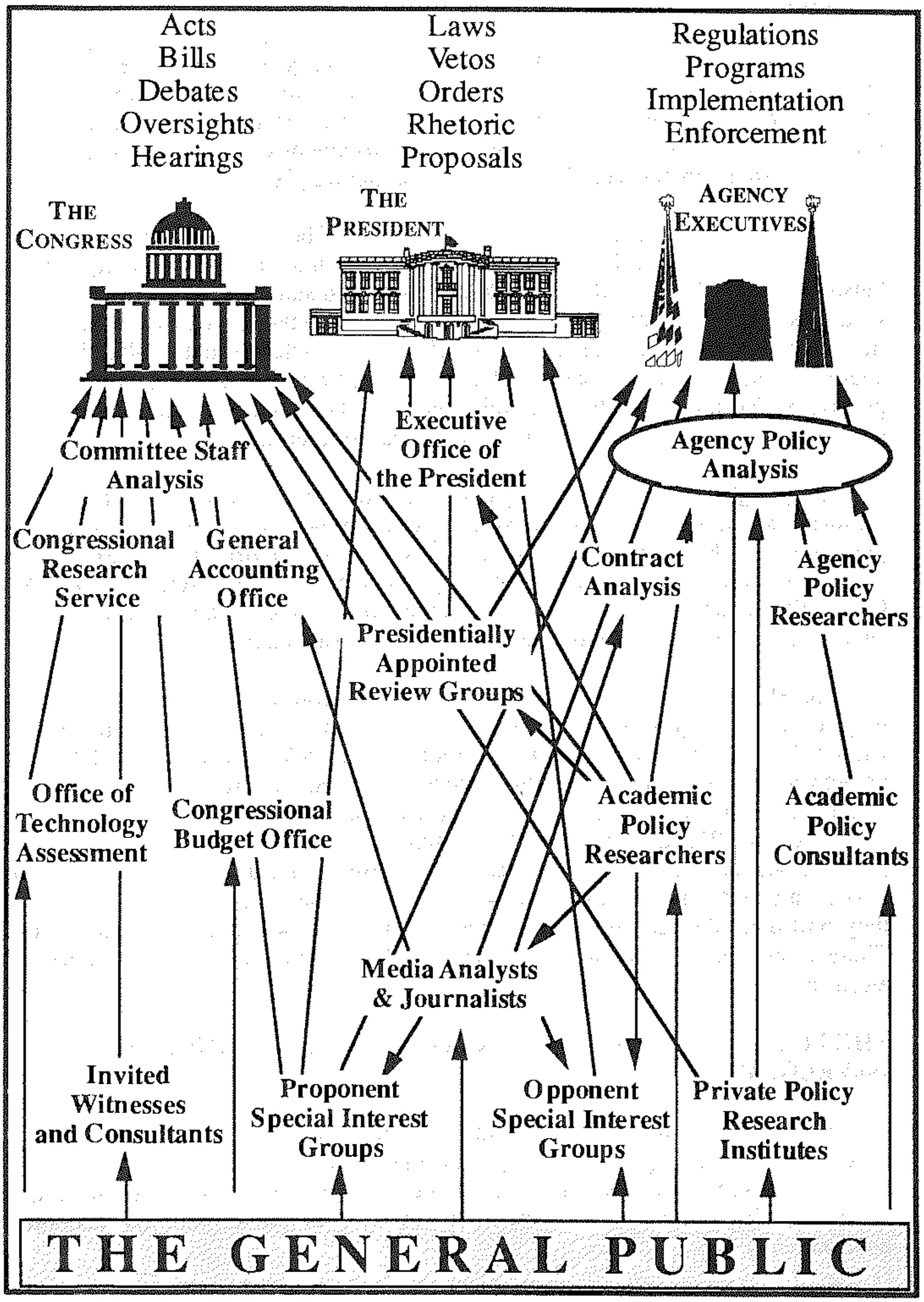
Executive Order 12291 — Executive Order 12291, effective on February 17, 1981, requires a thorough cost-benefit analysis of every proposed major regulation, "to the extent permitted by law." Specifically, Executive Order 12291 requires Federal regulatory agencies to prepare detailed technical and economic analyses, collectively termed regulatory impact analyses (RIAs), for every proposed major policy, rule or regulation.

A primary objective of the RIA process is to ensure that regulatory decisions are based upon adequate information concerning the need for and consequences of regulatory action. When regulatory actions are undertaken, the RIA process should be used to facilitate compliance with three basic criteria:

1. The potential benefits to society should outweigh the potential costs,
2. Regulatory objectives should be selected to maximize net benefits to society, and
3. Among alternative approaches to any given regulatory objective, the least costly alternative should be chosen.

Legislative requirements — Two principal pieces of legislation directly influence the structure of and the analytic procedures used in policy analyses conducted by Federal agencies. These legislative directives are the Paperwork Reduction Act of 1980, which notably restricts the scope of information collection permissible in regulatory actions and regulatory analyses, and the Regulatory Flexibility Act, which establishes specific requirements for the treatment of small entities in regulatory analyses.

Figure 1: PARTICIPANTS IN THE POLICY PROCESS



Although the intent of Executive Order 12291 and the RIA was to improve the process in both private and public sectors, state and local government, as implementors of policy, still find themselves the respondees to Federal regulation. Most programs that do provide Federal or state funding require a large amount of either data collection or analysis to qualify. Local government agencies are often at the mercy of larger agencies, which establish basic population benchmarks statistics such as the decennial census and subsequent estimates, to which they must correspond in applying for funding or preparing plans.

For local governments this provides some relief because it makes the process simpler, but it can be frustrating because there may not be total agreement between what is "local truth" and federally produced statistics. In an extreme case where issues of revenue or representation are at stake, it may even result in litigation. On the other hand, the net effect of mandatory data collection and analysis is that it must be presented and reviewed by local administrators of the programs. To the extent that federally required data collection and analysis has some impact on local government, IS/GIS is part of their policy formation.

Judicial decisions — Several judicial decisions have materially affected the required substance and permissible methodology of regulatory analyses performed by Federal regulatory agencies such as Environmental Protection Agency (EPA) and Occupational Safety and Health Administration (OSHA). Generally, these decisions have maintained or expanded the assessment and analytic requirements for policy and regulatory impact analysis.

The effects of judicial decisions, state and federal, are as relevant locally as they are at the federal level. The relatively recent interpretation of the Equal Rights Act has spurred the Justice Department to review a number of locally created voting districts for discriminatory practices. There can be no greater single policy change than to have boundaries realigned to meet the requirements of the Equal Rights Act and place minority candidates in power. Those jurisdictions that have not come under the scrutiny of the Justice Department are making a significant effort to re-draw the lines for their local jurisdiction so that they will meet the requirements of the Act, and thus will not face legal action. There is no better example of IS/GIS in a local process than the creation of electoral boundaries.

THE PC REVOLUTION: INTERACTIVE APPLICATIONS AND DEVELOPMENT

In the latter years of the 80s and, certainly, now into the 90s, many if not most of the Federal agencies have policy analysis and research offices in which ubiquitous computer knowledge in the professional ranks and the widespread use of P.C.s with attendant sophisticated software is the commonly accepted environment.

With this capability, it is possible for the policy analyst to design rather sophisticated systems which capture not only the data bases relevant to a particular agency but also the technical "smarts" it takes to use this information effectively. Application design and development is moving farther and farther downstream — closer to the people who are closer to the issues: consequently programming is no longer the exclusive territory of specialists in a sequestered environment. By the year 2000, it is estimated, end users will be developing 80 percent of all business and government applications.

The National Science Foundation's Science Policy Information System is an excellent case in point. Data analysts have collaborated with computer programmers to create a data retrieval system that allows executives and analysts the same access to the agency's gold mine (literally!) of science and engineering statistics that veteran programmers have. For executives, the system mimics the expertise of seasoned analysts, serving up facts in their historical context, along with an overview of related information. For analysts, the system offers a sophisticated menu system that allows them to quickly pinpoint needed data in a large, customized data base.

NSF's data retrieval system has three unique components. First, a highly customized data base called CASPAR (Computer-Aided Science Policy Analysis and Research) is fronted by a friendly menu system that helps analysts quickly retrieve the particular data they need — not only for policy analysis, but also for instant responses to executives' questions during briefings. Second, a library of customized Lotus 1-2-3 macroprograms allows analysts to combine data obtained from CASPAR into customized Lotus 1-2-3 spreadsheets in any desired format. Finally, a natural-language query system allows users who are not computer literate to get comprehensive responses to questions typed in simple English.

Peter W. House, Director of NSF's Policy Research and Analysis Division, spearheaded development of the system under Erich Bloch, whose tenure as NSF Director ended in August, 1991. "When (Bloch) asks a question, he expects the answer virtually immediately," House has said. "So he encouraged us to get as much data as we could in-house and under our own thumb." (Knauth, 1991)

These attributes allow CASPAR users to quickly generate data in a variety of formats including spreadsheets, lists and charts specifically designed for data analysis. Policy analysts and other users can even design customized data bases, using CASPAR's regular menu system to extract the data they need directly from the NSF mainframe.

At all levels of government, the IS/GIS field has moved ahead in the area of access to computer processing power. The PC and workstation revolution and the increased availability of graphic data bases such as the TIGER line file, has brought the ability to analyze geographic data in the same manner that Lotus 1-2-3 has made statistical data available. In a single user environment, the workstation is often superior to an IBM mainframe. PC based geographic systems, such as Map/Info and Atlas Graphics, and graphical interfaces such as Motif, have opened the access to geographical data analysis. This puts an added burden on the IS/GIS professionals to make their skills available to provide data, and in more complex situations, incorporate this information into a geographic context for analysis.

The examples of easily accessed systems, due to their use or availability, are almost certainly a harbinger of what will actually be common practice throughout government at every level in the months and years ahead.

In the last fifteen years the society as a whole has become much more sophisticated in terms of every form of analysis. What major retailer would locate without some form of market share analysis. Although local governments have been slow to make the same kinds of analysis, the competitiveness of local governments to seek funds has generated additional data collection and modeling activity to validate their need for an initial, greater share of federal or state revenue.

Modeling at a local level is often performed in relationship to a federal or state guidelines. Transportation and air quality planning often make use of mathematical models. Recent congestion management programs require extensive data bases and modeling. With the advent of the PC and the even more powerful workstation technology, it is now feasible to perform much of this activity on desk top equipment. Once again, the use of models, which often have a IS/GIS as a component, become part of the application for grant money and potentially have the opportunity to be used by public policy makers.

Several, very lively, national level debates have been involved with "my analyses against your analyses." Where the focus is on the state of the economy, analyses reflecting local level consequences — of job and income impacts, public health outcomes, change in consumer price levels, local tax levels, and other local quality of life indicators — are political dynamite. A good example of this process at the local level is the current litigation that New York City, State of California and others have against the Commerce Department concerning the Post Enumeration Survey (PES). The case requires extensive use of expert witness testimony as well as local knowledge to substantiate the general background with specifics.

Such analytic systems are almost certain harbingers of what will actually be common practice throughout the public sector in the months to years ahead. Given the impressive leaps ahead in computer hardware and software, there is great incentive for users to attempt to add the power of the personal computer and workstations to their profession. And all the simplicity and power that these machines seem to deliver really is there. Once the resource investment is made and a data base is in place, the rest is straightforward. The day is actually here that the policy analytical decisionmaking level can be given the most up-to-date information on which to base a choice. In fact, the analytic capability has gone so far as to make a significant portion of this data available automatically.

WHO SAID THERE'S NO MONEY FOR POLICY GIS?

Most of the commentators in the field of large-scale policy analyses modeling have commented on their many flaws and weaknesses, e.g.: the mismatch between the model, the data/inputs, and the policy question, itself; the lack of currency, completeness, reliability and model-compatibility of the data base(s) used; the exclusion of key factors; the aggregation of nonidentical factors; the limited range of prior experience; incorrect assumptions about the reversibility of relationships; uncertainty in the specification and estimation of behavioral responses; and, in general, little **real** knowledge about the analytic model's theory or data accuracy, validity, or completeness.

So why are these tools increasingly popular? Why did the latest count of such models in everyday use in the public sector exceed several hundred? Partly, we believe, the answer resides in the political users (of such models) who either know the above limitations of models or are told the same by an honest, trusted, analytic staff. If a user realizes that the results of the model are not so definitive that they can be taken as gospel, then his most prudent move is to use the results of the model when it agrees with his best judgment and to take it less seriously or ignore them when they do not.

Another reason: the most successful, widely celebrated models are those used because they are effective weapons in ideological, partisan, and bureaucratic warfare over fundamental issues of public policy. Those models that have been most successful were those that have proven most effective in the political battles over either a wide range or, more frequently, a specific policy arena, e.g., the environmental, public health, industrial policy, or similar issues where "playing politics" has become routine. More benign than revolution, or gunplay among politicians, are the several recent attempts to insert analytic procedures into the adversarial process used to make public policy at the federal level. Few, indeed, doubt that the presentation options and the solution of controversial issues through political debate and decision is an appropriate role for the government.

The gross sum of monies such professional assignments have not, to our knowledge, been totaled for each of the last several years, but we have been witness to an order of magnitude increase (in our opinion too little) in the unfolding global climate drama, or the most recent national health policy debates, or those involving global industrial and competitiveness issues. The URISAN could, can and should become involved in the tradeoff analyses involved, in bringing less "panic" and fear to the table and more emphasis on **how** and where to adjust so as to minimize dislocation costs or take advantage of local area "opportunity" benefits.

Government functions, including litigation, at every level have become more sophisticated. As counties challenge states or cities challenge counties in litigation, as they seek to increase their representation or funding, the ability to mount a successful argument will depend on a government's technological skills, including IS/GIS being part of the individual tool kit or arsenal.

GIS AND POLICY ANALYSIS

As we have already mentioned, for most URISANs, GIS and "policy analysis" have been oxymorons. We have, ourselves, not **explicitly** tied these together. We didn't have to. With little or no forethought as to the theoretical significance of tying GIS phenomena to policy problems, one of the authors (Steger) set about — in 1987 — to inform policy clients in the Executive Branch, Congress, the Fortune 1000, small business and industrial trade associations (and policy analysis colleagues) that he was prepared to examine the subnational state, regional, county, urban, congressional district, and other geographical areas — boundaries for their demographic, economic, socioeconomic, public administration, public health, public safety, and other policy outcomes.

A portion of this output has already been documented through the last three URISA Proceedings papers, (Steger, 1989, 1990, 1991) a trilogy on environmental issue problem-solving and the use of geographic information. The first two papers dealt with local air quality and air pollution issues (1989) and, then, the Clean Air Act of 1990 and its regional/national geographic consequences (1990). The third paper dealt with the study, through geographic information systems, of local and regional consequences of global environmental issues, e.g., stratospheric ozone depletion and possible climate change (e.g., sea level rise).

We have not been alone in seeing the top-down (global), bottom-up (local/regional) nexus. Others have dubbed it the "global interest — local consequences" phenomenon. Many see the NIMBY concept (not-in-my-backyard) as a key component. In the words of the 1990 Economic Report to the President concerning global issues:

> Like environmental problems at the local or national level, global environmental problems arise because actions taken by one individual have unintended adverse effects on another. Global environmental problems are complicated by the fact that the individuals involved live in many nations. Because one nation cannot impose its wishes on another, international cooperation is required to solve such problems.

What might URISANs — through their wonderful, often incredible successes in the design and support of GIS technolog —bring to the policy table? Clearly, there are a large number of unique problems of a targeted, **spatial** nature so meaningful to URISANs. The "ground-level" implications—either direct socioeconomic, health and industrial consequences or those scientific phenomena which directly and indirectly interact with and produce climate changes—have been given limited attention (in our opinion too little) in the unfolding global climate drama, or the most recent national health policy debates, or those involving global industrial and competitiveness issues. The URISAN could, can and should become involved in the tradeoff analyses involved, in bringing less "panic" and fear to the table and more emphasis on **how** and where to adjust so as to minimize dislocation costs or take advantage of local area "opportunity" benefits.

If this isn't a challenge for URISANs — replete with GIS requirements — as well as a sense of spatial order, modeling, and quantitative estimation techniques, we don't know what one would look like!

CONCLUDING REMARKS

Even with all the policy implications and the role that IS/GIS should play in policy analysis and policy formation, many GIS managers are either unaware of the tool which they possess or do not wish to enter into the process. Policy is for the most part political, but even policy makers like as much information as possible from which to make decisions. Even though this may fly in the face of the notion that policy makers want to remain "deaf, blind and vocal," they are becoming more enlightened. They have some comfort in the idea that their decisions are not just arbitrary.

Perhaps our initial thought — that national and global policy crises and opportunities are only "local" areas, writ large, is the **nub** of our message, here. Another, perhaps, is the recognition of the importance and magnitude of global issues — so enormous that they are structurally different — but the true impacts are almost entirely **local**. From the point of view of presenting an issue clearly, IS/GIS has a distinct advantage as one of the most easily understood of the emerging technologies. The extent that this makes a GIS a more relevant part of the political process (therefore, more in demand) and improves the chances of a more economically viable project, depend a lot on the individual URISAN's interest in the political process.

The URISAN has a great comparative advantage in these matters — local, regional, national, international, or global:

- The GIS technology approach to **ground truth** is an absolute requirement for all policy issues that are a mix of the physical (technology, science, engineering) and the social (economic, socioeconomic, financial) — which they will come to realize and appreciate. We must increasingly bring it to the attention of policy analysts, politicians, and all involved in the fray.

- **Local** public interest is where the action will be, whether the initial issue is "local" (e.g., a steel plant's emissions), national (e.g., the Clean Air Act), or global (as in climate change): Whose jobs, health, pocketbooks, and quality of life will be affected, and how?

Essentially, all public policy—as politics—is "local": "microeconomic" units are people and businesses. Where they are and how they fare is fair game for the URISAN—either professionally or just to "do good." This is the lot of the fortunate URISAN as he or she prepares for the twenty-first century.

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A PROGRESS REPORT ON PUBLIC POLICY OBJECTIVES ACHIEVED THROUGH IS/GIS/LIS/...

Abstract: Public policies at all levels of government pursue a number of common objectives. These include improving administration through more effective, efficient, economic operations, as well as improving the public infrastructure, and the economic, social, environmental, etc. aspects of life of citizens. And, also shared among governments is the difficult task of defining, selecting, and applying the "best" mix of policy variables and policy information for achieving policy objectives.

In this paper we use three stages to examine the relationship between public policy and IS/GIS/LIS. First, drawing on the literature and the authors' public sector experience, the public policy-IS/GIS/LIS relationship is made explicit. Several scenarios are used to illustrate how changes in external circumstances change public policy responsibilities or choices, which in turn affect IS/GIS/LIS requirements. Second, the published record of URISA is selectively examined in terms of the ways, extent and purposes that IS/GIS/LIS etc. have actually contributed to public policy objectives.

Then, for the third phase, we present a 10-15 year prospective on the potential contribution of IS/GIS/LIS to public policy. Our basis for divining the future is focussed on five major issues or trends that we believe will be central to the IS/GIS/LIS - policy objective relationship for at least a decade. The interpretations and implications attached to the trends are directed at drawing attention to new or different public policy circumstances or objectives, which in turn that could lead to new, different, or increased/decreased policy demands on IS/GIS/LIS.

INTRODUCTION: DEFINING THE NATURE OF THE POLICY FUNCTION

This paper is one of two Perspectives Track reports which examine the contribution of information systems, financial information systems, geographic information systems, land information systems, management information systems, etc. (IS, FIS, GIS, LIS, MIS, etc.) to the formulation and realization of public policies[1].

The potentially wide scope of the policy objectives paper is illustrated when we note the two general purposes served by public policies. First, public policies represent governments' views on the preferred states of affairs—social, economic, environmental, financial, spatial, etc—which they wish to secure or promote for their constituents. And, second, public policies provide direction for programs and plans (the "means") designed to achieve the preferred social, economic, environmental etc. outcomes (the "ends") sought by governments for their constituents.

As specified by Wellar and Parr (1992) in their "instructions" to contributors, we are examing the literature, and our collective experience, to ascertain the contribution of (IS/GIS/LIS) to the **realization of public policy objectives.** The complementary task of Steger and Bannister (preceding paper) is to report their findings on the role and significance of electronic information systems in the public policy process. Tosta and Croswell in turn (the following paper) address the related matter of policies on IS/GIS/ LIS etc. capabilities, and associated data and information inputs and outputs.

In the remainder of the Introduction, we outline and discuss the place of policy objectives vis-a-vis other components of policy formation. A central part of the Introduction and the paper is the need for a framework which serves a dual purpose:

1) It explicitly relates policy objectives to the other components of policy formation; and

2) It provides a generic basis for examining the contribution of IS/GIS/LIS to policy formation matters in general, and to the realization of policy objectives in particular.

Before considering the framework, however, there are several other matters that require discussion.

POLICY TERMS AND POLICY LANGUAGE

We begin by briefly stating what is meant by several key terms which underlie public policy activities at all leavels of government, that is, federal, state/provincial, regional, or municipal.

Goals: These are generalized principles that seek or receive broad acceptance. Their purpose is to encourage and inspire, from the local to national to global levels, and they are often found in constitutions and charters. Conversely, they are not specific statements, and do not directly yield operational guidelines or instructions.

Policy Objectives: These *desiderata*, as means or ends to be achieved by public policies, represent the purpose behind the driving policies specified by an elected body on behalf of its constituents. Policy domains include social, economic, environmental, financial, cultural, political, technological, spatial, and "informational". Policy objectives may pertain to any of the domains in principle and/or practice and may, and indeed often do, involve conflicts in the purposes served.

In regard to our present task, the following terms warrant an explicit reference, as their application "tests" the efficacy of the IS/GIS/LIS contribution to policy objective formulation, monitoring, and continuance or modification:

Success Indicators track the effectiveness of policies in achieving their objectives.

Disruptive Indicators track the adverse impact(s) of policies and policy objectives on other interrelated policy domains or policy objectives.

Distribution Indicators track the incidence of costs and benefits (or other evaluation measures) associated with the adoption and achievement of a policy objective.

For obvious reasons, it is not within the purview of this paper to set out all the basics or fundamentals of policy formation. Hence, we limit ourselves to noting, without further elaboration, that putting the indicators into full, robust operation can involve data/information burdens of "awesome" proportions.

There are two other, related objectives that also bear on policy and IS/GIS/LIS development. We note them here in the interest of completeness, and expect that they will be discussed in detail in other papers.

Tactical Objectives are statements of aims or intentions that specify how resources are to be used to attain explicit parts of the policy objective(s). They may include programs, plans, projects, services, etc. as means to the desired ends (policy objectives).

Operational Objectives are specific assigments of responsibilities, tasks, sub-tasks, etc., and are typically associated with volume, frequency, and other input, through-put or output indications.

As noted earlier, the interest of this paper is in **policy objectives**. The purpose of the preceding serveral paragraphs is to put policy objectives in context: that is, they serve goals, and policy objectives are served in turn by tactical and operational objectives. The latter are topics in themselves, however, and are not elaborated here. Further, we are well aware that development of policy objectives is an integral part of the policy process. However, and as noted earlier, that matter is within the purview of the Steger-Bannister paper (1992).

In addition to defining the key terms which underlie our paper, it is neccesary to examine the **language** behind or in front of a policy objective. And, we use the term "necessary" advisedly, for the obvious reason: many an error has been made, and many a harsh consequence suffered, because of lack of understanding about what was meant by a policy statement and policy undertaking. (This caution is especially pertinent in regard to statements made at election time).

The following are suggested as generally representing the **classes of policy language**: absolute; mandatory ("shall"); permissive ("will", "should", "could"); indifference; and, absence or silence, as in a policy vacuum.

The significance of language to policy statements may be self-evident to some readers, but we include variations on a policy statement in Figure 1 to establish a key point: namely, that there can be varying levels of political commitment to a policy objective.

First, the initial emphasis of policy decision-makers was on Management Information Systems (**MIS**). And the dominant policy interest was planning, as that function contained, and contains, many of the policy objectives of urban and regional governments.

Second, while politicians and their advisors operated then, as now, on the basis of "intelligence", and "feel" for their constituents' wants, they also accepted and called for more and better information. Readers are reminded that "**the urban problem**" arose in the 1960's, due in part to the high level of development action that occurred throughout much of the industrialized world.[4] Among the "decision supports" enlisted to cope with the new order of urban and regional complexity were, in point of fact, information, and for that matter, URISA.

FIGURE 1. On the Language of Policy Objectives

CLASS	TOPIC	COMMITMENT
Absolute:	Wetlands?	A sacred trust!
Mandatory:	Wetlands?	They shall be conserved.
Permissive:	Wetlands?	They will be conserved.
Permissive:	Wetlands?	They should be conserved.
Permissive:	Wetlands?	They could be conserved.
Indifference:	Wetlands?	Of no present concern.
Vacuum:	Wetlands?	

NOTE: The topic of wetlands is, of course, illustrative only, and could be replaced by heritage buildings, old age pensions, spotted owls, green spaces, landfills, highways, mortgage interest deductions, jobs, lakes, tax breaks, property rights, etc. And, obviously, the topics are coupled with appropriate replacements for the policy action verb to correspond with the degree of commitment to achieving the policy objective of interest.

Fascinating and valuable as further consideration of those policy nuances may be, for the purposes of this paper our interest in policy language is at a more prosaic and elementary level. That is, our focus is on the variations in **information requirements** between and among the statements— they range from substantial to totally different—for the tasks of monitoring, evaluation, or impact assessment.

Moreover, to complicate information and decision support matters, shifts from "shall" to "should", or vice versa, or choices to initiate or drop policies,—(the sacred trust - vacuum pairing)—can be cause for great difficulty at the information end of things. And, to complete the picture of politics as "murk", the difficulties of knowing what is intended, and how to do it, are likely compounded if language changes in policy content or direction are of a counter, abrupt, unanticipated, etc. nature[2].

To summarize the Introduction to this point, and relate it to the Perspectives Track, we observe that the intended role of policies is to provide the rationale, envelope and instructions for programs and plans, as well as for staff activities. And, in principle at least, everything involved is proposed, approved, and carried out in the public interest.

In the most effective, efficient and productive of information worlds, properly specified and administered policy statements—on wetlands, housing, economic development, modal splits, taxes, CFC's, water quality, air pollution, land uses, information technology, etc.—would be (perfectly) matched by corresponding, properly specified and administered programs and plans. And, there would be (perfect) consistency and complementarity among the policies, and associated programs and plans. Less-than-perfect situations, and we know that they exist, include those where policies are not supported by programs or plans, where programs or plans do not meet policy needs, or where there are programs or plans that exist without a policy reference.

Obviously, then, since public policies set the course for whatever governments do or do not do, it is a matter of highest priority to examine the relationships connecting policies, plans, programs and the information provided via IS/GIS/LIS.

REVIEW AND ASSESSMENT FRAMEWORK

Our final, introductory remarks concern a critical research design matter. That is, a framework is required to review and assess how IS/GIS/LIS have actually contributed to realizing public policy objectives.

As the reader is likely aware, many approaches are used to elaborate or depict the parts which make up policy formation. We adopt the model developed by Wellar (1987), because the structure and entries in his framework best suit our immediate needs. Of particular importance, and value, is the ability of that model to enable making connections between IS/GIS/LIS and the achievement of policy objectives.

Since it is intended to serve as a context, we do not examine Figure 2 in detail. However, it is necessary to briefly address each set of components-elements. This is done now, so that later in the paper we will not have to repeat

FIGURE 2: Components and Elements to Consider in Examining the Process, Content, and Direction of Urban Policy Formation

COMPONENTS	ELEMENTS
Government Players in the Urban Policy Process **A**	Federal/Central State/Provincial Regional/Local
Status of Government Authority for Urban Policy **B**	Centralized Centralizing Joint Devolving Devolved
Urban Policy Approach/Philosophy **C**	*Dirigisme* *Accommodation* *Laissez-Faire*
Urban Policy Reference **D**	Explicit Implicit
Urban Policy Impacts **E**	Direct Indirect
Urban Policy Objectives **F**	Growth Efficiency Balance Equity Quality of life...
Urban Policy Domain-Spatial **G**	Urbanization Urban Systems Metropolitan Regions Urban Places... Urban Processes Urban Dynamics Urban Interactions Urban Events... Urban Relationships Urban Links Urban Flows Urban Patterns...
Urban Policy Domain-Sectoral **H**	Political Moral Economic Social Cultural Environmental ...
Urban Policy Instruments **I**	Programs Plans Regulations Controls By-Laws...
Urban Policy Variables **J**	Interest Rates/Mill Rates/Taxes/Loans/Grants/ Subsidies/Public Works/ Immigration Levels/ Tariffs/Permits/Land Use/Zoning/Pollution Indexes/ Energy/Recycling/Social Service Levels/Welfare and Unemployment Payouts/Budget Allocations/.../.../...

Source: After Wellar (1987)

**FIGURE 3: Questions to Accompany Figure 2:
Exploring the "Information Situation" Under Various Policy Formation Scenarios and Tasks**

A. What happens to policy formation if a government opts out of, or in to a policy domain (eg., urban affairs, welfare, environment, water, transportation, forestry), or an information activity (eg., a census, a statistical series, a mapping project)?

B. How are adjustments made to deal with decisions of a government to down-load responsibilities, or expand spheres of influence over land, water or air resources?

C. What are the implications of governments changing their positions from leading on on issue (*dirigisme*), to letting the market decide (*laissez-faire*), or vice versa?

D. If policy choices are not explicit at the outset, do they get clearer or murkier over time?

E. For any and all of the aspects of the real world for which governments have policies, what is our capacity to identify, measure, study, and assess the impacts?

F. How do you establish and reconcile policy objectives, most of which are dynamic and many of which are in competition across jurisdictions?

G. What is the policy relevance of the geographic dimension, or "geo-factor", to land, water or air uses and activities? How is that relevance measured, and then applied to policy processes and decisions?

H. What affect does assigning policy priorities to the sectors have on IS/GIS/LIS activities?

I. On the key matter involving the means for achieving policy objectives, to what extent and degree do policies shape the content and administration of programs, plans, etc.? And, conversely, how is information on the performance of programs, plans, etc. connected to policy analysis, evaluation, and assessment?

J. On the key matter involving the **ways** for translating research information into policy advice: How well do we understand the benefits, costs and consequences of choosing among policy variables? How solid is our information on the variables? And, finally, What do we know about their effectiveness when used for achieving the policy objective(s) under consideration?

Source: All the questions are "real-world" in origin; even when taken in total, they merely begin to hint at the "rich" yield that is inherent in Figure 2.

explanations of policy-plan-program connections, information and policy variable or policy objective connections, or the prospective (future) nature of policy objective - IS/GIS/LIS connections.

For convenience, we label the component-element sets in Figures 2 and 3 by A, B, C, D, etc. Then, although much could be written about each set (and Figure 2), we use a question for each set to illustrate what it entails. We believe that the questions presented in Figure 3 combine to effectively demonstrate the connections between the real world, informational activities, and the policy function

Obviously, Figure 2 can be used to raise other questions, concerns, issues, relationships, etc. that extend well beyond those noted in Figure 3. The shift from "urban" to "regional" or "rural" comes immediately to mind.[3] For our present purposes, however, interest in Figure 2 is due to its value as a framework for putting policy objectives in context, for relating policies to programs and plans, and for illustrating that **policy variables** are the basic building block of policy formation. In the next section, and employing Figure 2 as the "filter", we document and briefly discuss reported progress on the ways, extent and purposes that IS/GIS/LIS have **actually** contributed to achieving public policy objectives.

ACTUAL CONTRIBUTIONS OF IS/GIS/LIS TO ACHIEVED PUBLIC POLICY OBJECTIVES: RESULTS OF A SELECTED AND LIMITED LITERATURE SEARCH

It is appropriate to present several qualifiers at the outset to ensure that the limits to this paper are fully appreciated.

First, our work cannot identify and assess all that has been achieved, for an obvious reason: not all that is achieved is published in the open literature, as many readers can readily attest from personal experience. The best-case scenario, therefore, is that what does appear is representative of the state of affairs; the worst-case scenario, on the other hand, is that what appears seriously misrepresents the contribution of IS/GIS/LIS to the realization of policy objectives. Regrettably, we are not yet in position to provide any "hard" evidence one way or the other on that score.

Second, for reasons of time and resource constraints, we make no claim nor pretext of having encountered everything that warrants being included in our inventory of articles or reports.

In that regard we simply observe that this is a first approximation, and that we welcome readers bringing pertinent materials to our attention so that we might do better the next time we address this topic.

TWO KINDS OF REPORTS: EXHORTATION AND DEMONSTRATION

The literature search and our experience confirmed two basic types of articles: those which **exhort** and those which **demonstrate** the use of IS/GIS/LIS to realize policy objectives. We note in the Tables our assessment of the papers as being in the exhortation or demonstration modes, with both terms used on occasion to indicate papers which fall into both camps.

Due to space constraints, there are restrictions on how much can be written about the selected articles. However, for those in the early URISA Proceedings, which may not have been readily accessible to some readers, we present brief summaries.

The articles from the early URISA Proceedings (1965-1969), which are referenced in Table 1, are sufficient to make several key points about our progress.

TABLE 1. Articles on IS/GIS/LIS for Policy Objective Purposes: From URISA Proceedings, 1965-1969

Year	Title, Author, Summary of Contribution, Type of Paper	
1965	**Title:**	"Urban Information Systems and Urban Management Decision and Control"
	Author:	N. Grundstein (1965).
	Summary:	Discusses the politico-strategic area of urban decision and control, notes limits to progress due to urban complexity, and the need for IT to breach constraints of socio-structural processes to enhance policy deliberations and achieve policy objectives.
	Type:	Exhortation.
1966	**Title:**	"Development of a Managment Information System for the New York Planning Department"
	Author:	W. Steger (1966).
	Summary:	Notes the policy domain, ties the matter of "more than 100 truly definable housing policies" to selection of alternatives (policy objective choices), and emphasizes need and difficulty of employing analyticaly based IS at the urban level.
	Type:	Exhortation
1967	**Title:**	"Information Systems for Regional Management"
	Author:	C. Laidlaw (1967).
	Summary:	Succinctly discusses IS as a management device, management as the very political business of getting desired ends accomplished, and IS as the means to enable considering a range of policy alternatives in a mix of decision environments.
	Type:	Exhortation

that are broadly regarded as going wrong due to policy failures, it may be fair to say that (on the basis of what is reported in the URISA Proceedings) the gap between policy interest and policy attention—as they relate to objectives—has widened.

TABLE 2. Articles on IS/GIS/LIS for Policy Objective Purposes: From URISA Proceedings 1987-1991

Year		Title, Author, Type of Paper
1987	**Title:**	"Information Technology for Natural Resource Planning, Management, and Monitoring: A Review and Analysis of Eleven Applications"
	Author:	B. Niemann and J. Sullivan (1987)
	Type:	Demonstration
1988	**Title:**	"Some Observations on the Real Impact of Integrated Land Information Systems Upon Public Decision Making in Australia""
	Author:	P. Zwart 91988)
	Type:	Demonstration - Exhortation
1988	**Title:**	"The Australasian National Strategy on Land Information Management and Its Application by LANDATA".
	Author:	B. Eddington (1988)
	Type:	Demonstration
1988	**Title:**	"Incorporating the Policy Dimension in Local Government Information Systems: Getting Our Priorities Right"
	Author:	B. Wellar (1988)
	Type:	Demonstration-Exhortation
1989	**Title:**	"The Impact of Information Systems on Conflict"
	Author:	E. Epstein and T. Duchesneau (1989)
	Type:	Exhortation
	Title:	"A GIS Design Methodology to Determine the Impact of Large- Scale Commercial Development"
	Author:	M. Kramer (1989)
	Type	Demonstration
	Title:	"Information Resources and Public Decision Making"
	Author:	D. Laws, M. Gross, J. Fabos (1989)
	Type	Exhortation-Demonstration

Table 2 continued

1990	**Title:**	"GIS as a Support System for Designing and Evaluating Urban Expansion Alternatives".
	Author:	S. Geertman (1990)
	Type:	Demonstration
	Title:	"GIS in the Context of Land Use Policies"
	Author:	A. Lam (1990)
	Type	Exhortation
	Title:	"A Geographic System Approach to Fiscal Analysis"
	Author:	L. Tomaselli (1990)
	Type	Demonstration
1991	**Title:**	"Maximizing the Value of Information in Urban Policy-Making"
	Author:	M. Enache (1991)
	Type:	Demonstration-Exhortation
	Title:	"Analysing Rural Development Policies Using a Geographic Information System"
	Author:	S. French and R. Belknap (1991)
	Type	Demonstration
	Title:	"Empowering Local Land Use Planning Officials Through Use of Land Information Technology"
	Author:	B. Haskins, L. Buchan, P. Thum and S. Ventura (1991)
	Type	Demonstration
	Title:	"Fishing for Solutions: Regional and Local Government Entities Cooperate Toward Management/Development Solution"
	Author:	S. Little and C. Turkington (1991)
	Type	Demonstration
	Title:	"California's New Seismic Hazards Mapping Act: Implications for Technology and Policy"
	Author:	C. Real and R. Yoha (1991)
	Type	Exhortation - Demonstration
	Title:	"Feasibility and Application of GIS Linked with Economic Models for National Resource Policy in Australia"
	Author:	P. Sharma and S. Harrison (1991)
	Type	Exhortation

2. The mix of Exhortation-Demontration papers has changed substantially. The latter type of article is taking on an increased presence and conviction, and is addressing a number of the concerns and expectations expressed early in URISA's history. On the other hand, however, and as noted in the recent exhortation-type papers, changes in many of the policy formation components (Figure 2) are precipitating new rounds of concerns and expectations that call for further, moresophisticated applications of IS/GIS/LIS to formulate and realize policy objectives. And,

3. For reasons which may of themselves constitute a separate and important research topic, **there is no** (apparent) **overall coherence or cumulativeness in the literature in general**, as to what is being done or reported in regard to the application of IS/GIS/LIS to formulate and realize policy objectives.

Nevertheless, and notwithstanding our guarded assessment of progress to date, there are grounds for optimism. That is, and in full recognition that the policy function is far and away the most difficult function to comprehend, and to render amenable to IS/GIS/LIS applications, examination of the selected papers in Table 2 clearly reveals that significant contributions are in fact being made.

Moreover, and this point must be emphasized, a number of other relevant contributions are contained in the **seventeen** URISA Proceedings between 1969 and 1987. We are optimistic that the present work will serve as a model or catalyst for a more vigourous and expanded study, as even a cursory review reveals that much more has been achieved than we were able to document in these few pages.

The encouraging reality of what we found, and what we know remains to be processed, is a sufficient condition for believing that, having "cracked the nut", we can pick up the pace in the coming decade or so. In the following section, we present a prospective on several broad trends which we suggest will have a major influence on the nature, degree and extent of our progress towards realizing policy objectives through IS/GIS/LIS activities.

FUTURE TRENDS AND THEIR IMPLICATIONS FOR IS/GIS/LIS APPLICATIONS IN THE POLICY DOMAIN

In this section we attempt to divine what the future holds for information systems in urban public policy-making.[5] Five current trends are reviewed in terms of their perceived impacts on urban communities. They are examined to see if they may lead to new, different, or increased/decreased policy demands on IS/GIS/LIS. The trends we selected for consideration are: globalization; devolution; privatization; decision-making; and, freedom or democratization of information.[6]

Globilization

Globalization is resulting in the freer movement of goods, services, information and companies. In the future, economic success will depend upon selling innovative ideas, and on planning and political "savvy". Global businesses of the future will include amongst others education, information, electronics, biology, communications, transportation, and environmental, financial and personal services.

To be competitive in world markets one must select a market segment, have an economic vision and develop competitive operational and service strategies. This applies to cities as well as companies. We "must be competitive so we can have social programs. The private sector is the engine of growth. However it can't do its job without a good public framework for business."[7]

Cities are now competing for companies and jobs like city states, one against the other. In each case they must look at the base they are building on, identify shortages, and plan improvements. To develop long-term investment policies, cities need to complete economic, environmental, social and infrastructure assessments, that is, collect information and examine their competitive positions.

Some cities may target manufacturing firms "... with a traditional strategy based on low wages, scale, or focus. These older, cost-based strategies require managers to do what is necessary to drive down costs: move production to or source from a low-wage (area); build new facilities or consolidate old plants to gain economies of scale... These tactics reduce costs at the expense of responsiveness" (Stalk, 1988, p.45). Cities attracting these firms may concentrate on supplying low cost trained labour, and on having minimal environmental restrictions, good transportation, and strong social order. By implementing this strategy, less-developed and developing countries are now acquiring more manufacturing jobs and a larger share of the world's wealth.

Other cities may concentrate on having a highly educated and trained labour force, sophisticated communications networks, strict environmental regulations and a self-regulating social community. Their forte may be ideas, education, biology, etc.. Or, it may be manufacturers who use time-based strategies "based on the cycle of flexible manufacturing, rapid response, expanded variety, and increasing innovation." (Stalk, 1988, p.45). These firms use IS systems to collapse order times and engage in re-engineering. They operate capital-intensive, just-in-time factories.

Cities with complementary market strategies may form alliances. In any case strategic planning, both public and private, will require extensive information derived from many sources, including physical and social municipal information.

The aim of the policy objective in the future, as at present, is to organize, make compatible, structure, and deliver information products to the private sector so they can use the information to the community's economic advantage. IS/GIS/LIS can and must be more than a corporate resource service. It can supply information vital to the city's private sector. Community information is part of the municipal infrastructure. Cities and regions could substantially improve their global market positions by developing operational and service strategies fed by community information.

Devolution

In many countries there is a trend of shifting responsibilities—"down-loading" is the popular term—from federal and state/provincial governments to the local level. (Row "B" of Figure 2 and Figure 3). In the past, municipalities were primarily concerned with the development of the physical infrastructure base and its maintenance, police and fire protection, and with primary and secondary education. Decentralization is adding social maintenance and development to the local burden.

Previously, decentralization occurred mainly through delegation, such as by mandates imposed by senior levels on lower tiers. Effective decision-making was retained by the senior level, and municipalities were only accountable for delivery. Since the 1960's, data processing centres have been set up at the local level to handle thousands of individual transactions. This has resulted in a regulated form of operation, the delivery of fragmented services, and client dissatisfaction, as many articles in URISA Proceedings and daily newspapers attest.

In the future, decentralization may be done by devolution. **Devolution means local decision-making** within a "home-grown" policy framework, **and local accountability** for program and plan effectiveness. (Although this aspect is well beyond the scope of our paper, we would be remiss if we did not explicitly note an associated condition. That is, devolution must include—in all fairness—the right or power of municipalities to raise resources (through taxes, charges, etc.) in a manner commensurate with these new responsibilities).

Devolution encourages citizen participation. It satisfies the tradition of keeping government as close to the people as possible to fulfill local needs and desires.

Additional social services may be devolved to the municipal levels. Regional governments could be responsible for integrated planning, setting overall objectives, and coordinating a wide range of services. Local municipalities, of a human scale, are better able to deliver services to the client. To be effective, all services should be integrated at the point of delivery in a holistic manner.

This will require that social and economic information is made compatible, and synthesized at the top (political) level for programming and planning. Specialists would work in the middle to develop, analyze and re-engineer the programs. At the bottom, all programs should be integrated for delivery and data input. Each client may have a "smart card" that contains health data, for example, and permits access to other personnel data. Such a social system should respond quickly and effectively to social needs.

In contrast to central processing and rigid regulations, information compatibility, distribution and service flexibility will be the keys to success. Policy success may be measured in rehabilitation, self-fulfilment and social contributions, and not just in volumes such as the number of visits or number of transactions. IS/GIS/LIS support would concentrate on standards, networking, distributed data bases and compatibility of users' hardware, software and data.

Privatization

There is a trend away from central authority and impersonal institutions and towards self-reliance, interdependence and production sharing.[8] Included in this trend is the breaking of monopolies, and the privatization of public services.

Companies are being changed by satellite communications, electronics, graphic computers, mass media and the use of English as the international working language. As a result, information and ideas are being instantaneously shared and understood. Many large companies are waning, with Olympia and York Developments, the world's largest developer, being a current world-class example of probable "down-sizing" due to its $14.3 billion debt. Small, flexible firms are working together in value-added partnerships.

And, the nature of work itself is changing drastically. Technical and service work is on the ascend.[9] Variety-driven robotic factories are allowing products to be assembled close to the customers. The trend towards miniaturization is continuing. In "the wired world", personal office contact may not be needed on a daily basis. Firms can disperse their offices. It is becoming more important to move ideas, designs and information than to move people and goods. "In the computerized age we are dealing with conceptual space connected by electronics, rather than physical space connected by motorcar." (Naisbett, 1982, p. 33).

As the electronic-information-service economy evolves, living patterns will change. Workers and companies may relocate within the region or they may move out. In any case, changes of "the information society" will change the physical structure of urban communities. Do we need less, or more central office space, urban intensification, and home offices? Will people want to live in our municipalities for self-fulfilment or just to be near to work, that is, to earn money for food, shelter and health?

To understand and properly prepare for and support all these changes, information about the community is required by both the private and public sectors. Can it be unfettered and made available to all? Could this be done by privatizing some municipal IS/GIS/LIS services, while ensuring that privacy and confidentiality rights are **not** violated?

Information is now considered a commodity. It can be kept and given away at the same time. It can be both a current asset, which can be sold out of inventory, and/or a capital fixed asset that is maintained and can be leased and held for its long term value. Valued urban information could be privatized, and the municipality could be the prime customer.

One very pertinent example is a city's GIS mapping data. Such data are expensive to collect and keep current, as we well know. However, mapping data are useful to both the public and private sectors as the foundation of corporate data bases and for many applications. That body of data/information could be collected, maintained and distributed, for municipalities, by private firms which would cause numerous structural and functional changes.

Decision-making

Changes are taking place in a decision-making, in terms of both outcomes and processes. Decision makers are being held accountable for the disruptive side effects of decisions. The side effects are often devastating. The recent Earth Summit in Rio de Janeiro, we suggest, was really a conference about side effects.

A dynamic and multi-purpose framework is needed to help policy-makers create shared visions and monitor results. It should help evaluate which policies, programs, and plans would do the most good without causing disruptions in other areas. Such a framework should give life to Figure 2, for example, by dynamically illustrating interactions and interrelationships under near- or real-time conditions.

An IS/GIS/LIS system that integrates administrative data with physical, geographical information (the natural and built environments) and cultural information (social, economic and political) would be a powerful tool. Figure 4 is a modified geographical version of the Illustrated Goal Areas chart found in the Design for Decision-Making report of the Economic Council of Canada, 1971 (p.69). The chart can be extended to identify specific, tactical objective areas. For example, the goal area "Man-Made Environment"—Settlement and Structures /Infrastructure—can be extended to include transportation, communications, water, sewers, etc... (We note that the term "Man-Made" is that of the Council and not the authors of this paper!)

Figure 4 also includes sample disruption indicators. Unsatisfactory situations, both locally and globally, are often caused by undesirable interactions between programs. Including disruptive indicators in the policy process can help to minimize adverse effects. For example, damage to wetlands may be caused by policy objectives involving roads, buildings, etc.. The damage may manifest itself as pollution or degradation. The public policy-making process should take into account the effects of policy objectives on other areas, and their disruptive indicators.

Figure 5 is a basic illustration of how an IS/GIS/LIS geographical mapping system can form the foundation to integrate and make compatible physical and cultural information. This is a geographical decision-making model of interrelationships at the **fundamental** level.

And, on the other side of the institutional coin, corporate organization structures are also changing. These changes are, in part, induced by information technology. The existing command-and-control organization structures were designed when middle managers held the knowledge, and "the masses" did menial as opposed to mental work. There were many departments and divisions with many middle managers.

FIGURE 4. Government Goal Areas Decision-Making Goal Areas Disruption Indicators

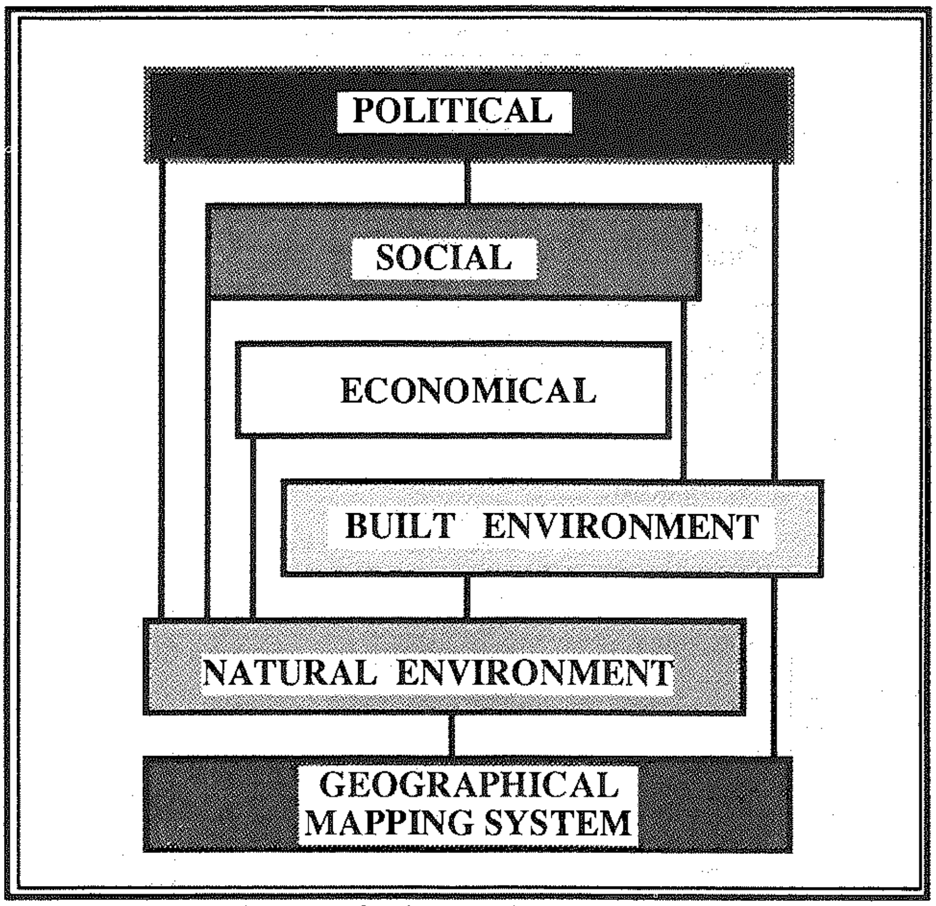
DECISION-MAKING GOAL AREAS			DISRUPTION INDICATORS
Political	Individual Rights and Responsibility	Freedoms and Legal Rights; Political Rights & Responsibilities	**Abridged Rights and Freedoms**
	National Identity	Domestic Affairs; International Relations & Military	**Loss of Identity or Integrity**
Social	Personal Fulfillment	Health, Knowledge, Culture	**Curtailed**
	Social Order	Security of Life & Property	**Failures**
Economic	Goods and Services	Inputs, Efficiency, Distribution, Research	**Shortages; Not Competitive**
	Distribution of Wealth	Training, Resources, Recourse	**Poverty, Concentrated Wealth**
Man-Made Environment	Settlement and Structures	Infrastructure, Shelter, Commercial, Leisure	**Breakdowns, Shortages**
	Land Divisions	Ownership, Use, Administrative	**Destructive Patterns**
Natural Environment	Land, Water Air	Soils, Geology, Hydrology, Climate	**Pollution, Degradation**
	Biology	Ecology, Genetics Distribution	**Unsustainable**

Source: After Economic Council of Canada (1971)

In traditional organizations, IS/GIS/LIS/MIS/etc. stressed control over users. Computers were used for clerical efficiency and for automation of applications.

In an information-based organization—at present and in the future—senior staff must rely on well-educated and confident specialists. "Converting data into information...requires knowledge. And knowledge, by definition, is specialized... The knowledge will be primarily at the bottom, in the minds of the specialists who do different work and direct themselves... Traditional departments will serve as guardians of standards, as centres for training... They won't be where the work gets done. That will happen largely in task-focused teams." (Drucker, 1988, p. 47)

FIGURE 5. Geographical Decision-Making Model: Making Connections



NOTE: Many variations of this model appear in the literature. This version best serves our present purposes because it explicitely illustrates the primacy of the political element in public sector decision-making, the fundamental elements from which and for which policy objectives are derived, and the essential role of the geographic mapping system as the foundation upon which informed policy decisions are based.

Senior staff will be able to tap into the knowledge pool. Barriers to the exchange of ideas and facts will be reduced. There will be a flatter structure with fewer middle managers and many knowledge and service workers.

Management will concentrate on developing common goals, rather than telling workers how to do their specialized jobs. Managers will be learning how to react to possible futures, experiment with ideas, develop what-if scenarios, and **analyze and synthesize impacts**. They must communicate their driving policies and tactical objectives to the independently operating knowledge workers so that the roles and activities of all are optimized. Treating information as a corporate resource will require each participant to "constantly be thinking through what information he or she needs to do the job and to make a contribution." [Drucker, 1988, p. 49]

The numerous islands of information must be integrated for effective decision-making. Regional and local municipalities will increasingly be required to work together and develop standards and rules that minimize complexity. Compatible data, systems, devices, interfaces and networks are needed. The anticipated result is value-added information products, and the delivery of services at lower cost.

Freedom of Information/Access to Information

People who live in urban communities are directly affected by the decisions made. They are therefore increasingly demanding to be part of the process. The trends towards decentralization, devolution and privatization are all related to empowering citizens. Recent freedom of information acts, whistle blower legislation, and sunset laws are all examples of citizen empowerment.

Citizens groups are also asking for access to information. They already have personal computers and on-line access to many data services. They are looking to municipalities to provide systematically organized information about what's planned to happen where, when, at what scale, with what anticipated consequences. They too, want to visualize impacts (Epstein and Duchesneau, 1989; Hydeman, 1974; Saumier and Wellar, 1974; Wellar, 1989 and 1990).

Access to on-line geographically structured information would help them contribute positively to decisions affecting their communities. They would also be quick to point out adverse impacts, both imaginary and real.

In the true spirit of an information society, therefore, it is appropriate that ordinary citizens be the ultimate beneficiaries of whatever is done by local governments to develop and use IS/GIS/LIS capabilities and services. Under that circumstance, it is the unwise local government that is not already taking steps to ensure that **democratization of information** is realized as a **policy objective** in the coming decade.

It may be useful at this point to look forward by looking backwards, and remind ourselves that URISA has been down this road before, with relatively little to show for our efforts in real terms.

That is, at the 1974 Conference, which had **Resources and Results** as its theme, the keynote papers specifically addressed the matter of plugging citizens into the decision-making loop via IT. The combined messages of the papers by Hydeman and Saumier and Wellar were two-fold: **if** properly developed and applied, **IT could** be the means to simultaneously empower citizens—a reasonable expectation in democratic societies—and **could** be the catalyst to bring about needed, rational reform of local governments, indeed, of all levels of government.

As Hydeman said in 1974, "We're on the launch-pad; but it could be a long countdown" (p. 5). We suggest that the time to seize the moment (*Carpe diem!*) is already upon us, and that how well we advance the case of information democratization in the next few years will dramatically affect societal happenings for a number of decades.

Summary Implications of Future Trends

It appears most likely, and indeed may be inevitable, that the five trends explored will significantly impact on municipal policy making and IS/GIS/LIS. In general, there will be an increased demand for information products. The demand will be user driven, and will concentrate on timely service. It is the value of information to the end users that will count in the future, not technology, which now is and will increasingly be taken for granted. Managing the information so that it is compatible and readily available for use is the challenge.

The move towards information-based municipalities does not mean controlling information, we repeat and emphasize. Rather, it is just the opposite, and is achieved by establishing standards and rules that free up the information resource. **IS** will mean **INFORMATION SERVICES.**

The framework presented earlier in the paper (Figures 2 and 3) established ten component-element sets for examining the relationship between IS/GIS/LIS and policy objectives, and for our literature review on what has been achieved in realizing policy objectives via IS/GIS/LIS. The observations in Figure 6 are our divinings as to some of the implications of the five trends for the future of IS/GIS/LIS in a policy formation context.

The second part of this paper provided a view from a distance on past URISA papers. This part provides a "future perspective". Divining the future helps us grope forward down a long dark hall. Or, as Dr. Marshall McLuhan said, "We are driving forward looking through a rear view mirror. We don't expect to be correct but we feel we are heading in the right general direction".

FIGURE 6. Combining the Components-Elements of Policy Formation (Figure 2) and Key Trends: A Prospective on IS/GIS/LIS Futures

"A" The functions of government will change and adjust to an electronic-information-service society. Local governments will increase their information activities to keep their communities globally competitive.

"B" The devolution of authority to municipalities will result in a need for more policy-related information.

"C" Because of the shared public and private need for some information, new public/private alliances will be formed.

"D" The new work environment with many knowledge and service workers, and few middle managers, will require additional information to continually analyze impacts, and to develop and communicate explicit future objectives.

"E" A decision-making framework based on information and feedback with success indicators will be needed.

"F" The decision-making framework will include disruption indicators to help reconcile policy objectives.

"G" A geographical decision-making framework will be used because it includes the interrelationships and interactions between various policy areas and objectives.

"H" A lack of or low policy priority given to information and feedback will result in major damage to policy areas such as the environment.

"I" Policy objectives must recognize the need to monitor adverse impacts on other policy areas, and to implement appropriate means to react to these impacts.

"J" As in the private sector, strategies must be developed to operate effectively in an information-based society. One possibility appears to be to use the freedom of information trend to allow and enable citizen groups to help monitor the adverse impacts of policies, and to actively participate in the selection of policy variables.

CONCLUSION

This paper examines our progress to date, and future prospects, for using IS/GIS/LIS/etc. to formulate and realize public policy objectives. We present a framework of the policy formation process and, using that framework and its elaboration as our basis and guide, we review the contents of two sets of URISA Proceedings: five volumes of the early years (1965-1968) and the five most recent volumes (1987-1991). It is our conclusion that while much has been done, many opportunities were missed. Further, however, while the task is increasingly daunting, there are grounds for optimism that we can close the gap between the needs of the policy function and the offerings of our IS/GIS/LIS/ capabilities.

We completed the paper by discussing the implications of five major trends—globalization, devolution, privatization, decision-making, and freedom or democratization of information—for the relationship between IS/GIS/LIS and the policy function. Just as we used the policy formation framework (Figure 2) as the guide and basis for the literature review, it is used to frame a series of fundamental observations on the emerging linkages between societal and urban futures, technological futures, and information futures.

Our final remark deals with implications, that is, where do we go from here in terms of pursuing the IS/GIS/LIS - policy objective relationship. From a research/education perspective, two initiatives are especially promising, and are summarized as follows.

First, much more material was derived from the literature review than could be incorporated in this paper. As a result, Wellar and his student collaborators will undertake to publish more of their findings during the next year.

Second, there is a distinct possibility that "urban policy" may again come into vogue, after 10-20 years of hiatus in the U.S. and other industrialized countries such as Canada, U.K., France, Germany, etc. If so, the present reference to an urban policy formation framework is most pertinent and most timely.

On the other hand, however, if newspaper, television and radio accounts are accurate in regard to the low level of understanding accorded "urban", "urban problem", "urban policy", etc, then the framework needs to be re-visited and further refined. That is, the framework needs to be shifted from the contextual to operational modes. That includes explicitely stating policy objectives in a variety of combinations of Components-Elements, illustrating which policy variables yield what policy objective outcomes and consequences, and establishing the IS/GIS/LIS information base to support policy variable choices.

During the next year, therefore, Wellar will be reporting on operational adjustments to the policy formation framework. Of particular importance, and difficulty, will be making the changes necessary to reflect current realities in diverse environments. We hasten to add, therefore, that suggestions from readers regarding the Components-Elements, under urban, regional and/or rural conditions would be gratefully received.

NOTES

1. For ease of presentation in this paper, we tend to use IS/GIS/LIS to represent the **family** of information systems resident in governments, business, academia, etc. We note and emphasize, however, and especially in view of the **Making Connections** theme, that we use IS/GIS/LIS only because it is convenient. The trilogy of terms does **not** adequately

represent either the urban or regional information or decision realities, and any one of the IS, GIS, or LIS terms is even less adequate than the three combined.

2. This discussion is adapted from the earlier reports by Wellar (1989 & 1990) on the linkages between policy issues and IS/GIS/LIS issues, and of the need for politicians to "clean up" their policy language.

3. By way of illustration, the framework can be readily shifted from "urban" to "regional" or "rural" policy formation; the only significant modifications are in the component-element sets involving the policy domain-spatial, and the relevant policy variables.

4. Aspects of this topic are discussed by Wellar-Harris earlier in the volume. The current, widespread concern in the U.S. about "the urban problem", precipitated by recent events in Los Angeles and other cities, serves notice of the serious consequences that can arise, or erupt, due to policy formation failures or limitations.

5. Our focus here is "urban", but the comments appear to be applicable to metropolitan areas or regions in general.

6. Obviously, since our "divinings" are based on the trends holding, and generally unfolding in the future as they have through the present, there are some fairly heavy assumptions underlying this Section.

7. That paraphrased remark, contained in a presentation by J. Crispo, Professor of Political Economy, University of Toronto, at a conference in Toronto, March 1992, is indicative of current thinking about the implications of globalization for firms and local governments.

8. We, and the reader most likely, are aware that there are many ideological and other reasons behind the privatization trend. The privatization debate is only important in the present paper, however, for its implications involving IS/GIS/LIS and information futures.

9. In a wide-ranging, "shop-till-you-drop" tour of IT offerings that could transform the workplace, Kindleberger (1983) offers a number of scenarios and references that extend far beyond our brief incursion into future relationships among economic activities, work, and IT.

AKNOWLEDGEMENT

Under very trying circumstances, four students in the Department of Geography, University of Ottawa, reviewed a number of the volumes of the URISA Proceedings, and other proceedings and journals. For their work, feedback, and comments on many aspects of the Perspectives Track, we gratefully acknowledge the contributions of John Blatherwick, Steve Dolan, Roy Ketcheson, and Dave Sutherland. In addition, we are indebted to Nicole Boucher-Chabot, whose deciphering and typing skills made this paper possible.

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THE EFFECTS OF "POLICIES" ON THE IMPLEMENTATION AND USE OF INFORMATION TECHNOLOGY

Abstract: The charge accepted by the authors was to examine the URISA literature in an effort to identify the potential effects of policies on the evolution of technology. Policies were broadly interpreted to mean mandates, laws, or procedures that established a general course of action or direction in use of technology in and agency. Examples include adoption of standards or data dissemination procedures. The task proved to be a daunting one. The URISA literature represented a narrow (perhaps somewhat biased) perspective on the world of information technology and relatively little continuity in agency activities over the years. After searching many years of URISA Proceedings and examining an additional historical record of technology documentation (Datamation magazine 1962-1990), a few threads of issues were revealed. The authors attempt to relate the issues to a variety of Acts of Congress, Presidential Executive Orders, and Office of Management and Budget (OMB) Circulars (policy directives) and to technology activities of URISA members. Lack of time has hindered the successful completion of this exercise in time for publication and URISA '92, but the authors have benefited by the process and offer suggestions to the URISA membership for making better use of their Association.

[Editor's Note: Production schedules required that this paper be placed last in this volume (page 272) rather than with the other papers in this session.]

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ROLE AND USE OF IS/GIS IN THE PLANNING PROCESS

Abstract: This paper explores the ways by which urban information systems technology has influenced the public planning process, and discusses the kinds of additional impacts that can be anticipated in the years ahead. The paper emphasizes changes that have occurred during the last 15 years, building on the 1977 URISA Proceeding papers which explored this topic. Alternative approaches and methodologies for planning as used in different governmental settings are identified. Issues of data collection, modeling, analysis, consensus building, presentation and communication are among the topics examined.

The findings in the papers are developed using several means: a) a modified literature search; b) opinions from representatives of large planning agencies; c) the views of a combination of academics and consultants with experience in this area; and d) communication with others participating in Session III. The authors combine information with observations based on their own many years of direct involvement in the planning process.

INTRODUCTION

Where were you in 1977? Jim Carter was president and most of us had not heard of supply side economics, junk bonds, roller blades or microwaves. URISA experienced its 15th Anniversary, an event that was recognized in the 1977 Proceedings. Now, 15 years later, URISA has its 30th Anniversary, and another opportunity to reflect on the past and to look to the future.

This paper considers how the public planning process has been changed by information systems technology during the last fifteen years and how it is likely to evolve in the years ahead. The paper is organized in terms of five major components.

* A review of the planning process in North America—how it works in different state, provincial and local government settings.

* The dream of planning information systems support—long held aspirations on the part of planners for the use of computer technology.

* The reality of the last 15 years—positive, neutral, and negative implications of technology for the process by which urban and regional planning is practiced.

* Expectations for the future—technical and organizational change that lies ahead and the implications for planners.

* Reflections on URISA—its achievements during the last 15 years and its challenges in the coming years.

From certain perspectives almost everything seems different. In 1977 Stephen Jobs and Wosniac were still in the garage; Bill Gates was a college student; Visicalc had yet to be invented, let alone Lotus 123 or Microsoft's Excel.

But, from other perspectives, things seem more alike than different. Some of the issues of 1992 are very familiar—frustration between generalists and technicians; gaps between rhetoric and reality; computerbased solutions that aren't significantly more productive than manual approaches.

As one would expect, much is different and much the same. This paper strives to identify and explain the many changes associated with computerbased technology that have and that will occur. It concludes that information systems progress, while messy and disjointed, has for the most part been very positive.

THE PLANNING PROCESS

Urban planning is an ancient art, more honored in some societies than others, but practiced by nearly all to some degree. Conscious organization of the layout of towns and villages is evident from archeological excavations throughout the world.

In North America, urban planning has been shaped primarily by democratic ideology. Although special attention was given to urban design in L'Enfant's layout of Washington, D.C. and, later, in plans for company towns and Utopian communities, this practice was the exception not the rule. In Canada, Britain's town planning tradition became a strong influence in shaping twentieth century planning practices.

The common pattern was *laissez faire* subdividing of land into rectangular grids, which provided some degree of order but largely ignored topography and natural hazards. Not until the undesirable health, safety and aesthetic side effects of the Industrial Revolution reached critical stages in many North American cities did the forces for city planning organize.

Emerging from the professions of architecture, public health, engineering, law and the arts, in the United States the city planning movement became a part of the great political reform era that took form around the turn of the century. It took at least another half century to establish urban planning as a normal part of local government.

EARLY URISA ERA PLANNING

In the 1960's when URISA was in its infancy, planning was institutionalized in some form in most North American localities. Many cities by that time had prepared a comprehensive plan for future growth and some were experimenting with early forms of information systems development.

Some states like California began to experiment with mandatory planning requirements for local governments. California is a home rule state which had traditionally delegated land use control to cities and counties. However, in the early 1970's, it became one of the first states which adopted detailed statutory requirements governing local planning and zoning practice.

Under these statutes, each locality was required to have a comprehensive, long range general plan which in turn was required to include a land use element as well as circulation, housing, conservation, open space, noise and safety elements. All general plan elements were required to be mutually consistent, e.g., the land use element could not designate an area for high intensity commercial development while the open space element designated it as a nature preserve.

Also, local zoning was required to be consistent with the general plan. For example, commercial zoning for high rise structures would not be allowable on land designated for single family residences in the general plan. These statutory requirements have been further elaborated in a detailed set of state general plan guidelines.

This legislation triggered a virtual revolution on California planning practice. Prior to this point, adoption of comprehensive plans was largely a matter of local discretion, plan subject matter was up for grabs, and zoning in many instances bore little or no relation to comprehensive plans. Local governments were now essentially being told by the legislature to take planning seriously—a hitherto alien concept among many municipalities.

Meanwhile, other states followed suite in different ways. In Hawaii and Oregon, statewide growth management programs featuring urban limit lines were under way. Florida was experimenting with areas of critical state concern. In Dayton, Ohio, and many other areas, an important issue was the distribution of affordable housing among the various towns and communities within the larger region. In many areas, early traffic models were being applied to areawide networks to determine future transportation infrastructure requirements.

Earth Day 1969, triggered by the Santa Barbara oil spill, stimulated a wave of environmental and natural resource conservation interest. The National Environmental Policy Act (NEPA) initiated environmental impact reporting, first on public projects, and subsequently on private projects in California and certain other states.

Within this rapidly changing context, local planning has evolved to include a number of basic functions, including preparation of comprehensive plans, zoning and development reviews, and special studies.

Comprehensive planning features preparation of extensive studies leading to citywide, area and neighborhood plans for land use, circulation, open space and infrastructure. Prepared along lines of classic problem-solving models, such plans are labor intensive, involving a series of steps such as problem definition, data collection and analysis, examination of alternatives, goal setting, plan formulation, plan production, plan presentation and public discussion, revision and adoption, implementation and feedback. As they have become commercially available, information systems have become important aids to data development and analysis.

A second major function deals more directly with the control of development through zoning and project review, including such processes as zone changes and conditional use permits, design reviews, environmental impact reports and growth management analysis. Information systems have become beneficial to these processes which involve collection and maintenance of substantial quantities of data regarding ongoing development activity.

A third major function is the preparation of special studies responding to short-term inquiries and requests from elected officials and other entities for information on matters such as population and housing, commercial and industrial activity, redistricting, emergency planning and citizen complaints. Many of these latter tasks were aided by early database development efforts, funded in whole or in part by the federal government.

THE DREAM

URISA began as a professional association in the early 1960's, just a few years after the invention of the integrated circuit and 10 years before the microprocessor. From the start, the focus was on ways by which computer technology might improve the operations of state, provincial and local governments. While concerned with all the operational and management functions of government, a special interest has revolved around computer support for planning and policy making.

With most new technologies, there is a constant tug between rhetoric and reality, between the promise of day-to-day life made easier and more fulfilling, versus the reality of old problems persisting or, at best, being partially displaced with new problems. This has certainly been the experience of most URISA members.

For over thirty years the information systems dream, and the frustrations, have been expressed by planners in many settings. In 1963 Hearle and Mason published A Data Processing System For State And Local Government (Hearle, 1963), a book that described, what for most is, an unrealized ideal system. A review of many initiatives since then reveals a number of common themes that collectively have constituted goals on the part of planners everywhere:

* Common data sets that would reduce redundancy, improve accuracy and facilitate interdepartmental and intergovernmental data exchange. The goal has been one of easy access on the part of all authorized users, to master address lists, property files, incident records, all routinely maintained and accurately maintained. In this scenario, the planner is a consumer of data, typically created and maintained by some other department, rather than the builder of a static "data bank."

* Interactive, on-line geographic queries capable of being carried out by generalists rather than computer experts. The goal has been simple, intuitive retrieval of information in a timely fashion. The information may relate to specific records or to larger geographic areas. The ideal systems would present the information visually and indicate the presence of any anomalies.

* Easy access by planners to information associated with other communities. The goal is the ability to conduct an easy search of approaches used by other jurisdictions (e.g., how they deal with zoning variances, tax increment financing, or historic reviews) and of programs offered by other levels of government (e.g., available funding sources, technical support programs or existing literature).

* Tools with which to build and use practical "what if" models. The goal has been that of creating and accessing models able to accurately forecast the likely effects of a new legislative ordinance, administrative policy, development decision or new economic or demographic conditions.

* Communication mechanisms that help diverse groups of citizens to appreciate the realities of community issues and to convey their opinions. The goal is that of better understanding by citizens of planning and development issues, and concurrently a better understanding by public officials of citizen interests.

The words used to describe planning information system goals have changed with time. Today's jargon would likely have seemed quite foreign to URISA members during the first half of our existence. Few would have articulated the ideal system in terms of its "transparency" to the user, its "robustness", "functionality", or its ability to support "seamless" transitions between applications. However, if the vocabulary has changed, the underlying intent remains the same — that of having low effort access to information and the analytical capability to help shape better planning decisions.

THE REALITY

In the late 1970's, there was a considerable amount of cynicism and frustration about planning support systems. The large scale computer models had been shown not to work; many regarded the Urban Information Systems Inter-Agency Committee (USAC) to have been at best a failure and, in the eyes of some, a rip off (USAC Support Panel, 1976); the Fairfax County Plus System initially featured in "Time" magazine, had collapsed. Perhaps, one could generalize that technology had been oversold throughout society — the promise of Defense Secretary MacNamara and his Wiz Kids ("the best and the brightest") in the early sixties had not succeeded in avoiding the agony of the Vietnam War.

This frustration was apparent in the responses to a survey of planning directors distributed in the early eighties (Kindleberger, 1982). Results suggested that systems development progress had been less than expected for a variety of familiar reasons: lack of budgetary priority; poor cost/benefit returns; inter-agency rivalry; too much dependence on technical intermediaries between the user and the machine; too much reliance on ad-hoc rather than routine data collection; insufficient appreciation for the complexity of systems development; and inconsistency with the political process.

1992 PLANNING DEPARTMENT SURVEY

Responses to a survey ten years later (spring 1992 - Table 1) reveal a much more optimistic situation. A letter sent to 50 city planning departments and 50 county planning departments generally confirmed our sense of considerable progress based on communication with a cross-section of experts.

TABLE 1 - Participants - 1992 Information Systems Survey of Selected Planning Departments

City of Albuquerque, New Mexico	City of Naperville, Illinois
Town of Amherst, Massachusetts	Nashville & Davidson County, TN
Village of Buffalo Grove, Illinois	City of Newark, Delaware
City of Colorado Springs, Colorado	City of Phoenix, Arizona
Metropolitan Dade County, Florida	City of Portland, Oregon
City of Greenville, North Carolina	Sacramento County, California
Indian River County, Florida	City of St. Louis, Missouri
City of Indianapolis, Indiana	St. Louis County, Missouri
Livingston County, New York	City of Santa Ana, California
City of Long Beach, California	Sullivan County, New York
Maricopa County, Arizona	City of Tampa, Florida
City of Miami, Florida	City of Tucson, Arizona
City of Milwaukee, Wisconsin	

The survey was organized in terms of five open ended questions designed to elicit opinions. It resulted in about a 25 percent response rate. The fact that individuals at varying levels of responsibility within each department participated and the subjective nature of certain questions make rigorous interpretation of the results difficult; nevertheless, we believe a valid description of the status of planning information systems that can be derived. As with everything, the impact of technology on the planning process has a "good news" and a "bad news" dimension.

The computerbased applications being used to support the planning process are hardly surprising. If typewriters (and carbon paper), columnar pads and key punch cards were standard tools 15 years ago, today's typical planning office relies on word processing, spreadsheets, database management and other common microcomputer or workstation based capabilities.

INNOVATIONS

More surprising is the diversity of innovations about which planners have obvious pride. Typical planning information system innovations include:

* Networking system within and between departments.

* Direct computer links to central property files maintained elsewhere.

* Permit tracking and other case management applications.

* More attractive reports and newsletters made possible with desktop publishing packages.

* Zoning enforcement systems.

* Access to ordinances, regulations and the comprehensive plan.

* Retrieval, analysis and display of demographic, social and economic databases.

* Access to pertinent information associated with every address in the city.

* Improved site plans, cover designs, complex displays, report graphics.

* Monitoring systems for subdivisions, land development and redevelopment plans.

* Improved transportation, air quality and related models.

PRODUCTIVITY

Typical responses to the question of how these new applications have improved productivity tend to be very positive. The general message is that fewer staff can complete more work, that work has become more effective, and that morale has improved.

A much smaller number of individuals are less enthusiastic. They wonder if computerbased applications don't generate more work — more demands for information processing, for revisions, for alternatives. They worry that more data and data processing capability may not only extend the time to complete planning assignments, but lead to data intensive reports that substitute for solid, professional plans. They report of unsophisticated clients who allow planning staff or consultants to provide impressive looking "reams of printout" that don't effectively address the real issues.

EXPECTATIONS

Respondents to our survey are consistent in their anticipation of more useful geographic information systems. Most planning offices are today still in an exploratory or development stage of their GIS, or have one that is used by a limited number of specialists. As they look ahead, planners expect that products like ArcView and other desktop mapping systems will allow GIS to become part of the normal domain of their work.

On the other hand, a surprising number of respondents worry that budget problems will preclude GIS implementation in the coming years. Presumably these are departments who think of GIS in terms of community-wide, parcel level systems with engineering levels of accuracy, rather than the desktop packages and census tract or zip code level maps that can be purchased for little cost.

Other expectations were diverse, if predictable. For example:

* Improved inter-platform communications.

* Better networking with other departments.

* More use of scanning and image processing systems.

* More use of CD-ROM based information.

* Better use of graphic and presentation systems.

* An integrated city (or village) parcel database.

DEPARTMENTAL RELATIONS

How has reliance on other departments, particularly the data processing organization, changed in recent years? Most respondents were clear that planning departments are considerably more independent, using words like "far less" or "drastically reduced" reliance. Some spoke of "downsizing" wherein applications have been transferred from the main frame to a local area network. Others noted their new ability to download information from the central computer for analysis at the departmental level.

Yet the picture is far from clear. Some planning departments indicated more reliance or different kinds of reliance on central data processing, as technical requirements have changed. Moreover, as the planners' appetite for information has grown, a growing number of departments from throughout the city or county government are called upon to share information.

ACCURACY

Responses divided into two categories when asked if their new systems had improved the accuracy and timeliness of data. One group is very positive about the improvements (e.g., words like "definitely", "most certainly", "absolutely"). The second group sees no real change. One or two speak of using the data collected by planners to improve the quality of the enterprise wide files maintained by the central data processing department.

Our sense is that the planners dream of routinely receiving accurate land use, owner-occupancy, building condition, and similar data from other departments remains somewhat elusive.

COMPUTER LITERACY

We asked about the number of computers in each department in comparison with the staff, perceptions as to computer literacy, the level of computing related frustration experienced by staff and the presence or absence of formal computer training programs.

The average responding department indicated the presence of 22 microcomputers and/or terminals, covering 54 percent of the staff. But the range of responses was wide: four departments reported 100 percent coverage of their staff, while at the other extreme three departments reported that less than 20 percent of their staff had P.C.s or terminals.

Most expressed a growing level of computer competency; some, but not a great deal of training; and a mix of frustrations. Examples of frustrations tended to include the slow pace of automation (both a function of budget limitations and the need for authorization by a committee or department other than planning); general planners concerned that GIS specialists were slow in responding to requests, and GIS specialists concerned that general planners were not interested enough in potential GIS uses. Some, but not a lot, of frustration continues to relate to perceived insufficient support from the central data processing department.

COMMUNICATION

Still another area of inquiry related to the extent to which computerbased applications are being used to improve communication with citizens and with the political leadership of the community.

Many clearly think that planning databases are of real importance in dealing with politicians because of the ability to provide "objective, up-to-date, comprehensive data, quickly." Some have initiated routine reports to council members relating to activities in their respective districts, and at least one department reports of supporting a terminal in the city council chambers. Understandably, some stress the continuing "importance of the human interface" —the need for a planner able to filter and interpret information that is given to busy political leaders who, according to one respondent, are often more interested in "public emotion rather than hard evidence."

Planners report of a variety of ways by which computers are beginning to support communication with citizens. Examples include:

* Distribution of public hearing notices.
* Preparation of newsletters and annual reports.
* Information exchange with the public library.
* Voice systems to report on commission actions.
* Voice systems for inspection scheduling.
* Enhanced presentation capability.
* Public access to computer bulletin boards.
* Faxed information to the real estate community.
* Access to ordinances and planning documents.
* Creation of a "24 hour city hall".
* GIS workstations for citizen use at the public counter.
* Preparation of graphics/maps for hearings.

If many of these applications are still in a developmental stage, it is nevertheless clear that planners believe their work can and will be more effectively communicated using technology.

GIS

It is appropriate to close the discussion of the current reality with a look at the GIS explosion. The Guide to URISA Proceedings published in 1975, and covering the papers presented during the Association's first ten years, contained no titles with a reference to GIS (Mathews, 1975). This, of course, understates the growing level of GIS activity during that era.

Starting with relatively crude map products of the 1960's and progressing to more sophisticated products in the 1970's, the potential utility of GIS was increasingly recognized. Maps featuring very broad classes of data depicted in coarsely derived geographic cells were replaced by more precise delineation of map features at much closer scales.

Systematic linkage of mapped data to tabular records and the evolution of relational databases expanded the potential for GIS development for a variety of urban planning applications. Parallel to this was increased exploration of other information system technology and applications to routine planning functions. By 1977, GIS and IS advocates within local planning departments were beginning to catch the attention of decision-makers at the managerial and governing body level, who in turn were asking for more detailed documentation and examples of the benefits of the new technology.

GIS ADVANCES SINCE 1977

Since the late 1970's, new IS/GIS applications in planning have encompassed a multitude of purposes, from conversion of simple road maps and commercial atlases to demographic analysis which shapes comprehensive planning policy, zoning and growth management practices and service district boundaries. Progress has been accelerated by several broad technological trends:

* Improved scanning of data from remote sensing and photographic data sources has increased efficiency of natural resource and land use mapping.

* Hardware miniaturization and diversification, and software improvements have decreased dependence on central mainframe computers.

* User-friendly software together with the introduction of the personal computer has opened up IS/GIS applications more directly to planners in each type of urban planning function.

After decades of hesitation, in the 1980's public and private planning organizations began committing to major investments in GIS due to increased familiarity with its benefits. Utility companies and large municipalities started converting paper maps of their power, water, sewer, gas, and other pipeline and generating facilities into automated files. Planning, building, engineering, public works, tax assessor and related local government departments started building land parcel data files and maps.

As URISA reaches its 30th Anniversary, GIS has become a major growth industry. Industry revenues are reported to have risen last year to something on the order of 3.5 billion dollars, and the demand for GIS products in America alone in one forecast is reported to amount to 100 billion over the next eight years (Economist, March 21, 1992). The GIS World Source Book at 600 pages is now four times its size when first published in 1989 (Parker, 1992). The GIS phenomena has clearly captured the attention of a huge audience, one much larger than those concerned with traditional planning matters.

THE FUTURE

Planners, like most social scientists, do not have a particularly distinguished record in terms of forecasting or predicting the future. The future of technological change and its likely impact on the planning process constitutes a special challenge.

A hint of what may happen five to 10 years out is discernible in the university and corporate research labs. But shrinking elapsed time for product cycles, and the exponential pace of hardware and software development, make even this a very uncertain exercise. To go out a full 15 years may best be accomplished by considering "cyberpunk" and other genre of science fiction (Frauenfelder, 1991).

A shorter range look is presumably easier. Much of the software and computer equipment that will be available at mid-decade is in prototype, or even at an alpha or beta test stage. However, there is no definitive way to know what will find success in the marketplace. At a time when major new operating systems (OS-2-2.0, Windows 3.1, Windows NT, Pink, Power Open, Solaris 2.0, Next Step, and others) and major new microprocessors (Intel 586, DEC Alpha, MIPS R4000, IBM Power PC, and more) have been, or will soon be, announced, even the short term future appears cloudy.

With these caveats, and lots of uneasiness, we look to the future with two time frames — the next three years and the next 15.

THE PLANNING PROCESS IN 1995

This summer Intel is expected to announce its 586 microprocessor chip. Coming only two years after introduction of the 486 DX, it is said to contain 3 million transistors (versus 1.2 for the 486) and achieve speeds of 100 million instructions per second (versus a typical 10 MIPS for a 486 machine). The 64 bit RISC chips from Digital and the MIPS Computer Systems Division of Silicon Graphics will be even faster.

Dramatic technological gains will also be made in the areas of computer storage (both magnetic and optical), networking, data compression and decompression, power requirements and, of course, software.

What will we see over the next three to five years in the typical planning office?

WORKHORSE MICROCOMPUTERS

In all but the poorest or most conservative office, the norm will be that all professional and clerical employees have individual access to a networked IBM compatible 386, Mac II or low end Unix work station. The typical planner will:

* Use a mouse and keyboard to interact with the computer through a graphical user interface.

* Have access to a broad array of agency information (e.g., census, rezoning petitions, subdivision plats, etc.) and to personal resources (e.g., calendar, phone and fax numbers).

* Link via a gateway to one or more organization-wide computers, thereby allowing retrieval of property, business, tax and other public databases for the community.

16 kilobit chips which would be used in the first IBM PCs. As our 30th Anniversary occurs, we are on the verge of having 16 megabit chips commercially available. While a few experts argue that the 60 percent annual rate of increase will slow because the limits of physics are going to begin to be approached, most would argue that Dynamic Random Access Memory (D-RAM) chips holding 16 billion transistors (16 gigabits) will be commercially available well before passage of the next 15 years.

William Joy, Co-Founder of Sun Microsystems, articulates a similar "law" predicting the increase in millions of instructions per second (MIPS) for microprocessor chips (Bairston, 1987). The fastest 64 bit microprocessor chips will achieve around 200 MIPS this year. The Intel Corporation anticipates having a 1 square inch microprocessor containing 100 million transistors by the turn of the century. It will run at 250 MHZ and process 2 billion instructions per second. Similarly hard to comprehend advances will occur in the density with which information can be stored on magnetic and optical disks (and their solid state replacements), and in the transmission speeds of information both within and between computers.

How does one begin to think about both the opportunities and the dangers that will be presented to government planners and to society over the next 15 years. Let's start with the observations of diverse experts:

* William Gates, CEO of Microsoft and John Sculley, CEO of Apple Computer, have each articulated a vision of the future under the terms "Information at Your Fingertips" and "Knowledge Navigation" respectively (Schwartz, 1992). In broad strokes they speak of a world where ordinary people will be able to gain easy access to relevant information from around the world; and to edit, add to, and communicate that information to others with equal ease. This will be an environment in which computers will monitor and filter information in keeping with an individual's defined preferences. This latter concept of, in effect, customizing your own newspaper has been around for some time in prototype form (Brand, 1988); rumors abound that Apple will soon release a program (code-named Rosebud) that scans news wire services for specific requested information.

* Mark Weiser, Head of the Computer Science Laboratory at Xerox Palo Alto Research Center sees a world of "ubiquitous computers" (Weiser, 1991). He describes future environments in which computers are so small and so omnipresent that they have "disappeared" into the background. Currently Weiser and his colleagues use "tabs" ("inch scale machines that approximate active post-it notes"), "pads" ("foot scale" machines the size of books or magazines) and "boards" ("yard scale displays that are the equivalent of a blackboard or bulletin board"). This array of mostly inexpensive machines will welcome people when they walk into a room, ask them if they'd like coffee, monitor activity in the

neighborhood and do a thousand other things to make the details of life easier.

* David Gelernter, Professor of Computer Science at Yale envisions mirror worlds (Gelernter, 1991). These will be highly complex "oceans" of information, full of "live" data streams that can be monitored and analyzed. Mirror worlds will exist to describe specific institutions - a hospital or a school - and whole cities, for use both by specialists and average citizens. We will be able to define or purchase software "agents" that are always on the lookout for particular items or events of interest. We will be able to browse as wide or as deep as we like, bringing a "camera man" with us, as we go from "room to room," or "room within room."

Gelernter sees a computerbased map of a city covered with "performance" meters that describe, typically in colors (e.g., blue is good, red is bad), the congestion of the street, the crimes and cleanliness of the parks, the performance of the schools, etc. At all times, one can seek additional information for a given geographic site, or a given subject, or simply "browse," chatting if you like with others who are browsing. Or one can "zoom out instead of in" striving for an overview, what Gelernter refers to as "topsight."

* William Gibson, author of Neuromancer, (Gibson, 1987) writes of a world of neon, chrome, petty theft, drugs, violence, and computers. "Console cowboys" strive to rob information using "viruses" and "ice breakers" designed to deal with "ice," intrusion countermeasure electronics. Users put on the "trodes," "jack into the matrix" and enter a dimensionless world of cyberspace - full of colors, temperature changes, smells, sounds and visions, always seeking information that others would protect.

IMPLICATIONS FOR THE PLANNING PROCESS

There are countless other views of computer systems in the mid term future which seems to be approaching with such speed. If we can begin to understand the potential of the 100 MIP machines that will enter government departments during the mid 90's, the implications of 1000 MIP machines, high resolution television, national "data highways" and other capabilities expected well before URISA's 45th Anniversary are much more murky.

Here is one speculative view of the planning process in 2007, described in terms of the traditional elements of that process.

Problem/Goals Definition. Government information systems in the early 21st century will presumably allow officials and citizens alike to track community conditions - to know the status of crimes, fires, rusting bridges, vacant buildings, development sites, market trends and all the other incidents and social phenomena with which we work. It is likely that citizens will be able to effortlessly register complaints and express their goals and aspirations, using the interactive cable TV, telephone or equivalent.

Less clear is the extent to which systems will assist in the delineation of major problems from minor problems, or in the development of community consensus around goals and objectives. Planners and other government managers will be challenged to find ways to fill their traditional intermediary role as interpreter and filterer of information. It may be much harder to organize data, putting it in context before its review by the outside world.

Data Collection. It is reasonable to think that the operational systems of government - the revenue collection, permitting function and all the other line operations, will provide ever more data useful for planning. Even traditional land use or building condition survey requirements may be automated (one can image video surveys that are then interpreted by expert systems capable of determining if the gutters need painting or the facade requires tuck pointing).

Major changes can be anticipated as regards our ability to communicate with others in communities around the world and to stay informed about their approaches, techniques and solutions to similar problems. Thus, the promise of LOGIN and other network initiatives in the 1980's should be largely fulfilled.

Retrieval systems, combined with better archiving solutions, should also help departments preserve and make use of their institutional memory. Recalling, for example, the disposition of similar rezoning or site planning matters in the past should become much more a normal activity.

Alternative Analysis. Planners succeed to the extent that they evaluate and explain the costs and benefits of alternative courses of action. Already computerbased systems are beginning to help planners and designers "visualize" an alternative. More and more powerful interactive design assistance machines will enable us to "fly over," "walk through" and otherwise explore hypothetical realities. These visual expressions will not simply describe potential individual improvements - a new building or a new bridge - they will help us to see the likely community-wide implications of specific policies (e.g., a new zoning district) and of continuing market forces (e.g., new construction and abandonment).

Small and medium scale models will help us better understand the likely impact of proposed actions - the traffic implications or school implications, for example, of a proposed development. Less clear is the probability of significant improvements in the ability of complex models to explain and predict social and economic trends.

Plan Formulation. Most planning decisions involve the balancing of competing goals, held by different individuals, often with different concerns on a short term versus long term basis. These are the kind of decisions that may be aided, but not made, by information systems. Perhaps future planning support systems will be able to contribute to the wisdom, inspiration and insight of those who make planning decisions. It is hard to see that such systems will replace them.

Implementation. Traditionally community plans have been implemented using a combination of laws (e.g., the zoning ordinance, the building permit requirements, etc.) and persuasion (e.g., recruiting investors, incentives, etc.). Expert systems will provide direct help in both categories. Future systems will clarify what the existing plan/ordinance allows, indicate steps that need to be followed and highlight possible inconsistencies inherent in a developer's proposal. Systems will also have vastly more powerful ability to explain plans, demonstrating to the political leadership and citizens alike why they are important, and how to carry them out.

The computer will bring visualization to the planning commission room, the board of zoning appeals meeting room and the city council chambers. The potential exists to "even the playing field," to provide information for all, in an environment where too often certain participants (e.g., the developer able to retain an attorney) have been more effectively represented than others. Again the challenge will be to use the computer, with all its multimedia pizazz, in a way that contributes, rather than detracts, from a judicious decision.

Monitoring. The final stage in the planning process brings us to where we started, and to what may be our most troubling challenge. Those concerned with the health of a community need to monitor conditions. Computer systems will soon be able to do that in amazing detail, recording what we read at the library, what we purchase in shops, where we spend vacations and much, much more.

Author Natalie Robins has recently studied the files kept by J. Edgar Hoover during his tenure at the FBI (Robins, 1992). The degree of detail meticulously collected on ordinary citizens is frightening (e.g., the file on William F. Buckley, Jr. was 690 pages). If this kind of privacy invasion could occur in what was mostly a pre-computer age, what of the future? Can we design monitoring systems that meet planners and other government official needs, without endangering basic individual freedoms?

The potential problem may be further aggravated as more and more large private sector files are developed that integrate information about individuals and their dealings with governments and businesses. Balancing the right to privacy with the right to free access to information will be a continuing challenge.

URISA

What is the proper role of the professional association as we look to the future? To a large extent, "more of the same." Annual conferences that provide a forum for learning and exchanging ideas, professionally taught workshops, a newsletter and a journal are all important services, services that URISA provides effectively.

Surprisingly, a considerable number of planning departments contacted in our survey indicated little reliance on professional associations. Whether this reflects perceived shortcomings relating to the associations or simply insufficient budgets to take advantage of them is not clear. However, the finding does suggest that URISA might experiment with additional services in the years ahead.

We can think of a number of possibilities:

* A new set of workshops that are available on tape and computerbased media. These could be rented or sold to both members and non-members. They could provide a reasonable substitute (and perhaps even complement) to the traditional workshops that are offered.

* A CD-ROM with full text retrieval software that contains all our proceedings, exemplary system papers, journal articles, vendor descriptions, etc. Would not the GIS vendor community be willing to underwrite such a project, especially if some advertising could be included?

* Intensive community seminars wherein a group of URISA professionals would conduct systems brainstorming and/or peer review for a governmental jurisdiction. This would be analogous to the Regional Urban Design Analysis Teams (RUDATS) that have traditionally been put together by the architectural profession.

* A variation of this service would be a professional pro bono assistance program whereby URISA members devoted some free time to assisting less affluent communities in their information systems planning.

* An in-depth series of discussions with senior planners, administrators and elected officials. The purpose would be to better understand what information is relevant to various categories of decisions, and the degree of data accuracy (hence cost) that is required.

* A lobbying program to define and advocate positions on privacy, universal access, standards, etc. As computing and telecommunication issues get more complex, it will be increasingly important to consciously define and fight for the best interests of urban and regional communities.

As always the Board of Directors and the membership will be challenged to select those services and projects that will solve problems at a price we can afford.

CONCLUSIONS

Think of the acronyms that we didn't know at URISA's 15th Anniversary. The PC, GUI, LAN, let alone GIS or TIGER, were all, for most of us, terms we would learn in the future. During the next 15 years, we will learn a whole new set of concepts and vocabulary, as the information explosion continues.

This is an exciting prospect. Information systems will do our drudgery, improve our responsiveness, help us to understand and stimulate our creative instincts. The democratizing, liberating and empowering forces made possible by these new tools should make for better planning decisions and, in turn, communities.

Yet, the dark side of computing needs to be recognized. New planning information systems will bring with them further risks of violations of privacy, the potential loss of common standards and procedures, the opportunity for shallow or misleading reports, the ability to avoid planning decisions by getting lost in data, and the further breach between those who have computer access and those who don't.

We end with several simple admonitions. Let's not forget that the real test of new systems will be the extent to which they help lead to better plans and better plan implementation. Nor should we minimize the degree to which management within the organization can make the critical difference between planning information systems that contribute in a fundamental way to the planning process, and those that are irrelevant or impediments to that process.

See you in the summer of 2007.

ACKNOWLEDGEMENTS

Many individuals have contributed helpful ideas. We thank especially Dan Parr, Barry Wellar, Chuck Kofron, Dick Klosterman, Dick Brail, Michael Duncan, Steve Kinsey, Michael Shiffer, Nancy Ferrell and, of course, all the individuals who took the time to respond to the survey.

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ROLE AND USE OF IS/GIS IN ASSESSING LAND USE/TRANSPORTATION PLANS

Abstract. GIS will play a significant role in supporting analysis of land use-transportation interactions in response to growing demands for coordinated land use-transportation planning. GIS support will produce improved data used in equilibrium modeling and GIS will provide for improved visualization of land use-transportation model inputs and outputs.

INTRODUCTION

In 1977, Dueker, Vitt, and McGimsey (Wellar, 1977) each examined information systems (IS) inputs to urban planning. Dueker reviewed the state-of-the-art using land use-transportation planning and environmental impact analysis to illustrate IS inputs to planning. Little tangible impact of IS use was found, but promising steps were anticipated. Better integration of IS, models, and decision-making processes was identified for attention.

Vitt assessed the development and use of a socioeconomic impact analysis system for use in economic development decision-making in Kansas City. McGimsey called for IS to support plan preparation and IS to facilitate independent action of citizens. Improving the overall delivery of information to citizens was stressed.

Common, but implicit in each of these papers was a call for small area data to support planning analyses, and for use to monitor and assess progress toward goals. Subsequently, this demand for data was more systematically articulated (Kinzy, 1980, and Dueker, 1988) by differentiating data requirements by type of application — planning and policy, management, and operations. Development of small area databases around common scales and resolutions facilitates systematic development of GIS databases that support these classes of applications. Clarifying data requirements was an essential step in shifting from an ad hoc or project approach to planning, to an information systematic approach, i.e. the building of databases that serve a class of analysis needs that warrant an investment in building and maintaining a small area database.

A more dramatic change occurred on the supply side. The rapid emergence of GIS technology in the late 1980s has enabled the development of geographic databases and the spatial analysis of them. The GIS technological advancements, coupled with the articulation of the urban data model (Dangermond and Freedman, 1984) has led to dramatic increases in urban applications at the detailed level of resolution, city block and parcel level.

Now that we are able to handle the demands of the 1970s for analysis, circumstances have changed and the demands for analysis have grown. Demands have grown to an extent that new stress is being placed on the supply of technology.

The purpose of this paper is to re-examine database and GIS technology issues in light of new requirements. As in 1977, the land use/transportation planning process will be used to illustrate the role of GIS inputs.

First, the changing requirements for land use/transportation planning will be assessed so that systems to "fight the last war" are not proposed. Second, the development of GIS to support the new process requirements is proposed. However, the paper ends on a cautionary note, pointing out some limitations to the rational planning model that have been identified in the literature.

CHANGING REQUIREMENTS FOR LAND USE/TRANSPORTATION PLANNING

Urban transportation modeling techniques have become a hotly-debated topic, as it was in the '60s (Fagin, 1962). Again the land use–transportation interaction process is central. A number of factors and changes in the past two years have forced another reevaluation of modeling techniques, the focus of the modeling process and the ethics behind the modeling procedures and manipulation. These new developments include the Clean Air Amendments of 1990, the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), and the successful suit brought by the Sierra Club against the Metropolitan Transportation Commission (MTC).

The Clean Air Amendments of 1990 imposes stringent new air quality requirements and deadlines. Regional transportation improvement programs must be assessed annually for conformity with regional air quality requirements. The Intermodal Surface Transportation Efficiency Act of 1991 stresses coordinated planning process to achieve consistent land use and transportation plans. The Act also provides more direct funding to local governments and more flexibility in the use of federal funds for alternative modes of transport.

The court battle between the Sierra Club and the Metropolitan Transportation Commission, the regional transportation planning agency in the San Francisco Bay Area, is the primary genesis of the reevaluation of modeling techniques. This battle began in May, 1990, as part of an effort by the Sierra Club to force various governmental agencies to adhere to the 1982 regional plan designed to bring the

Bay Area into compliance with Federal air quality standards. It revolves around the question of whether adding capacity to severely congested freeways will improve regional air quality as the MTC models showed, or whether this added capacity will simply lead to more sprawling development and more cars using the freeway system, thereby creating more air quality problems. The Sierra Club's success with this suit has serious implications for all regional transportation planning agencies in the country.

At the heart of this battle, is the notion of the relationship of land use and transportation in the American city. This relationship is still not clearly understood and is often referred to as a "which came first, the chicken or the egg?" problem. The traditional focus of transportation planning has been that transportation serves land use. Planners have historically been unsuccessful at defining and modeling the effects of transportation decisions on land use development patterns. A great deal of the literature indicates, however, that:

> In the short run, the direction of influence is predominantly from land use to travel. That is, trip making patterns, volumes, and modal distributions are largely a function of the geographic distribution of activities... What is more relevant in the present context, however, is that accessibility – both immediate and as estimated over the economic lives of real property investments – is a vital consideration as locational decisions are made. Thus, over time, transportation is a significant factor in shaping land use. (Altshuler, 1979)

There are significant feedback loops between transportation and land use. The present challenge to transportation planners is to rework their models to include these relationships. It has become clear that transportation modeling can no longer be done in a vacuum, as has been done in the recent past, and that the results of the modeling process must be "robust" and "defensible" if they are to be used for decision making on major transportation changes. The process must now take into account land use and environmental implications of transportation decisions, rather than take land use and growth patterns and projections as "givens" at the beginning of the process.

As a result of enforcing the Clean Air Act Amendments, the transportation modeling and planning capacity of a major regional transportation planning agency has come to be under the close scrutiny of the Federal Court. This concerns the nation's transportation planners. In response, the National Association of Regional Councils has established a Clean Air Project to provide guidelines to Metropolitan Planning Organizations (MPOs) on how they can best respond to the new modeling expectations (Harvey and Deakin, 1991). "Robust" and "defensible" have now become the key buzz words in transportation modeling circles.

The dispute between the Sierra Club and the Metropolitan Transportation Commission boils down to whose analysis of the effects of adding highway capacity to an already over-congested highway system is correct. As Downs

(1962) has shown, the congestion relief resulting from adding freeway capacity is quickly negated as peak hour congestion rises to meet maximum capacity. The convergence in commuters' timing and route choices tend to force the level of travel to meet capacity. Adding roadway capacity only shortens the duration of the peak. Consequently, Downs concluded that low congestion and optimal speeds during non-peak hours probably constitutes much more practical goals for urban transportation planning than any goal connected with rush-hour traffic. The analysis by Downs exposes a flaw in both the MTC and Sierra Club arguments. Both fail to deal with the true nature of the problem. The freeways of the Bay Area are congested in large part because of severe underpricing of highways. This underpricing has led to over-consumption of highways and to the negative externalities associated with it, i.e., air pollution. Congestion is an inefficient method of pricing the highways: commuters "pay" with their time. Unfortunately, as long as this pricing imbalance exists and highway capacity is provided, inefficient levels of demand will exist. Nonetheless, pricing solutions are largely unacceptable, politically. The search for second-best options continues.

EVOLUTION OF GIS TO SUPPORT COMPREHENSIVE URBAN LAND USE/ TRANSPORTATION PLANNING

Metropolitan Planning Organizations (MPOs) are responsible for comprehensive land use/transportation planning for urbanized areas. In fulfilling this responsibility, small area forecasts of socioeconomic data are needed for input to the travel demand models used in urban transportation planning. These forecasts are driven by monitoring shifts and growth in population, land use and employment that are derived from data geographically referenced by land ownership parcels or street addresses.

As a result of these fundamental demands for data, MPOs and cooperating local governments are increasingly employing GIS to develop and maintain small area databases at the Traffic Analysis Zone (TAZ) and/or census tract level of geographic granularity. In addition to the TAZ attribute data on population, land use, and employment, the GIS is used to maintain the boundary files of the small areas for mapping and display of shifts and growth.

The capability of many, if not most, MPOs is limited to management of small area data. Increasingly though, many have become more technically sophisticated, aided by GIS technology. The following is more a description of leading edge applications.

The data sources for demographic and economic change that are used in forecasting emanate from vital statistics, building permit records, and employment data that are referenced by street address. Consequently, MPOs have become users of street centerline files, DIME and now TIGER, to assign individual records of population, land use, and employment change data to small areas, such as TAZs or census tracts. Having a GIS with address matching functionality is very important to MPOs and other units of local government wanting to monitor urban growth and development.

Finally, MPOs are becoming involved in parcel-level GIS as well. This may be done to get a better handle on measuring and monitoring the quantity and quality of vacant land, sometimes alone, but more often in some multi-participant cooperative venture. A multi-participant setting may be necessary, because the MPO cannot assume responsibility for maintaining a parcel level GIS. Once a parcel-level GIS is implemented, a number of applications become possible, such as buffering around proposed transit or highway centerlines to identify takings for right-of-way acquisition costs, or wider buffers for impact assessment.

The three databases will continue to have separate functions and existence. The small area database will continue to support a variety of monitoring and forecasting functions. The street centerline networks will continue to support a variety of address matching and dispatching applications. And the parcel level GIS database will continue to attract new applications. Improvements in GIS technology have enabled greater efficiency at each of these three levels of geographic granularity. The technology is also providing opportunity for even greater effectiveness by means of integration of these three data resources, which heretofore have been separate and largely unrelatable.

The integration of these databases requires geodetic control that allows their spatial registration. This means that TAZ boundaries correctly match up with streets and jurisdictional boundaries in the other two files, and that street centerlines fall at the center of rights-of-way in the parcel level database. This will assure the correct aggregation from the micro to the macro level. It also facilitates the next step, which is to register digital imagery with the three GIS databases to enable aggregation of interpreted land cover data to parcel, block, and TAZ levels. In addition, integrated GIS databases allow for improved analytical capacity. Instead of conducting locational analysis using straight line distances between pairs of TAZ centroids, the street centerline file can be accessed to compute interzonal distances along streets. Also, more robust allocations of population to service area buffers can be employed by using parcel level data rather than an area proportion method when using TAZ data. This kind of integrated GIS is now feasible in urban areas, and they will be needed to support the growing demands for data to fuel the models.

GIS SUPPORT FOR MODELING

Although the interaction of transportation and land use has been well recognized for many years, the computational power to model the interactions was not well developed. Consequently, the models used were greatly simplified, as illustrated in Figure 1. Land use was forecast and/or planned, and transportation demand was forecast to serve that plan, without a feedback loop. From this forecast came a plan for transportation facilities to serve the land use.

FIGURE 1: Sequential Urban Transportation Planning Process

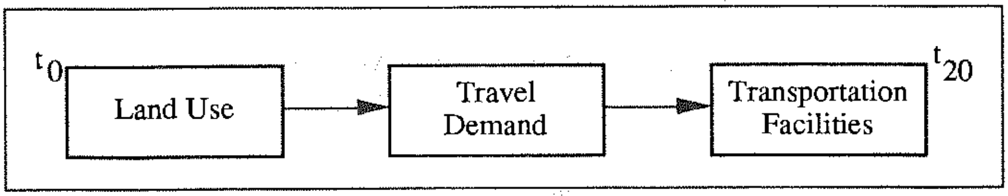


Figure 2 illustrates the process with the appropriate feedback loops to provide an iterative solution to achieve equilibrium between land use and transportation, at more frequent time periods.

FIGURE 2: Feedback Loop to Achieve Equilibrium Between Land Use and Transportation with Five Year Iterations

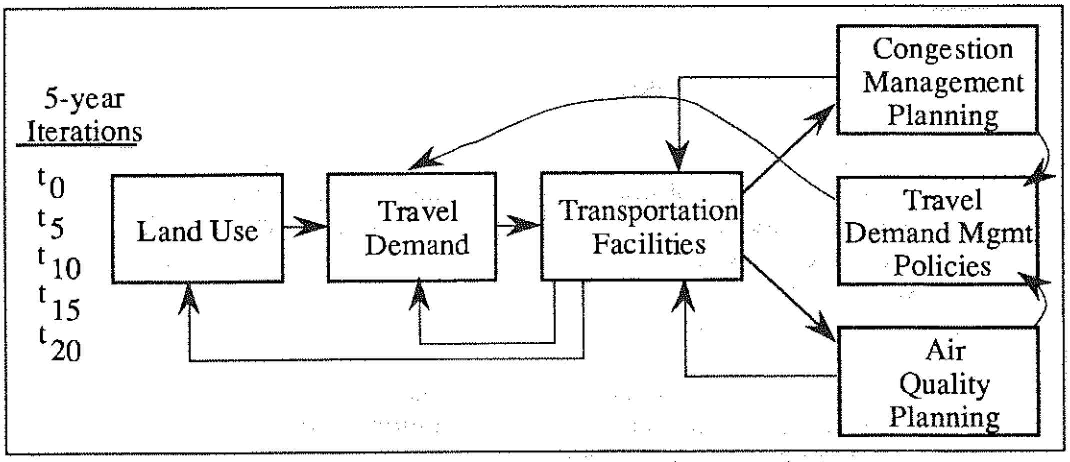


Figure 3 illustrates the minimal application of GIS to land use and transportation planning. It is used merely to prepare data for input to the land use-transportation models, and to display the results.

FIGURE 3: GIS Used for Inputs/Outputs

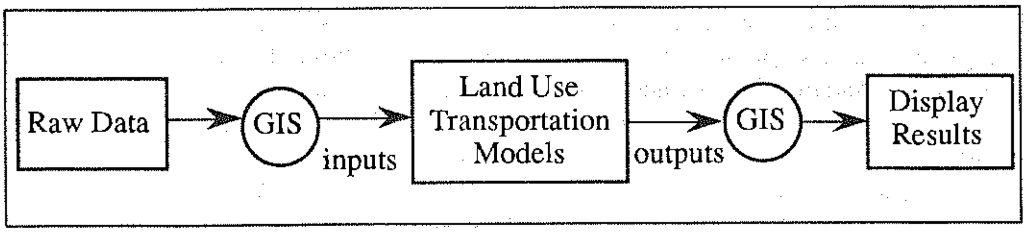
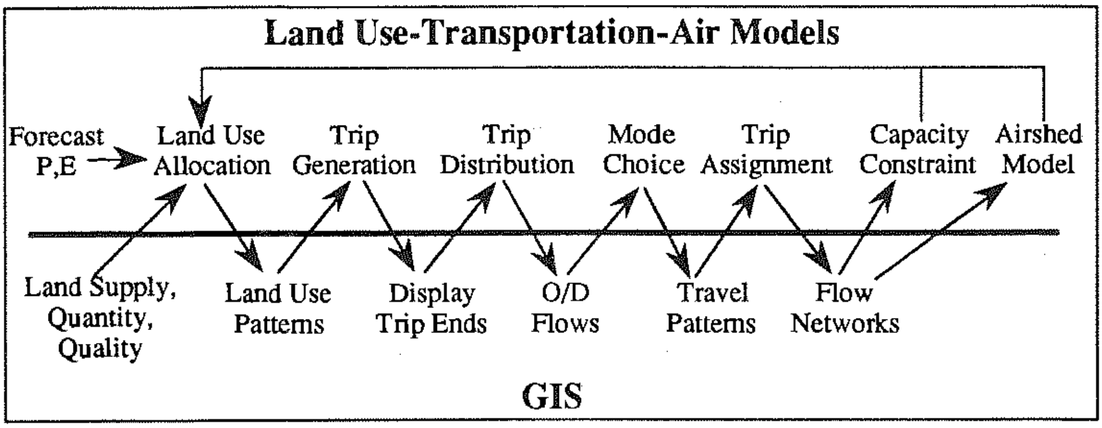


Figure 4 illustrates a more integrated use of GIS with land use-transportation models. The integrated GIS and land use-transportation models approach calls for data transfers at a number of points in the process. It also calls for interfacing GIS with the models, not embedding one within the other. Granzow and Lockfeld (1991) contend that GIS and travel demand models be appropriately interfaced to preserve the computational emphasis of modeling and the data processing emphasis of GIS.

FIGURE 4: Integrating GIS and Models



A CAUTIONARY CONCLUSION

This analysis of how GIS can support the land use-transportation modeling process indicates two types of improvements in the process. First, improved data will help achieve modeling equilibrium. Second, the improved visualization of model inputs, internal workings, and outputs will help achieve consensus on results. Whether improvements in the rational planning model will lead to improved decision making is another matter.

Examining the literature on the use of information technology in the practice of planning leads to some cautionary expectations. In an analysis of the development of computer-based planning and information systems in a large land use planning agency, Adler (1987) found that automated systems will likely facilitate a shift away from map-based long-range comprehensive planning toward short range sectoral planning, and that planning agencies will have to develop an information services strategy to broker among competing interests. The transformation of planning departments to "intelligence centers" was first proposed by Webber (1965). Adler's interpretation of Webber envisions planning departments operating as urban intelligence centers seeking to improve the short-range planning capacity of all participants in the land development process, thereby increasing the rationality of the process as a whole. This is consistent with Dutton and Kraemer's (1985) study of the politics of fiscal impact analysis systems. They found that the process of modeling—the "modeling effort"—was more important than the model itself, because the participants reached agreement on assumptions, methods, data, and alternatives in advance, thereby securing commitment to the model outputs, which facilitates negotiation, consensus building, and conflict resolution.

de Neufville (1987) looks at the same example—fiscal impact modeling—to make the point that planning methods need to mesh with understandings of users, by means of strategies and processes to integrate knowledge of non-technicians, clients, and the public with expert knowledge. This means less emphasis on model outputs and more on designing the analysis.

Just as GIS has relaxed technical, economic, and institutional barriers or constraints (Dueker, 1987), will the power of this technology relax the constraints that have been identified in the studies of information technology applications in relation to urban planning? To the extent that GIS empowers all the participants in the process, the technology will open the models for additional scrutiny. However, if the GIS is used to merely display the results of "black box" models they will not provide for an advancement in planning.

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ACKNOWLEDGMENTS

Julie Menken, graduate student in urban and regional planning, Portland State University, wrote the first draft of the section on Changing Requirements for Land Use/Transportation Planning.

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INFORMATION SYSTEMS TECHNOLOGY IN PLANNING EDUCATION: A RETROSPECTIVE ON URISA'S ROLE

Abstract: Education and training have historically been at the core of URISA's mission. Planning educators, Edgar Horwood among them, have been key figures in URISA's birth and continued expansion and growth, but the penetration of information systems expertise into planning education has been slow. This paper reviews the planning literature concerning information systems technology, the integration of computing into planning education, and URISA's role in influencing such developments during the past thirty years. The paper concludes with an assessment of prospects for further integrating information systems technology into planning curricula and proposes new roles for URISA in the continued education of professional planners.

PROLOGUE: PLANNING EDUCATORS AND THE BIRTH OF URISA

At this, our thirtieth meeting, various versions of the critical events involved with URISA's birth are likely to be told. Almost all of them will include Edgar Horwood and his colleagues and students at the University of Washington's Department of Urban Planning. Several of the latter have served in various capacities as officers and members of our Board of Directors. Horwood's influence continues to this day; he is honored annually by the Horwood Critique Award. Much of the early vision for URISA reflected Horwood's convincing advocacy that integrated urban and regional information systems were a fundamental requirement for successful planning. Because the major professional planning organizations, the American Society of Planning Officials and the American Institute of Planners, responded positively to that vision, URISA's identity was quickly linked to the field of urban and regional planning. URISA has since developed into a multidisciplinary organization with a broad and diverse membership, but it could be argued that planning educators served as midwives at URISA's birth.

Given the significant role that planning educators played in URISA's early development, one might presume that the impact of information systems technology upon planning education would be dramatic and lasting. This paper explores that supposition, concluding that, despite planning educators' continued involvement in URISA, planning curricula have been affected only marginally by the emergence of information systems technology during most of the past thirty years. The paper also considers fundamental questions regarding the future impacts of computing technology on the structure and content of planning education. Despite recent evidence that computers are now widely used in planning curricula and interest in geographic information systems is high, the long-term influence of information systems technology upon planning education and the future roles of planning education in the technology transfer process are far from clear.

These issues are explored by taking stock of circumstances during three different periods over the past thirty years, using a play as a metaphor. The first period, called Act One, covers the period leading to the very first URISA meeting and considers the events that led to URISA's creation. The act is divided into scenes: Scene One describes information technology themes within the mainstream planning literature; Scene Two provides an overview of computing within planning curricula; and Scene Three addresses the activities of planning educators in relation to URISA. The exercise is repeated at fifteen year intervals — in 1977 at the time of the first major retrospective of URISA's influence, and again in the present. The paper concludes with an epilogue that contemplates the future of information systems in planning education and the role of planning educators in preparing professionals to successfully implement information systems in planning practice.

Throughout, the paper specifically distinguishes between urban and regional information systems and broader issues related to computer use. The intent is to focus upon the vision advocated by Edward Hearle (1963) at our first meeting and developed as a Unified Information System in A Data Processing System for State and Local Government (Hearle and Mason 1963). That vision, evident in much of the early URISA literature, promoted developing integrated systems capable of handling a wide range of information, largely independent of their eventual uses. Properly designed and implemented within government organizations, these systems promised to provide a common framework for a variety of computer uses relevant to planning, management, and operations. Though early attempts to implement integrated information systems have generally been judged unsuccessful, the vision seems pertinent today as we consider implementation of integrated geographic information systems.

Still, one might legitimately question this special attention to the early vision of URISA. After all, technology has undergone dramatic change and URISA's diverse membership is interested in all sorts of creative uses for it. As interesting and important as many of these specialized applications or technologies may be, the simple response is: information remains URISA's middle name and integrated information systems underlie the effective use of many of these specialized technologies. For all the progress that's been made, garbage in remains garbage out.

One might also question the special attention paid to planning education rather than education for geographers, engineers, surveyors, public administrators, landscape architects, computer scientists, or any of the other disciplines that contribute to URISA's identity. The focus on planning education implies no slighting of these other disciplines, but simply represents an effort to reflect on the origins of our organization and acknowledge the historic connection that URISA has had with the planning field.

ACT ONE: IN THE BEGINNING

Act One opens in 1961 with a phone conversation between Edgar Horwood, Professor of Planning at the University of Washington, and Jack Beresford of the U.S. Census Bureau. Horwood was interested in using detailed data from the recently completed 1960 Census of Population and Housing, but was told that Census publications wouldn't be available until 1963. Not satisfied with that answer, he asked about receiving the data on magnetic tape. Though the Census Bureau had never before considered the possibility, Beresford sent Horwood the tapes he had requested. Once received, tools for standardized access had to be written and people trained in their use. URISA emerged from this humble "need for communication among professionals in a new field and from their need to learn skills, outlooks and philosophies in a new field ... that had not been included in their formal scholastic background (Horwood 1977: 5)." Who could have imagined how far URISA would come since that serendipitous beginning or the slow response of planning educational institutions to the developing capacities of information systems technology after planning educators would play a crucial role in URISA's birth?

Scene One: Planners and the Emerging Computer Age

The middle fifties to the early sixties ushered in the practical possibilities of information systems technology. Until that time, computing technology was simply too complex and expensive to be applied effectively to everyday problems. The first significant civilian government user of computing systems was probably the U.S. Census Bureau, but systems were generally only feasible for large accounting and tabulation functions. By the early sixties, the development of new computing languages, such as FORTRAN and COBOL, along with reduced system costs and the commercialization of computing systems, finally created potential for useful implementations of information systems technology in government. Popular articles promoted the idea that massive "data banks" on "high-speed" electronic computers would revolutionize government and hopes were high about the new Computer Age and the benefits that it would bring.

During this period, the planning profession had begun to discover the value of information in achieving its goals. The 1950 Census, compiled for the first time with state-of-the-art electronic computers, had provided detailed published data as a commonly available resource for planning studies. Federal fundsprovided for the urban planning assistance program authorized in the Housing Act of 1954, known as Section 701 grants, promoted experimentation, pilot studies and research that required data collection and analysis and further stimulated the need for information management. By the early sixties, Kennedy's New Frontier and Johnson's Great Society helped promote scientific approaches to studying and solving social problems and further enhanced Federal funding for planning. While most of the data management and analysis activities of planners were still being done manually, the growing importance of data created ripe conditions for the emerging information systems technology.

Still, the planning literature before the first meeting on urban and regional information systems in 1963 contained only a few hints that information systems had a role to play for planners. A special issue of the Journal of the American Institute of Planners (Voorhees, 1959) brought the potential of computing technology to the attention of the professional planning community, but focused almost entirely on transportation modeling. Only a piece by Creighton, Carroll, and Finney (1959) related directly to information systems or data processing. A later article by Britton Harris (1960) on computer modeling was also widely read by planning professionals, but computers and information systems generally received little attention in the planning literature before 1963. Not even Horwood managed to publish anything about his emerging interest in information systems within the mainstream planning journals.

Projects like the Chicago Area Transportation Study pioneered comprehensive databases that support planning activities, particularly transportation and land use modeling (Creighton, Carroll, and Finney 1959; CATS 1959). CATS served as a basis for comprehensive land use and transportation modeling efforts that energized planners' interest in computing technology in the mid sixties, but the development of a comprehensive database to support purposes beyond its transportation modeling needs was one of the project's most important legacies.

By the early sixties, Edward Hearle had been presenting papers to professional organizations and consulting with state and local governments about multipurpose information systems and, with Mason, was in the process of writing Information Systems in State and Local Government (Hearle and Mason, 1963), which proposed a Unified Information System that included support for spatially referenced operations. Hearle's work was well-known among planning educators interested in the practical uses of computing technology and, indirectly, helped shaped many of the public sector information systems still in use today. Hearle later served as URISA's third President.

Scene Two: Planning Education in the Early Sixties

Although the planning literature on computing technology was widely read among planning educators, its impact upon planning curricula prior to 1963 was limited. As is often true, practitioners were ahead of the educators; except for a few isolated cases, graduate programs in planning showed little evidence of the emerging computing revolution. Harvey Perloff's definitive piece (Perloff, 1956) on planning education described planning as a general staff activity of government and proposed an educational model to produce planners as "generalists with a specialty." Specialties identified as appropriate included urban design, construction and movement (transportation, housing, urban utilities and facilities), planning administration and law, socio-economic analysis and research, and regional analysis and planning. Most planning curricula reflected Perloff's basic model. As information systems and computing technology began to develop, they were viewed as tools to support one or more of these specialties, but only rarely considered as appropriate specialties themselves. That view has essentially remained unchanged to this day.

Planning practice was, however, becoming increasingly dependent upon data; in response, planning programs began adding courses on statistics and data analysis to their core curricula. Census data were of particular interest, though students in graduate planning programs generally made do with extracting data from published sources and manipulating them with mechanical calculators. Statistical maps were drawn by hand, if at all. No wonder the Master's in City Planning degree (MCP) was sometimes referred to as a Master's in Colored Pencils!

Scene Three: Planning Educators and the Emergence of URISA

At the University of Washington, Professor Horwood was setting events in motion that would ultimately fill the vacuum between the needs of planning practice and the offerings of planning curricula. Horwood quickly grasped the enormous value of data collected during the 1960 Census. However, to use the tapes he received from Jack Beresford, who was to become URISA's President in 1972, he had to develop tools to read them and tools to use the data he extracted from them. To put this in perspective: most universities had only limited computing facilities, FORTRAN had only recently been developed, and nobody knew how to read data from Census Bureau tapes, yet alone what to do with the stuff once the tapes were read. Horwood and his colleagues developed programs to access the census tapes and began to teach short courses in their use, including courses at eleven major American universities and one in Europe during the next several years. Many of the participants were planning educators. By 1963, Howard T. Fisher of Northwestern University was developing SYMAP to permit mapping of census data. Fisher later went to Harvard to direct its Computer Graphics Laboratory where so much of the groundwork required for the later commercialization of geographic information systems software took place.

In retrospect, it seems that the confluence of technology and information—new computer technology and newly available Census data—created an environment that required an organization like URISA, but Horwood was a major catalyst. He introduced professionals and educators interested in census data, planners in particular, to information systems technology through his courses and the work of course graduates. By August 1963, forty-eight people met to discuss their work at the First Annual Conference on Urban Information Planning Systems and Programs at the University of Southern California. At that conference, they not only shared their knowledge and experience with computer processing of census data, but also witnessed a demonstration of interactive graphic editing that influenced later work on network editing for geocoding, and heard about an emerging style of public administration that viewed computing technology as an essential tool for effective government (Horwood, 1977: 4). Many of the participants at this meeting were already or were later to become affiliated with institutions involved with the education and training of professional planners.

Nevertheless, it would be mistaken to presume that URISA was ever intended to be an organization for planners or to conclude that planning education was dramatically affected by the interests of this relatively small group of visionaries. At the time of the first meeting of URISA's founding fathers, few graduate planning programs showed any evidence that computing technology was thought to have any direct bearing on the future of the profession. The historic educational mission of URISA has had much to do with that lack of attention within our educational institutions.

ACT TWO: THE FIRST FIFTEEN YEARS

Act Two spans the fifteen years from the first meeting of URISA's founding group to the fifteenth annual meeting in Kansas City in 1977. During that time, URISA had become a well-established professional organization with a small but growing membership. The theme of the 1977 conference, "Information System Inputs to Policies, Plans, and Programs," reflected "the close ties between members' interests in information systems and the uses to which such systems are put by the members (Wellar, 1977a: vii)." Special attention was given to evaluating the extent to which information system inputs affected policy analysis, development, formulation, or implementation. Edgar Horwood, still on the planning faculty at the University of Washington, set the tone for the session by reflecting on prospects for a theory of urban and regional information systems (Horwood, 1977).

Information systems technology had changed dramatically during the fifteen years since URISA's first meeting. While census data could not be distributed, read, and processed on magnetic tape in 1962, by 1977 such capabilities were assumed to be routine—both for organizations and individual researchers. Indeed, the administrative, operational, and research subcultures all had learned to productively take advantage of the increased capacity of mainframe computing systems to support their respective interests, though little progress had been made towards the vision of productive integration among systems used by these subcultures that had been articulated by Jones (1967) in his URISA Presidential address.

By the mid-seventies, minicomputers had begun to replace mainframes to meet specialized requirements for analysis, modeling, or mapping and offered significant new opportunities for computer applications. Papers presented at URISA's 1975 conference were indicative of this trend; the proceedings included eight papers specifically devoted to minicomputers and their uses in government and another seven on issues of data management. Compelling cases were made for using minis as cost-effective solutions to computing needs related to: bus routing, court scheduling, and computer-aided dispatch (Demitriades, 1975); library and financial control systems (Degroff, 1975); and assessment, budget, tax, registrar, engineering, recreation, and payroll and accounting systems (Pearson and Werner, 1975). Other papers concerned structured methodologies for system selection (Abell, 1975) and distributed computing based upon the newly emerging technology (Penne et al, 1975). Murch (1975) argued that technology trends required attention to data base administration while other papers addressed specific data management themes: documentation (Gignilliat, 1975), standardization (Lavallee, 1975), data integrity (Kennedy and Quinn, 1975), and schemes for data management (Kozik, 1975). Though minicomputers enhanced access to computing and promoted new applications for government, they also introduced new obstacles to integrated information systems related to data management and coordination: a double-edged sword that remains relevant today.

By the 1977 conference, there existed a number of operational implementations of information systems, albeit not the comprehensive information systems that early URISA visionaries had advocated, but productive implementations nonetheless (Kraemer et al., 1976; Matthews et al., 1976). And yet, while planning educators continued to be involved in URISA affairs, there is little evidence of significant impact upon the content of planning curricula of the mid-seventies. At the conference, no special attention was given to the impact of information systems technology on education, neither planning education nor education for any other discipline.

Scene One: The Rise and Fall of Interest in Information Technology

While interest in integrated information systems for government remained high through the mid-seventies (Kraemer et al., 1974), the mainstream planning literature shows that broad interest in computing systems had changed from enthusiastic advocacy in the early sixties to benign disinterest. The two most significant milestones during this period were probably the special issue of the Journal of the American Institute of Planners (Harris,, 1965) and Douglass Lee's "Requium for Large-Scale Models" (Lee, 1973), which served as virtual bookends to an era. Relatively few articles concerning computing or information systems technology appeared in the mainstream planning literature before the special issue or for more than a decade after Lee's critical piece.

The special JAIP volume placed particular emphasis upon computer modeling. The issue included articles on the future of models in planning (Harris, 1965), model design (Lowry, 1965), mathematical programming methods for policy analysis (Schlager, 1965), and several articles on simulation models for Pittsburgh (Steger, 1965), Boston (Hill, 1965), and San Francisco (Robinson et al., 1965). The issue has been widely referenced within the planning field and was thought to signal the beginning of a new era of computer support for planning. Two years later, the American Society of Planning Officials echoed this optimism about this emerging era, devoting a significant portion of its annual conference to the "Threshold of Planning Information Systems" (ASPO, 1967). JAIP articles by Webber (1965) on the roles of intelligence systems in planning, by Harris (1967) on "how to succeed with computers," by Siegel (1968) on linking information system design to its program purpose, and by Hemmens (1968) documenting planning agency experiences with urban development models and data processing systems also reached the mainstream planning audience. Council of Planning Librarian bibliographies (Tucker, 1968) on computing in the planning field also reflected the growing interest among planners.

Although generally removed from the attention of most planners, much of the work presented at URISA conferences pertained directly to planning interests. Of special significance was the Urban Interagency Advisory Committee (USAC) project sponsored by the Department of Housing and Urban Development to test the feasibility of building practical information systems. USAC was the subject of eighteen papers appearing in URISA conference proceedings between 1968 and 1972 alone. Another 106 papers presented between 1964 and 1973 concerned either physical planning, housing, or transportation issues, while a number of others addressed other issues of interest to planners (Matthews and Kraemer, 1975). USAC received almost no attention within the literature read by most planners.

Lee's requium article, only six years after the special JAIP issue, marked the end of the "First Computer Revolution" (Arbeit, 1988) for planners by dramatically documenting the sins of model builders. Among them were "comprehensiveness" and "data hungriness," both directly related to the information systems vision advocated by early URISA members. The article was viewed by many as confirmation that comprehensive information systems and models represented a poor investment of scarce resources and that planners could more productively focus their attentions elsewhere. Planners interested in computing applications were urged to focus their efforts on special-purpose models rather than comprehensive models that required demanding theory, enormous volumes of data, and massive computing capacity. As interest in comprehensive models declined, enthusiasm about the generalized, multi-purpose information systems that had been advocated by Hearle, Horwood, and their colleagues also waned.

Nonetheless, work on computing applications to planning continued, though out of view of the mainstream professional planning organizations, which provided fewer opportunities for exploring technology issues during this period. The publications of the American Institute of Planners and the American Society of Planning Officials only occasionally featured pieces on computers, information systems, and modeling between 1973 and 1977. Computers continued to be used effectively by transportation planners (Pack, 1975) and by some local agencies to maintain databases for demographic, employment, housing, and land-use data (Kraemer et al, 1976; Matthews et al., 1976).

While visibility for computing applications declined within the major professional planning organizations by the seventies, URISA conferences continued to serve planners interested in information systems technology. Unlike the early years of this period, when the professional planning organizations often focused on similar themes to URISA, such as at the 1967 ASPO conference (ASPO, 1967), one can find few references to any of the work featured in URISA publications or events during this period. This absence of interest within the profession partially explains the active role played by planners in URISA's early growth. While non-planners often perceived this activity as evidence that URISA was primarily an organization for planners, the planning profession demonstrated a benign indifference to the contributions of URISA.

Scene Two: Planning Education During URISA's First Fifteen Years

The content of planning education during the 1963-1977 period generally reflected the cyclical attention to computing shown in the mainstream planning literature. Early years were marked by widespread interest in computer modeling and the information systems technology upon which it depended. In part, this was stimulated by the 1965 JAIP special issue, but the period of broad interest was relatively brief and information technology never rooted within planning curricula. Nonetheless, the era witnessed a remarkable change in technology used in planning education—from mechanical desktop calculators to computer terminals providing time-shared access to campus computing systems, though this latter capacity was often only taken advantage of by advanced graduate students to support thesis research.

More influential on the content of planning curricula, especially those of the many new graduate programs created during this period, were scientific and positivist paradigms applied to problem solving and decision making (Harris, 1967b; Chadwick, 1971). Courses in statistical methods, probability, decision theory, spatial analysis, and even computer programming were introduced and, in many instances, integrated into core curricula. The primary purpose of these additions was to support the various specialized areas of the planning profession: housing, transportation, community development, urban design, land use management, historic preservation, social planning, and other areas of substantive interest.

Planning information systems were not among those interests. Despite the increased use of computers, faculty with computing interest remained a minority, most of whom were more concerned with the uses of data than with multipurpose information systems within complex enterprises. Of eighty-four graduate programs offering degrees for professional planners in 1976, only fifteen of 618 faculty with more than half-time appointments, representing only thirteen graduate planning programs, expressed explicit interest in information systems or computer applications. Of the fifteen faculty members, only six specialized in information systems or geographic information systems. Only the University of Washington, where Horwood remained, and the University of Pittsburgh, where his former student Clark Rogers had gone, actually offered specializations in information systems technology (ACSP, 1976).

Scene Three: Planning Educators and URISA

As a planning educator, Horwood recognized that graduate curricula had only limited ability to adapt quickly to new educational needs, and some other vehicle was needed. At the 1977 URISA conference, he recalled that the most essential *raison d'être* of URISA was to package "the needed educational equipment" for the new information systems specialists demanded by the rapidly changing technology (Horwood, 1977). Wellar (1977b) went further, noting that practitioners enrolled in the "true school of hard knocks" were better positioned to learn about the use of the new technology than were students enrolled in universities where such learning rarely took place. Within URISA, educators continued to provide crucial leadership in shaping the organization's educational mission.

The strong early tie between URISA and the planning field is nowhere more evident than in the conference themes during the first five years, four of which were "Urban Planning Information Systems and Programs." Educators with interests in urban and regional planning were significant contributors to URISA conferences during these and subsequent years, which included papers by: Horwood of the University of Washington (1964, 1965; Horwood and Calkins, 1972); Ken Dueker of the University of Wisconsin, the University of Iowa, and later Portland State University (Dueker, 1966, 1967, 1969, 1977; Dueker and Talcott, 1975); Clark Rogers of the University of Pittsburgh (1970); Kenneth Kraemer of the University of California at Irvine (1970; Kraemer and King, 1975); Barclay Jones (1967, 1968) and Alan Feldt (1966) of Cornell University; Mel Webber (1964), Andrei Rogers (1965), and Donald Foley (1965) of the University of California at Berkeley; William Garrison (1965) and Duane Marble (Thomas and Marble 1965; Marble and Horton 1968; Marble and Wittick 1971) of Northwestern; Richard Duke of the University of Michigan (1966); George Hemmens of the University of North Carolina (1973); Ira Robinson (1964), later of the University of Southern California; Alan Schmidt (1968, 1972) of Harvard University, and other prominent educators of planning, urban studies, geography, and related fields. Horwood, Jones, Clark Rogers, and Dueker all served terms as URISA Presidents, with Horwood and Jones as the first two. The list reads almost like a Who's Who Among Planning Educators.

The benefits of the active participation of educators flow in two directions: from academia, where much of the conceptual work and empirical research is done; and to academia, where the tendency to overlook the practical effects of technology is a constant threat to scholarship. In view of Wellar's observations regarding the school of hard knocks (Wellar, 1977b), the participation of such prominent planning educators assured ongoing exposure of some planning students to new directions in information technology despite the absence of any major direct influence upon the structure of planning curricula.

There's little basis for accurately determining changes in educator participation in URISA affairs, but there is evidence of significant continued involvement during the first fifteen years. Publishing is an important criterion for success among educators. Though presentations at professional conferences generally are not valued as highly as articles in refereed journals within academia, they are viewed as an important aspect of scholarship. It would be normal to expect, under such circumstances, that authors with academic affiliations would be disproportionately represented among papers published in URISA proceedings. Discounting the very early years, between 1968 and 1977 the proportion of papers with academic affiliations during this period was somewhere in the neighborhood of twenty-five percent, with as may as thirty-four percent of all papers published from the 1975 conference written by authors with academic affiliations. In the absence of membership lists for much of this period, it's reasonable to infer that academic membership averaged between fifteen and twenty percent of the total membership during this period.

Compared with URISA's first several years, however, participation among planning educators probably declined by the mid-seventies. Only fifteen of 618 faculty members of planning programs listed in the 1976 Guide to Collegiate Schools of Planning identified themselves as having scholarly interests in information systems, GIS, computer applications, or other computer specialties (ACSP, 1976). Only four of these fifteen made presentations that appeared in URISA proceedings through 1976: Edgar Horwood, Ken Dueker, Clark Rogers, and Alan Feldt. While other planning faculty had been members of URISA during this period, they did not identify information technology or computing applications as among their academic specialties. Even many educators who had participated actively in URISA affairs at some time during the first fifteen years did not consider information technology to be one of their areas of special interest —surely an indication of its perceived lack of relative importance within the field.

The apparent failure of Horwood's vision for information systems technology to take root within planning curricula of the mid 1970s must have been a disappointment to URISA's founding fathers. The implications are perhaps best revealed in Wellar's summary of a 1976 symposium concerning the roles of management, planning, operations, and information technology functions in government (Wellar, 1976). Planning participants felt that they should appropriately assume lead roles in using information technology to integrate functions of operating departments, communicate with the public, and bring about critical improvements in methodologies, problem solving, and institutional structures. In contrast, management, operations, and information technology participants felt that planners had no grasp of analytical methods and techniques, did not know how to effectively use computers, were not concerned with data integrity, tended to use data erroneously if at all, and preferred to deal in generalities rather than focus on the details required for effective use of information technologies. To their credit, participants offered suggestions for improving planning curricula to overcome these perceived shortcomings. Even if these perceptions were only partly correct, some changes in planning curricula were critically needed if planners hoped to become effective players in the technology arena.

ACT THREE: THE LAST FIFTEEN YEARS

Act Three brings us to the present, where we contemplate how far we've come in the fifteen years since 1977. Much has happened—technological advances have been more dramatic than most of us could have foreseen and the pace continues to accelerate. URISA has itself grown beyond even the most visionary expectations, having diversified and recruited members from well beyond the planning community that so strongly influenced its early years. Along with professionals and academics from other fields, planning educators have found URISA to be an appropriate place to share their interest in information technology in general, and geographic information systems in particular. Unlike thirty years ago when planning educators were intimately involved in developing a vision for URISA, URISA now is influenced by a more diverse constituency. The planning profession has historically benefitted from the infusion of creative ideas from outside the field, and the net effect upon planning of this diversity should be positive. Whether or not planning education will be significantly affected remains an unanswered question.

Scene One: Computers on the Desktop, Maps by Computers

Two technology trends have had significant impacts upon planning education during the past fifteen years, particularly during the last ten: the maturation of desktop computing and the commercialization of geographic information systems technology. Their impact can be summarized by a single statement: though neither desktop computing systems nor commercial GIS products existed in 1977, together they have dominated the planning literature concerned with computing technology during the past ten years.

From the mid seventies to the early eighties, much of the writing concerning issues of computing technology for the planning field was generally critical of efforts to implement information systems within government (Danziger, 1977; King 1982; Kraemer et al., 1981). Other thoughtful contributions, including those presented at URISA conferences, didn't reach the mainstream planning literature at all. There were exceptions. The few notable publications concerning computing technology included a special issue of Planning magazine in 1981 and a special compendium of computer use in local government for planning (Auerbach Publishers 1980).

The first strong signs that microcomputers would renew interest in information technology and computing within the planning field appeared in the early eighties (Ottensman, 1981; Whited, 1982). By the mid-eighties, the significance of computing to planning educators became clear when a special issue of the Journal of Planning Education and Research (ACSP, 1984) was devoted to the topic and the first books on microcomputer use for planners were published (Ottensman, 1985a, 1985b). By 1987, several textbooks written by planning educators were available, some of which emphasized programming (Ottensman ,1985b) and others which applied microcomputers to city planning purposes (Brail, 1987).

The literature on computing in planning, especially that written by and/or for planning educators, has continued to grow since the mid-eighties and has become increasingly diverse. The Computer Technology Review Series begun in the Journal of the American Planning Association in 1986 has evaluated microcomputer software for planning analysis (Klosterman, 1986, 1990), thematic mapping (Wiggins, 1986; Wiggins and French, 1990), expert systems (Ortolano and Perman, 1987), computer-aided design and drafting (Brown and Schoen, 1987), statistical analysis (Langendorf, 1987), time-series forecasting (Cervero, 1987), economic impact analysis (Sivitanidou and Polenske, 1987), demographic data (Levine, 1988, 1990), project management (Page, 1989), database management (Ferreira, 1990), hypermedia (Wiggins and Shiffer, 1990), presentation graphics (Langendorf, 1991), and geographic information systems (Levine and Landis 1988; Landis 1990). Also appearing since the mid eighties in JAPA have been articles by: Sawicki (1985) on new applications for computers, Levine (1985) on population analysis, and Landis (1985) and Hoppes (1990) on economic analysis, all of which concern uses of spreadsheets; Dueker (1987a) and Harris (1989) concerning geographic information systems; and Han and Kim (1989) about expert systems. Planning educators have been publishing their work on computing in other journals as well, most notably the Journal of Planning Education and Research, Environment and Planning B, and Computers, Environment and Urban Systems. Special issues of Environment and Planning B have been devoted to microcomputers (Yeh, 1988) and GIS (Yeh, 1990).

Given the growing accessibility of desktop systems, it's not surprising that the bulk of what planning educators have been writing about computing since the early eighties has concerned microcomputer applications. The literature also has increasingly emphasized geographic information systems. More recently, expert systems have received attention (Kim, Wiggins, and Wright, 1989; Han and Kim, 1989a). A few published studies have focused on planning practice (French and Wiggins, 1989, 1990); Innes, Steiner, and Landis 1989), while several have considered the impact of technology on planning itself (Klosterman, 1987a; Harris, 1989). Aside from a few exceptions (Jacobs, 1989), planning educators have yet to seriously consider integrated information technology within the context of large, multipurpose organizations—a theme so familiar during URISA's first decade.

Scene Two: Computing Technology in Planning Education

The resurgent interest in computing technologies among planning educators was signaled by the establishment of a Microcomputer Users' Group among faculty members of the Association of Collegiate Schools of Planning in 1983. That group, which has met once or twice a year since its first meeting at Rutgers University, has provided a forum for computing in planning education unlike any offered by either the ACSP or the American Planning Association. At the time of its first meeting, few of the participants were members of URISA, though many are now. In 1987, the newsletter of this educators' group was consolidated with the newsletter of APA's Information Technology Division. More recently, this group of educators has convened international conferences on computing in urban planning and management, held in Hong Kong in 1989 and Oxford in 1991 (Klosterman, 1991). A third biannual conference is scheduled for Atlanta in 1993, to be held in conjunction with URISA's annual conference. Much of the renewed interest within URISA among planning educators and the expanded presence of computing and information technologies within planning curricula are attributable to members of this group.

Despite growing interest among some planning educators, the integration of computing technology into planning education remains incomplete. Brail and Klosterman (1991) recently attempted to determine the current state of computing in planning education by surveying 142 planning programs affiliated with the Association of Collegiate Schools of Planning. Though they were able to provide only a sketchy portrait based upon forty-four responses, the results document a pattern of broad but shallow penetration that starkly contrasts with the deep but narrow uses of computing technology in the early seventies (Klosterman, 1992: 250). More than two-thirds of the programs (31 of 44) offered a general introductory course in computers and information technology, but only 40 percent of them indicated that the course was a required component of their curricula. Since all but one program indicated that computers were used in their planning methods and/or statistics courses, however, most students were required to use computers in their studies. Of the 465 faculty members represented, 38 percent taught courses employing computers while 17 percent taught courses that dealt primarily with computers. All programs with nine or more faculty members had at least one with advanced computing skills. While that's the good news, the survey also suggests that instruction in computing and information technology is significantly constrained by inadequate hardware and software, lack of faculty and staff knowledge, and insufficient resources for training faculty.

Such constraints continue to inhibit the penetration of computing and information technology into planning education. Moreover, explicit interest in integrated urban and regional information systems has remained sparse. Brail and Klosterman's surveys show that statistical packages, spreadsheets, and demographic/economic models are among the major uses for computing systems and that single-user systems provide the predominant environment for the computing experience. A separate review of 87 universities with graduate programs listed in the Guide to Graduate Programs in Planning (ACSP, 1990) shows that only 22 had core faculty with primary interest in information systems, geographic information systems, or computer applications to planning. Another nine had affiliated faculty with those interests. Only about thirty individuals with information system/GIS/computer specialties held at least half-time appointments at those institutions, from a total of 764 such positions. These figures rely upon self-identification of interests and reveal the extent to which interest in information systems technology has shaped—or failed to shape—planning education during the past thirty years, at least until very recently.

Within the past several years, however, new courses or course sequences devoted explicitly to geographic information systems have been added to a growing number of planning curricula. Many of these are based on the standard curriculum in GIS developed by the National Center for Geographic Information and Analysis (Goodchild and Kemp, 1990) while others have been made possible by the recent surge of literature concerning GIS (Klosterman, 1991a). Huxhold's An Introduction to Urban Geographic Information Systems, published in 1991, is particularly well-suited to serve as a textbook for the classroom. Several graduate schools of planning, most notably MIT, have begun to produce graduates with concentrations in GIS and others are certain to follow. GIS concentrations exist or are being developed in planning and geography programs throughout North America, from some of the oldest accredited graduate planning programs, such as those at Georgia Tech, the University of California at Berkeley, and the University of Illinois, to smaller programs at places like Southwest Texas State University.

Scene Three: Planning Educators and URISA

Within recent years, it has become clear that a new generation of planning educators have discovered URISA while educators who have long advocated roles for computing have renewed their involvement in URISA. One indication of this is the growth of persons with university affiliations on URISA's master membership list from 188 in November 1986 to 689 in March 1992. Though a modest twelve percent of the entire list in both instances, and far less than the proportion of academic membership during URISA's earliest days, this healthy growth of 500 new members in less than six years is a positive sign. The resurgence has something to do with the maturation of geographic information systems technology and the heightened visibility of URISA as an important forum for information systems and computing technologies. Educators in related fields, such as geography, landscape architecture, and civil engineering, also have increased their levels of participation in URISA activities.

Increased participation of educators in the URISA program is a reasonable indicator of the potential impact of URISA upon academic programs. Of the papers presented at the 1991 annual conference, almost twenty-three percent (60 of 255) had authors with academic affiliations. By comparison, only seventeen percent of the papers (27 of 158) with author affiliations listed for the 1987 conferences had authors with academic affiliations. A sample of papers presented and published in URISA Proceedings from recent conferences include contributions by planning faculty at: Portland State University (Dueker, 1987b, 1988), the University of Akron (Klosterman, 1987b), the University of Florida (Zwick and Latimer, 1987; Zwick and Schneider, 1989), the University of Washington (Slachowitz, Quinn, and Bell, 1987), MIT (Ferreira and Menendez, 1988; Ferreira and Azar, 1991), Rutgers University (Brail and Amer, 1988; Amer 1989), California Polytechnic (French 1988; French 1991; French and Belknap 1991), the University of Pennsylvania (Harris 1989b), the Georgia Institute of Technology (Ferguson and Drummond, 1989), the University of Waterloo (Chu and Newkirk, 1989), the University of Cincinnati (Prosperi, 1989), Florida Atlantic University (Prosperi and Schultz, 1990), the University of Illinois (Han and Kim, 1989b), and the University of Wisconsin-Milwaukee (Huxhold, 1991b). Unpublished presentations have been made by numerous others, including planning educators known for their work during the early years of URISA and others associated with the recent surge of computing interest.

The URISA workshop program is another area where planning educators have been active. Planning educators have recently served as instructors in workshops for Introduction to GIS (David Arbeit of the University of Illinois, William Huxhold of the University of Wisconsin-Milwaukee, Barry Wellar of the University of Ottawa), Managing Public Information for Public Use (Clark Rogers of the University of Pittsburgh), Permit Tracking (Richard Brail of Rutgers University), Small Area Modeling (Brail), Artificial Intelligence and Expert Systems (Lyna Wiggins of MIT), Transportation and GIS (Lewis of MIT), and Census Data for Small Computers (Landis, University of California at Berkeley). Several planning educators also are frequently involved in non-URISA workshops on computing technology, particularly those devoted to GIS.

Among these are workshops sponsored by universities themselves or by specialized educational organizations, such as those sponsored by the Lincoln Land Institute.

Planning educators also have been involved in developing the URISA Journal, the first issue of which was published in late 1989. Ken Dueker of Portland State University is a Coordinating Editor and co-Editor of the Journal's refereed paper section. Serving on its Editorial Board are planning faculty from Rutgers University, Georgia Institute of Technology, MIT, the University of Illinois, the University of Wisconsin-Milwaukee, the University of Akron, the University of California-Berkeley, and the University of Virginia. Other board members include faculty from related disciplines at the University of Minnesota, Ohio State, the University of California-Irvine, the University of Toronto, Cleveland State University, and the University of Ottawa. Articles published thus far include contributions from planning faculty at Portland State University (Kjerne and Dueker, 1990) and the University of Illinois (Armstrong and Hopkins, 1991). Wilbur Steger, and now a faculty affiliate at Carnegie Mellon University, has also contributed to the Journal (Steger, 1991). Steger was URISA President in 1970 and an early contributor to the planning literature on computing (Steger, 1965).

What does all this increased participation mean? Certainly, such participation suggests that educators are actively engaged in exploring issues related to developing and effectively using urban and regional information systems rather than sitting on the sidelines. For the long-term, the implications are less clear. Planning educators have generally responded creatively to the computer age: at least they have not resisted incorporating computers into planning curricula. Still, no one has yet come forward to advocate the strong and coherent vision for planners that Horwood and his colleagues advocated during the sixties and late seventies. Computers continue to be viewed as tools for analysis or model-building with personal or limited purpose data sets. Analysis and modeling are appropriate activities for planners, yet such efforts are fundamentally weakened by the absence of suitably designed urban and regional information systems capable of organizing and processing data into useful information, preferably by integrating administrative, operational, and research processing functions. If participation by planning educators in URISA results in a rediscovery of the need for such integrated systems, then the benefits could be significant indeed. Even in the absence of such insight, the education of students of urban and regional systems will either directly or indirectly benefit from involvement in the active intellectual dialog that takes place within the URISA environment.

EPILOGUE: A PLACE FOR INFORMATION SYSTEMS IN PLANNING EDUCATION

This paper has been written from a point of view that well-defined urban and regional information systems are required for the effective planning and management of urbanized regions and, as such, must become more widely integrated into the training and education of planners. Ideally, planning curricula would include one or more courses on the design, development, maintenance, and use of such information systems. Despite the recent excitement about geographic information systems among planning educators, the historical evidence for such a prospect is not encouraging. While computers and information systems continue to be widely used to support analysis, modeling, and design, it remains unclear whether we'll see widespread curricula changes that focus upon information systems themselves in the immediate future.

At the same time, it seems increasingly likely that the concept of comprehensive, multi-purpose information systems will gain new support as basic tools of local, regional, and state governments. The trend in both the public and private sectors to re-engineer organizations for the computer age plus increased interest in integrated geographic information systems are significant signs that such expectations are reasonable. For planning educators, this prospect raises two sorts of issues: (1) what roles should planners have in the design, implementation, and use of such systems; and (2) how should planners be educated or trained to assume such roles? Despite the recent interest in computers to support planning activities, planning educators have not seriously considered either of these issues since the early days of URISA, principally through the voice of Edgar Horwood.

To seriously consider these issues, planning educators need to differentiate between "the problems of technology to which a great deal of thought and energy have been given" and "the problems of data management and utilization to which far too much energy and relatively little thought have been given." (Jacobson, 1967: 4) The first category includes everything from keeping up with the latest computer hardware device or software product to the development of sophisticated simulation models; the latter includes the information infrastructure upon which the simulations or analyses depend. Alonso (1968) has demonstrated that simple models generally provide better results than complex models when data quality is poor. Yet, planning educators continue to pay less attention to building systems that promote consistent, accurate, and current data than in conducting complex analysis or building computer intensive simulation models with the latest hardware and software. Planning educators should be accountable for providing some appropriate balance between the two sorts of issues.

It has become popular recently to define geographic information systems in broad terms that include hardware, software, data, people, and organizations rather than in purely technical terms. The view is appropriate, as such systems are unlikely to achieve successful implementation unless both their substance and context are defined. Ironically, this view reiterates a fundamental premise of earlier work regarding urban and regional information systems, especially that of Hearle and Mason (1963). Herein lies an appropriate answer to the mission of planning education: we need planners who are generalists with specialties in designing and building integrated man-machine systems that promote improved planning and management within complex organizations concerned with urbanized areas and regions. This specialization would be added to those already offered in planning curricula, many of which will increasingly depend upon the effective use of such systems for their success. Such information systems specialists can be educated within planning curricula while continuing to adhere to the educational model first outlined by Perloff (1956) and which still guides planning education today.

The need for education and training related to information systems is confirmed by continued interest among planners in the highly successful URISA workshop program, especially workshops concerning geographic information systems. If planning practice is to take advantage of this new technology, planners will need to be trained in its use. If planners are to have a significant role in shaping the form of the technology, as Horwood felt was appropriate, then planning educators will need to be concerned with more than using the tool, but with designing the tool and placing it within an appropriate institutional setting. After thirty years of URISA activity, planning educators should be prepared to accept this challenge.

ACKNOWLEDGEMENTS

I would like to especially thank Richard Klosterman, Professor of Geography and Planning at the University of Akron for sharing his insights into recent computing trends within planning education. Dr. Klosterman deserves much credit for promoting interaction among planning educators interested in information technology.

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INFORMATION SYSTEM INPUTS TO PROGRAMS APPLICATIONS OF IS/GIS IN GOVERNMENT

Abstract: The paper provides a retrospective view of the contributions or applications of IS/GIS in government programs over the past fifteen years. The role of IS/GIS is examined with respect to the continuing evolution of new government programs. Where possible, the impact of IS/GIS on the effectiveness, efficiency and economics of administering these government programs is evaluated. The changing nature of issues and the progress in the development of IS/GIS applications in government over the past fifteen years serves as a barometer of IS/GIS development in government. Progress in the application of IS/GIS in government is evaluated from three perspectives. The first perspective involves a discussion of the types of government organizations, operational environments and initiatives in information resources management that have been documented in government over the past fifteen years. The second includes a review of the government applications, tools and technology for the period of review. The third perspective from which progress in IS/GIS is evaluated, includes a review of the implementation of geographical concepts and the impact of data availability in government. The accomplishments, failures and present understanding of IS/GIS applied to government programs are provided for all levels of government.

Given the development of applications of IS/GIS in government, documented in URISA proceedings over the past fifteen years, the paper seeks to infer trends in the evaluation criteria that may be applied to the next five to ten years.

INTRODUCTION

In evaluating urban and regional information system inputs to government programs over the past fifteen years, one is alerted to the constantly evolving terms of reference for urban and regional information systems. Early definitions of urban and regional information systems as cited by Horwood (1977) illustrate this evolution:

> 1. An urban and regional information system is one involving the sequence of steps in the synthesis of information from broad data inputs by the use of automated methods to bear on the solution of particular problems involving management decisions relating to the functions which control, shape or anticipate change in the urban and regional environment. (Horwood, 1965)
>
> 2. An (urban and regional) information system is a collection of people, procedures, computer hardware, computer software, and a data base organized to develop the information required to support a particular mission. (U.S. Department of H.U.D., 1968)
>
> 3. An urban and regional information system is one involving the sequence of steps in the synthesis of information from diverse data inputs by the use of automation to bear on the definition display and solution of a set of problems relating to planning, political and management decisions in urban affairs. (Horwood and Calkins, 1970)

By contrast, in 1992 we propose that urban and regional information systems have a far broader scope and that any evaluation of inputs to government programs be conducted from three relatively distinct but interrelated perspectives. For the purpose of this fifteen year evaluation of applications of IS/GIS in Government, the first perspective involves a discussion of the types of organizations, operational environments and initiatives in information resources management that have been documented in government over the past fifteen years. The second perspective includes a review of the applications, tools and technology for the period of review. The third perspective from which IS/GIS is evaluated, includes a review of the implementation of geographical concepts and the impact of data availability in government.

Given the development of applications of IS/GIS in government, documented in URISA proceedings over the past fifteen years, the paper seeks to infer trends in the evaluation criteria that may be applied to the next five to ten years. The authors recognize that to some degree, this review reflects the nature of the URISA organization, participants and academic direction.

DISCUSSION

Over the past fifteen years URISA has provided a forum in which to showcase applications of IS/GIS in government. These applications have been introduced to the URISA audience in a variety of ways. As inputs to government programs, applications of IS/GIS in government have been presented as applications for tools and technology, discussions of organizational development and the development of strategies in information resources management and operations. From an operational perspective, inputs to government programs as applications of IS/GIS have also been presented in terms of the ongoing development of geographic concepts and models with continuing concern over the significance of data availability.

Strategies in Organizations, Operations and Information Resources Management in Government

Over the past fifteen years the organizational structures of the governmental agencies, responsible for initiating programs that house IS/GIS applications, have undergone considerable evolution. The application of management philosophies in moulding organizations, the development of operational environments and strategies in information resources management appear to have evolved as inputs to programs (Wellar, 1977) along with the development of the IS/GIS tools and technologies, geographical concepts and issues in data availability. In retrospect, at the start of the period of review the City of Milwaukee was conducting the pre-implementation phase of the Milwaukee Computer Graphics System in 1977 and had installed an interactive computer graphics system (Huxhold, 1977). Co-operative approaches to data processing in local government were being advocated (Smolin, 1977) along with initiatives to strengthen regional, state and local planning information systems by improving user access to federally produced statistics (Gibbs and Rauner, 1977). By 1977 concern was being expressed that information technology was receiving a disproportionate degree of attention and that a co-ordinated and sustained effort was required to address the administrative and jurisdictional concerns inhibiting the transferability of data (McCoy, 1977), (Rejfek, 1978). As inputs to programs in 1992, user access to governmental data and the administrative and jurisdictional concerns inhibiting the transferability of data remain very real hindrances to the further development of IS/GIS applications in government.

In the late seventies, an incremental approach to the design of geographic information systems was being offered as an alternative to the traditional systematic, sequential, problem definition approach to system design, analysis, development and implementation. This incremental approach evolved from specific applications in capability-building initiatives in geographic systems design (Dueker & Talcott, 1977).

In 1978, issues raised in information resources management included the need for general, transferable methods for the assessment of IS/GIS data requirements (Loder, 1978) and the benefits of adopting a relational approach to urban data design (Bohl, 1978). Formulae for low cost, high technology solutions to geographic information systems were also under consideration (Downard, 1978). Much of the concentration of programs in government was focused on applications in local government and included such projects as the assessment of requirements for health planning (Reeves, 1978), (King, 1978),(Logan, 1978), information systems in regional, city and neighbourhood planning (Turke & Gatzweiler, 1978), (Lima & Shelman, 1978), (Levy, 1978) and systems for economic and environmental growth impact analysis (West, 1978). In the physical sciences, applications in government programs were focused on efforts in land use data systems for water management (Perciasepe & Johns, 1978), (Palmerlee, 1978),(Coan & Kevany, 1978).

From an organizational management perspective, the focus on Management Information Systems provided one of the primary inputs to government programs in IS/GIS in 1979 (Hyman & Alexander, 1979), (Hunt & Hunt, 1979). The concept of hybrid geographical information systems was introduced (Cowen, Crosley & Holland, 1979) and the requirement for mutual support and co-operation in facilitating the growth of computerization in local governments, remained an ongoing theme (Norris & Charest, 1979). The focus of physical science applications of IS/GIS in government were directed largely toward applications in transportation (Tucker, 1979), (Wilson & Shamel, 1979), (Porter, 1979), but included trends in the development of applications in zoning (Johnson, 1979), (Blackmon, 1979) and emergency response (Tien & Colton, 1979), (Phillips & Russell, 1979).

Applications of IS/GIS in local government remained the focus in 1980 (Jefferson, 1980). Information Resources Management was offered as the preferred direction in managing information as a measurable, planned resource during the 1980's (Kettinger, 1980). As an input to programs, the need for a survey of data and assessment of analytical requirements for the development of a geographic information system remained an ongoing theme in 1980 (Brooks, 1980), (Reed, 1980). Social science applications of IS/GIS in government included such projects as the development of information systems for policy and planning research (Rothwell & Li, 1980), (McMaster, 1980), applications in generating a variety of social indicators (Perle & Forkenbrock, 1980), (Gayk, 1980), (Snider, 1980) along with the ongoing development of census/DIME-File applications (Somers, 1980), (Firestone & Goldstein, 1980).

In 1981, applications in IS/GIS in government covered a variety of themes and included several GBF/DIME File applications (Dyer, 1981), (Van Denmark, 1981), (Jay, 1981), land use planning models (Dyer, 1981), (Gierman & MacDonald, 1981), (Hanson, 1981) and environmental assessment applications (Webb, 1981), (Ader, 1981), (Berkun, 1981), (Wilson, 1981). Many of the IS/GIS applications continued to apply to more urban than regional programs in local government (Dueker, 1981) with ongoing emphasis on the development of management models for data sharing amongst local government (Gilbert, 1981).

Primary inputs to government programs involving the application of IS/GIS in 1982 were focused at a more regional level of government and raised such issues as the multi-disciplinary nature of most land information systems (Porter & Niemann, 1982), the political support required for the modernization of land information systems (Ayers, 1982), data standardization (Eichelberger, 1982), (Saltman, 1982) and the policy, tools and access essential in addressing the politics of data sharing (Gilbert, 1982), (Swank, 1982). Applications of a multi-purpose, multi-function nature (Carlson, 1982), (Crane, Domsch & Hall, 1982) seemed to broaden the scope of issues being raised as inputs to programs from a local to a regional level of government. The broadening of the scope of these administrative and management issues (Steger, 1982) in IS/GIS developments in government was accompanied by the introduction of microcomputers and the development of systems for micro-based geographic analysis (Barber, 1982), (Dakan, 1982), (Robinson, 1982). The development of census applications (Bright & Pryor, 1982), (Rogoff, 1982), (Evatt, 1982) continued as a high profile theme in 1982 along with the development of land use models (Anderson & Freedman, 1982).

The broader administrative and management issues continued to dominate IS/GIS inputs to government programs in 1983 with specific concentration on the development of decision support systems in environmental and land use planning applications (Peters & White, 1983), (Engelman & Fittipaldi, 1983), (Dyer, Brklacich, Bond and Smit, 1983). Concepts in distributed processing (Dedischew, LaPorte & Wilson, 1984) and distributed information management (Selby & Reick, 1984), (Nicholson, 1984) were raised as inputs to government programs in 1984 and were accompanied by the further development of micro-based applications (Lam, 1984). Further to this trend of increasing microcomputer use, the need for widespread computer literacy (Head, 1984) was identified as an issue in the management of information systems in government. The range of technical applications in IS/GIS in government in 1984 included a continuing emphasis on online systems on census (Kutsal & Zaidi, 1984), (Wang, 1984) and environmental assessment systems development (Johnson, 1984), (Henderson, 1984), (Rosenfield, 1984), (Beard, 1984).

Further multipurpose, multi-user applications of IS/GIS in government (Wilson, 1984), (Clapp, McLaughlin, Sullivan & Vonderohe, 1985), (Wellar, 1985), (Alexander, 1985), (Green, 1985) continued to broaden these issues in regional information systems with the presentation of concepts for national land data systems (Keffer & Anderson, 1985), (Jacobs, Dickhut & Moyer, 1985). The trend to the modernization of land information systems (Merideth, Clapp, Niemann & Sacks, 1985) provided further input to IS/GIS applications and facilitated interagency consensus building (Brussard & Bos, 1985), (Bayer, 1985). Other administrative and operational governmental issues raised in 1985 were carried over into 1986 and included concerns over data accessibility (Behrens, 1985), (Roitman, 1986) and IS/GIS implementation costs (Kenney, 1985), (Green, 1985), (Kenny & Hamilton, 1986), (Laroche & Hamilton, 1986).

One of the primary trends in the variety of IS/GIS applications in government in 1986 was the widespread use of microcomputers. Along with this trend, broader consideration was given to public administration inputs to government programs in IS/GIS with an evaluation of the impact of computerized IS/GIS systems on the public sector (Kirby, 1986), (Lam, 1986), (Beidler & Williams, 1986) and the development of long-range and strategic system plans for IS/GIS systems in government (Moore, 1986), (Bisceglia, 1986).

From a conceptual perspective, by 1986 IS/GIS systems in government appeared to have emerged as programs rather than inputs to programs. As demonstrated in the 1986 URISA proceedings, program evaluation and review was being conducted on IS/GIS applications and IS/GIS long range or strategic planning had surfaced in local and municipal governments. The scope of evaluations continued to broaden with the applications in maximizing productivity gains in IS/GIS (Kevany, 1986), (Somers, 1986), (Antenucci, 1986).

By 1987, evidence of IS/GIS programming emerged at a regional level (Perkins, 1987), (Licht, 1987) along with local governmental applications in information resources management (Crebari & Kittleson, 1987), (Arbeit, Heald & Szkotak, 1987), (Hurst, 1987). With the broader focus of IS/GIS programs in government and the continuing development of multi-purpose IS/GIS systems, (Niemann & Sonza-Novera, 1987), (Neimanis, 1987) concerns with compatibility between IS/GIS developments in government were increasing in profile in 1987 (Cooper & McLaughlin, 1987). Wider varieties of IS/GIS applications in government continued to develop with further emphasis on distributed processing techniques (Evans, 1987) and the emergence of expert systems.

At the program level, issues in the management of IS/GIS programs in government began to receive attention in 1987. Issues in selling GIS to government policy makers (Roitman & Antenucci, 1987) and managing expectations in implementing IS/GIS arose in the management of IS/GIS government programs. Along with the mounting public interest in government programs in IS/GIS came a steadily increasing range of legal issues over public access, liability and risk and responsibility associated with IS/GIS developments in government (Epstein, 1987), (Roitman, 1987). As a secondary input to these IS/GIS programs in government, certain legal reforms were proposed in response to the legal concerns over public access to government IS/GIS systems.

In 1987, a number of government IS/GIS programs were reaching maturity. An additional input to these programs was the notion of mature IS/GIS systems in transition. This stage in IS/GIS development may be viewed as an extension of the IS/GIS program evaluation and review referred to earlier in this discussion. As a further input to IS/GIS applications in government in 1987, considerable attention was given to the ongoing development of the concept of expert systems (Eichelberger & Barb, 1987), (Barb, 1987).

With the constantly expanding variety of governmental applications in IS/GIS programs, methods of classifying IS/GIS systems into wide-area or regional, local and application/facilities-oriented systems began to appear as foundational GIS issues in 1988 (Dueker, 1988). By 1988, it was apparent that an entire market existed for IS/GIS system applications in government and that apart from the need for comprehensive systems for cost/benefit analysis in IS/GIS system development (Killpack, 1988), government had the opportunity to initiate cost recovery measures in IS/GIS programs (Pressegur, 1988). Focus on the continued application of integrated IS/GIS systems development (Florence, 1988), (Burt, 1988), (Condi, 1988), added momentum to initiatives in integrated systems and raised the issues of maintaining data integrity and the impact of public records laws (Roitman, 1988).

As inputs to IS/GIS governmental programs, government applications in IS/GIS continued to expand in 1988 with the aid of formalized marketing strategies for government information products (Byrnes, 1988), (Glenn, 1988).

National and regional government applications in IS/GIS continued to emerge despite the mounting legal and administrative concerns over the multi-purpose, multi-user and multi-jurisdictional nature of many of these regional projects (Wellar, 1988), (Eddington, 1988), (DeCario & Harper, 1988).

With the political sponsorship for many of the national, regional and local government IS/GIS programs in place and with the vendor community maintaining the pace of development of technical IS/GIS applications; the legal, social and administrative issues (Salmon, 1989), (Sookman, 1989) appeared to pose some of the greater obstacles to government IS/GIS developments in 1989 (Pissimissis, 1989), (Beard, 1989). Initiatives in strategic planning, prototyping and consensus-building in IS/GIS developments (Levinsohn, 1989), (Rourk, 1989), (Wellar, 1989) provided inputs to IS/GIS programs in government that attempted to bring us closer to a formula for the successful implementation of IS/GIS programs in government.

By 1989, the stature of IS/GIS programs had reached the point where IS/GIS initiatives were no longer viewed as simply applications in many government organizations and had reached the profile of programs where organizational changes were considered as warranted to ensure the successful implementation of certain IS/GIS initiatives (Somers, 1989). As a dimension in the infrastructure management of these programs, privatization in IS/GIS public-private partnerships was introduced as an input to IS/GIS programs in government (Thorpe, 1989), (Roe, 1989). Strategies to assure the ongoing relevance and efficiency in the lifecycle infrastructure management of these IS/GIS initiatives received considerable discussion.

In 1990, institutional, organizational and legal issues again took the fore as inputs to IS/GIS programs in government. Strategies in securing organizational change in the successful implementation of IS/GIS programs in government provided a central focus (Crain, 1990), (Perkins, 1990). The complexity of these strategies had to address all levels of government from the large scale, multi-user, multi-purpose IS/GIS initiative to the traditional local government, single-purpose application (Dawson & Allen, 1990). Strategic issues in cost/benefit analysis provided a central framework for input on the concerns over the administrative and legal responsibilities in the development, management and transition of IS/GIS programs in government (Foresman & Kelley, 1990).

Inputs to government programs in IS/GIS in 1990 had a definite emphasis on the marketing, pricing and cost recovery strategies in the development, management and transition of these IS/GIS initiatives (Lawrence, 1990), (Ahner & Archer, 1990), (Cross, 1990). The success of many of these strategies are closely dependant on the organizational structure of the host organization and the infrastructure lifecycle of the proposed IS/GIS. Strategies in centralized GIS management were offered as inputs to IS/GIS programs in 1990, addressing some of the issues in organizational planning and structure (Edwards & Foresman, 1990). Concerns over maintaining data integrity, while assuring public access continued to curb developments in IS/GIS programs in government in 1990 (Behrens, 1990). These issues posed the greatest concerns amongst the increasing number of multi-participant, multi-jurisdictional IS/GIS initiatives in government (Stockton, 1990), (Scott & Young, 1990). Initiatives in networking were offered as a potential solution to certain IS/GIS problems with access to information (Kenk & Anderson, 1990), (Ford, 1990), along with strategies for managing expectations of IS/GIS projects and programs (Cowden, 1990), (Ricketson, 1990).

Inputs in 1991 to IS/GIS programs in government provided further initiatives in the expansion of the scope of multi-jurisdictional IS/GIS programs in government (Edwards, 1991), organizational models for multi-participant IS/GIS systems in government (Gole-Quinn, 1991) and potential solutions to the ongoing legal and administrative challenges (Black & Cowen, 1991) with public access to information (Kozub, 1991), (Colbert, 1990), liability for data, copyright (Peterson, 1991), (Challender, 1991) and strategies in funding, cost amortization and cost recovery (Krejcarek, 1991). End-user needs, the use of focus groups and the concept of public participation in IS/GIS program planning and development gained profile in 1991 (Terp & Williams, 1991). Continuing emphasis on initiatives in the multi-participant, multi-jurisdictional coordination of IS/GIS programs in government (Wright & Adair, 1991), (Little & Troeger, 1991) continued to effectively 'decrease the size of world' of IS/GIS programs in government and increase the number of participants and the complexity in the resolution of the expanding number of administrative, organizational and legal issues in the lifecycle management of new and mature IS/GIS initiatives (Edmondson, 1991), (Sieber, 1991).

In scanning the inputs to IS/GIS programs in government over the past fifteen years, with the realization of mature IS/GIS programs in 'perpetual transition' and with the IS/GIS world beginning to decrease in size; we may be witnessing the coming of age of the 'information age' (Klein, 1991).

Applications, Tools and Technology in Government

The role of applications, tools and technology as an input to IS/GIS programs in government has served as a catalyst for many of the organizational, operational and information resources management issues discussed in the preceding section of this paper. Without the enabling technology and applications, organizational development, growth and maturity of many of the governmental IS/GIS programs would not have evolved over the past fifteen years.

In 1977-78 practitioners in the field were faced with predominately mainframe single-purpose systems. Operating systems of the order of 64K were common and many operated in a batch environment. Applications were focused on dataprocessing, mapping and geoprocessing (Kevany, 1977), (Smolin, 1977), (Kinzy, 1978), (Blumberg, 1978), (Irish, 1978) and were oriented largely around census (Carter, 1978), (Kluess & Moyer, 1978), (Grier, 1978), health (Reeves, 1978), (King, 1978), education (Werner, 1977), criminal justice (Wierman & Shostak, 1977) and emergency response applications (Miller, 1977), (Colton, 1977), (Miller, 1978). Resistance to the use of computers amongst local government officials remained a very real issue in 1977 (Murtagh, 1977).

By 1979-80, minicomputers were the order of the day (Kirwin, 1979), (Grooms & Kevany, 1980) and the focus of applications had tended to shift toward a more formalized view of GIS (Webb and Davis, 1979), (Cowen, Crosley & Holland, 1979), (Brooks, 1980). The realization of the growth of computerization in local government (Norris & Charest, 1979) and growing expectations of the benefits of Information Technology in local government (Jefferson, 1980) tended to bridge the gap between computer specialists and management (Ludwick, 1980). Trends in applications appeared to centre more on land use planning (Gayk, Carstens, Dedischew & LaPorte, 1980), (Lavigne & Charbonneau, 1980), (Chamberlain, 1980), (Moyer, 1980).

In 1981 the primary technological input to IS/GIS applications and programs in government was the introduction of the microcomputer (Nelson & Smith, 1981). The introduction of the microcomputer was probably one of the largest single contributors to the proliferation of computer literacy in government in the 1980's. Geoprocessing remained the central focus of applications (Jay, 1981), (Robinson & Coiner, 1981), (Baltz, 1981), (Johnson, 1981) although more specialized applications in land-use planning (Dyer, 1981), (Gierman & MacDonald, 1981), (Moyer, Portner & Mezera, 1981) and environmental assessment (Webb, 1981), (Ader, 1981), (Berkun, 1981), (Wilson, 1981) had begun to surface.

Developments in telecommunications (Kindleberger, 1982) provided further technical inputs to government IS/GIS applications in facilitating the adoption of microcomputer technology and the surge in the variety and scope of IS/GIS applications in government (Evatt, 1982), (Barber, 1982), (Dakan, 1982). The individual spreadsheet, textual and mapping applications were giving way to an interactive graphics environment (Cardinal, Godbout & Corbeil, 1982), (Coan, 1982), (McNabb, 1982).

By 1983-84 the impact of the introduction of the microcomputer environment was continuing to be felt in government (Morgan, 1983), (Head, 1984). The scope of IS/GIS micro applications continued to expand, most notably in the environmental sector, with the introduction of decision support systems in 1983 (Van Sambeek, Wei & Zouzoulas, 1983), (Peters & White, 1983), (Engelman & Fittipaldi, 1983), (Dyer, Brklacich, Bond & Smit, 1983). Techniques in distributed processing appeared as inputs to IS/GIS applications in government in 1984 (Dedischew, Wilson & LaPorte, 1984), (Selby & Reick, 1984). Technical innovations in IS/GIS in government included more formalized online, multipurpose GIS facilities providing spatial analysis capability (Lam, 1984), (Kutsal & Zaidi, 1984), (Wilson, 1984) and the introduction of concepts in relational database management (Juhasz & Treworgy, 1984).

Applications in global-positioning systems (Wells, 1985), video disc technology (Kitchen, 1985), (Kindleberger & van Bakergem, 1986) and techniques in graphic image analysis (Lam, 1985) provided technical inputs to IS/GIS programs in government in 1985. The scope of IS/GIS applications continued to expand with a strong emphasis on the development of techniques in spatial analysis (Teng, 1986), (Robbins, 1985), (Love & Diechert, 1985).

Technical applications of IS/GIS in government in 1986 continued to be focused on micro-based systems (DeLap, 1986), (Routsala, 1986), (Djunaedi, Hinojosa & Fowler, 1986), (Heseltine, 1986), (Simmons & Maffini, 1986). Techniques in object-oriented modelling and the functionality of grid and vector data structures continued to fuel the wide range of IS/GIS applications in government (Kjerne, 1986), (Dolton & Dueker, 1986), (Ventura, Sullivan & Chrisman, 1986).

In 1987, initiatives in open architecture and systems integration provided one of the key technical inputs to IS/GIS programs in government (Brandes, 1987), (Mohr, 1987). Further innovations in decision-support systems distributed processing and expert systems (Evans, 1987), (Eichelberger & Barb, 1987), (Barb, 1987) and the introduction of knowledge-based systems provided technical inputs to government IS/GIS programs in 1987.

Distributed spatial analysis (Ferreira & Menendez, 1988), advances in spatial modelling (Kunkel, 1988), the integration of raster and vector data for building intelligent databases and the application of CASE technology contributed to the technical inputs to IS/GIS programs in government in 1988. Concepts in expert systems (Geisman & Redlin, 1988), (Kim, 1988), (Steger, 1988), (Vijayaraghavan & Tien, 1988), (Olson, 1988) received widespread application in 1988 but initiatives in systems integration probably formed the focus of technical inputs to IS/GIS programs in government (Olson, 1988), (Elgarf, 1988), (Myers, 1988), (Westwood & Brinkman, 1988), (Daniels & Mohr, 1988). Techniques in scanning (Skiles, 1988), (Fain, 1988), applications of optical disk technology and applications of linkages between image and digital data provided secondary technical inputs to IS/GIS programs in government (Jones & Crabtree, 1988).

In 1989, systems integration and networking continued to provide the focus for the technical inputs to IS/GIS programs in government (Cook, 1989), (Chandler, 1989). Data conversion and techniques in the integration of raster/vector GIS systems along with techniques for integrating differing types of spatial data contributed to the secondary technical inputs to IS/GIS programs in government. Refinements in videodisc, CD-ROM and optical disc technology provided further input to technical innovations in IS/GIS programs in government (Moosic, 1989).

Technical inputs to IS/GIS programs in government in 1990-91 continued to place considerable emphasis on initiatives in networking (Kenk & Anderson, 1990), and systems integration. The proliferation of heterogenous, multi-vendor systems have added to the complexity of the technical solutions to systems integration. Applications in transparent data access in heterogenous networked systems, techniques in the integration of information management and spatial analysis tools and use of prototyping in GIS systems design provided input to efforts in systems integration. Refinements in all-relational solutions to GIS data management, object-oriented approaches to the analysis of GIS systems, (Oaten and Shortis, 1990) and CASE tool applications in major systems migrations (Lowe, 1990) all have contributed to the ongoing development of technical inputs to IS/GIS programs in government and the quest for integrated, knowledge-based, intelligent and predictive models in IS/GIS systems.

Trends in Geographical Concepts Development and Data Availability in Government

When government Geographical Information Systems were first undertaken, it was expected that a given system would satisfy a specific task or purpose. Most applications in the civil sphere were intended to support administrative record keeping (Census, Property Assessment), service planning (delivery routing), general planning (Environmental Assessment), service delivery (incident and location reports) or some such purpose. For any of these functions to work, one needed to collect data and associate that data with geography. Over time there have been changes in approach to geography and data on behalf of government.

While the interaction of developing organizations, developing technologies and evolving strategies for the management of this development maintained a fever pitch over the past fifteen years; the development of geographic concepts appears to have marched at a different pace. In part, this may be attributed to the institutional barriers in government that limited IS/GIS initiatives to local, single-purpose applications until the early 80's. Since the early 1980's, regional applications in government appeared to flourish with the proliferation of the microcomputer, distributed processing and concerted efforts in multi-jurisdictional, multi-purpose IS/GIS initiatives in government. With relative success in migrating from local to regional government IS/GIS applications, concepts in national IS/GIS initiatives had emerged by 1984.

Geographical References

While there are many ways to taxonomically classify GIS projects, one common set of classes revolve around the geographic approach to organize and process the stored information. This system of classification would include: 1/raster/grid, 2/parcel/point/polygon, 3/network/graph. The past 15 years have seen these three classes wax and wane. Within a given class there have been changes in the details of the approach and application. Recent emphasis has been on linking information, collected with one approach, with other information organized on a differing basis.

There has been an increased emphasis on refining the precision, accuracy, and repeatability of geographical references. Many of the early systems were organized around some geographical reference embedded in the source information or strongly associated therewith. If the system was a demographic small area then one used DIME or AMF or some similar approach. If the source was topographic or biophysical then one used a standard map base. If the source was macro scale (such as satellite-based remote sensing) one used a standard map projection. Often, if there was no default encoding, an arbitrary system was used such as digitization values generated by a particular instrument used to encode information recorded on a particular map or map series.

Since the data and geography were compiled for one project, there was little concern with checking that the location description was accurate or that, if the items were areal in nature, that the grid cells or parcel polygons were precise. The exception was for Land and Property Assessment.

Property Assessment has an inherent bias for precision. If the assessment record shows a parcel as too large, then the property owner will likely notice the variation and launch an appeal. If the record undersizes the property, then the neighbours or business competitors will force a reassessment. If a parcel is misdescribed in tenure or attributes, then external actors will again sooner or later notice that the error has occurred and corrections will be applied. If the Assessor has lots of appeals against his rolls, he may be out of a job. Thus assessors were early adopters of parcel/polygon GIS type technology.

In the U.S. particularly, there has been a strong stream of interest in land records modernization. This involves the collection of geography, attribute information, and tenure changes to be shared amongst various public agencies. In Canada, the Maritime provinces undertook this activity on a trans-regional basis. For those jurisdictions which use the Torrens system of land registry there has been a series of projects to mass code the title information into online computer systems.

Raster/Grid Geographical Data

The raster/grid type system has been largely restricted to use with remote sensing (satellite and air photo or scanning). The collection grid is defined by the sensor or digitization system in use. The U.S. Landsat series of satellites has a resolution of 30 x 30 meters. As that system's data is freely accessible, it has largely determined the nature of systems provided. The resolutions offered are not useful for most urban municipalities, and are of limited use over urban or rural regions (such as Counties). It is only at the large region (typically state or province), national or international scale where this sort of system is in routine use. The French SPOT series of satellites have a 10 x 10 meter resolution. This scale is useful for small regions and many municipalities. Unfortunately the system operates with encrypted data so access to information is only routinely available on a commercial basis. The local governments and regional authorities who might make use of the information are not yet persuaded of the value of the information collected. They typically argue that much of the information available does not aid in the day to day operation of the government and that much of the information available from the satellite can be derived from administrative records or field collection.

The technical issue of matching the raster/grid data with the more conventionally mapped or recorded information used by most government agencies is a serious barrier to the effective use of such data. Additionally, the analysis of change, which ought to be easy to handle with remotely sensed data, assumes that the data for the time period of interest is collected and readily available. Only a few government agencies collect and store remote sensing data and have the means to merge/compare multiple samples to produce meaningful output.

Most of the URISA papers presented on the use of raster/grid type systems have been presented by or in conjunction with academics. The academics have access to the tools and data and the expertise to make the data useful. It is of note that most papers relating to this topic indicate that the resultant system, while of interest to the policy makers and influential parties, have not been seen as having dramatic impact on the decision at hand (approving a general plan, prioritizing utility line extension, locating utility corridors, defining environmental reserves, etc.)

Parcel/Point/Polygon Geographical Data

Because many government agencies deal with land in some aspect of their operation, there are usually records and maps dealing with land at the heart of the operation. Many of the GIS systems of the 70's and 80's involved collecting these records and organizing them so that they could be readily accessed using a common geographical key. The keys commonly include: Legal Land description, survey coordinates, some form of map coordinates, location names (buildings, complexes, towns), area names (jurisdictions, municipalities), or some form of address.

The common factor in these data sets is that the areas described are locations or areas that are normally irregularly positioned and bounded. Typically the data location (even those based upon survey or map coordinates) is not 'naturally' associated with the geographical descriptor. Whilst one indicates that a lake is located at a particular spot on a map and has a characteristic shape, it is often not true that the position and boundary is absolute and fully precise.

In Canada the national conversion from Imperial measure to System International metric measure provided both an incentive to computerize many data sets ('soft conversion' to allow mass conversion of the geographic and other data) and an opportunity ('hard conversion') to revalidate the stored information. Combined with the greatly increased price/performance ratios for computer graphics systems (often seen as Computer Aided Drafting rather than true GIS) there were mass captures of mapped as well as numeric and text data source.

Network/Graph Geographic Data

In the U.S., mandatory school busing resulted in many municipalities engaging in crash programmes to plan student allocation and establish efficient and economical routes that met the criteria of the Courts. These systems were often based on the U.S. Census DIME files and census summary data. A major problem with the effective application of such systems was the fact that the Census geography was often incomplete (in rapidly changing jurisdictions), and the network was topologically complete but geometrically and geographically imprecise. The jurisdictions then began to maintain the network information, adding new streets, updating address ranges, correcting positional and alignment accuracy, and associating administrative boundary information not included in the original file. Some private firms got into the business of providing such update services for jurisdictions which lacked inhouse expertise. Once the network was in place, it became easy to take administrative data containing addresses (crime statistics were especially popular) and map the results. The Cities of Milwaukee and Seattle were early exemplars of the use of networks for mapping.

The U.S. DOT and Canada's Transport Ministry both funded the development of various transportation modelling software packages. The easy availability of these packages also encouraged localities, states and provinces to build network databases.

As the U.S. Census moved to the TIGER system, and additional networks became available from the U.S.G.S. DLG series, the network systems have been extended across regions and states. Transportation departments have adapted nets to comprise pavement management, sign and signal inventories, and capacity analysis.

Integrated Geography and Data

While the taxonomy used in classifying the geographical organization of the government GIS projects outlined above is serviceable, it is an over simplification of the real world. Very quickly governments have come to realize that there is a need to merge the various approaches because the various data sets derive synergistic benefit when they are combined. Linking the parcel based data on land use (for example) to the transportation network allows better inferences about origin-destination activity. Tying a raster-derived biophysical inventory to a network allows for route planning and selection.

A major issue in establishing any GIS in the 80's was the question of whether or not to go to "full engineering precision" (highly accurate, precise positional and attribute information) collected over a long period (up to a decade for large jurisdictions); or to get a usable full coverage system, at lower precision but much lower initial cost. There was general consensus that the full precision base would be the best long run choice, but there was substantial debate about the willingness of senior bureaucrats and politicians to fund such projects, using a new and 'risky' technology, with little short term benefit. Many of the jurisdictions which started out with low precision systems used the early system to educate potential clients about the potential utility of the technology. The initial systems are now evolving into a higher precision system, and many of the smaller systems are being merged into multiparticipant databases.

By the late eighties an issue raised in several papers was that in GIS technology, especially in the large scale urban and regional systems, access by end users was being mediated through a "technological priesthood". This then made end users have to justify access on organizationally utilitarian bases, and discouraged exploration of system capabilities. This in turn acted as a brake on the opportunities for systems to find new applications. Various papers on use of artificial intelligence and alternative means to make systems more user friendly emerged since that date.

In 1989, we witnessed the arrival of the large scale integrated GIS. The difficulty was that the definition of integration depended on the system being discussed. The integration could be extended geographical coverage, integrating primary geographical systems (typically point/parcel with network/graph), and extending thematic content.

In the late 80's and the 90's much effort has been placed on integration of the data embedded into individual application and organizations so that the information can be 'bent' to be used for applications beyond the narrow objectives set for the original systems. Even when the information is stored in a compatible technology, organizations have found that they must resolve inconsistencies in the geography. When an administrative boundary polygon (and its data) is to be associated with census data compiled against block faces, and the boundary and the blockfaces are all derived from a particular stretch of a road, it is expected that they will all coincide at the correct locations on the ground. Making this happen is proving difficult as the primary data collectors have a large investment in doing things in a traditional manner. As noted earlier, current URISA papers are becoming increasingly focussed on addressing the organizational issues in the management of these data sources.

Thematic Data Issues

It is of note that whilst the geographic information was important in organizing the spatial component of the data base, the thematic or attribute information was often of crucial importance in the success of the system.

The 1983 URISA Proceedings discussed the issue of shared meaning when data was combined from differing suppliers, or when the data reader was from a different organization than the supplier. This reflected academic and practical experience as the GISs of the late 70's came into productive use where some of the data was obtained from an external data source and could not be easily verified or desegregated locally (such as Census Summary Tapes or Dunn and Bradstreet commercial reports). Other data was collected as part of administrative processes within an organization (such as licenses, inspections, permits, registration, and event logging) and it was sometimes possible to get the primary data collector to encode the data for downstream geoprocessing. A third approach involved the engagement of staff to field code information. Such encoding could involve retrospective analysis of administrative records (including maps), or actual primary data collection by field workers.

Many GIS implementers made use of various federal, provincial, or state employment programmes to hire unemployed casual labour (students if available and eligible) to carry out field work. Often the results were not good. Unless closely supervised, the field work was inconsistent, depending on the diligence, aptitude, and comprehension of the individual field workers. If mass encoding across the area of interest could not be accomplished over a short period of time, then there were temporal inconsistencies in the information reported. The collection of data over time was dependent on continued funding of the labour force. In the Reagan/ Mulroney era, such programmes were often cancelled or severely curtailed. If the data could not be kept up to date, or the time series information needed for change analysis and forecasting was not available, the system quickly became useless to end users.

It would appear that the systems based on programme-related, administrative processes, rather than GIS specific purposes, have proven staying power. It is also notable that the issues of proprietary interest and liability arising from downstream re-use of information, along with protection of privacy combined with the public's right to know have been constant discussion topics at URISA. U.S. participants have often been concerned with pragmatic and technical issues, while Canadians have assumed an uncharacteristically entrepreneurial perspective, their legal tradition of Crown copyright contrasting with the U.S. tradition of Public Domain.

SUMMARY, CONCLUSION AND INFERRED TRENDS

Over the past fifteen years, inputs to IS/GIS programs in government have undergone considerable metamorphosis. Relatively speaking, information technology has been revolutionized since 1977 and in many areas has forged ahead of the organizational evolution of government programs and the development of geographical concepts in IS/GIS initiatives in government.

For the period from 1977 to 1981, IS/GIS inputs to government programs were generally in the form of large centralized, single-purpose, single-means initiatives with applications focused on local government. Jurisdictional barriers, computer literacy and the transferability of data were primary obstacles in implementing broader IS/GIS government applications as we perceive them today. With the introduction of the microcomputer in the early 1980's, computer literacy levels soared, distributed information processing evolved and the development of applications, tools and technology within the vendor community flourished in response to government's quest to implement regional IS/GIS initiatives. Multi-purpose, multi-jurisdictional IS/GIS initiatives at a regional level of government had emerged by 1982 and were facilitated by the technical innovations in telecommunication links, interactive graphics, techniques in spatial analysis and relational database management and the development of concepts in decision support systems. This change in the scope of IS/GIS initiatives in government coincided with a change in the philosophy with which IS/GIS programs were directed in government. Application-oriented initiatives focused at the local level of government had given way to multidisciplinary IS/GIS resources management systems for programs at the regional level of government. As government programs moved from centralized data processing toward decentralized information management, the 'technological priesthood' no longer held governance over IS/GIS programs. The focus of IS/GIS initiatives broadened from applications in local government to regional government programs and focused on IS/GIS development that would provide interdisciplinary management tools. Through ongoing technical and institutional innovations, the traditional single-purpose IS/GIS application had broadened into multi-purpose, multi-jurisdictional platforms.

By 1986, IS/GIS programs at a regional level of government had broadened to include a national perspective, facilitated by such emerging technologies as global positioning systems, videodisc technology, graphic image analysis, object-oriented modelling and techniques using grid and vectors structures. Interagency consensus building and long range strategic planning for IS/GIS programs in government added impetus to the increasing focus on the development of open architecture systems and systems integration. Standardization of data, data ownership and jurisdictional barriers remained very real obstacles.

The appropriate political sponsorship of IS/GIS programs in government was recognized as critical in meeting the jurisdictional, organizational and legal challenges to the successful implementation of IS/GIS programs in government in the late 1980's. The role of IS/GIS programs as management tools for integrated resources management had to be matched with strategies to manage expectations of these IS/GIS systems in government. Continued refinements to decision support systems and the emergence of expert and knowledge-based systems added momentum to the need for these strategies.

Several of the IS/GIS programs had reached maturity by 1988 and we had begun to see the emergence of strategies for the lifecycle management of IS/GIS programs in government. Such strategies included the restructuring of organizations, the implementation of cost recovery techniques and the initial stages of privatization of IS/GIS government programs. The resolution of jurisdictional issues in IS/GIS initiatives could in part be rationalized through the use of cost/benefit analyses and the application of cost-sharing formulae. A market existed for government-based IS/GIS information products.

We could recognize the initiation of IS/GIS program evaluation and review in government as the technology reached the desktop and the end-user needs increased in profile. Essentially, the base technological platform in IS/GIS programs in government appeared to come of age in the late 1980's. Technical innovations in networking, systems integration and data conversion techniques effectively continued to decrease the 'size of the world' of IS/GIS programs in government. Techniques in scanning, raster-vector integration and the implementation of optical-disc technology and CASE tools added momentum to this trend.

The concept of IS/GIS programs in government had undergone considerable evolution from the view of IS/GIS applications held in the 1970's. With the emergence of multi-purpose, multi-user IS/GIS programs, the degree of specialization in any one theme of application had effectively been transferred from the core of the IS/GIS program to the end-user set of applications. The efficiency and effectiveness of a multi-purpose IS/GIS program could therefore be measured by the variety of end-user applications satisfied by the program, rather than the traditional measure of the degree of sophistication or specialization of the application to any one specific theme. As a result, the evaluation of the multi-disciplinary IS/GIS program is considerably more complex than the evaluation of the typical 1970's single-purpose, single-means IS/GIS application. Any specific theme or application is tending to become more transparent as multi-disciplinary IS/GIS programs continue to develop.

In the early 1990's, new dimensions in IS/GIS programs in government have included the emergence of organizational models for multi-jurisdictional IS/GIS programs. System migration strategies have also appeared in response to market conditions where heterogenous multi-vendor systems are becoming commonplace in IS/GIS programs in government. Techniques in IS/GIS management are tending to become more centralized in government as the computing power increases and the techniques for data processing become more distributed. Apart from the technological viability of this formulae there appears to be a cultural aspect of this status in IS/GIS programs in government. In many instances the fundamental issues in IS/GIS in government have not changed since 1977 even though the fundamental structure of the world of IS/GIS programs in government has changed radically since 1977. Jurisdictional barriers, limitations in systems integration or communication and the transferability of data remain very real issues in the 1990's. The complexity involved in resolving these obstacles, however, appears to have increased exponentially over the past fifteen years as the sophistication of the technology has increased, the scale of IS/GIS initiatives has broadened, the organizational structure of government has evolved and the relative 'size of the world' of IS/GIS application in government has decreased.

The issue as defined in 1977 was contained within IS/GIS applications in government programs. Today IS/GIS programs constitute a rapidly expanding system of programs in government and the task has become the direction, organizational development and infrastructure management of the IS/GIS government programs. Apart from the magnitude of the task, technological innovations are continually opening new frontiers in our ability to network the integration of systems, to increase our computing potential and to generate the government revenues to maintain the rate of research. The dynamo has been established.

From an organizational and operational perspective, technologies are becoming more transparent and an appreciation of the increasing complexity of integrated resources management is beginning to be heard over the jurisdictional wrangling in government. As the world of IS/GIS programs in government continues to decrease on a global scale, so the challenges of the complexity in the resolution of the expanding number of administrative, organizational and legal issues in the lifecycle management of new and mature IS/GIS programs in government continues to increase. In scanning the inputs to IS/GIS programs in government over the past fifteen years, with the realization of mature IS/GIS programs in 'perpetual transition' and with the IS/GIS world beginning to decrease in size; we may be witnessing the coming of age of the 'information age'. IS/GIS programs in government have been as much a product of the past fifteen years as the revolution in IS/GIS technology.

The stage has been set for the next five to ten years, and we could reasonably expect to observe government responding to the reality of a 'global world' in IS/GIS programs. With the downsizing of governments, the increasing tendency toward public-private initiatives and the viability of revenue generating IS/GIS programs in government, continued technical innovations in networking, systems integration and data conversion techniques could effectively continue to decrease the 'size of the world' of IS/GIS programs in government. Increasing numbers of IS/GIS programs are reaching maturity and are liable to result high-profile strategies in the lifecycle management of IS/GIS programs, focusing on system migration strategies and the notion of IS/GIS government programs suspended in a state of 'perpetual transition', as dictated by market conditions and client or stakeholder needs.

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IS/GIS, URISA AND THE PRIVATE SECTOR

Abstract: The general task of this paper is to document and examine the ways, extent, and purposes of IS/GIS use and selling by the private sector. Of particular interest, are matters linking IS/GIS and the private sector to urban and regional institutions, and the activities of URISA. Drawing on the URISA literature, related documentation, consultations with members of the business community as buyers and sellers of IS/GIS. The paper addresses a number of fundamental outputs of the past, present, and future IS/GIS—private sector connection.

Some of the important questions posed deal with the exchange of IS/GIS knowledge and ideas between private sector vendors and consumers, and the role of URISA as fosterer or contributor to the exchange: Has the exchange been beneficial to both vendors and consumers? Has it improved the development of products or services which the private sector needs for urban and regional purposes? Are there lessons learned about uses by the public sector which have private sector implications? What might be done to improve the quality and/or rate of exchange so that both sides of the private sector (vendors and consumers) benefit from better applications of IS/GIS in urban and regional institutions?

INTRODUCTION

An examination of information system/geographic information system (IS/GIS) use by the private sector during the past 30 years was a task beyond the time and resources available for this paper, and, realistically, beyond the scope of a conference paper. A comprehensive comparison of the progress and relationships between private and public use of IS/GIS certainly deserves the attention of a group of URISA professionals. However, the author reviewed 30 years of ***URISA Proceedings*** and abstracts of papers and presentations, as well as the ***URISA Journal*** and the ***GIS/LIS Conference Proceedings***. Some recent popular literature and discussions with individuals in the IS/GIS private sector were included as anecdotal reference. This approach does fit within the parameters set by Wellar and Parr (1992), and sets a stage for discussion of what the connection(s) is (are) between URISA and the private sector.

A recent issue of ***GIS World*** featured business applications of GIS. Giulio Maffini (1991) introduces the series with an article entitled, "GIS at Threshold of Business Applications." Each of the twelve articles featured in the issue is written by a vendor of GIS hardware, software, or services, and the implication is that business has not yet grasped the full importance of GIS technology, and that the connections need to be made for greater productivity and better use of information. One article presents a very brief overview of private sector use of GIS (Dangermond, 1991). It mentions nine business sectors using GIS: real estate, energy, forest products, tourism and recreation, transportation, agribusiness, communications, retail sales, finance. Some of these sectors were the first users and developers of IS/GIS applications according to Dangermond. The other ten articles enthusiastically describe applications of vendor's products to marketing, site location, and routing of private ambulances. The primary thrust of the feature section was to present the capabilities and promise of GIS for private industry to those not yet involved.

It seems that this is precisely the role the private sector has played in URISA and the development of urban and regional IS/GIS for the past 30 years—sell the capabilities and promise of technology. Several conversations with URISA members from private industry have suggested that this relationship is limited to marketing because a competitive market precludes extensive, detailed discussion of problems with one's products and most profitable markets. A review of the literature shows minimal connections with commercial applications. A tendency to limit frank discussion of products and services also appears. There is no published discussion of why there is a limitation, or if it is unique to the business sector (how much does anyone present information on failure or problems?).

BUSINESS AND URISA LITERATURE

URISA's literature, as represented by those published in full or part by the association, indicates that urban and regional government and business have developed (not surprisingly) a consumer-vendor relationship. In the first fifteen years of URISA twenty-two (22) papers were published in the *URISA Proceedings* which addressed commercial applications or the transfer of commercial technology/applications to the public sector. These are listed in Table 1. The list excludes businesses whose primary or major purpose was the selling of systems or services to urban and regional government on the assumption that these products and services were developed for the public sector.

In eleven of the 22 papers, five defense-related corporations with established automation capabilities and systems were "selling" automation or information systems to urban and regional governments: Boeing, Westinghouse, General Electric, North American Rockwell, and Lockheed discuss local and regional government applications as "consultants" to government. This reflects expertise gained through development of automation for their primary business of selling products and services to the Federal government. It also shows the role the aerospace industry played in developing information systems; Boeing, Lockheed, and McDonnell-Douglas developed information system businesses as corporate divisions. Westinghouse had an Urban Systems Center in Arlington, Virginia during the early 1970's. These instances illustrate the role of Federal government related industries, primarily defense, on the early development of information systems technology.

TABLE 1: Papers On Commercial Applications or Transfer of Commercial Technology to Urban and Regional Government

Corporation	Title	Author	Year
Auerbach Assoc., Inc.	PPB-MIS:The Critical EDP Interface	Wright, Ward J.	1970
Boeing Computer Services	A Polygon Overlay System	Carlberg, Edward F.	1972
Boeing Computer Services	Boeing Computer Services DIME Capability	Carlberg, Edward F.	1972
Boeing Computer Services	UNIMATCH Experience with Truck Survey Data	Carlberg, Edward F.	1974
Computer Communications, Inc.	Analysis and Design Eco-nomics of Time-Sharing Systems	Fagen, Robert E.	1966
Criterion Advertising	Urbanology Meets Outdoor Advertising	Colihan, William Jr.	1974
Digital Resource Corp.	Design of a Data Base Management Systems: Rela-tionship of User Requirements	Gack, Gary	1971
General Electric Corp.	Automatic Plotting and Digitizing	Christensen, Robert	1973
General Electric Corp.	A GBF/OSP Facilities System	Nussbaum, Ernest	1967
General Motors	A Hierarchical Urban Information System and Its Applications to Transportation System Analysis	Gustafson, Richard	1972
General Telephone	Experience with a Man-Machine Graphic Approach to Updating Geographic Base Files	Christensen, Robert	1972
Goldmark Communications	Integrated Data Processing, Cable and the Community	Kumar, Anand	1973
Lockheed Missiles & Space Company	A 'Federated' Statewide Information System	Donati, Robert	1966
Lybrand, Ross Bros. and Montgomery	Management Information Systems	Kaufman, Felix	1969
Manufacturers Hanover Trust	ABLES:Automated Branch Location Evaluation System	Healy, Joyce	1972
Marketing Consultants, Inc.	Computerized Land Use/Sales Activity for Marketing Allocation	Summer, Harry H.	1972
North American Rockwell Corp.	Policy Management Information Systems—Redondo Beach	Jaycox, Thomas C.	1969
Systems Science Development Corp.	Aerospace Technology and Public Safety law Enforcement Executive Development Program	Shumate, Robert P.	1972
Westinghouse Electric Corp.	Notes on Possible Queries of Data Bases and the Use of Network Analysis by Urban Planners	Trilling, Donald	1964
Westinghouse Electric Corp.	A Planned Program	Wilson, Robert W.	1972
Westinghouse Electric Corp.	The Quest for Manageability in Urban Systems Delivery	Carlston, Robert A.	1972
Westinghouse Electric Corp.	Jurisdictional Aspects of Implementing a Land Record System	Bennington, Bernard	1973

URISA's primary government constituencies were viewed as potential markets for the expertise and capabilities gained elsewhere. Urban and regional governments were "on the threshold" of information systems technology. One can see the stimulus of Federal government spending in the IMIS/USAC (Integrated Management Information Systems/Urban Systems Interagency Advisory Committee) under the Department of Housing and Urban Development (HUD) beginning in 1968,(Kraemer, 1974; Wellar, 1973) and other federal urban programs. These are discussed from other perspectives in this volume by Arbeit, Eichelberger, Kindleberger and Topping, and Wiggins *et al.* There is some evidence of an upswing in participation by the private sector in URISA conferences and a concomitant presence in the literature. It should be noted that the defense related firms disappear by the mid- and late eighties when the market expanded so dramatically

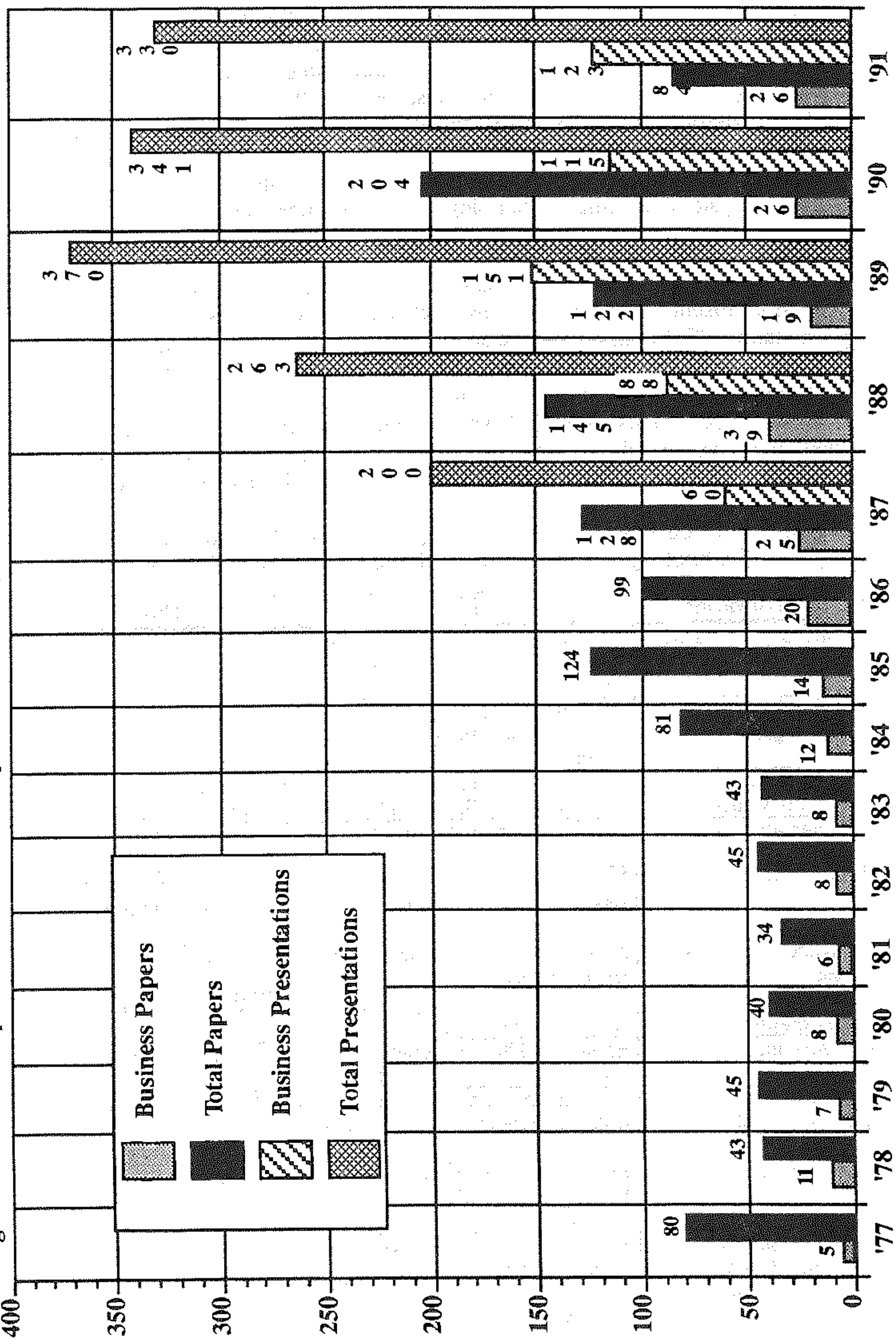
Almost simultaneously the U.S. Census Bureau was a major contributor to the development of IS/GIS and URISA though its GBF/DIME project for the 1970 and 1980 censuses. These policy and financial stimulants provided, or at least enhanced, a market for IS/GIS development in urban and regional government. USAC alone involved $26 million (unadjusted) between 1971 and 1978 (Kraemer, 1979). It should be noted that nowhere in this volume, nor in the literature is the role of National Aeronautics and Space Administration (NASA) discussed for its contribution to hardware development, systems design, project management, or software development.

The business contribution to early URISA literature as presented in Table 1 is six percent of the *Proceedings* papers from 1963-1976. By far the greater business contribution is from firms whose primary or major market was urban and regional government information systems. There were 83 business-generated papers (including Table 1) among the 378 published during this time—sixty percent from consultants and the remaining forty percent from vendors of hardware, software, or data. The topics of these papers are indistinguishable from those offered by the various public sector participants in URISA. They discuss the issues of clients and potential clients, and proposed or implemented solutions. This anecdotal approach dominates URISA literature, providing good snap shots of IS/GIS progress in urban and regional institutions.

Business sector papers constituted 22 percent of papers in the first 15 years. This ratio holds throughout the history of the organization. Figure 1 illustrates the relationship between private sector papers and total papers for the last 15 years (1977-1991). Business presentations to total presentations is shown for the last five years (1987-1991). For this latter period business papers constituted 17 percent of the papers in the *Proceedings.*

The statistical evidence of a limited business application presence should come as no surprise given URISA's urban and regional focus. The geographic qualifiers in our name, and the public sector focus of our founders, appear to exclude many of the applications which are specifically business related, e.g., sales, marketing, profit/loss financial systems. However, even in those areas of mutual concern, personnel, inventory management, systems planning and development, and geographic information systems, URISA has little or no record

Figure 1: Business Papers/Presentations Compared to Total Papers/Presentations at URISA Conferences 1977-1991



of meaningful exchange with the private sector, except through vendors of systems and services to urban and regional government. Even in the case of IBM which has long taken part in URISA, and dominated much of the early system development in government and business sectors, there was no presentation of business experiences with IS as applicable to urban and regional organizations. In the first 15 years of URISA, while IBM was one of the primary developers and publishers of business system planning ideas, not one of IBM's five papers addressed system planning methodology or case studies—private or public.

An examination of all presentations made at URISA conferences 1987-1991 reveals that the lack of published material on commercial IS applications reflects a near total absence of such a commercial-public exchange at URISA. Twelve presentations (Table 2) on private sector applications, or the exchange of data or technology between private and public sectors were accepted for these conferences, out of a total of 1,504 presentations. It is unfortunate that only four of these presentations produced written papers, so their message is contained solely in the published abstracts. As of this writing there are two planned sessions discussing commercial IS/GIS applications for the 1992 URISA conference.

TABLE 2: Papers On Commercial Applications or Transfer of Commercial Technology to Urban and Regional Government 1987-1991

Corporation	Title	Author	Year
University of Louisville	The Private Sector and Geographic Information Systems: A Survey of End-Users	Dakan, A. William	1987
University of Washington	Application of an Expert System to Model the Construction Bidding Process	Barb, Charles E.	1987
NTT Integrated Communication Labs	Multi-Node Switching System Through No. 7 Signaling System	Saito, Isao and Nakagawa, Kazuyuki	1987
Roulac and Company	Expert System in the Private Sector	Castle, Gilbert	1987
Roy F. Weston, Inc.	MUMS—An Expert System to Assist in Hydroelectric Reservoir Regulation Planning	Pandit, Nitin S. and Harvey, Bradfor	1988
Deloitte Haskins & Sells	Applied GIS Technology in Real Estate Investment	Castle, Gilbert	1988
Donohue Intelligraphics, Inc.	Topics Relevant to Digital Data Acquisition and Exchange	White, William	1989
EDAW, Inc.	Energy and the Environment: Transmission Line Routing	Houston, Gayle	1990
Lowe Engineers & Southern Bell	Information Sharing of Right-of-way Data by State DOTS and Private Utilities Can Save Millions	Drysdale, Jon W. and Piper, Marie	1990
Coopers and Lybrand	Privatization: The Catalyst for the Evolution from AM/FM to GIS in the UK Water Industry	Thomas, David	1990
Morgan Mining & Environ. Concerns	Fly Ash Disposal in Inactive Mine Workings: A GIS Solution	Knox, Brenda L.	1991
City of Bellvue, WA	Bar Coding of Municipal Development Review and Permitting Processes	McKenney, Jim	1991

The situation is similar for the GIS/LIS conferences—1987 to 1991. There are only 13 business application papers in those proceedings (Table 3). This does not include the ASPRS and ACSM Fall Convention technical papers which deal directly with the surveying and remote sensing professions.

TABLE 3: Papers On Commercial Applications or Transfer of Commercial Technology to the Public Sector at GIS/LIS Conferences 1987-91

Corporation	Title	Author	Year
Weyerhaeuser	GIS and Weyerhaeuser—20 Years Experience		1987
HRB-Singer, Inc.	The On-Line Atlas: A GIS for Flight Simulation	Goodwin, Cecil W.	1987
Bonneville Power	Computer Assisted GIS Data Entry at Bonneville Power Administration	Preis, RA Sherer, S.D. Schowengerdt, R.	1988
Martel Laboratories, Inc.	Enhancing Employee Productivity in Geographic Information System Data Entry	Young, Olive	1988
Ontario Hydro	Technology and the Power Line Planner: The Impact of the Computer on Environmental Impact Assessment for New Transmission Facilities	Ladha, Nargis Robertson, Andrew	1988
Dames and Moore, Inc.	A GIS Approach for Corridor Siting and Environ. Impact Analysis	Moreno, Daniel Siegel, Michael	1988
Temple Inland Forest Products Corp.	Integrating Geographic Information Systems and Decision Support Systems	Sieg, Gregory McCollum, Michael	1988
M.J. Harden, Inc.	AM/FM/GIS Corridor Models: The Automation of Cross-Country Facilities	Domsch, Ronald	1989
ATT-Digital Record Systems	A GIS Design Methodology for Evaluating Large-Scale Commercial Development	Kramer, Michael Lembo, Arthur	1989
Illinois Department of Energy and Natural Resources	Illinois' Geographic Information System Meets Dun and Bradstreet: Applying a Commercial Data Base to State Energy, Environ. & Regulatory Issues	Oliver, Sheryl	1989
	We Needed Maps: We Built a GIS	Stout, Larry Avey, Charline	1990
University of Edinburgh	GIS in Harvesting Scheduling of Private Forest in Finland	Nutinen, Tuula	1990
Southern Bell	An AM/FM Success Story: Southern Bell	Rector, Joyce	1990

One cannot conclude reasonably that the use of information systems in the private sector has not influenced, or been influenced by, URISA and public sector information system technology and applications. One can, however, conclude that URISA's view of IS/GIS technology is almost exclusively focused through the lenses of those who sell to the public sector, or are themselves, public sector professionals. Even an unscientific review of the 1977, 1984, and 1991 *URISA*

Proceedings suggests that URISA does not even reference non-URIS business or mainstream IS literature [1991: 8 papers of 84 contain such references; 1984: 3 of 81; 1977: 2 of 80].

This situation raises questions for which URISA should have answers, if the connections with the business community are to be made, and be beneficial to all:

Is this professional incest?

Do we spend too much time talking to ourselves?

Does the situation limit or expand URISA's ability to be an educational association for its members?

Is it the source of an illusion that GIS is unique among information systems?

Does it guarantee a constant sense of discovery surrounding issues that are thirty years old, but still discussed as unique by client and consultant alike?

Does the private sector within URISA provide a connection, a sufficient connection, to the broader world of IS/GIS?

Is the connection an exchange of information, or a transfer from private to public sectors only?

Does the discussion improve products and services, or influence their development in any way?

Can the private sector discuss technological or managerial innovation and limitations without revealing trade secrets, or is marketing its primary, or only, viable form of communication?

These questions have not been asked in the URISA literature, nor in the conference presentations. The business connection is being discussed now as having great potential. This "potential" needs to be defined within the context of finding answers to these questions, if the exchange is going to prove beneficial to the consumer and vendor sectors of URISA—and urban and regional information systems.

MAKING CONNECTIONS

This scan of the literature cannot illustrate the relationship between URISA and IS/GIS in the commercial world because it reveals only an absence of a record of such a relationship. The most important questions should be concerned with the quality of the public/business exchange which does take place; is it as beneficial as possible to all members? The connection between the business IS/GIS professional and the government/public professional is evidenced by the presence of papers and presentations by each, and by their membership in the Association. The nature of the exchange is consumer/vendor. The quality of the exchange, its value to the development of IS/GIS in urban and regional organizations, is as variable as the participants, and subject to as many judgments. The criteria for judging should be: **honesty, objectivity**, and **contribution to the knowledge-base** needed by URISA members—public and private.

Honesty and objectivity should be universal criteria for professional interaction, so whether or not a particular paper or presentation adds to the knowledge base which constitutes the urban and regional information systems (URIS) should be the primary criterion for judging the quality and value of each exchange through the business/public connection. Wellar and Harris (1992) discuss the building of the knowledge base in this volume. It is precisely this body of knowledge which is the basic glue which keeps URISA together according to Horwood (1977). He began defining URIS at the last major retrospective at the URISA '77 conference. His thought-provoking paper is reprinted in this volume not because it provides a snapshot of URISA's birth, but because it defines our purpose and offers criteria for judging our existence and progress

In defining the URIS discipline Horwood writes:

> "I submit that any field claiming to be one of "information systems" shares common information systems theory which I will allude to in greater detail shortly. I believe it is the intellectual content of information systems theory that is the basic glue that holds any information systems group together and that the differences are mainly the sets of objects, the points of view from which the objects are viewed, the tools, the practical applications, and the historical circumstances of a discipline's origin and development.

The reason for the absence of a discussion of commercial applications within URISA is that commercial organizations do not share the same sets of objects, points-of-view, and practical applications with the government and academic sectors which constitute the majority of URISA membership. They are the majority because of the historical circumstances of the discipline's origin and development. There is certainly a connection with the tools of information systems technology and, in some instances, the management of projects and organizational issues. It is this connection which has not been thoroughly explored during the past thirty years.

The most distinguishing factor between business and public sector is— business sells products and services for **profit**; government provides services to guarantee or enhance the health, safety, and well-being of the governed. Profit is a straightforward, quantifiable measure while health, safety, and welfare are quite subjective and determined by policy choices. Policy is a significant topic throughout this volume [see the Index].

To sell produc ts one must make potential buyers aware of the product and its potential benefits. Business does this through URISA conferences and publications directly—in the exhibit hall and through advertisements in publications. URISA's consumer members depend on these sources for information about IS/GIS industry developments. It is one of the services URISA provides to members. This exchange does not add to the URIS knowledge base because it lacks objectivity; promotion is outside the educational exchange.

Products and services are sold also indirectly through papers, presentations, and articles in publications. It is here that business sector professionals share a purpose with all others in the organization. Each professional can present ideas for review by peers. It is this connection which fuels the exchange of ideas and helps fulfill URISA's constitutional mandate as an educational association. Is the business contribution in this area as valuable as it can be to membership? Or, is business limited by the constraints of competition, as suggested by several business sector URISA members? There appears to be no record of a bi-directional exchange; business members do not discuss what they have learned from the public sector, and put to the test in products and services.

Good examples of the exchange of common tools, and organizational or management practices between private and public sectors are: Steger and Steger (1984), "What Can the Private Sector Tell Us About Trends in the Distribution of Processing Power?" in which the authors propose that government could learn from commercial sector experience how to incorporate microcomputers into their organization; and Cross (1990), "Estimating Costs and Comparing Tangible and Intangible Benefits to the Costs of Geographic Information Systems." The paper uses methodologies from the mainstream information system world to present a case for cost/benefit analysis for URISA members. It would have been ideal if there had been a response from one or two government sector members who attempted to use the ideas and methodologies in their organization.

The more direct discussion of the tools and services for public sector purchase is by far the bulk of the business community's contribution to URISA, and the industry. These have remained similar in nature, but changed in content as the technology and its applications have matured. The best of these papers are characterized by objective presentation of a specific technology or application of interest to URISA members. The individual writing the paper is professionally involved in the product or service. For example, in 1972 Dangermond presented a paper entitled "A Classification and Review of Coordinate Identification and Computer Mapping Systems," in which he describes basic graphic data models and their application in recent developments by his company, ESRI. That same year Carlberg (1972) presented Boeing Computer Services latest polygon overlay system developed for the federal government (Bureau of Land Management), and Noles (1972) presented System Development Corporation's experiences trying to automate the Charlotte, North Carolina Fire Department.

Twenty years later there are more papers and presentations by the vendor community which has grown with the market, but the topics are the same. ESRI made three presentations (no papers submitted) on new developments in their products, Waltuch (1991) on the recent development of the product's user interface, and Clancy and Drews (1991) and Chambers (1991) on applications of their product. In fact more than one third (37%) of all presentations at URISA '91 were by vendors of products or services (Figure 1). Most vendors are represented. The "What We Have" and "What We've Done" papers dominate.

URISA has taken action to monitor vendor presentations to minimize direct marketing in papers and presentation. This is a review of quality based on objectivity and the absence of direct promotion. The Association also limits the number of presentations/papers from any one corporate entity (including public and academic) or individual. The association recognizes the value of product information to members interested in technological innovation; URISA has decided that education and not promotion is our purpose. The value of a balanced presentation by business is clearly recognized.

The private sector has developed as an important part of URISA and is our primary connection with technological innovation. The perspective is, however, one of vendor presenting to consumer, and requires monitoring for fairness and objectivity. URISA has taken on this responsibility.

PERSPECTIVES ON THE FUTURE

The urban and regional information systems field and industry have grown rapidly during the past five or six years. URISA's concomitant growth has included an increased participation by the business community. The level and nature of participation by business is currently a significant issue in the Association. One major aspect of the discussion is URISA's appeal, or need to appeal, to business through commercial applications of IS/GIS. The continued growth and effectiveness of the organization are the primary motivations for the discussion.

URISA has not had a significant participation by the private sector outside of the vendors of products and services to local and regional governments or quasi-governmental institutions such as public utilities. The literature does not explain this situation, but the overwhelming absence of such literature strongly suggests that the commonalties between URISA and that sector of the business community are no more than those common to all information systems.

Do we need a greater exchange with the larger "information systems" community to improve URISA's contribution through education to the development of high quality, effective urban and regional information systems? Can the commercial application of IS/GIS technology provide this to URISA? Are there other sectors of the IS industry able to provide this to URISA? How can URISA best relate to these other IS fields? These issues should be part of our future exchange.

Commercialization

One interesting commercial/public hybrid of IS/GIS which may prove productive in the future is the commercialization of public data, or the promise of public data as a money-making product. This issue blurs the basic distinction between the sectors—profit. This has surfaced in the past several years as a topic of much interest (Lawrence, 1990; Barr in URISA, 1991 Vol. 5). In 1989 Antenucci made a presentation, the abstract of which states, "...The paper describes the components of a cost and pricing model, the relative impact of public policy, and market forces. Specific examples of the model's use in public agencies is described." (Anntenucci in URISA, 1989 Vol. 5). No paper was submitted for publication, and this is the only paper or presentation which discusses actual examples of sales of public data products. There is no indication if actual dollar figures or different economies of scale were presented.

There is nothing in the URISA record which quantifies the products, the market, the costs, the value, or the real income from public data such as land records, infrastructure inventories, digital and traditional map products. This appears to be one area where the business community experience in business planning, product development, market research, and cost analysis could be especially helpful, but is glaringly absent from the discussion. The discussion taking place within the URISA community is limited to the same consumer/vendor public sector professionals who have dominated the literature and discussion for 30 years. URISA members and the field would do well to explore the commercial sector experience in identifying markets, designing products and services, and calculating real costs and benefits of selling data and products—before setting prices and planning budgets. It is the latter which constitutes the bulk of the discussion within URISA.

The sessions on "commercialization" at URISA '92 promise to further the discussion. However, the participants are once again consultants who sell to the public sector and one government employee. Does URISA need to go beyond this in the future, or are we collectively searching for a pot of gold at the end of the IS/GIS rainbow—certain that the direction we are going is right because we heard it from reliable sources? Only facts, systematically researched and objectively presented can add to the body of URIS knowledge on this issue.

Privatization

One topic concerning the public/private sector interaction which has been with URISA from the beginning, with time-sharing (Fagen, 1966) and service bureaus (Chapman, 1977), is privatization of public information systems and/or operations which include information systems. The idea that private enterprise can better manage systems of public information has not been examined within URISA, but should attract more attention as larger data bases are developed without regard to the need for a market for the products, and the costs of data and system maintenance. The privatization of Landsat in the mid-eighties is one example which could be examined at URISA for at least anecdotal evidence of the viability of privatization.

The issue central to privatization of public information systems or data is the commonality between a business sector whose goal is profit and a public sector whose goal is to provide necessary and desired services to the public. URISA has not examined this issue anecdotally or systematically. In Horwood's (1977) terms, what are the objects, points of view, tools, and applications under consideration? Is an entrepreneur better at applying tools to public objects, from a public point of view, and applying them to services which are not traditionally profit-making? Where does the public's point(s) of view fall in this calculation? Is either the entrepreneur or the public sector professional able to represent this significant stake in the decision to move from service to profit as a motivation or goal? URISA is the ideal forum for addressing this issue—systematically.

CONCLUSION

The connection between URISA, IS/GIS, and the private sector is, and will remain primarily consumer—product—vendor. This connection is valuable to URISA's role as an educational association. It appears that the relationship has not taken advantage of a connection between IS/GIS and commercial applications. URISA's connection to the larger IS industry and discipline in general is lacking.

URISA '92 is an ideal occasion for initiating this connection to examine the shared issues and knowledge. This could be accomplished best, if there is a systematic review of the common tools, practical applications, and organizational experiences in both the public and private sectors which will build on the knowledge-base described by Wellar and Harris (1992) in this volume.

Such a systematic review should be planned by representatives from both sectors. There should be a program which allows quick responses to ideas and hypotheses, with documented give-and-take between discussants from all sectors. This can be done in conference papers, journal articles, and the newsletter. This is an ideal project for the Special Interest Group (SIG) structure, but currently there is no obvious candidate SIG under whose jurisdiction such a program could fall. A full review of the SIG organization is necessary before such projects could be undertaken. It would be useful to review all SIGs to see if they could deal with other significant connections in a similar, systematic program. Perhaps, the entire SIG struture should be revamp with this planned purpose in mind.

ACKNOWLEDGEMENTS

Several people provided many ideas as building blocks for this paper. However, I must take blame for the architecture and structural integrity of the final product. Materials, encouragement, admonitions, and contradictions were offered by: Ron Domsch, Jon Nelson, Rebecca Somers, Peirce Eichelberger, Tom Palmerlee, Ed Crane, and Barry Wellar. A special note of thanks to Bud Dettman, a long-standing member, thoughtful enough to send his copies of old *Proceedings* to URISA HQ where they are available for research. I hope others do the same.

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APPLICATIONS OF IS/GIS: SCIENCE AND EDUCATION

Abstract: Publicly funded programs in science and education represent a diverse arena in which IS/GIS has found varying degrees of usefulness. This paper reports on a survey of the literature, and this is intended as a first step towards an understanding of the degree, extent and purpose to which IS/GIS has emerged as a component of science and education programs.

Specific examples of the use of IS/GIS have been cited for many scientific disciplines and there have been recent papers describing applications in education. Nevertheless, the quantity of these published applications is surprisingly low. Although the literature review yields few specific examples of IS/GIS applications in science and education, the paper sets out to estimate the real and potential strengths and weaknesses displayed by IS/GIS within science and education programs since URISA's formation. Implications for URISA are drawn from what appears and what does not appear in the literature.

INTRODUCTION

Whether by creation or evolution, URISA now prides itself as being a learned body of spatial information professionals who gather together to debate theory, foster research and education, and encourage new applications and development of urban and regional information systems. It does all this activity basically to serve the policies, plans and programs of the society within which it exists, with special emphasis on the government, business and academic sectors.

An incremental view of the progress that URISA has made since its inception can be seen within URISA's entire collection of published material, including the proceedings of URISA's conferences, its journals, and newsletters. Each paper, panel discussion, keynote speaker, news item, and article adds to the potential stock of acquired or learned knowledge that is URISA today. This paper reviews a slice of this stock of potential knowledge, and reports on the published applications of IS/GIS in science and education programs.[1]

Science and education cover a wide range of disciplines, levels of understanding, and programs where IS/GIS could conceivably find a user. In order to obtain a clear view of the progress of IS/GIS we have considered science and education separately. For science, programs reporting the use of IS/GIS within "a *particular branch of knowledge*" (The Macquarie Dictionary, 1985) have been reviewed, noted, and discussed.

Defining applications of IS/GIS in education requires further distillation before a clear view of progress can be seen. To illustrate, we considered the use of IS/GIS in teaching not to be an educational program application nor *"the act of putting* (IS/GIS) *to a special purpose"* (The Macquarie Dictionary, 1985). Although many higher education programs teach IS/GIS with the latest hardware and software, and in many cases, involve real world problems and solutions (Parent, 1989), we viewed this activity as demonstration of IS/GIS rather than application of IS/GIS. This definition appears logical and, as a valuable by-product, it certainly improved the logistics of reviewing papers which discussed or reported on applications of IS/GIS in education programs within URISA's literature over the past 30 years.

A literature review of available URISA and AURISA conference proceedings, GIS/LIS conference proceedings and URISA Journals has been undertaken. Published contributions suggesting a topic concerning the application of IS/GIS in science and education programs were filtered out first by title, second by abstract, and finally by paper content. Several papers published outside the realm of URISA have been cited. These publications were obtained on an *ad hoc* basis.

An important caveat to the findings presented in this paper is the fact that the research did not seek out publications from scientific and education journals and proceedings. It could be argued that these publications are most likely to contain material describing IS/GIS applications pertaining to science and education programs. We agree with this argument, and would assuredly have pursued it had time and resources permitted such a detailed search of all scientific and educational publications.

APPLICATIONS OF IS/GIS IN SCIENCE

Science is an all encompassing term representing human knowledge that results from the systematic study of humankind and the universe (The Macquarie Dictionary, 1985, Webster's New World Dictionary, 1984). Science can be as simple as the high school classifications of physics, chemistry, and biology, or as complex as the recently evolved disciplines of computer science or environmental science. Scientific disciplines have in common fundamental tools which are used to expand the breadth of knowledge within each discipline. Some of these tools include data, mathematics, language, jargon, computers, statistics, maps, and so on. The question concerning URISA's 30 year perspective is: To what extent, degree and purpose is IS/GIS one of these tools?

IS/GIS development can be simply described as the combination of the tools of data, computers and maps into a single computerized system. One of the first applications of IS/GIS was for the Spokane community renewal program (Horwood et al, 1963). Horwood's team was one of the early pioneers of IS/GIS and was an early supporter of URISA (Parent, 1989). Certain areas of applied science were very quick to pick up on IS/GIS. These disciplines include geography, cartography, surveying, forestry, town planning, landscape architecture, environmental assessment, and natural resources. All of these disciplines have continued to show a strong presence in URISA's Proceedings over the past 30 years.

Once we go beyond the applied sciences, the trail of IS/GIS applications in science starts to cool rapidly. It appears that scientific disciplines that are focused more on the content of individual objects and phenomena, and to a lesser degree the spatial extent of such objects and phenomena, are not found in abundance in URISA's literature. Scientists whose expertise and energy are more focused on non-spatial entities such as biologists or zoologists, tend not to be overly concerned with IS/GIS as a tool worthy of investment of time and money. In brief, their inclination is to use resources to invest in instrumentation more suited to the task at hand, that is, for dealing with the aspatial aspects of research in biology and zoology.

One of the graduate assistants who helped with the literature research for this paper did find some recent publications in the *Biological Report* which reference the use of IS/GIS. On close inspection, these papers were produced by scientists from the applied science disciplines of geography, remote sensing, and environmental science (Cheshire and Khorram, 1990; Davis et al, 1990; Sinclair et al, 1990). They all reported programs using IS/GIS for mapping environmental features, which suggests that IS/GIS technology is slowly diffusing into the sciences outside the "core" applied sciences associated with URISA.

APPLICATIONS OF IS/GIS IN EDUCATION

In considering the application of IS/GIS in educational programs, we have not included applications of IS/GIS used for teaching IS/GIS. This is due to our interpretation of application as opposed to demonstration. This interpretation differentiates the application of IS/GIS in teaching as opposed to applications in business and government. We maintain that the teaching role of educational programs applies IS/GIS to produce IS/GIS spatial information specialists, or researchers with training in IS/GIS among other tools in the research tool-kit, whereas business and government apply IS/GIS to produce spatial information products and services.

Papers describing applications of IS/GIS from higher educational programs are mainly focused on research or the reporting of scientific advances in IS/GIS technology, and therefore should be considered as an application to science or the expansion of knowledge. There is an abundance of these papers within URISA's literature spanning the entire 30 years of its history.

Papers describing the use of IS/GIS to produce information products within education are very rare. Indeed there are very few papers reporting on any aspect of IS/GIS and education, not withstanding that URISA for many years has had a Special Interest Group (SIG) whose interest is education (SIG-Education). The literature search uncovered one session at an Urban and Regional Planning Information Systems conference (URPIS 1980, Surfers Paradise) which was focused on education. Within this session three papers (Morris, 1980; Hannigan et al, 1980; Cooper, 1980) describe the following topic areas:

1) The use of information systems (IS) and databases for computer assisted instruction. The paper speculates on the possibilities of the use of these teaching tools within the coming decade.

2) The introduction of land information systems courses into the surveying program at the Queensland Institute of Technology (now Queensland University of Technology).

3) The problems of privacy issues for students as educational programs develop information systems and databases on student enrollment and performance.

The first paper describing an application of IS/GIS in education illustrates a proposed system to be used by the Education Department in the State of Victoria, Australia to keep track of its land inventory and to assess demands for educational facilities by monitoring changes in population (Butler, 1977). Four more papers (Dakan, 1984; Davies and Anderson; 1985; Nicholson and Hanson, 1985; Graham and Shackleford, 1991) came to light which added to the short list of IS/GIS applications in education programs. These papers described the following:

1) A geographic-based student information system designed to eliminate *de facto* segregation in Jefferson County, Kentucky (Dakan, 1984). From *URISA Proceedings*, 1984.

2) A paper which describes a computerized system that improves written communication skills (Davies and Anderson, 1985). From *URISA Proceedings*, 1985.

3) A description of a teaching method called 'performance-based education' which reportedly improved the efficiency of training mapping information management systems (Nicholson and Hanson, 1985). From *URISA Proceedings*, 1985.

4) A geographic based computer-aided bus routing system called the Transportation Information Management System (TIMS) which claims to have "reduced mileage by 6% over a two-year period and has reassigned or parked nine buses during the same time" (Graham and Shackleford, 1991). From *Technological Horizons in Education Journal*, 1991. (This paper was happened upon by chance and may well be indicative of what can be found outside the bounds of URISA and AURISA publications.)

GENERAL OVERVIEW

Apart from the applied sciences that are well represented in URISA and those URISA participants from higher education who teach and carry out research in IS/GIS, there is little evidence that URISA has diffused IS/GIS technology to applications in science and education programs. Having said that we hasten to note that we did not look outside URISA (and AURISA) to test this "hypothesis." Indeed, we did stumble upon one or two papers by chance that indicated that there may well be evidence elsewhere showing that the scientific and education communities are pursuing IS/GIS technology.

By most standards, and most certainly when compared to other organizations in terms of growth, service, publication, etc. URISA has achieved remarkable success as a learned or quasi-learned association over the past 30 years. Indeed in latter years, URISA has seen some phenomenal growth. This growth does not appear to be in applications within science programs that are not focused on geographical extent, however nor in education programs that do not teach IS/GIS.

While it is not unreasonable that IS/GIS has yet to make significant inroads into all aspects of science, there is reason to be concerned about IS/GIS progress in education programs that do not teach IS/GIS.

In our overall view, science and education should be more concerned for the geography and spatial relationships between humans and the problems that science and education are addressing. We take our position on this from the discussion between John Borchert (1990) and Barry Wellar (1990) during the Plenary Session at the 1990 GIS/LIS Conference in Anaheim, California.

Borchert shed light on IS/GIS in science and education when he stated: "We have to move from Geographic Information Systems to Geographically Informed People." Wellar (1990), for his part, expressed concern that while we were congratulating ourselves because we could map things better, all the while that we were doing so, the "Dooms Day Map" was growing bleaker. Wellar re-emphasized Borchert's position of the need to ensure that the full potential of IS/GIS across all aspects of society were realized, and especially in regard to the ordinary citizens being included in the equation.

CONCLUSION

This selected and preliminary review of the literature is a tentative first step towards identifying the real and potential contribution of IS/GIS to science and education. Since a continuation of this approach is intended , suggestions as to approaches, articles for inclusion, etc., would be most welcome.

ACKNOWLEDGMENTS

The authors wish to thank the following graduate students from Corpus Christi State University for their assistance in researching available URISA and AURISA publications: Teresa Barrera, Joseph Debeau, Michael Garrett, Harry Keen III, Linda May, Tim Pendergraft, Dan Prouty, Tammy Rochard, and Don Waechter.

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[1]The terms of reference for this article are outlined in the paper by Wellar and Parr which appears earlier in this volume.

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BUILDING THE IS/GIS CAPABILITY TO SUPPORT POLICIES, PLANS, AND PROGRAMS: THE LOCAL GOVERNMENT PERSPECTIVE

Abstract. The impetus for the development of advanced IS/GIS systems by local governments may be traced to three primary influences: Federal initiatives and mandates, state/provincial programs and requirements and local initiatives. Examples are drawn from the literature to illustrate the nature, extent and degree of involvement of each influence in shaping the IS/GIS capability of local governments, with special reference to system impacts and interfaces.

Then, drawing on lessons from the literature, as well as on evidence from several key tendencies—such as an improved understanding of the relationship among GIS and traditional information systems and services—the next decade of IS/GIS activity in local governments is considered.

Although functional areas that are common to many local governments are discussed, for reasons of practicality, the discussion of IS/GIS capabilities as "case studies" is limited to systems from the southeastern U.S.

INTRODUCTION

Three initiatives for the development of advanced IS/GIS will be described. The first initiative describes the U.S. Federal impact on local system's development, the second will discuss state directives and the third will examine purely local initiatives. Examples of each will be noted with particular reference to on-going implementation efforts. Have the systems attained some degree of "staying power" or institutionalization? These initiatives will also be discussed in reference to hardware and software trends which this author projects as one of the primary reasons for later successes and earlier attempts.

Federal Initiatives

Federal initiatives in the development of local information systems precedes the USAC program which began in the late 1960's and early 1970's. USAC was a demonstration program sponsored by Urban Information System Inter-Agency Committee (USAC). Prior to USAC, 701 planning monies were distributed to local governments to assist with the clearance and rehabilitation of blighted areas. These were the very earliest dollars spent on urban system automation for a planning or a management perspective.

USAC was established in 1968 by the U.S. Department of Housing and Urban Development (HUD). The original idea was that prototype systems would be developed and could then be transferred to other cities. This transfer of automation would thus allow for increased governmental productivity and efficiencies due to the use of advanced information systems. USAC cities included the following: Des Moines, IA--geographic information, planning and analysis system; Charlotte, NC--integrated systems; Reading, PA--human resource subsystem; Wichita Falls, TX--integrated systems (Edwards, 1975); City of Long Beach, CA--physical and economic development subsystem (DeGroff, 1974); and Dayton, OH--finance. The idea behind USAC was fairly simple, if advanced automation could improve local government operating efficiencies then any funding (Federal or otherwise) would go further. This notion of improving operating efficiencies in government would take another 20 years to be fully realized again!

USAC led to the development and design of many prototype systems. It further developed the need for uniform system development and design practices and certainly highlighted the requirement to integrate and to tie systems together better. Many of the USAC by-products were copious volumes of design documentation, screen and report layouts. Many exciting hours were spent by this author in HUD's Washington, D.C. library perusing the many USAC design documents. The importance of a "mappable tie" from block face, line segment files to a parcel entity were well developed in the USAC literature. The clear link among street segment files (DIME type and later TIGER) and the government's information architecture was also well developed with many local GIS implementation efforts needing to review this fundamental relationship. In most cases, nothing of USAC exists in most locales were it was funded, while in others, it still provides a framework after many years. USAC was a direct funding of local government information systems, the projects were consortium based with the local government providing "in kind" funding including staffing and other materials. In Des Moines' case, the City of Des Moines, Polk County, Battelle Institute, Vernon Graphics and various consultants provided assistance (City of Des Moines, no publication date). For the very best overview as to the intent of the USAC program, Kramer's Integrated Municipal Information Systems is a must to read (Kraemer, 1974). Kramer's approach to cost benefit analysis is still the classic and worth reading today.

At about the same time, the LEAA (Law Enforcement Assistance Administration) was funding the improvement of various police record, dispatching and system automation programs. Several LEAA funded programs also developed various Computer Aided Dispatching (CAD) programs using geographic base files. LEAA monies were often used to fund "stand alone" processors for dedicated CAD and records functions. Other LEAA monies were used for the development of "full blown" criminal justice information systems (CJIS) (Willstadter, 1975). It was the beginning push of minicomputers into local governmental computing. In this area, more than perhaps any other, large scale working automation exists today. Several notable examples dealt with the use of DIME type files, reformatted as block or span files for dispatching. Parallel work was funded by the International Association of Chief of Police (IACP) which lead to the development of software that could reformat the DIME files. Several of these computer programs could be used to build an intersection file from DIME.

Also contemporary to USAC, was the U.S. Census Bureau's DIME file encoding work. The Bureau funded file development and maintenance, not by agencies that would use the files on a daily basis, but by regional planning agencies that would be responsible for the metropolitan area. While in retrospect, it is easy to understand the Bureau's willingness to have one point of contact per metropolitan area. These same dollars may have provided important "seed money" for many local governments to stay with geographic information processing through the 1970's-80's. If the Census Bureau did not directly fund automation into local governments, the DIME files and attendant Census summary tapes were often used, especially early to mid-decade where Census information was the "life-blood" of physical and social program planning information. Capabilities were developed to access the summary tapes and several computer mapping atlas projects were undertaken. Another Census program demands special mention here. In the early 1970's the C-Map choropleth mapping program was distributed by the Census Bureau. The C-Map computer mapping program for a line printer was written in FORTRAN (about 50 lines of code) for very small computers by Dr. Morton W. Scripter (U.S. Department of Commerce, 1971).

During the mid-1970's, and even into the 1980's, in some cases the Community Development Block Grant (CDBG) programs were used to develop automated systems in support of CDBG efforts. These systems were used to summarize Census data and often funded housing condition and land use surveys. The Comprehensive Employment Training Act (CETA) program also funded staff in many locales. Staff were responsible for data collection, map digitizing and other system implementation tasks.

In other situations, other federally funded programs lead to the development of systems directly related to program delivery. Environmental Protection Agency (EPA) and clean water programs occasionally were used for automated systems development. Even today, the clean water focus on non-point pollution sources has been instrumental in GIS implementation. The idea that data is a "capital" item and bond programs that pay for pipes and treatment plants could also be used to automate data about the infrastructure is only now, taking hold. The federal programs that have been long lived, such as the Clean Water Act and all of its amendments, indicate that local policy must look to local systems for program continuity and build on accomplishments of earlier periods.

Urban Mass Transit Administration (UMTA), and Department of Transportation (DOT) funds were used for the development of planning models and data sets. The planning/transportation models of the late 1960's and early 1970's were also funded with federal monies. DOT monies are still used for transportation planning purposes, some of which assists with other system implementation, network building and data collection activities.

Another area of federal support requires special mention. During the late 1960's and mid-1970's, the Department of Housing and Urban Development (HUD) funded useful research by the Rand Institute that provided an operation's research (OR) perspective on the solution of urban problems. HUD funded Rand for the development of a series of fire station and patrol car allocation computer models that were implemented by many local governments across North America. HUD also funded Public Technology Incorporated (PTI) in their development of the Fire Station Location Package (Walker, 1979). This technology was fairly inexpensive to implement and provided important capabilities, though it did require a skilled project team.

State Initiatives

State programs have also been instrumental in funding or driving local information systems development activities. While most of the emphasis was placed on social programs within local governments, many planning type programs have been funded within either regional planning agencies (or councils) or in water management districts. Other programs provided mandates but few direct dollars. Florida's long running comprehensive planning legislation provided some impetus during the mid-1970's. The Local Government Comprehensive Planning Act (LGCPA) sought to improve the implementation of planning processes and lead to the development of first generation planning type systems for several large urban areas (Eichelberger, 1977). These systems could best be described as parcel or land-use type files.

In the 1990's, Florida again leads the way with innovative planning programs that deal with concurrency. Concurrency has led to much automation within Florida's many planning agencies. Concurrency is also referred to as 9J-5 for the administrative description which describes the intent of concurrency. The intent of concurrency is that all infrastructure (water, sewer, streets and parks) should be "in-place" to service any additional demands from new development. While the jury is still out on the effectiveness of concurrency (many projects are already vested for some stage in the development pipeline), it has been the impetus for much local government automation, especially GIS.

Automation in most of Florida's water management districts has been centered on the development of many permitting/engineering (initially), land-use/land cover programs and (later) GIS systems. This automation in conjunction with management of the hydrologic cycle should provide an integrative approach to system design and implementation (Brown, 1987). State programs were used to fund the Regional Planning Councils in Florida even though they supported federal programs like A-95 review.

State support of various health and social service programs at the local level has also led to system automation. In some states health inspections, social program eligibility or crime information sharing has been a local impetus for data system development. Other revenue collection programs, such as resort taxes, etc. also led to state/local automation impetus.

Local Initiatives

While traditionally, in a local government setting, automation began with revenue collection (property taxation and valuation) functions, spread to payroll and personnel systems, more advanced MIS type systems came much later, if at all. If the focus shifted from revenue collection functions, it was toward incident type systems that measured workloads (fire incident reporting) or again collected revenues (building permitting systems). Payroll/personnel and finance systems also received the lion's share of local government system development resources through the 1970's. Due to the proprietary nature of many of these third party software packages, little experience was gained in data independence via data base management software, since few packages supported more advanced data handling methodologies. Few, if any, truly M.I.S. systems were ever successfully developed. More advanced planning type systems were also slow to develop. One exception to this was the development of the Broward Impact Zoning System by IBM for Broward County, Florida (Blumbert, 1974).

Into the 1980's, local governments were finally getting beyond the basic revenue collection systems and were starting to focus on systems that dealt with the "expenditure side" of automation. Improved systems could help measure productivity, provide management information and improve organizational control. It was realized that spending dollars on systems that allow for improved productivity and management control were dollars well spent. Increasing productivity of existing staff was very similar to a net increase in revenue collection because existing dollars went further!

Local governments' role was changing as well as new functions of government were recognized—economic development, community development, increased emphasis on social programs, affordable housing, crime prevention, environmental concerns, stormwater management were all new responsibilities. In the 1980's, the advent of PC's/Macintoshes, the real acceptance of data base management software and the rise of interest in GIS has led to much additional capability for delivering more sophisticated systems.

TRENDS AND TENDENCIES

If the impetus for local government systems have come from federal, state or local initiatives, what about the staying power of these systems? How have they been influenced (helped or hindered) by hardware, software or architectural trends? The following trends section will describe significant events that allow for continued system innovation. Each section will also look at breaking trends to identify key elements that will impact local government automation during the 1990's.

Hardware Trends

The increase in computing's cost effectiveness has made its presence felt in the availability of faster workstations and more powerful PC's and Macintoshes. If we examine key ideas and trends from the literature, our desires for governmental computing perhaps, only now, can be realized due to advances in hardware and software. Key hardware trends are as follows: influence of the

Macintosh, rise of PC's, faster workstations, cheaper/faster computers, improved networks and cheaper/faster disks. Future trends that will impact our ability to deliver advanced systems will be: optical disk drives, lower cost networks and a merging of graphic and attribute devices.

The influence of Macintoshes and PC's have greatly impacted user expectations—PC's in that everyone should be able to have access to low cost computing and Macintoshes for their consistency of user interface and the rise of the mouse. The low end has worked to keep the workstation vendors on their toes (price/performance ratios) but has also directly influenced "look and feel" issues that the user community is demanding. Faster workstations allow for more practical work at the desk top with far larger databases. The GIS' databases are GIGABytes in size. Workstation price/performance only makes it easier to buy hardware for a larger user community. With the availability of workstations appearing in the mid-1980's to the present, workstations have evolved through five generations of improved price performance. While workstations are a bit cheaper now than just a few years ago, those that are purchased presently have 4-6 times the amount of disk and 3-4 times the amount of memory with processing speeds 15-25 times faster!

Not only have workstations become more cost effective, larger processors have also climbed the price/performance curve. Competition among the vendors, especially for open systems using UNIX or its derivatives have also helped local government as a consumer. The database engine, file/server, client/server architectures also mean that the larger, shared database architectures are a more practical reality.

The goals of distributed computing were aptly described by James Martin in his Design and Strategy for Distributed Data Processing in 1981, though it took many years for practical reality to catch up with government's effective use of standard commercial products (Martin, James, 1981). Distributed computing was made possible by a combination of telecommunication protocols (transparent to the users), relational data base software that viewed the network as an adjunct rather than a challenge, and low cost computing nodes. The protocols allow for a transparent interchange of data among various computing nodes, allowing for specific applications to be supported where they make the most sense. The advances in relational data base software allows for network joins among tables as easy as joins on one workstation.

Future trends will be in the area of larger, faster optical disk drives to support the real-time archiving of large data-sets, especially those dealing with historical time slices of the GIS' maps and records. Presently, these optical drives cost about one-half of the cost of magnetic media. With continued performance improvements possible, optical technology faces a bright future. The potential size of many of the GIS' databases increases logarithmically with some staff desires for archive access.

Other trends will be a continued use of more window devices--X-window terminals, PC's/Macintoshes, even for primarily attribute or text based applications.

Software Trends

In the days of USAC, the system designers were trying to implement data driven systems with much data sharing with only the most rudimentary of file management systems. Even rudimentary data base management systems were a technological leap beyond file management software, with relational DBMS going even another major step beyond the older hierarchical, network and inverted list systems. Software advances with relational data base management systems can only be described in as significant in terms as we view workstation advances. These software trends are particularly enabling: maturity of relational data base software products, the availability of the "family of products" around the data base software, the telecommunications protocols and the maturity of the GIS and application vendors.

While it is nearly impossible to separate some software and hardware trends, i.e. UNIX's impact on vendor workstation competition, advances in relational data base management system software has been especially pronounced. The products have allowed for an increase in software speeds that have equalled increases in hardware performance. The commercial products have become more error proof (more robust), easier to use with stronger utilities, and can be used to develop all forms of on-line systems. Product enhancements allow for distributed architectures across network nodes. These enhancements have allowed for joins across nodes and for multiple node updates or commits.

The family of products around the relational data base products have also become more of an extended family. The report writers, query languages and application generators have become much more advanced. The ability to automate the software development life cycle through Computer Aided Software Engineering (CASE) products. The addition of CASE tools as part of the relational data base management system family will only speed the development of "applications". These applications will be neither graphic nor only textual, but in the future, much more tightly coupled. Today when most people talk about applications they are referred to graphic macro-language routines written with software provided by their GIS vendor.

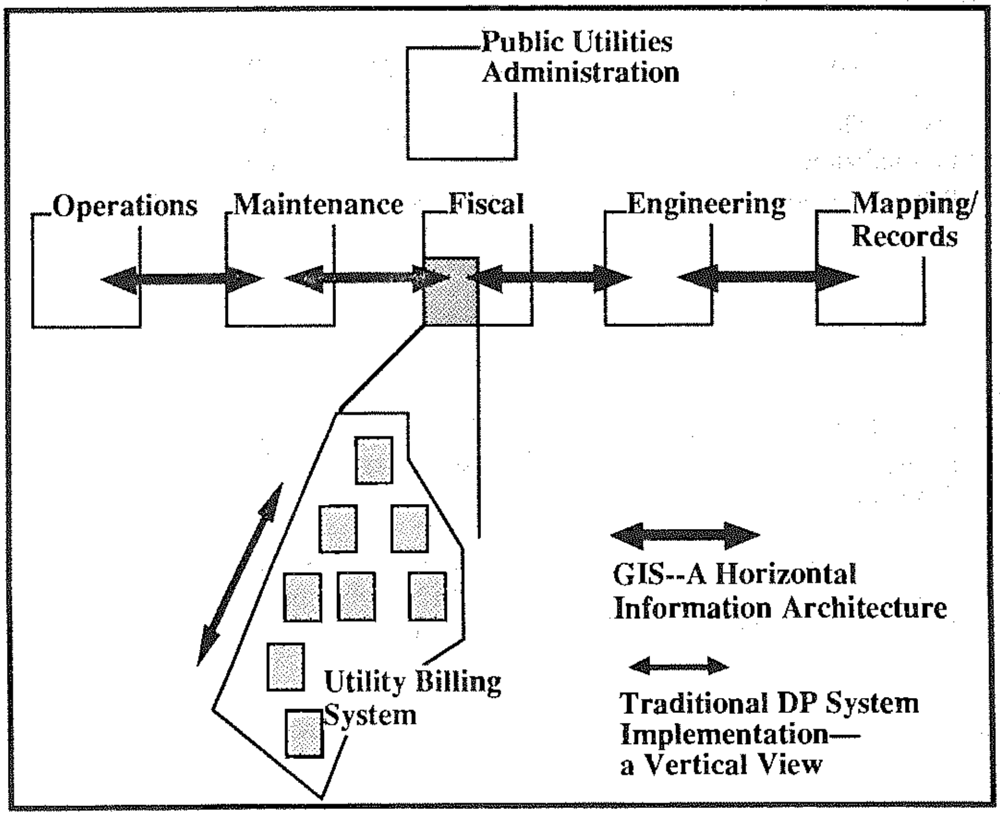
Some evolving trends are a complete implementation of "true distributed data base management" that will handle all graphic entities as well, too. The development of commercially viable "object oriented" data base management systems is also another development that may impact the local government arena later in the 1990's. Shorter term the relational vendors will be adding much additional object functional to their relation products. The ability to handle graphic objects as a column in a relational data base table is one such example. Providing for entity integrity is another example of how the relational vendors are enhancing their products. The adoption of object oriented methodologies will undoubtedly lag as much as the adoption of wide-spread AI (Artificial Intelligence) techniques, especially in the local government setting.

Architectural Trends

While many ideas of the 1960's and 70's are now practical realities to implement, there has been a shift, only recently, that places local governmental computing into a revised context. This new context helps to clarify the role of all governmental computing platforms at a time when we are groping for an architectural underpinning that makes sense into the 1990's and beyond. A particularly important trend is the realization that GIS is a "horizontal" information architecture where earlier automation can be viewed as "vertical" systems.

The following figure provides an illustration of the relationship between horizontal and vertical systems within a newer, GIS context. As shown in the figure, vertical systems tend to automate, within a narrowly defined system boundary, all closely related users. The opportunity is often to make this data/information shareable across that particular system boundary. With the users of common software products and uniform communication protocols, these horizontal and vertical boundaries can be easily bridged. Other requirements are that key data standards and readily identifiable entities are defined across the entire organization or enterprise. These data standards include such items as: proper formatting of address standards (including suite, room and apartment numbers), standardization of entities such as, people's names, their telephone numbers, etc. Physical characteristics such as bulk and cubic content, area measurements, land use/space use and occupancy use coding schemes are other standards that will need to be adopted and enforced (Eichelberger, 1982).

FIGURE 1: GIS as a Horizontal Information Architecture



One could have the very finest hardware/software architecture in-place only to experience no common base of shared entities available to build information from the tables or files.

CONCLUSION AND SUMMARY

Local government impetus for advanced IS/GIS systems can be traced to federal, state or local initiatives. If the federal focus on system development activities is stronger in the criminal justice areas as it relates to operating system code, the influence on the theoretical/knowledge base of GIS technology has been further reaching. The notion that ideas might just move further and faster than a working example, demonstrates that until local monies are earmarked for additional automation, actual progress will be slower than hoped for. The experience also demonstrates that basic research and development, though the lag time might be decades, is more far reaching than direct funding mechanisms. The GIS strengths of today may well be due to innovative federal programs in the 1960's and 1970's.

Local initiatives lead to local system successes, especially where the technology has been adopted to complete the job at hand. Local initiatives will continue as policy makers look for methods of increasing staff productivity. What other methods are there other than the use of newer computing technologies to increase staff productivity via improvements in record handling and information processing? These initiatives, working in conjunction with newer, tried and tested software and hardware tools, are the proper ingredients for success. The initiatives will also be helped as the percentage share of local government computing (<3% of total expenditures) approaches private sector computing costs (8-11%). The difficult and tough issues of training, staff retention, system institutionalization are as ever present today as they were in times of USAC. We make much technological progress (sometimes) only to be stymied by slow organizational progress/change.

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THE EFFECT OF POLICIES ON IMPLEMENTATION AND USE OF INFORMATION TECHNOLOGY

Abstract The charge accepted by the authors was to examine the URISA literature in an effort to identify the potential effects of policies on the evolution of technology. Policies were broadly interpreted to mean mandates, laws, or procedures that established a general course of action or direction in use of technology in an agency. Examples include adoption of standards or data dissemination procedures. The task proved to be a daunting one. The URISA literature represented a narrow (perhaps somewhat biased) perspective on the world of information technology and relatively little continuity in agency activities over the years. After searching many years of URISA proceedings (1965-1991) and examining an additional historical record of technology documentation (Datamation magazine, 1962-1990), a few threads of issues were revealed. The authors attempt to relate the issues to a variety of Acts of Congress and Office of Management and Budget (OMB) Circulars (policy directives) and to technology activites of URISA members. Lack of time has hindered the successful completion of this exercise, but the authors have benefited by the process and offer suggestions to the URISA membership for making better use of their Association.

INTRODUCTION

Several authors, over the last decades of URISA's history have examined URISA and other bodies of literature to document the effect or role of information systems on policies (to name a few, Steger, 1977; Cody, 1977; Simpson, 1977). Significantly fewer attempts have been made to specifically identify the effects of policies on technology (Steger, 1977). Reviewing the URISA literature in an effort to ascertain what policies may have affected the development and evolution of technology must be similar to what an epidemiologist experiences as (s)he searches for the cause of a disease outbreak. Evidence of the use of technology is all around, but establishing the cause of proliferation or spread of technology, in one case, and lack of use or spread in another, is a challenge. The URISA literature is somewhat like finding one family with the disease and trying to understand what else is going on in the world. But there is information available on other families (other periodicals and proceedings that cover a number of years) and we have taken advantage of that documentation.

Policies are used to set a course of action or to define strategic directions. An example might be to establish a policy to provide data at the lowest cost to all users. Policies are implemented by practices or procedures. In the case of lowest data cost, a practice could be to charge for data based on the cost of reproduction. Where policies leave off and practices or procedures begin is sometimes a fuzzy line.

In the course of investigation for this paper, the term "policies" was interpreted liberally. We do not focus on the U.S. technology policy such as exists in the form of government spending for defense-related research and development, or expenditures on military technologies (Branscomb, 1992). Although defense applications have certainly driven aspects of technology development, these are seldom reported in the URISA literature. Instead, we looked for trends in the use of technology, or patterns in issues and problems described in the URISA literature, and tried to determine the presence of a policy that might have influenced the trend or pattern. We also examined three decades worth of Datamation magazines in an effort to establish patterns of technology change.

One challenge of trying to assess the effect of policies on the evolution of technology, is that technology often changes organizations (see for example Crain, 1990). Traditional organizations, particularly government agencies, tend to be organized as hierarchical bureaucracies with strict vertical lines of authority and communication. The introduction of technology into an organization can shift the distribution of data and responsibilities, drastically alter communication, and change lines of authority. These changes may result in a redefinition of policies, which might have a different effect on technology, and so forth. The cycles of cause and effect can be difficult to discern.

The preliminary results of this process are presented as a chronological outline below. The authors offer this outline as a beginning. It is not complete. A future publication will hopefully expand on the effort. The outline is an attempt to identify temporal relationships among policies implemented primarily by federal agencies, technological evolution, and the practice of technology as reflected in the URISA literature.

The outline is by no means exhaustive. There are three threads that are followed that were derived from the literature review. Many other threads exist, and given time, they might be tracked, as well. The first thread dates back to the U.S. Constitition, which calls for a national census of the population. The U.S. Census Bureau, over the years, has had a significant effect on the use of technology as computers have been applied for population counts and policies have been established on how, when, and in what format to distribute data. Some policies related to public access and privacy have been related to Census Bureau activities. The second thread relates to governmental and intergovernmental cooperation policies and programs, such as USAC in the late 1960's/early 1970's. A third thread is policies related to standards. In the early days of computing, standards issues were primarily focused on hardware. More recently data are of concern. In some instances dates are noted in the outline because the topic of interest appears to be timeless. That is, ideas and problems that were relevant or of concern nearly thirty years ago, are still topics of discussion today.

TABLE 1: Brief Chronology of Policies, Technology, and URISA

(C=Census related, I=Intergovernmental, S=Standards)

TYPE	YEAR	POLICY EVENT/ACTION SUMMARY
C	1787	US Constitution calls for an "Enumeration of the population to be made within three Years after the first Meeting of the Congress and within every subsequent Term of ten Years" (U.S. Government Printing Office, 1989).
C	1910	Census Bureau works with New York City to establish census tracts for reporting sub-city data (Marx, 1992).
S	1918	Departments of Commerce, War, and Navy join with American Institute of Electrical Engineers, the Mining and Metallurgical Engineers, and the American Society of Testing and Materials to establish the American Engineering Standards Committee (Grove, 1969).
S	1928	American Engineering Standards Committee reorganized and renamed the American Standards Association (ASA) (Grove, 1969).
C	1948	Census Bureau orders a digital computer to process 1950 census.
C	1951	Remington Rand delivers UNIVAC to Census and new era of federal data processing begins.
I	1953	Bureau of Budget issues Circular A-16 (Programing and coordination of surveying and mapping) in an effort "to insure that surveying and mapping activities may be directed toward meeting the needs of Federal and State agencies and the general public, and will be performed expeditiously, without duplication of effort."
I	1954	Areawide Comprehensive Planning Grants (701) available from Department of Housing and Urban Development (Blumberg, 1980).

Table 1 continued (C=Census related, I=Intergovernmental, S=Standards)

I	1957	Federal Interagency Data Processing Committee created under direction of Bureau of the Budget, to coordinate computer procurements and use.
S	1960	International Standards Organization (ISO) establishes Technical Committee-97 on Computers and Information Processing whose scope is "Standardization of terminology, problem description, programming languages, and communication characteristics of computers and information processing devices, equipments, and systems." (Clippinger, 1962). In U.S., the American Standards Association creates a Sectional Committee X3 to address the issues (Grove, 1969).
C	1960:	First time census data are available on tape for small areas (tracts) (Foley, 1966.
I	1961	Federal Interagency Data Processing Committee re-vitalized and enlarged to over 45 government agencies. Chaired by Bureau of the Budget. The Committee will consider such areas as "development of courses in systems analysis; establishing computer "sharing" plans in geographic regions; developing alternative approaches for continued computer operations in the event of attack, or other emergency; establishing a "library of applications" for sharing procedures and experience" (p. 23, Phillips, 1962).
	1961	New positions for federal government computer operations functions established at higher organizational levels. "There is even a good chance that the 'total systems approach,' long a dream but seldom (if ever) a reality, may break the barrier of organizational jealousy in 1962 through this top-level understanding and support." (p. 24, Phillips, 1962).
S	1961	Bureau of the Budget issues Circular A-54 (Policies on the selection and acquisition of automatic data processing equipment). Rescinded 1974.
	1962	"URISA" is born from an off-campus training course of the Urban Data Center of the University of Washington, held in Los Angeles in September (Horwood, 1965).

Table 1 continued (C=Census related, I=Intergovernmental, S=Standards)

S	1962	"In this early period [early 1960's], the Department of Defense made the only meaningful effort toward [computer] compatibility in the federal government. Defense has always been our dominant user of computers." (Brooks, 1969).
	1963	First "URISA" conference of about fifty individuals interested in urban information systems, Los Angeles (Horwood, 1965).
I	1964	Bureau of Budget issues Circular A-27 (Policies and Responsibilities on the sharing of electronic computer time and services in the executive branch, and TM-1). Rescinded 1974.
	1965	Over 1964-65 Fiscal Year, State and local governments are spending about $60 million nationally on computers (about 630 of them), while federal agencies are spending around $350 million for 2,600 computers (Price, 1967).
I	1965	Amendments to HUD 701 grants (Blumberg, 1980), 701 grants tie federal assistance to planning (McDowell, 1969).
S	1965	Bureau of Budget report to President on data processing management cites problems with system incompatibilities and calls for strong definition of standards.
	1965	Bureau of Budget issues Circular A-71 (Responsibilities for the Administration and management of automatic data processing activities). Replaced by Circular A-130 in 1985.
S	1965	Bill introduced by Congressman Jack Brooks becomes law (PL 89-306). Brooks Bill removes responsibility from agencies for computer procurements and establishes an Adminstrator in the General Accounting Office to coordinate and standardize purchase, utilization, and disposal of federally owned/leased edp equipment. Bureau of Budget has responsibilities to frame policies to guide the "Administrator". (Hirsch, 1965)

Table 1 continued (C=Census related, I=Intergovernmental, S=Standards)

C	1965	Census Bureau begins to think about how to make data more easily extractable from tapes as they design 1970 census and have just started allocating street address to census tract - first geocoding (Brunsman, 1965).
S	1966	American Standards Association becomes the USA Standards Institute (Grove, 1969).
	1966	Congress passes Comprehensive City Demonstration Program (more commonly called "Model Cities" program) - this had little to do with technology, but is reflected in many articles in URISA literature (ie.1972) related to identification of city problems and solutions.
	1966:	Freedom of Information Act passed by Congress (5 USC 552).
I	1966	ADP viewed as way to achieve total information system and to serve public and private operational and future planning needs, availability of 701 grants helpful to establishing IS, use of 1960 census data and computer mapping techniques in Los Angeles (Johnson, 1966).
I	1966	Paper presented at URISA conference that proposes a "federation of autonomous information centers, to be interconnected by a statewide information indexing, switching, and communications network" in California (Donati, 1966). California is one of few states (New York, Illinois, Wisconsin, Puerto Rico are others) to have a plan to develop local government data processing capabilities that are tied to a state system (Price, 1967).
C	1966	Census Use Study initiated in New Haven, Connecticut by U.S. Census Bureau to exploit a "dress rehearsal" data base of the 1970 census (Deshaies, 1969).
	1967	Concerns about privacy, confidentiality, and computers (Dueker, 1967; Gallati, 1967; Nickerson, 1967)
C	1967	First mention of DIME files in URISA literature (Cooke, 1967). (Note: DIME came out of the Census Use Study.)

Table 1 continued		(C=Census related, I=Intergovernmental, S=Standards)
S	1967	Bureau of Budget issues Circular A-86 (Standardization of data elements and codes in data systems). Rescinded 1973.
I	1967	Senate Bill 917 authorizes $50 million for data processing support to state and local law enforcement agencies (Datamation, 1967).
I	1967	Bureau of Budget revises Circular A-16 (Coordination of Surveying and Mapping Activities).
S	1968	Department of Defense and National Bureau of Standards are only federal members of the USA Standards Institute (which has approved 25 standards to date and has 56 proposed standards in development through the work of 8 subcommittees and 39 working groups) (Grove, 1969).
I	1968	Departments of Army, Commerce, Labor, Transportation, Defense, Justice, Housing and Urban Development, Health, Education, and Welfare, the Bureau of the Budget, and the Office of Economic Opportunity combine efforts to create the Federal Urban Information Systems Interagency Committee (USAC). The objective is to create a capability for combining greatly increased human, material, and financial resources together with technology to create Integrated Municipal Information Systems (Weaver, 1971).
I	1968	Law Enforcement Assistance Administration (LEAA) initiates planning grants for developing law enforcement information systems. Objections raised to FBI/Dept. of Justice stipulations that police information systems must be independent of other IS at local/state level (Lewis, 1972).
I	1968	Intergovernmental Cooperation Act passed by Congress (PL 90-577)
I	1968	Bureau of Budget issues Circular A-90 (Cooperating with state and local governments to coordinate and improve information systems)—replaced by Circular A-130; and Circular A-79 (Report of accomplishments in the use and management of automatic data processing)—rescinded 1972.

Table 1 continued		(C=Census related, I=Intergovernmental, S=Standards)
I	1969	Federal Urban Information Systems Inter Agency Committee (USAC), chaired by HUD, issues request for proposals to 352 municipalities with populations between 50,000 and 500,000 (Hines, 1972). 269 municipalities express interest. 99 proposals are received from 79 municipalities in 30 states (Kraemer, 1970).
	1969	Privacy and confidentiality issues of concern to URISA (Kindleberger, 1969; Fanwick, 1969).
	1969	Number of computers in federal agencies is estimated to be 4,620 (there were 531 in 1960). Given government competitive procurement policies, the diversity of machines is greater than are shown in a national survey, dramatizing the need for standards to optimize machine use (Cunningham, 1969).
I	1969	HUD 701 Planning Grant is used to start an information system for the Association of Bay Area Governments—ABAG (Totschek, 1969).
C	1969	Address Coding Guide System developed by Census Bureau to assign geographic codes to addresses for the 1970 census (Daly, 1969).
I	1970	USAC issues contract awards to Wichita Falls, Texas and Charlotte, North Carolina for municipal information systems; to Reading, Pennsylvania for a Physical and Economic Development subsystem; to Long Beach, California for a Public Safety subsystem; to Dayton, Ohio for a Public Finance subsystem; and to St.Paul, Minnesota for a Human Resource Development subsystem (Kraemer, 1970).
I	1970	Witchita Falls reports on its Urban Management Information System (Dunn, 1970).
I	1970	Charlotte, N.C. reports on development of its Integrated Municipal Information System (IMIS) (Plante, 1970).
C	1970	Geographic Base Files are being prepared and will be made available on tape from the Census Bureau (Gura, 1970).

Table 1 continued (C=Census related, I=Intergovernmental, S=Standards)

I	1971	Numerous URISA papers on USAC.
C	1971	Many applications of Geographic Base Files in URISA literature and descriptions of other computer mapping systems.
S	1971	Standards issues of concern to URISA. Observation is made that "it appears that information flows within and between levels of government are increasing and will continue to do so at an exponential rate." (Wellar, 1972)
S	1972	Several sessions at URISA conference focus on standards (Wellar, 1972).
	1972	Privacy, confidentiality, and security issues of concern in URISA literature (Orr, 1972).
I	1972	Many URISA articles on USAC, including one description of a "failure", St.Paul, MN (Hines, 1972).
	1972	NASA launches first Earth Resources Technology Satellite (ERTS) later called "Landsat". Era (8-10 years) of available funds for technology transfer projects begins to encourage use of remote sensing.
	1974	Privacy Act (5 USC 552a) passed by Congress
	1974	Several articles on Criminal Justice Information Systems, Privacy, and use of Geographic Base Files and Geoprocessing in URISA literature.
I	1976	Life after USAC in Witchita Falls (Ondrejas, 1976).
	1976	Several articles on remote sensing and geoprocessing in URISA literature, as well as concerns about human services issues.

Table 1 continued (C=Census related, I=Intergovernmental, S=Standards)

C	1976	At least 4 articles on criminal justice systems in URISA literature, including one on use of census data to report crime statistics as part of LEAA project (Hill, 1976).
C	1976	26 out of 54 articles in URISA Proceedings mention use of census data.
	1977	URISA Proceedings - 15 Years of Review
	1977	Carter Administration launches the Federal Data Processing Re-organization project designed to revamp federal data processing activities and policies (Datamation, 1977).
I	1979	URISA article on effects of national policies on transportation planning (Schmitt, 1979).
I	1979	City-Regional cooperation using model and information system to develop general plan (Lewis, 1979).
I	1980	Paper Work Reduction Act passed by Congress (44 USC, Chapter 35).
	1980	Discussion of need of local governments to "treat information as a measurable planned resource which can be accounted for and evaluated similar to other local resources such as money and personnel." (Kettinger, 1980)
I	1980	URISA literature identifies needs for national data bases (Moyer, 1980; Switzer, 1980)
I	1982	Intergovernmental Cooperation Act (see 1968) repealed and replaced (31 USC 6501-8)
I	1983	URISA article discusses changing investments in information technology (Kindleberger, 1983).

Table 1 continued (C=Census related, I=Intergovernmental, S=Standards)

I	1983	Office of Management and Budget issues Memo-83-12 (Coordination of Federal Digital Cartographic Data Programs) to "initiate a process to bring about coordination of digital cartographic activities of Federal agenices. Proper coordination is needed to avoid duplication and waste in these activities. It will also facilitate private sector use of digital cartographic data." A committee, the Federal Interagency Coordinating Committee on Digital Cartography (FICCDC) is formed under the Memo. FICCDC was a precursor to the Federal Geographic Data Committee (see 1990).
I	1985	Discussion of public records and Freedom of Information Act in URISA literature (Behrens, 1985).
I	1985	Office of Management and Budget issues Circular A-130 (Management of Federal Information Resources) related to the Paper Work Reduction Act.
S	1988:	Proposed Spatial Data Transfer Standard (SDTS) published (American Cartographer, 1988)
C	1989	TIGER files released by the Census Bureau.
I	1990	Office of Management and Budget revises Circular A-16 (Coordination of surveying, mapping, and related spatial data activities) establishing the Federal Geographic Data Committee, encouraging interagency cooperation in development of a "national digital spatial information resource".
S	1991	SDTS submitted to National Institute on Standards and Technology for acceptance as a Federal Information Processing Standard.

Table 1 continued (C=Census related, I=Intergovernmental, S=Standards)

I	1992	Office of Management and Budget issues revision of Circular A-130 (Management of Federal Information Resources) for review (by August 27, 1992). A-130 replaces several previous circulars related to privacy (A108), cost recovery (A121), data processing administration (A71), and state/local government cooperation (A90 - see 1968). The purpose of the proposed revisions is to emphasize "(1) IRM planning, with special focus on information life cycle, (2) The role of State and local governments in the management of IRM resources and information, and the need for Federal agencies to consider the effects of their information activities on those governments..." (U.S. Government Printing Office, 1992.)
	1992	URISA Conference to provide "perspectives" on URISA literature and roles.

SYNOPSIS

While concerns about sound information management did not begin with digital computers, our increased need and capacity to collect, store, process, and exchange information have intensified the need for better information management procedures and policies. Most professionals in the information system field today have grown up with computers being a major part of their lives. We can easily lose sight of the fact that the history of general purpose digital computing is a short one spanning a period of only about 40 years, ever since the Census Bureau took delivery of their first UNIVAC in 1951. It has only been in the last 25 years that computers have become an accepted part of the operations of federal, state, and local government. This is a relatively short period of time to assimilate a shift in operations as significant as information technology offers, particularly in government organizations.

Our review of thirty years of policy effects on information systems might easily give the impression that government policy initiatives have been reactionary, often shortsighted, and an attempt to control information systems, rather than making them an accepted and productive part of our organizations. An even more critical view of certain policy initiatives might be that they have contributed very little to the evolution of technology. Take, for example, the topic of intergovernmental coordination. On this timeline we see efforts as far back as 1957 with the creation of the Federal Interagency Data Processing Committee under the Bureau of the Budget. This Committee was strengthened and expanded over the years. Circulars A-27, A-130, the Brooks Bill, USAC, the Intergovernmental Cooperation Act, and more recent initiatives such as formation of the Federal Geographic Data Committee under Circular A-16, illustrate the interest and energy expended to encourage agencies to work together in using technology to manage information. With all this effort, we still seem to face the same challenges in bringing organizations together to share resources.

Perhaps we need to be less harsh, and realize how much progress has occurred and the environment in which that has taken place. The only consistent thing about the technology has been how rapidly it changes. We are trying to set policies and learn how to cope with complex tools that constantly change. The evolution from centralized mainframe processing to stand-alone personal computers, and more recently to distributed networked workstations has meant constant organizational turmoil to many technology users. We should credit ourselves with learning how to use new tools, how to make use of new data, while at the same time maintaining our organizations' ability to respond to increasingly complex issues.

Thirty years ago we were worried about being able to use the same punch cards in different machines. Our concerns about standards were almost entirely related to hardware. Then we turned to trying to standardize software, such that systems might better communicate and share data. Today we are realizing that our data are a resource to be managed and shared (Bryce, 1987; Guimaraes, 1985). The Spatial Data Transfer Standard addresses how we exchange data and document its quality. We really have made progress, and some of that ability to agree on standards has evolved from interagency coordination. We are realizing the value of coordination versus control, both in our interagency interactions and how we make use of technology.

RECOMMENDATIONS

Having been given the opportunity to perform this exercise of providing a perspective on URISA, we offer the following suggestions. There is great value in exploring patterns of change as provided by a historical review such as this. We've seen processes and evolution from a slightly different angle, gained a much broader perspective, and hopefully can be more responsive to bringing about needed future changes. But trying to track thirty years or more of something as broad as "policies" is a nearly impossible task (particularly for two people who already have more-than-full time jobs). More URISA members need to be involved in this process.

Clark Rogers states that URISA's "function is to increase knowledge exchange, and provide social perspective to the technological aspects of information and communication. Continued reporting of survey and analysis studies will assist the organization to maintain this function." (1970). We think that the association has strayed a bit from this function. There are many more papers in the URISA proceedings now than there were thirty years ago, but a smaller percentage of these papers take the time to conduct surveys or analytically examine a body of literature. Many papers are case studies - the "I did it this way" approach, without an examination of how what was done might fit into a larger context. Some sharing of experiences is beneficial, but only when we start looking for patterns and connections do we maximize the advantages of an organization such as URISA.

URISA is an unique organization of practioners on the leading edge of technology. URISA members collectively hold a wealth of wisdom on real uses of technology, organizational structures and change, policies and legislation, and effective interpersonal interactions. This knowledge needs to be better focused and applied, and made more accessible.

For an exercise such as this, there would be great benefit to being able to access URISA Proceedings on-line. The ability to conduct keyword searches would make examination of trends much easier. Perhaps this is a task for the Special Interest Groups (SIG's). If key URISA staff and leaders could define a framework/data base and format, many people might be responsible for entering data or text. When volunteers are the source of labor, the tasks must be spread over many if the job is to be done and maintained. SIG members might also consider tracking other literature that they read. Having a data base that would allow one to note a few key points of an article just read, with bibliographic reference, could be immensely valuable in developing linkages later.

The SIG's might also consider what key issues URISA could be addressing. "Standards" is one that has already been identified, but we've created a committee, rather than using the SIG structure. There might be more benefit to bringing people together over the issues that concern them, rather than simply a common denominator such as being a "state" person, or someone interested in GIS as SIG's are currently derived. We might provide more flexibility in how SIG's are created, more responsiveness to issues of the day, with the ability to dissolve SIG's when other issues become more relevant or of interest.

URISA members need to be more conscious of documenting their activities over time, and reporting what does not work, as well as what does. Whatever happened to those cities that received USAC grants in the early 1970's? Are they better off today? Did the policy and practice of federal support for local information systems result in tangible long-term benefits? We cannot answer these questions from today's literature. Do we have the justification to start or fund other cooperative federal-local information system development programs? Couldn't URISA be a forum to provide that type of analysis?

Conferences might be more focused on an in-depth analysis of issues. Rather than a broad call for papers, specific invitations to "experts" might be extended. These could be people who presented information in previous years, that we would like to check in with again this year, to actually track progress, or change. Technology gurus and policy analysts in a variety of agencies might be asked to participate.

Our review of URISA's literature has only strengthened our conviction that URISA has much to offer the world.

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INDEX
FOR MAKING CONNECTIONS
WITH PEOPLE, TERMS, ISSUES, AND IDEAS

As the first full index for *URISA Proceedings,* this index illustrates the intent of the entire year-long **Perspectives** project—**to connect** URISA members with our wealth of knowledge, ideas, issues, and to each other. The whole **should** be greater than the sum of the parts. Unless we **make connections**—with our past, present, and future, with our knowledge and ignorance, our successes and failures—we will each (bureaucrat, elected official, researcher, consultant, vendor, academician) achieve less than we can. As a group we can make a difference, improve our urban areas and world, only if we stay connected.

A word of caution to the user of this index: The inevitable delays which plague volunteer projects, especially those involving tens of people submitting papers, precluded the planned review of this index by the contributors. Dan Parr has attempted to be as inclusive as possible, but takes all responsibility for errors of omission or commission—and regrets any missed connections which may result therefrom.