Developing a Compendium of Ideas on Using the Retrospective Approach to Mine for GIS Nuggets: Initial Considerations

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ABSTRACT. This compendium of ideas on using the retrospective approach to mine for GIS nuggets addresses two needs: 1) It is a means to involve many more people in the GIS retrospective program; 2) It creates an initial compilation of ideas which directly contribute to mining the various literatures – corporate/institutional-private; corporate/institutional-public; learned legal; oversight agency; popular (media); professional; public interest; etc. – for nuggets such as: New or different ways to add to GIS technology: New or different reasons to add to geospatial information; and, New or different uses of GIScience research methods. Four design principles (Focus on connecting "ideas" and "nuggets" Use a modular approach; Limit the modules to those required to effectively and efficiently launch the project; and Make it easy for those with different interests to modify the content of modules) provide clear instructions and directions throughout the compendium-building process. And, each of the four idea-based compendium modules (Ideas about "doing"; Ideas about objects of attention; Principal GIS components as ideas and sources of ideas; and Ideas as questions and questions as ideas) can readily be expanded, extended, contracted, re-oriented, etc., to accommodate general as well as particular interests affecting decisions about principal GIS components that are identified, adopted, and implemented by governments, businesses, learning centres, research centres, and other users of GIS technology and GIScience methods, techniques, and operations.

KEYWORDS. Analysis, Applied Research, *AutoCarto Six Retrospective*, Chains, Colloquium, Compendium, Core Concepts, Curriculum Design, Derivative, Doing GIS, Doing Research, Findings, Foundations, Geographic Information Science (GIScience),Geographic Information Systems (GIS), Geoscience Methods, Geospatial Data, Geospatial Information, Geospatial Knowledge, Geospatial Technology, GIS Applications, GIS Education, GIS Management, GIS Research, GIS Training, GIS Users GIScience Methodology, GIScience Techniques, GIScience Users, Ideas, Links, Literature, Mining Processes, Model, Modular, Modules, Nuggets, Objects of Attention, Originality, Pre-test, Principal GIS Components, Project Design, Research Colloquium, Research Methodology, Research Mission, Research Questions, Research Techniques, Retrospective Approach, Science, Scientific Inquiry; Space-Time Continuum, Synthesis, Temporal Dimension; Time,

1. Origins of the Idea of Developing a Compendium of Ideas on Using the Retrospective Approach to Mine for GIS Nuggets

The idea of developing a compendium of ideas arose in part in response to two perceived needs involving the Colloquium on Using the Retrospective Approach to Mine for GIS Nuggets in early 2015, and the Conference on Using the Retrospective Approach to Mine for GIS Nuggets, which is planned to be held in early 2016[1].

First, by design the colloquium is a small-scale vetting or pre-test project, and participation in the colloquium in 2015 is limited to 8 to 10 presentations and associated question-and-answer (Q&A) sessions. Similarly, plans for the one-day conference in 2016 presently call for six presentations and Q&A sessions.

On the one hand, these are reasonable numbers for initial meetings on a topic which to has received limited public attention from academia, business, governments, or professional and trade organizations.

On the other hand, however, investigations and communications since beginning the “GIS retrospective" dialogue in 2013 suggest that numerous potentially pertinent ideas would not be duly considered, and might not receive as much as a mention even if we tripled or quadrupled the number of presentations made at both meetings[2].

The idea of developing the compendium of ideas was therefore borne in part as a way of overcoming organizational and logistical constraints. In brief, circulation of ideas about colloquium and conference presentations had been largely limited to communications with members the *AutoCarto Six Retrospective* contact lists[3], a sounding board of a half-dozen GIS and GIScience researchers, and several dozen potential contributors[4].

Their exceptional experience and expertise notwithstanding, the fact remained that only a very small portion of the GIS and GIScience communities was involved in discussions about the colloquium and the conference.

Fortunately, a similar circumstance had been encountered several years ago in my role as Distinguished Research Fellow, Transport Action Canada (TAC), and it was resolved by introducing the idea of a Transport Research Topics (TRT) Compendium[5].

Constructive lessons learned from the TRT Compendium and adapted here are that developing a compendium which is digitally accessible serves an international audience, opens the door to more ideas being introduced to the discourse, and creates a “host” to which more ideas can be added,

Four tables in the following sections present initial thoughts on the contents of the GIS retrospective compendium, and are the basis for suggesting how the compendium could assist in identifying, prioritizing, and designing missions to mine the literature and other productions for GIS nuggets[6].

Second, there is the matter of time, which is of paramount importance in the fast-changing fields of GIS and GIScience, as well as in the research, education, training, and applications aspects of using GIS and GIScience.

In the case of the GIS retro program, a colloquium in 2015 and a conference in 2016 means considerable downtime for persons not on the contacts list.

Moreover, a year between public meeting events, bridged only by irregular status or event reports, would significantly inhibit receiving feedback from the GIS and/or GIScience communities.

Fortunately, again, previous experience with the TRT Compendium revealed that once the design is complete, a preliminary, indicative body of contents can be compiled relatively quickly from a mix of keyword-based literature searches, list serve inquiries, and surveys of experts, and posted. Then, updates ranging between incremental and comprehensive can be prepared as need requires and resources permit.

The idea of a compendium of ideas has the significant feature, therefore, of being a means to:

1. Achieve continuing visibility of the GIS retro program between the colloquium and the conference; and
2. Enable interested parties to become involved in GIS retro matters as soon as the compendium is published, and to remain apprised of compendium developments, by subscribing to an email list maintained by B. Wellar, or monitoring the GIS Retro website (http://www.wellar.ca/wellarconsulting/).

In addition to the idea of a compendium of ideas arising in response to perceived needs involving colloquium and conference matters, stimulus for the compendium also came from members of the GIS and GIScience communities who had contributed to *AutoCarto Six Retrospective* (Wellar, 2013), and/or had reviewed the two related papers prepared for the *International Journal on Applied Geospatial Research* (Wellar, 2014, 2015).

Specifically, there was general agreement that a correction was needed to bring better questions and more rigour into research involving GIS technology, GIScience methodology, and the uses of GIS and GIScience. And, there were also suggestions that the materials in the *Guide for Papers on Using the Retrospective Approach to Mine for GIS Nuggets* should be used for purposes beyond a specific conference. That is, the materials should be disseminated in a more general way to encourage broader engagement in examining why and how to use the retrospective approach to mine for GIS nuggets.

Serendipitously, perhaps, the decision to split the colloquium and the conference caused the *Guide* to be withdrawn, which in turn opened the door to the idea of re-casting the materials in the *Guide* as the core components of an initial compendium of ideas. However, before committing to the compendium approach, a final check involved

exchanges with several *éminences grises* of science in general, and GIS and GIScience in particular on a project design matter.

That is, since scarce resources require choices between options, and the perception of "too much information" can be a distraction, second opinions were sought about the value of producing the compendium as a bridge between the colloquium and the conference, and as a contribution to the GIS and GIScience literature.

The idea of the compendium of ideas was greeted as an innovative and useful way to advance using the retrospective approach to mine for GIS nuggets. Further, in addition to endorsing the idea of a compendium, it was suggested that publishing the initial version would likely be a catalyst for prompting additional entries in updates, revisions, etc. As a result of that "vote of confidence", the decision was made to proceed with the compendium.

2. Terms of Reference for the Compendium Design

Three broad terms of reference appear sufficient to put the compendium design in context, and to provide guidelines for additions to the present compendium, or to create a variation of the present version. The terms are:

2.1. GIS Nuggets as Findings.

2.2. Bodies of Literature and Other Productions to Mine for GIS Nuggets.

2.3. Nuggets as Links in Chains that Tie Past, Present, and Future.

2.1. GIS Findings as Nuggets

GIS nuggets are findings from the literature or other sources which serve one or more of the three core missions expressed in Figure 1.

Figure 1. GIS nuggets defined

GIS nuggets are findings from the literature or other sources which serve three core, related missions:

M1. Designing and developing geographic information systems technology;

M2. Defining and elaborating geographic information science;

M3. Using geographic information systems technology and/or geographic information science.

GIS nuggets of possible or probable value include those listed in Table 1. As indicated, each nugget serves one or more of M1, M2, or M3. The common feature among all entries in Table 1 is the phrase "new or different", which has a range of applicability from the general or universal, to the particular or individual for each of the 15 entries.

The objective of the compendium of ideas, therefore, is to provide suggestions, hypotheses, theories, impressions, pointers, clues, indications, hunches, concepts, notions, beliefs, inklings, perceptions, guesses, estimates, views etc., that support, encourage, and offer direction on mining the literature and other productions in the search for nuggets such as those listed in Table 1.

Table 1. Illustrative nuggets to be derived from using the retrospective approach to examine "the literature"

1. New or different reasons to add to GIS technology;
2. New or different ways to add to GIS technology;
3. New or different reasons to add to geospatial data;
4. New or different reasons to add to geospatial information;
5. New or different reasons to add to geospatial knowledge;
6. New or different ways to add to geospatial data;
7. New or different ways to add to geospatial information;
8. New or different ways to add to geospatial knowledge;
9. New or different uses of GIS technology;
10. New or different uses of geospatial data;
11. New or different uses of geospatial information;
12. New or different uses of geospatial knowledge;
13. New or different uses of GIScience research methods;
14. New or different uses of GIScience research techniques;
15. New or different uses of GIScience research operations.

2.2. Bodies of Literature and Other Productions to Mine for GIS Nuggets

Table 2 presents an illustrative selection of bodies of literature which are candidates to be mined for GIS nuggets, including those listed in Table 1 and summarized as missions **M1**, **M2**, and **M3** in Figure 1.

In addition, there is an entry labelled "Other productions",

This approach gives due recognition to materials that are generally perceived as conventional literature, and also has regard for works or entities which may seem to be outside the purview of what is conventionally regarded as "literature", but which could be sources of GIS nuggets. As discussed in section 2.3, there is a macro-temporal aspect – past, present, future – to the evolution of GIS, GIScience, and the uses of GIS and GIScience The phrase 'Other productions' is an effective way of taking into account materials for which labels are still in progress.

Table 2. Bodies of literature and other productions to mine for GIS nuggets

1. Corporate/Institutional-Private Literature
2. Corporate/Institutional-Public Literature
3. Learned Literature
4. Legal Literature
5. Oversight Agency Literature
6. Popular (Media) Literature
7. Professional Literature
8. Public Interest Literature
9. Regulatory Agency Literature
10. Special Interest Literature
11. Vested Interest Literature
12. Other Productions

(After: Wellar, B. 2005. *Geography and the Media: Strengthening the Relationship*. Ottawa: Canadian Association of Geographers, Canadian Royal Geographical Society and the Canadian Council on Geographic Education. http://www.ccge.ca)

The objective of the compendium of ideas is to provide suggestions, hypotheses, theories, impressions, pointers, clues, indications, hunches, concepts, notions, beliefs, inklings, perceptions, guesses, estimates, views, etc., that support, encourage, and offer direction on mining the bodies of literature (and other productions) listed in Table 2 in the search for nuggets such as those listed in Table 1.

2.3. Nuggets as Links in Chains that Tie Past, Present, and Future

The third nugget returns to the theme of time mentioned in section 1, but from a significantly different perspective, courtesy of a comment by Prof. W.L. Garrison on the proposed compendium.

Prof. Garrison has made many insightful comments since the beginning of the GIS retro program in 2013, and this one significantly expands both the scope and the implications of the compendium as a source of ideas on using the retrospective approach to mine for GIS nuggets[7]:

> *"You use the word nuggets in useful ways. Perhaps nuggets could be thought of as links in the chain that ties the past to the present.... and in important ways the present to the future. Is that a thought about using nuggets to achieve richer futures?"* W.L. Garrison.

A leader in bringing about the quantitative revolution in geography and regional science in the 1950s, a colleague of Edgar Horwood in the early days of defining the field of urban and regional information systems more than 50 years ago, and a pioneering

advocate on behalf of small area data in the infancy days of GIS and GIScience, Prof. Garrison has pretty well 'seen it all' when it comes thinking about GIS nuggets in any manner, shape, or form.

An important message to be derived from the Garrison communique, therefore, is that it is prudent to think past tense, present tense, and future tense in association with any and all of the entries in the compendium tables in sections 3.1, 3.2, 3.3, and 3.4.

Or, to re-phrase, since there is a macro-temporal aspect (past, present, future) to the evolution of GIS and GIScience, and the uses of GIS and GIScience, it follows that regard for the macro-temporal aspect also applies to entries in the compendium tables which follow in section 3.

3. Compendium Design: Initial Considerations

As noted in section 1 on the origins of the idea of developing a compendium of ideas on using the retrospective approach to mine for GIS nuggets, the retrospective colloquium in 2015 and the planned retrospective conference in 2016 are small-scale vetting or pre-test projects.

Therefore, since the compendium is a bridge between the colloquium and the conference, it is designed accordingly.

Reviews of other compendium projects and exchanges with members of the contact list suggest four primary design considerations for the initial phase;

1. Focus on connecting "ideas" and "nuggets";
2. Use a modular approach;
3. Limit the modules to those required to effectively and efficiently launch the project; and
4. Make it easy for those with different interests to modify the content of modules.

In addition to that brief background statement on initial considerations, the following comments introduce the four primary characteristics of compendium design which define the modules presented in sections 3.1, 3.2, 3.3, and 3.4.

1. Ideas about "doing". The applied aspect of the GIS retrospective program involves doing research and doing GIS to derive nuggets such as those listed in Table 1. Table 3 in section 3.1 lists a number of activities in which we engage while doing research and/or doing GIS. The terms in Table 3 serve both as ideas, and sources of ideas, for designing projects to retrospectively mine the literature and other productions for GIS nuggets.

2. Ideas about objects of attention. The activities of doing research and doing GIS by academic, government, business, trade association, professional association, and other interests are driven by numerous objects of attention. For the purposes of the compendium, a limited quantity of proposed core objects of research and GIS attention are presented in Table 4, section 3.3 as ideas, and sources of ideas, which could guide retrospectively mining the literature and other productions for GIS nuggets.

3. Principal GIS components as ideas and sources of ideas. The term 'principal' is used to refer to GIS components which are also described as critical, vital, central, core, essential, fundamental, basic, etc., the implication being that principal components play key roles in achieving GIS research, education, training, applications, operations, and management objectives. Principal GIS components, such as those presented in Table 5, section 3.4, are the products of ideas on the one hand, and the spawners of further ideas on the other. As a result, they are included in the compendium as starting points in thinking about why and how to mine the literature and other productions for GIS nuggets.

4. Ideas as questions and questions as ideas. Questions about situations, issues, concerns, goals, policies, programs, plans, etc., for which we want or need answers, are frequently behind decisions to engage in research activities and/or to undertake GIS projects. The questions in Table 6, for example, add a variety of perspectives to ideas from Tables 3, 4, and 5, with the net result being the potential generation of even more grounds to retrospectively mine the literature and other productions for GIS nuggets.

As for the order of the modules, several combinations were tried. The one chosen and presented above is the one that I found most conducive to designing and elaborating the initial version of the compendium.

However, I believe it is important to ascertain whether and how module selection affects the design or the outcome of retrospective mining experiences, and I look forward to receiving feedback in that regard.

In the following sub-sections, brief explanations accompany the tables used to express the compendium modules.

Detailed descriptions are not provided because they do not appear to be necessary for readers likely to be interested in this phase of the retrospective research program.

However, if feedback indicates that details are necessary, they can be added in a revision.

3.1 Ideas about research and GIS procedures, actions, efforts, initiatives, or other kinds of doing upon which to base retrospective mining for GIS nuggets

The 104 terms in Table 3 represent a mix of ”doing” types of activity in research in general, and in the applications, design, development, education, management, operations, research, and training aspects of GIS.

Table 3. Examples of research and GIS verb forms which are sources of ideas for doing research and/or doing GIS

adapting	disaggregating	incorporating	rating
adopting	displaying	indexing	recording
aggregating	disseminating	indicating	representing
analyzing	distributing	informing	researching
applying	educating	interpolating	reviewing
approximating	elaborating	locating	routing
ascertaining	engaging	managing	sampling
assessing	enhancing	mapping	scoping
buffering	envisioning	measuring	searching
calculating	estimating	mining	sectioning
calibrating	evaluating	modelling	selecting
cataloguing	examining	modifying	separating
certifying	expanding	monitoring	shaping
championing	experimenting	observing	simulating
classifying	explaining	organizing	structuring
combining	exploring	parameterizing	studying
computing	extrapolating	parcelling	supporting
confirming	forecasting	plotting	synthesizing
connecting	functioning	positioning	testing
constructing	generalizing	postulating	theorizing
deconstructing	generating	predicting	tracking
depicting	hypothesizing	projecting	training
describing	identifying	promoting	validating
designing	illustrating	prototyping	viewing
detecting	implementing	quantifying	visioning
directing	improving	ranking	visualizing

Given their prominent usage in analog and digital productions (textbooks, academic papers, industry reports, conference papers, list serve notices, videos, maps, media stories, images, software packages, manuals, workbooks, etc.), the terms and ideas associated with the terms are *de facto* part of the core language in the fields of GIS and research.

Further, the verb form of every term in Table 3 can be logically preceded by modifiers or qualifiers, such as “how to”, as in how to adapt, how to adopt, how to aggregate, how to

analyse, how to apply, how to approximate, how to buffer, how to calculate, how to calibrate, how to catalogue, how to champion, etc.

As a result, each of the terms is a possible keyword for finding of one or more nuggets contained in previous work, and can be the basis of a project which investigates previous work searching for GIS nuggets on why or to how to adapt, how to adopt, how to aggregate, how to analyse, how to apply, how to approximate, how to buffer, how to calculate, how to calibrate, how to catalogue, how to champion, etc., when doing research and/or doing GIS.

And, of course, adding better or best to any of the verb forms likely increases the value of nuggets that are extracted from the mining operations.

With regard to other terms for doing research and doing GIS, I believe that an expanded list would be a welcome addition to the literature. Of particular interest to future retrospective work would be a more comprehensive compilation of doing terms from the early days of GIS origins and evolution, and especially contributions from international sources.

Finally, when developing the compendium of terms (verb forms) that represent doing research and doing GIS, it is instructive to recall the comment by Garrison in section 2.3 about the past-present-future connection.

Specifically, due to the dynamic nature of language where technology is involved, it is prudent idea to begin thinking now about how to maintain the compendium so that is can effectively support retrospectively mining for GIS nuggets in the face of rapidly-changing terminology.

3.2. Ideas about objects of research and GIS attention

There are thousands of objects of attention that receive consideration when doing research or doing GIS. By way of brief elaboration, objects of attention are “entities” (targets, matrixes, platforms, obligations, mandates, intended results, etc.) which motivate doing research or doing GIS by, for example, any of the activities listed in Table 3.

These entities may already exist in general or in a particular organization, and for various reasons are subject to one or more of the doing activities listed in Table 3. Or, they may not exist in general nor in a particular organization, and for various reasons are the object of attention involving one or more of the doing activities listed in Table 3.

For the purposes of this (initial) compendium of ideas on using retrospective research to mine for GIS nuggets, it appears prudent to focus on what I refer to as core or prescribed objects of attention.

Each of the items in Table 4 has an established track record, and appears to represent several to many ideas which are passwords to “good mining” for three reasons in particular.

Table 4. Core objects of attention for mining activities

algorithms	functions	orders	relationships
analyses	generalizations	organizations	reviews
applications	heuristics	overviews	routes
approaches	imagery	paths	routines
arcs	instruments	patterns	schemes
areas	links	plans	standards
attributes	maps	plots	structures
charts	means	polygons	styles
controls	methods	practices	syntheses
courses	methodologies	procedures	systems
designs	modes	processes	techniques
devices	models	programs	tools
frameworks	operations	protocols	ways

First, because they are core objects, entries in Table 4 are more likely to have benefitted from above-average documentation and archiving. As a result, mining for GIS nuggets among core objects of attention should be less difficult and less time-consuming than the proverbial downer of "searching for a needle in a haystack".

Second, because the objects of attention are in the core category, they are likely to have received consideration on multiple occasions in a variety of circumstances over an extended span of time. That being the case, it seems most probable that GIS nuggets associated with core objects of attention did not occur in isolation, and finding them in batches or clusters could be a matter of connecting the dots through doing research and/or doing GIS in the manners suggested in Table 3.

Third, preliminary examination suggests that many if not most of the doing terms in Table 3 are applicable to each of the objects of attention in Table 4. As a result, limiting the entries in Table 4 to core objects gives the compendium focus.

The focus reason notwithstanding, however, readers may want to pursue different objects of attention which are more pertinent due to historical, institutional, geographical, political, or other factors. The modular, table-based design of the compendium readily accommodates such choices.

Again, as noted above, there are thousands of objects of attention among which to choose. By way of illustration, numerous other objects of attention can be derived simply by using the noun forms of the verb forms listed in Table 3.

Examples of such objects of attention drawn from a small segment of Table 3 include: estimate, evaluation, examination, explanation, exploration, forecast, hypothesis, , identifier, illustration, image, index, indicator, information, investigation, layer, list, location, map, mapper, measure, measurement, model, monitor, parameter, prediction, predictor, promotion, and prototype.

Separately, Table 3 and Table 4 contain terms which of themselves have little or no practical beginning or end. However, in combination they provide an insightful indication of the variety of things and activities – in essence, ideas – which are central to elaborating how to design and use retrospective research to mine for GIS nuggets.

Further, the term indication is used advisedly, since the items listed in Table 4 are a small portion of the ideas that have been the focus of attention in previous research and/or GIS initiatives. Moreover, there are numerous other doing activities beyond those listed in Table 3 which are pertinent to inquiries about previous research and/or GIS productions.

Of particular value to the elaboration of this module, I believe, are suggestions from contributors to the doing research and doing GIS literature (and other productions) about objects of attention to add to Table 4. The initial list is just that, an initial list, and additions are key to moving this module (and the other modules) into subsequent phases of compendium evolution.

3.3. Principal GIS components as the results of and the spawners of ideas

The principal GIS components selected for Table 5 are culled from the literature and other productions by academic, government, business, trade, and professional organizations listed in Table 2, so they are representative of a variety of pertinent interests. Further, most of the components date from the earliest days of GIS evolution. Consequently, in terms of track records all the presented components have been "works in progress" and potential GIS nugget generators for at least 30 years, to as many as 50 years or so for some, and counting.

Table 5. Principal GIS components as initial targets for mining activities

GIS applications	GIS operations
GIS calls for proposals	GIS opportunities
GIS capabilities	GIS performance
GIS challenges	GIS plans
GIS decision systems	GIS policies
GIS education programs	GIS programs
Enterprise GIS	GIS protocols
GIS expressions of interest	GIS requests for proposals
GIS futures	GIS research activities
GIS implementation	GIS research gaps
GIS infrastructure	GIS research needs
GIS innovations	GIS research programs
GIS management practices	GIS research trends
GIS markets	GIS standards
GIS maxims	GIS training programs
GIS needs	GIS trends

> *Although the entries in Table 5 represent many of the core terms of the GIS literature over the past 50 years, they represent only a very small portion of the principal topics which could be obtained by listing the combinations of GIS and core terms which have appeared in academic, business, government, media, professional, and trade organization literature and other productions.

The proposition underlying this module is that mining the literature on principal components for GIS nuggets involves perceiving the components as both the results of GIS ideas, and as the spawners of GIS ideas in a complementary relationship of inputs-outputs-inputs I use the approach of "On the one hand, on the other hand" to illustrate this association.

On the one hand, with regard to the results aspect, each principal component is the derivation or result of a combination of ideas that are comprised of processes and products, which themselves are comprised of ideas.

However, because of varying degrees of influence by legislative, institutional, organizational, political, social, ideological, administrative, financial, technological, technical, financial, entrepreneurial, competency, etc., there are differences in GIS ideas. And, as a consequence, there are differences in the principal GIS components that are identified, adopted, and implemented by governments, businesses, learning centres, research centres, and other users of GIS technology and GIScience methods, techniques, and operations.

In terms of mining the literature for GIS (and GIScience) nuggets, therefore, potential nuggets for the GIS user are all the inputs to principal components and, specifically, any ideas incorporated in a component that:

- Had not been identified by the GIS user;
- Had been identified by the GIS user but not adopted; and,
- Had been adopted but not implemented by the GIS user[8].

Or to re-phrase, whatever others did that was not done by a GIS user, from identify to adopt through to implementation of a principal component or parts thereof, represents nugget potential for that user[9].

On the other hand, once a component is in place it is subject to the same kinds of influences as those noted above, and the component becomes a spawner of questions, declarations, announcements, affirmations, rejections, doubts, concerns, convictions, positions, etc., that is, ideas, about whether and how to maintain or change that component.

In terms of mining the literature for GIS (and GIScience) nuggets, therefore, potential targets and nuggets for each GIS user are all the outputs from principal components

and, specifically, again, any ideas (questions, declarations, announcements, affirmations, rejections, doubts, etc.) spawned by a principal component that:

- Were not identified by a GIS user;
- Were identified but not adopted by a GIS user; and,
- Were adopted but not implemented by a GIS user.

Or to re-phrase, whatever outputs from other governments, agencies of governments, businesses, etc., that were not shared by a GIS user, from identification through to adoption and implementation, represent nugget potential for that user[10].

And, on it goes, in a cycle of inputs-outputs-inputs-outputs ….

Of particular value to the elaboration of this module, I believe, would be suggestions from contributors to the doing research and the doing GIS literature (and other productions) about principal GIS components to add to Table 5. The initial list is just that, an initial list, and additions are key to moving this module (and the other modules) into phase two of compendium evolution.

3.4. Ideas as Questions, and Questions as Ideas

The decision to include a list of question-based topics in a table as a compendium element is driven by the following factors:

- It is an effective way for contact list members to participate in defining the content of the retrospective colloquium and planned conference;
- A tabular format is an easy-to-follow and easy-to-update means of tracking items which have been put out for consideration;
- Providing a list of topics through questions is an instructive and efficient way to illustrate to presenters, attendees, and interested parties the scope, objectives, goals, etc., of the colloquium and planned conference;
- Providing a list of topics through questions is an instructive, efficient, and inclusive way to illustrate possibilities for future retrospective research and GIS conferences, seminars, or other projects.

The questions in Table 6 are derived from multiple sources, including suggestions from members of the contact list. Several comments about the intent, derivation and organization of the questions may be instructive for follow-on researchers.

First, the focus of the majority of questions is on the how dimension, with the intention of leading to papers and presentations which contribute to our knowledge about how to design and how to apply the retrospective approach to mine for GIS nuggets. Examination of the GIS research publication record suggests that the how aspect is

under-served relative to the who, what, where, and when aspects, so it is appropriate that the colloquium address that shortfall through the questions in Table 6.

Table 6. A List* of question-based topics to advance the idea of using the retrospective approach to mine for GIS nuggets**

1. **How can the 'retro approach' contribute to documenting the GIS field as science?**
2. **How can the 'retro approach' contribute to increased knowledge about the time-geospatial continuum?**
3. **How can the 'retro approach' contribute to increased public understanding of knowledge about the time-geospatial continuum?**
4. **How can the 'retro approach' contribute to more informed use of time-geospatial continuum knowledge in federal government programs?**
5. **How can the 'retro approach' contribute to more informed use of time-geospatial continuum knowledge in federal government policies?**
6. **How can the 'retro approach' contribute to more informed use of time-geospatial continuum knowledge in provincial/state government programs?**
7. **How can the 'retro approach' contribute to more informed use of time-geospatial continuum knowledge in provincial/state government policies?**
8. **How can the 'retro approach' contribute to more informed use of time-geospatial continuum knowledge in local government plans?**
9. **How can the 'retro approach' contribute to more informed use of time-geospatial continuum knowledge in local government programs?**
10. **How can the 'retro approach' contribute to more informed use of time-geospatial continuum knowledge in local government policies?**
11. **How can the 'retro approach' contribute to more informed use of time-geospatial continuum knowledge in school curricula?**
12. **How can the 'retro approach' contribute to more informed use of time-geospatial continuum knowledge in business?**
13. **How can the 'retro approach' contribute to reducing the hype in communications about "analytics"?**
14. **How can the 'retro approach' contribute to reducing the hype in communications about "Big Data"?**
15. **How can the 'retro approach' promote continuity among members of the GIS community?**
16. **How did best practice concepts affect GIS evolution?**
17. **How did client-driven research affect GIS evolution?**
18. **How did curiosity-driven research affect GIS evolution?**
19. **How did curiosity- and client-driven research combine to affect GIS evolution?**
20. **How did design-evaluation tools contribute to GIS adoption?**
21. **How did design-evaluation tools contribute to GIS implementation?**
22. **How did design-evaluation tools contribute to GIS use?**
23. **How did design-evaluation tools contribute to GIS acceptance?**
24. **How did enterprise GIS ideas arise and evolve?**

25. How did GIS-based decision support systems arise and evolve?
26. How did GIS research methodologies arise and evolve?
27. How did ideas of a GIS 'Champion' evolve?
28. How did mission-driven research affect GIS evolution?
29. How did prognosticators derive GIS futures?
30. How did Special Interest Groups (SIGs) advance GIS?
31. How has GIS affected business?
32. How has GIS affected catastrophic event monitoring?
33. How has GIS affected catastrophic event predicting?
34. How has GIS affected corporate confidentiality?
35. How has GIS affected corporate privacy?
36. How has GIS affected 'Doomsday Mapping'?
37. How has GIS affected education?
38. How has GIS affected environmental protection?
39. How has GIS affected geo-politics?
40. How has GIS affected interoperability of information technology?
41. How has GIS affected interoperability of systems engineering?
42. How has GIS affected intersection level of service mapping?
43. How has GIS affected land use planning practices?
44. How has GIS affected news media?
45. How has GIS affected organization of local government?
46. How has GIS affected performance of local government?
47. How has GIS affected personal confidentiality?
48. How has GIS affected personal privacy?
49. How has GIS affected petroleum exploration?
50. How has GIS affected political strategies?
51. How has GIS affected public participation?
52. How has GIS affected public policy?
53. How has GIS affected public right-to-know practices?
54. How has GIS affected qualitative analysis?
55. How has GIS affected qualitative synthesis?
56. How has GIS affected quantitative analysis?
57. How has GIS affected quantitative synthesis?
58. How has GIS affected real estate?
59. How has GIS affected retailing?
60. How has GIS affected risk analysis?
61. How has GIS affected social media?
62. How has GIS affected species mapping?
63. How has GIS affected spatial cataloguing?
64. How has GIS affected spatial hypothesizing?
65. How has GIS affected spatial theorizing?
66. How has GIS affected sustainable transport?
67. How has GIS affected traffic engineering?
68. How has GIS affected transportation planning?
69. How has GIS affected urban planning and development?
70. How has GIS affected urban management?

71. **How has GIS affected visualization analysis?**
72. **How has GIS affected visualization synthesis?**
73. **How has technology affected GIS evolution?**
74. **How have GIS and geo-based data added to processes examined in the medical sciences?**
75. **How have GIS and geo-based data added to processes examined in the natural sciences?**
76. **How have GIS and geo-based data added to processes examined in the social sciences?**
77. **How have GIS and geo-based data affected examination of built environment processes?**
78. **How have GIS and geo-based data affected examination of built environment structures?**
79. **How have GIS and geo-based data affected examination of natural environment processes?**
80. **How have GIS and geo-based data affected examination of natural environment structures?**
81. **How have GIS and geo-based data affected weather reporting?**
82. **How have GIS and geo-based data been used to assert claims of climate change?**
83. **How have GIS and geo-based data been used to counter claims of climate change?**
84. **How have GIS and geo-based data been used to demonstrate the cascading process which affects interdependent spatial infrastructures?**
85. **How have GIS and geo-based data been used to demonstrate degrees of urban traffic congestion?**
86. **How have GIS and geo-based data been used to demonstrate the concept of "traffic gridlock"?**
87. **How have GIS and geo-based data been used to examine the principle of integrating land use planning and transportation planning?**
88. **How have GIS and geo-data been used to examine the self- organization of urban structures and spaces?**
89. **How have GIS and geo-based data contributed to elaborating best practices in urban planning and development?**
90. **How have GIS and geo-based data contributed to elaborating the consequences of "building in harm's way"?**
91. **How have GIS and geo-based data contributed to indexes for measuring pedestrians' safety?**
92. **How have GIS and geo-based data contributed to measuring transportation system performance?**
93. **How have GIS and geo-based data contributed to measuring transportation system sustainability?**
94. **How have GIS and geo-based data contributed to modelling epidemiological processes?**
95. **How have GIS and geo-based data contributed to urban walkability analysis?**

96. How have GIS and geo-based data enabled looking inside aggregates and examining spatial processes?
97. How have GIS and geo-based data enabled looking inside aggregates and examining spatial structures?
98. How have GIS and geo-based data expanded the body of processes examined by academics?
99. How have GIS and geo-based data expanded the body of processes examined by business?
100. How have GIS and geo-based data expanded the body of processes examined by governments?
101. How have GIS and geo-based data expanded the body of processes examined by professionals?
102. How to backcast for GIS application nuggets?
103. How to backcast for GIS best practice nuggets?
104. How to backcast for GIS education nuggets?
105. How to backcast for GIS management nuggets?
106. How to backcast for GIS operations nuggets?
107. How to backcast for GIS research nuggets?
108. How to backcast for GIS technology nuggets?
109. How to backcast for GIS training nuggets?
110. How to design papers to make them "retro sensitive"?
111. How to design conference papers to make them "retro sensitive"?
112. How to design conference proceedings to make them "retro sensitive"?
113. How to design webinars to make them "retro sensitive"?
114. How to identify the foundations of GIS leadership and vision?
115. How to identify changes in the foundations of GIS leadership and vision?
116. How to identify changes in the evolution of GIS leadership and vision?
117. How to measure GIS return on investment?
118. How to search client-driven research for GIS nuggets?
119. How to search curiosity-driven research for GIS nuggets?
120. How to search for GIS nuggets in productions which combine client- and curiosity-driven research?
121. How to search mission-driven research for GIS nuggets?
122. How was GIS incorporated as a duty of care obligation?
123. How was GIS incorporated as a standard of care practice?
124. How were case studies used to promote GIS?
125. How were client- and curiosity-driven GIS research combined?
126. How were design-evaluation tools identified for GIS purposes?
127. How were design-evaluation tools adopted for GIS purposes?
128. How were design-evaluation tools implemented for GIS purposes?
129. How were design-evaluation tools used for GIS purposes?
130. How were elected officials engaged in GIS deliberations?
131. How were GIS and IT operations coordinated?
132. How were GIS and IT relations improved?
133. How were GIS and IT relations reconciled?
134. How were instructors selected for *Introduction to GIS* workshops?

135. How were topics selected for *Introduction to GIS* workshops?
136. What methods were used to derive GIS futures?
137. What methods were used to forecast GIS futures?
138. What methods were used to predict GIS futures?
139. What methods were used to scope GIS futures?
140. What methods were used to shape GIS futures?
141. What were the innovation drivers behind GIS evolution?
142. What were the origins of incorporating GIS in duty of care obligations?
143. What were the origins of incorporating GIS in standard of care practice?
144. Why was GIS incorporated as a duty of care obligation?
145. Why was GIS incorporated as a standard of care practice?

* Sources used to compile the list of potential topics include productions (journals, proceedings, newsletters, conference programs, workbooks, list serve comments, etc.) of professional, trade, and academic organizations, of government agencies, of businesses, of the popular media, and of websites such as slideshare.net. In addition, suggestions were received from members of a contact list created to assist with colloquium and conference planning, and interested parties responding to announcements about the colloquium and the conference.

** In the list of question-based topics it is frequently the case that two or more of applications, design, education, management, operations, research, or training can be interchanged with little or no loss of generality or pertinence. As a result, in the interests of flow, space, and the avoidance of mind-numbing repetition, the approach taken is to use one of the terms for illustrative purposes, with the expectation that presenters and other readers are fully capable of interchanging terms should they wish to produce a more detailed or more explicit listing. Further, and drawing on materials previously presented in Table 1, Table 2, Table 3, as well as those in Table 4 and Table 5, it is possible to create a listing of many, many hundreds of topics through interchanging related terms.

Second, the focus on how in the questions is consistent with serving the two primary goals of science, namely, to add to knowledge, and to add to ways of continuing to add to knowledge, neither of which happens at a non-trivial level without non-trivial how to do it methodology and empirical evidence.

I believe it is fair to say that answering the how to questions in Table 6, and similar how to questions in future versions of Table 6, will significantly contribute to firming up the science element of GIScience.

Third, due to the limited scope of the GIS retrospective program, it was not possible to employ a formal mail survey, focus group, Delphi, or other technique to assemble and prioritize the questions.

As a result, in large measure Table 6 represents my impression of questions to ask, and I am fortunate to be able to call on more than 40 years of professional engagement in teaching, research, GIS, GIScience, and the uses of GIS and GIScience, And, very importantly, I also have the benefit of interactions with hundreds of accomplished individuals, including those who contributed to *AutoCarto Six Retrospective*, and/or are participating in the GIS retrospective program.

Consequently, Table 6 is the product of a substantial body of expertise and experience in: GIS research and development, education, training, applications, management, and operations; and, hands-on experience in such fields as transportation, urban development, land use planning, surveying, applied geography, natural resources management, systems engineering, civil engineering, public safety and security, governance and inter-governmental relations, and social media.

Clearly, there is room to expand the scope and depth of inputs to Table 6, but the current compilation appears to be sufficient for the initial considerations stage.

A closing comment on Table 6 recalls the materials in section 2.3, and the advisory by Garrison about nuggets and past, present, and future linkages.

Feedback on Table 6 referred to it as a substantive contribution that will significantly increase in value as the GIS field matures.

Moreover, it was suggested that the “user-friendly” design will be a catalyst for more questions in the interim between the colloquium and the planned conference, and thereafter.

Table 6 will therefore be updated as circumstances dictate and conditions allow through to the conference, and perhaps another means will surface to continue the updating process.[11].

It is likely that some of the questions in Table 6, or variations thereof have been used in dissertations, theses, agency or installation reviews, research proposals, etc. I would appreciate having the source information brought to my attention for future reference.

Finally, of particular value to the elaboration of this module, I believe, would be suggestions about question-based topics to add to Table 6. The initial list is just that, an initial list, and additions are key to moving this module (and the other modules) into phase two of compendium evolution.

5. Conclusion

This paper pre-tests the idea of developing a compendium of ideas on using the retrospective approach to mine for GIS nuggets. The following findings support further work on the compendium model as presented in *Developing a Compendium of Ideas on Using the Retrospective Approach to Mine for GIS Nuggets: Initial Consideration*.

1. The compendium model invites various kinds and degrees of participation in elaborating a retrospective research and action program.
2. The four design principles (Focus on connecting "ideas" and "nuggets" Use a modular approach; Limit the modules to those required to effectively and efficiently launch the project; and Make it easy for those with different interests to modify the content of modules.) used for the initial phase of compendium development provide clear instructions and directions throughout the compendium-building process.
3. Due to the flexibility of the modular approach, the compendium can readily be increased beyond the four modules specified for the pre-test.
4. Each of the four modules (Ideas about "doing"; Ideas about objects of attention; Principal GIS components as ideas and sources of ideas; and Ideas as questions and questions as ideas) selected for the initial representation of the compendium can readily be expanded, extended, contracted, re-oriented, etc., to accommodate general as well as particular needs, interests, etc. affecting decisions about mining for GIS nuggets.

For the closing remark, I recall the observation by Professor Bill Garrison regarding the time factor, and its essential significance in retrospective research, and research in general.

> *"You use the word nuggets in useful ways. Perhaps nuggets could be thought of as links in the chain that ties the past to the present.... and in important ways the present to the future. Is that a thought about using nuggets to achieve richer futures?"*

The short answer to that central question is "Yes, most definitely," and the long answer continues to unfold.

5. Endnotes

1. As stated in posted reports beginning in late 2014, the decision was made to separate the colloquium and the conference rather than hold them both during a three-day event in February 2015. The current plan is to assess the value, impacts, and messages of the colloquium and, if appropriate, to proceed with a conference in 2016 in conjunction with the Esri Federal GIS User Conference in Washington DC.

2. To my knowledge, the GIS retrospective (or GIS retro) dialogue formally commenced publicly with *AutoCarto Six Retrospective* (Wellar 2013). In the event of a preceding initiative, I would appreciate having it brought to my attention.

3. The contact lists include more than 100 contributors to the 1983 *AutoCarto Six Proceedings* (Wellar, 1983), 37 of whom also contributed to A*utoCarto Six Retrospective* (Wellar 2013) 30 years later. While not large numbers relative to the population of those engaged in GIS and GIScience activities, examination of the table of contents of both publications reveals the presence of many of the most influential contributors to the evolution of GIS, GIScience, and the uses of GIS and GIScience. I am most appreciative of their contributions to my thinking about compendium matters.

4. In anticipation of holding the conference in February 2015, the *Guide for Papers on Using the Retrospective Approach to Mine for GIS Nuggets was* circulated in August for comment by members of the contacts list and the sounding board, and posted in September, 2014. As a result of the decision to split the colloquium and the conference, the *Guide* was withdrawn from two websites where it had been posted for some months, http://www.wellar.ca/wellarconsulting/ and https://www.google.ca/#q=slideshare.net. A new guide for contributors which is based on the response to the colloquium and the compendium will be prepared for presentations at the planned 2016 conference

5. For details see *Transport Action Canada Compendium of Transportation Research Topics: A New Approach for New Thinking (*Wellar 2010). http://www.transport-action.ca/dc/TRTCompendium2010.pdf

6.The four tables were initially included in the *Guide for Papers on Using the Retrospective Approach to Mine for GIS Nuggets,* and were designed to illustrate the mix of possible ideas -- themes, topics, issues, concerns, challenges, opportunities, etc., -- that could be considered as the bases, components, elements, and so on, of conference presentations. The proposal to re-purpose the tables and use them as the core of the compendium was endorsed by members of the contact lists, the sounding board, and potential conference contributors as a timely and productive use of the assembled materials.

7. The quoted text, and permission to use it in *Developing a Compendium of Ideas on Using the Retrospective Approach to Mine for GIS Nuggets: Initial Consideration* was received via email from W.L. Garrison, Professor Emeritus, Civil and Environmental Engineering, Institute of Transportation Studies, University of California, Berkeley, on December 26, 2014.

8. The three-stage process of identify, adopt, and implement was used in a study measuring the progress of Canadian municipalities in achieving sustainable transport objectives (Wellar 2009). This process proved to be a very effective and efficient way of ascertaining actions taken (and not taken) by municipal governments in regard to sustainable transport matters. It appears to be directly applicable to ascertaining and tracking the state of principal GIS components in governments, businesses, academic institutions, etc.

9. At the risk of belabouring the obvious, all organizations do not identify, adopt, and implement GIS policies, programs, plans, technologies, applications, etc. at the same time. As a result, decisions and actions by some organizations to identify, adopt, and

implement GIS, GIScience, or the uses of GIS and/or GIScience, create potential nuggets for organizations which have not yet done so.

10. The process of learning from both what is done and what is not done, aa well from both our successes and failures, has been the subject of numerous studies, reports, and papers since the 1960s on the evolution of principal GIS components. The several paragraphs in section 3.3 are a very brief account of the deep and significant documentation on this topic, and I encourage readers to examine the learned, professional, and other literatures which address this longstanding, core feature of methodologically designed research, including that employing the retrospective approach.

11. Under the best of conditions, Table 6 will be updated in time for the colloquium in February 2015, and posted at various websites, including http://wellar.ca/wellarconsulting/home.html. However, it is likely that the first major update will occur sometime between the colloquium and the planned conference in 2016.

6. References

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Wellar, B. (Ed.). 2013. *AutoCarto Six Retrospective.* mapcontext.com/autocarto/proceedings/TOC.html and wellar.ca/wellarconsulting/

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