Rewiring for a GIS/2

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Abstract

Increasing numbers of activist non-profits and traditionally marginalized peoples are adopting gis as a tool for social change. Its use is scrutinized by academics who worry that gis embodies a mechanism for misrepresentation, diversion, control, and surveillance. This critique has not slowed adoption, and for the past decade researchers have been investigating the use and value of gis in a variety of non-profits and citizens' groups. Many of these new users are calling for a different kind of gis – a gis/2. This gis must be able to represent different measures and visions of place and integrate local knowledge, support cultural and multi-lingual distinctions, and preserve – rather than reduce – friction, disagreement, redundancy, and even error.

In this paper I argue that one must "rewire gis" – that is, engage the code and the coding directly – to build a gis/2. A literature review on the use and value of gis in social movements, activist non-profits, and citizens' groups illustrates the limitations of current gis and the necessary ingredients for a more inclusive gis/2. I present four approaches, which are framed materially and discursively. Three approaches modify existing gis to achieve a gis/2. A fourth systems design approach is proposed, which incorporates two innovations in computing science: Unified Modelling Language (uml) and eXtensible Markup Language (xml). This prototype is sensitized to the needs of social movement, non-profit, and citizens' organizations. These four approaches, used separately or in conjunction, serve as blueprints for further discussions on the rewiring of gis.

Keywords: geographic information systems (gis); community-based organizations; Unified Modelling Language (uml); Extensible Markup Language (xml)

Introduction

Few individuals involved in the initial development of the spatial algorithms, topologies, and data structures could have foreseen the popularity of gis and related spatial technologies outside the mainstream of government and business. Today, gis is being used by thousands of social movement groups, non-profit organizations, non-governmental organizations (ngos), native tribes, community-based organizations, and grassroots groups. Uses range from siting affordable housing, associating breast cancer with non-point source pollutants, political redistricting for Mexican Americans, linking endangered species to non-threatened species, enhancing neighbourhood watch through crime-pattern analysis, and presenting land claims (Aberley 1993; Poole 1995; Sieber 1997; Craig, Harris, and Weiner 2002). Diffusion of the technology has yet to wane as new communities – among them, public-health interest groups, community-development corporations, and fisheries groups – discover and mould the technology to their needs and communicate their usage to other organizations.

Adoption proceeds, despite critiques that gis embodies a mechanism for misrepresentation, control, and surveillance (Pickles 1995; Sheppard 1995; Curry 1998). At best, this use of gis represents a simultaneous empowerment and marginalization: these groups gain social capital at the same time that they become co-opted by a difficult technology originally designed to support capitalism (Harris and Weiner 1998). To alleviate these problems, many users and their advocates are calling for a different kind of gis.

Proposals to create a more inclusive gis began in 1996 as part of National Center for Geographic Information and Analysis Initiative 19: gis and Society. Attendees devised criteria for the next generation of gis: a gis/2 or gis "too" (Schroeder 1996). Among more technical considerations, this new gis should involve more participants, allow diverse representations, integrate diverse data types, and preserve the history of its own development. They realized that a central problem in determining the criteria was definitional. Is gis a tool, a set of methods and instruments, a science, or a social practice? At minimum, gis/2 should involve "a redefinition of input participants and types, of how data is handled, and of system outputs, moving away from standard measures of completeness and control" (Schroeder 1966, 1). Focusing on inputs, outputs, and outcomes is a laudable beginning, but this formulation allows the technology itself to remain intact, presumably to be developed by those "who know best."

Additional initiatives emerged from the public participation gis (ppgis) literature (see *Cartography and Geographic Information Systems* special issue on ppgis, par-

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ticularly Obermeyer 1998a). Suggested changes include representing different measures and visions of place, and integrating local knowledge; supporting ethnic and multilingual differences; and preserving, rather than reducing, friction, disagreement, and redundancy. Public Participation gis is far more nuanced in its application of gis than initial proposals for gis/2, but the social and technical blueprint is still missing.

Curry (1998) dismisses attempts – technical or otherwise – to create a new gis because they focus on reworking a technology that is already ethically flawed. He argues that ppgis researchers ignore the wealth of community knowledge, for example, in local newspapers and computer chatrooms. Instead, current ppgis solutions consist of attempts to supply "more": more accurate and more complete representation as well as a nostalgic attempt to recreate "community" through technology. No, according to Curry, the solution to the problems of gis lie outside of gis entirely.

Ultimately, Curry offers yet another version of "who knows best": Grassroots groups and researchers alike should heed the censure and not use gis because the technology represents false consciousness. Ignore the growing numbers of activists who apply gis to social change. Do not become involved in gis development, even as giscience increasingly distances itself from the growing body of constructive critique (cf. chapter 1, Longley and others 2001). We can theorize, or we can attempt to actualize an imperfect yet more meaningful gis/2. Donna Haraway (1991) contends that if the marginalized are to have any influence in the future, they need to stop fighting existing systems and structures and be engaged in "writing the cyborg." This translates into actually writing the software on which the technology is based, and therefore changing the gis through coding (Schuurman 2002). It follows the challenge of Aitken and Michel (1995, 17) for grassroots groups and their supporters to move beyond participation and access, to ownership of gis development, because "participation in the creation of gis knowledge does not necessarily give power to those involved in, and affected by decision-making." Only when activists and marginalized engage in "rewiring" the gis will they write the "cyborg."

In this paper I draw a social and technical blueprint for gis/2. The paper is both cognizant of and subject to the critiques of "more." Initially I review works from ppgis, gis and Society, and giscience. These works illustrate the limitations of current gis to represent different ways of knowing place and space. I present four approaches to rewiring gis; these are framed materially and discursively. Three approaches retrofit existing gis, which are good beginnings but still rely on a rigid technology with strict geometry and insufficient insertion points for participation. I describe a fourth approach: a system design for a new gis, which is sensitized to the needs of social movement, non-profit, and citizens' organizations. It is hoped that this prototype for a gis/2, instead of representing the hard-wired solution to existing problems, will serve as a starting point for further discussions on the rewiring of gis.

The Problems with GIS as We Know It

The possibility of making gis more inclusive to the grassroots or general public provokes intense interest among gis researchers and practitioners. Geographic information systems is viewed as a technology that could expand entry into policy making where decisions are determined largely by computer modelling and spatial analysis and could allow groups to better understand and advocate for place (Obermeyer 1998a; Craig, Harris, and Weiner 2002). The ppgis literature generally explores two modes of public involvement: (1) the use of gis in public decision-making settings (e.g., public meetings, site-planning sessions) to facilitate public participation, and (2) issues in the adoption of gis by various groups and communities in order to understand and influence public policy (Sieber 1997; Shiffer 1998). One must guard against potential marginalization; however, gis appears malleable to the goal of enhancing participation.

In the first mode, Jordan (1998) classifies the process of public and stakeholder involvement in a ppgis framework. In his framework, one must account for the issues and priorities of a range of stakeholders. Information needs can be delineated, but constraints will modify the data that can be collected. Data collection – qualitative and quantitative – must involve community participation. Transposing and integrating data has costs as well as benefits: a ppgis can produce information that is useful to the group, but it can be viewed as extractive and non-participatory because it takes the data away for analysis rather than encouraging people to undertake their own investigations and analysis. Qualifications and caveats to each step are essential to remain cognizant to the context of the issue.

In the second mode, groups care less about increasing participation than using gis to effect social change (diminishment of the former to focus on the latter, which is duly noted by Craig and Elwood 1998). Many of the same issues mentioned above need to be addressed, such as data transposition and integration. Additionally, groups need to determine what to acquire (skills, hardware and software, data); how to collect, enter, and manage information; how to sustain the system with limited resources; and what the role of supportive intermediaries such as universities will be. Finally, groups must decide on their purpose in using the gis (e.g., process outcomes such as linkages with other stakeholders or disseminating and sharing of information; products such as maps or databases; social capacity building; better management of resources; or improved policies and law) (Barndt 1998; Craig and Elwood 1998; Kyem 2000; Leitner and others 2000; Sieber 2000b). Technical issues figure far more strongly in this mode of ppgis.

Whether the goal is increasing participation in policy making or facilitating grassroots adoption, the public can interact with gis in varied ways. But what constitutes this gis with which individuals and groups are interacting? That is, what are we rewiring? The technology of gis in these groups varies widely, from maps drawn in the sand with pebbles – ephemeral maps that are often a part of methods such as participatory rural appraisal – and sketches on topographic maps, to analysis of satellite imagery augmented with gps points (Poole 1995). Several conservationist gis users are fairly sophisticated in their geo-visualization; one even retains a well-known cartographic firm to enhance the quality of output (Sieber 2002). In many "community mapping" projects the community never uses the software, yet provides input and evaluates output, which has been integrated with other thematic layers. Many grassroots groups and community organizations apply gis with the support of universities and public libraries, gis consulting non-profits, and professional associations (Sawicki and Peterman 1998; Leitner and others 2000). Yet all of these all are grouped under the rubric ppgis, and a rewiring will have to account for these variances.

Jordan's framework suggests that it is also important to understand that this rewiring must take place in a process, for ppgis is as much a process as a software. Kyem (2000) contrasts gis with ppgis, which embeds the technology in expansive and bottom-up spatial decision support. For him, the applications should be appropriate as defined by the needs of marginalized people and groups themselves. Unlike Schroeder's original definition, in which gis was to be employed by interest groups to fit within the official policy-making structure, the purpose of these applications is empowerment, both as an end and a process. Researchers may disagree over the details of the dimensions (e.g., whether the location of ppgis is strictly rural or urban). Nonetheless, Kyem (2000) demonstrates that, to many ppgis researchers, ppgis must not be merely a different implementation of the technology, but be a different gis.

Perhaps ppgis the process and gis the technology are inextricable. Several researchers argue that gis itself is a process (Harvey 2000; Sieber 2000a; Schuurman 2002). This argument holds that gis is neither a CD in a box nor a science. Instead it reflects the choices made by gis developers and their institutions, existing spatial technologies, software languages, and accepted spatial theories (Obermeyer 1998a). It is the convergence of people in a particular graduate school, at a certain conference, in the right journal at the right time or at a chance meeting (Chrisman 1997). In this social construction, there is no clear division between people and the software, since probability and "schmoozing" construct the technology as much as algorithms and system design. Moreover, users of gis participate in the co-production of that technology. Latour (1987) affirms, "We are all multi-conductors and can either drop, transfer, deflect, modify, ignore, corrupt, or appropriate the claims that need our help if they are to spread or last." Latour (1987) provides numerous examples of scientifically or technically superior innovations that were not adopted because they did not comply with the agendas of developers and users. gis is widely adopted not because it is the best but because people jointly developed it.

This view holds that gis use and diffusion by users such as social movements depends as much as upon its perceived utility as its ability to be reformed by the movement. Indeed, these might be one and the same. It also suggests that grassroots groups must be predisposed to the technology – possess certain skill sets and ideological approaches – to effectively adopt gis. Of course, gis is not for every group or individual, and not every group requires the most sophisticated technologies. Some will approach gis more as a technology than a process. However, not everyone should have to become a giscientist in order to participate in the gis user/developer/scientist spectrum.

Is gis a technology or a process? This distinction becomes critical: if gis is a technology then it can be examined as rigid. If gis is a process then it is infinitely plastic. I argue that gis must be viewed simultaneously through a material (physical, technological) and a discursive (social construction, process) lens. It is material because users must purchase and install the gisoftware and then, in many cases, proceed to tear their hair out, attempting to geo-reference or otherwise manage their data sets in a seemingly inflexible system. This situation is exacerbated for small non-profits, many of which rely on equipment donations, transitory student support, and free or relatively easy access to data. Thus gis is a material tool and has material consequences. Likewise, the same gis must be viewed discursively. User interfaces (and user "friendliness") may reflect particular domains of knowledge and the social interactions of system designers; multiple software versions represent the creative destruction of capital; lack of public data access may reveal the dominance of local business interests. This is not to say that the distinctions between lenses are absolute: the boundaries are fuzzy. But just as a light can be analysed as both a wave and a particle, both gis lenses are needed for fuller understanding and enquiry.

difficulties in involving more participants and diverse representations

Having set the stage for defining and framing gis, how does current gis make it difficult to increase the number and diversity of stakeholders? Adding participants means facing very different concerns and priorities over space. Each age, gender, class, and race may have different concerns. Frames of reference may differ, depending on individuals' prior experience, familiarity, and expertise (called cognitive or mental maps – Gould and White 1986). Whether one participates in these activities as an individual (e.g., a neighbourhood resident) or as a representative of a group (e.g., a member of the local merchant's association) also affects expectations. How the user perceives an issue and how the user then applies the technology to attend to that perception will likely differ from each other and diverge from the official view. When gis is brought into public policy-making, a participant could

> employ [gis] visualization privately for personal spatial exploration and inquiry, either as a community resident or group representative, and, perhaps searching for different information, arrive at very different understandings or conclusions. Further, that same person could refer to a displayed map image and publicly communicate or illustrate an idea, either as a group's representative or as an individual – but those ideas might be quite different (perhaps even in conflict). (Heckman 1998, 7)

Once beyond the thematic "shuffling" and annotation, one has to represent what are essentially qualitative differences. Technically, difference could be ranked, classified, standardized, or otherwise categorized. However, something ineluctable may be lost in the transformation. How does a "five out of five" rating adequately convey a sacred burial site, a vibrant immigrant neighbourhood, or a favourite fishing hole? Casey and Pederson (1995, 1) encountered these problems when mapping community in West Philadelphia:

> With the parcel base maps, tax assessors data, tax delinquency and vacancy data, there does not seem to be any way, for example, to convey the beautiful old stone buildings […] the family owned barbecued chicken place […] the murals […] created by local artists […] or lively commercial corridors.

By design, most gisoftware requires quantification and normalization: geo-registered layers, classified data, and standardized database structures. Add to this a strict geometry of pixels or points, lines and polygons. Dependent on the data structure, co-located points cannot be stored in the same feature; features cannot possess fuzzy locations. Researchers can be limited to simplistic representations of difference that are spread across features, for example displaying stakeholder conflicts as overlapping polygons. What does it mean to aggregate into a hotspot very different valuations of the same space?

The gis is also designed for optimization: databases should contain the most succinct and accurate data, represented in the most efficient and flexible structure. Chrisman (1987) has challenged the assumption that spatial databases need to have the sole, most accurate solution and that redundancies should be eliminated. There may be historical reasons that redundancy exists, for example, because of legal or software requirements. Particular conflicts may represent a history of oppression that cannot be consensually negotiated. They often expose questions of legitimacy, veracity, and accuracy accorded to expert knowledge versus local knowledge (Ramasubramanian and Sieber 2000). Harris and Weiner (1998, 74) contend that a newer gis should "assume the existence of socially differentiated understandings of landscape. In this context, a conflictual gis would be an expectation rather than the surgically clean, illuminate, and homogeneous spatial representation that it currently is."

Even conflictual giss might still "shoehorn" communities into existing technology. Hodgson and Schroeder (2002) describe how counter-mapping exercises among the Masai in Tanzania – "clarifying" village limits, classifying and then dividing land uses into neat polygons – created boundaries that disrupted reciprocal relationships among communities. Rundstrom (1995) attributes the problem to Western design. In the West, if data fail to fit existing categories they will be classified as outliers. Eliminating or re-categorizing outliers is good because it elucidates generalized patterns. In contrast, some native people may see ambiguities – the outliers – as essential to understanding patterns. Unlike the discrete feature layers in traditional gis, nature is intertwined, ubiquitous in its relatedness, and necessarily indistinct. Adding another field or a fuzzy boundary does not alter the underlying data structure.[1]

Curry (1998) argues that gis structures human experience into rules and standards, which reduce people and places to variables and layers. Instead of the subtle practices – the processes – that comprise relationships within neighbourhoods and nations, gis allows the combination of data that hold nothing in common but proximity. The most valuable elements of place, such as emotions, become the "detritus of calculations" (1998, 55).

Standards and optimization point to a technology embedded in a technocracy: gis is employed because it enables more efficient determination of policy, and as implied above, reflects the dominance of expert knowledge. Technocracy is a system of governance in which technically trained experts and professionals control the policy discourse by virtue of their specialized knowledge and key positions in political and economic institutions (Fischer 1990, 17). In a technocracy, a tool such as gis is more efficient than public participation, which is seen as inefficient and tedious, driven by ideologies and moral criteria, and far too egalitarian (Putnam 1995). Moreover, when the issue is accuracy – truth – then bringing in people who are perceived to possess agendas clouds the quality of data. At its cynical extreme, gis allows experts to explain their ultimate objective decisions, free of inconvenient politics.

A very different way of knowing and negotiating place is seen in a "map" created by 70 aboriginal artists about an area in the Great Sandy Desert in Australia. It is a large piece of artwork (18 3 12 metres); the colourful swirls and dots bear little resemblance to an aerial or cartographic image that might be recognizable to Western eyes. But it is also a political document: it was submitted as evidence of the Ngurrura clan's native title claim at a conference convened by the National Native Title Tribunal in June 1997. The artists were inspired by a desire to represent and consequently own their land in the "proper white fella way" (Mangkaja Arts Resource Agency 1999; Turnbull 1999).

I do not wish to imply that this kind of map should cause us to abandon gis. Nor should this map be transposed into gis. Jordan asserts that we should not be attempting to capture and replicate all local information, "but to organise and present pertinent information that was not previously available, using the technological capability of gis, to assist [groups] in their decision making" (1998, 8). I agree that we should not attempt to capture all traditional and local information, but at the same time we should not absolve the technology or its developers if it cannot model the information that a community might find useful. We need not accept the wholesale technocratic annexation of a tool that appears useful for democracy. Nor should we excuse the technology from finding space for intersections that defy easy descriptions, diagrams, or answers. Instead, we need a technology that can better accommodate a world of disagreement, passion, complexity, and redundancy.

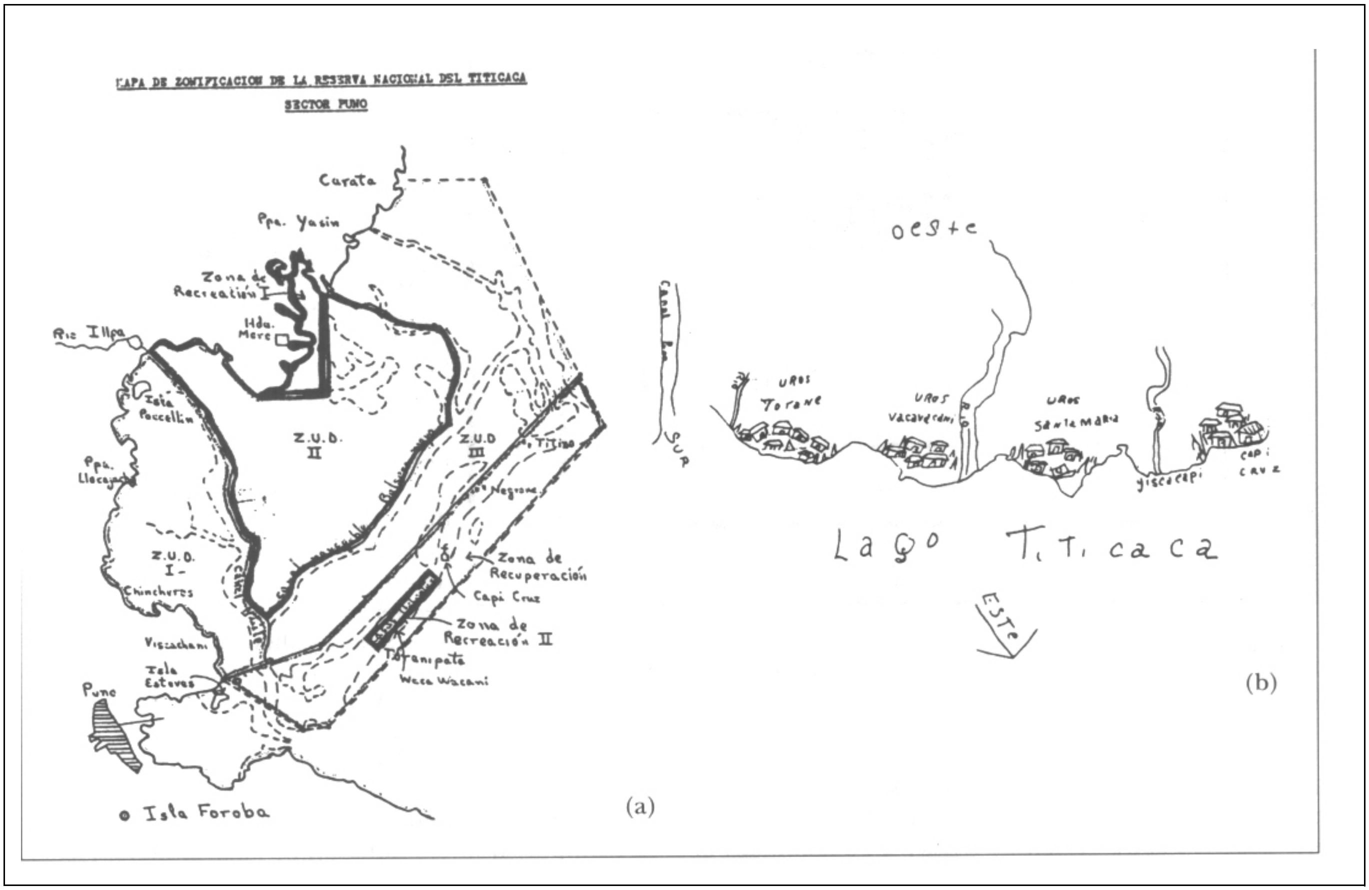

Figure 1. Different representations of the same space, National Reserve of Lake Titicaca, Peru.
1a. State map of areas of approved river grass collection.
*1b. Peasant map of areas of importance (villages and the orientation of huts). (*Source*: Orlove 1993, used by permission)*

problems in map geometries

Consider the famous Saul Steinberg map of New York city in *The New Yorker* as an example of the perception of scale. It shows one city block of New York and compresses the rest of the world – New Jersey, California, and the Pacific Ocean – in ever shrinking proportions. These scale inconsistencies speak to the importance of places and connectedness and not necessarily to official United States Geological Survey topography. gis currently is optimized for the latter but not for the former.

Figure 1 exemplifies the issues of scale, map extent, and generalization found in Orlove's (1993) research in Peru. Orlove (1993) presents the differences between the state and the peasant maps in representation of features: inclusive or exclusive of features, class of features, and relation of features. For example, Figure 1a shows the issue of centre periphery – placing communities in relation to distant cities, therefore showing their peripheralness as integral to the map. Figure 1b shows relation of features to each other – the circular pattern of houses shows familial linkages. In the peasant map, cities and roads were "generalized" out as unimportant. Scale, through feature layer and map extent, suited the villagers. Presumably the images could be reconciled, but the question is, What should remain and why must one map (undoubtedly the peasant map) fit another (the state map)?

Scale occupies a central role in political geography. Scale here is not a preordained hierarchical mechanism for ordering processes and phenomena, but is the process that shapes and constitutes social practices at different levels (Marston 2000). Differing scales cannot be solved simply with common referents in each map. Common referents privilege the scale space of the dominant party and geodetically control the scale needs of the minority party.

Scale possesses additional discursive meaning for grassroots organizations. The early 1990s saw a literature called "scaling up the grassroots" (Uvin and Miller 1996). It recognized the importance of organizational, political, and geographic scale to grassroots activism. Organizations devoted to small geographic areas may be impeded in working effectively at broader scales. Conversely, ingos (international nongovernmental organizations) may fail to "get it" at the local level. Likewise, scaling can occur as an organization grows to meet challenges, and through linkages among the state and non-state actors, such as other ngos (Annis 1992; Stonich and Cisna 1998; Sieber 2003). Thus the "cartographic" scale of the issue must correspond with the organizations' ability to

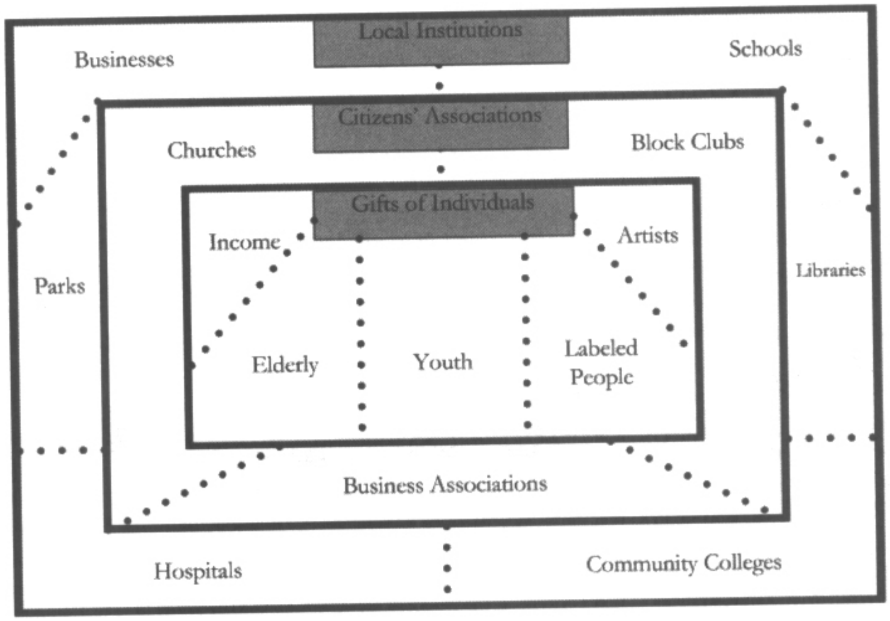

*Figure 2. Mapping community assets. (*Source*: Kretzmann and McKnight 1993, used by permission)*

effect change.

Another prime component of gis is topology. Instead of looking at topological relationships as merely geographic (and 2-D), a gis/2 might include relationships in terms of people, family, church, social service organizations, etc. Some of these relationships may not require a new topology, but they may demand a multi-dimensional set of topological relations. What if access to a cultural site is determined, not by distance, but by gender or status? Adjacency says nothing explicitly about access or control.

The following example from community-based organizations illustrates different views of topology.[2] Community-based organizations appear to be far behind conservation organizations in the gis adoption curve, even though they work on similar issues and are supported in gis diffusion by many university–community partnerships (Craig and Elwood 1998; Obermeyer 1998b; Ghose 2001). Perhaps the issue is not the difficulty in finding the right gis application, but that the current gis does not fit community-based organizations. Communities may or may not be geographic, and if geographic, may or may not be coterminous with existing political designations. Variables that describe communities – neighbourhood indicators such as percentage of households below the poverty line by census tract, or number of libraries in a community – may be used widely in urban gis applications, but they can be detrimental to a community-based organization's health. Kretzmann and McKnight (1993) have proposed a move away from representing community through spatial neighbourhood indicators, which focus on liabilities (e.g., poverty and crime). Instead they propose to represent a community in terms of its assets (e.g., a grandmother who takes in latchkey children and tells them stories, or a church group that offers an English as a second language program). Figure 2 demonstrates that these assets are not necessarily geographic, but are definitely topological (i.e., possess relationships in space, even if that is the "space" of organizational relationships). This is very different from how Wal-Mart or US Housing and Urban Development might model a community.

Rewiring GIS

Given these problems at the heart of gis, there have been concerted efforts in ppgis to retrofit gis technology to better accommodate multiple ways of seeing the world, to show conflict, and to allow for different social practices. I group these efforts into four categories. First, researchers and practitioners have developed tools to integrate local or traditional knowledge in gis, which focuses on collecting and validating data sets and opening up decision-making processes. Second, they have "infiltrated the cyborg": activists and social progressives periodically work for gis companies – influence the organizational culture – and vice versa. These two approaches focus on the discursive and largely leave the material aspect aside. The third approach concentrates on the material, in which ppgis practitioners have rewritten the code; that is, they modify the applications of existing technology and collectively engage in debates about models and methods.

The fourth approach begins to achieve Haraway's (1991, 149) "hybrid of the organism and the machine." It disassembles gis technology and rebuilds gis from the "ground up." This longer section attempts to address concerns from Rundstrom and others about data gathering, management, and representation. It does not address Curry's likely critique that gis/2 will rely on the formalities of computer language. However, every language – computer or human – requires a translation and transformation. The goal is to gain the flexibilities to represent the passion and the contradictions.

It should be noted that these four approaches do not represent mutually exclusive categories: they can be combined for best effect and to suit the situation. Table 1 provides a synopsis of the four approaches and examples of their material and discursive lenses.

integrating local and traditional knowledge into gis

Clearly the most practised method of rewiring gis involves integrating local and traditional knowledge into gis. It is the most discursive approach and most closely resembles Schroeder's definition. Many of these discursive aspects have already been described. Material adaptations involve instances in which gis output is enhanced with multimedia and data sets of a group's own creation (Harris and Weiner 1998).

Table 1. Approaches to rewiring GIS/2

GIS/2 Approach	Material Aspect	Discursive Aspect
Integrating local and traditional knowledge	Different file formats (e.g., mp3) Alternate, contextual data sets Counter (competing) maps Maps that represent conflict (e.g., with overlapping features)	Engage intermediaries (academics, vendors) for assistance, co-production Decide on appropriateness of data sets, outcomes; collect contextual data sets; transpose data sets Disseminate data to public; build non-profit capacity; improve/counter public policy Legitimate "truth" of alternate data sets Embed GIS into collaborative decision making, site design, futuring activities Employ artist; illustrate maps/output Construct physical (e.g., cardboard) models
Infiltrating cyborg	Greater integration of media, visualization (e.g., conservation symbol sets) Applications, extensions, software design tailored to PPGIS Software that supports low-end computing environments; inexpensive versions of software, less frequent, upwardly compatible versions Goal-oriented instead of technique-oriented technology	Employ activists in GIS companies, consulting firms; engage GIS vendors/researchers to work in/with NGOs, CBOs Influence company goals, conference programming tracks, examples in textbooks, hardware/software donation programs Establish alternative professional associations
Rewriting code	Commented/annotated features Different analytic methods NGO/CBO-created decision-support systems Alternate user interfaces, aspect browsers	Participate in software design Collectively discuss model assumptions, processes, outcomes Share information/data sets/scripts with other activists (e.g., via discussion lists) Engage in competing databases and analyses
Rebuilding GIS	Combined data models User-defined tags, dictionaries Alternate metadata schema Do-it-yourself component driven architecture	Collectively discuss data model/schema assumptions, processes, components, outcomes, outputs Delineate appropriateness of software components Jointly define tags, construct models

Multimedia files can be attached as attributes to point layers to represent oral histories; different weighting schemes for site suitability can be evaluated; and language-specific user interfaces can be created.

Figure 3 shows two of many examples of integrating local or traditional knowledge into gis. Figure 3a is an example from the Integrated Approaches to Participatory Development (iapad) Project. This project implemented participatory three-dimensional modelling in the Philippines. A traditional gis was used initially to produce the templates for constructing a cardboard model and used at the end to enrich existing spatial data. This initiative recognizes that the model building is the most important step because it affords a focal point for discussion. Mental and cognitive maps may be constrained to the 2-D world, but human experience is not. Figure 3b illustrates work done in New Zealand's south island to address development of a coastline. Hasse, Engle, and Milne (2000) constructed an "interface" so community members could enter information in different ways, from Post-it Notes on aerial photos and pencilled annotations on gridded maps to dialog boxes for text entry.

In other examples, Al-Kodmany (2002b) describes a collaborative planning project in which an artist uses an electronic sketchboard to draw citizens' perspectives on neighbourhood redesign, which is then overlaid on the municipal gis database. According to Krygier (2002), these sketchy graphics are perceived to encourage greater participation because they are less polished, and the unfinished image suggests that the issue is still undecided. A different program in the southern Philippines, which teaches community members to become artists or gis technicians, has participants annotate maps with indigenous place names and adorn them with hand-painted birds and trees (Waddag 2001, per-

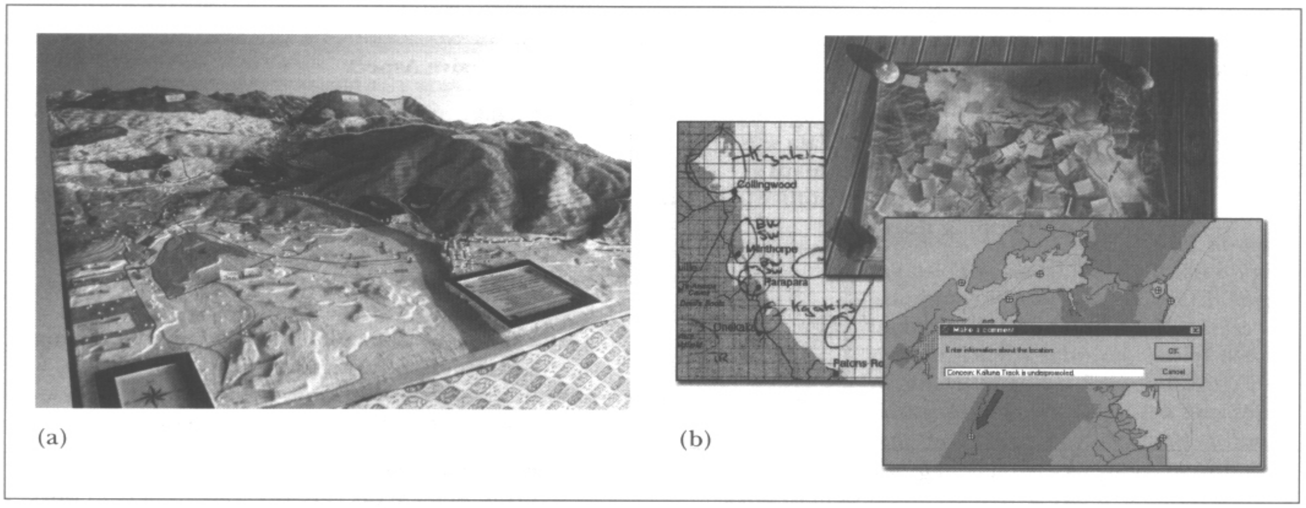

Figure 3. Examples of integrating local or traditional knowledge into GIS.
3a. Digital line graph is template for sheets of cardboard, which are detailed with pushpins (points), yarn (lines), and paint (polygons). The resultant 3D model is gridded for transposition into GIS. *(*Source*: Rambaldi and Callosa-Tarr 2002, photo Rambaldi, used by permission)*
*3b. Various "interfaces" to input community members' overlapping concerns on the New Zealand coast. (*Source*: Hasse, Engle, and Milne 2000, used by permission)*

sonal communication). These applications broaden the extent of gis to incorporate non-technological processes, illustrate meaningful places, and contextualize technology.

infiltrating the cyborg

Among social movements, the conservation movement is the most advanced in its use of gis (Laituri and Harvey 1995, Sieber 1997, 2002). Conservation organizations have been adept at socially reconstructing gis – infiltrating the cyborg – because conservation scientists, activists, and gis developers move regularly between roles (Convis 2001). A conservation student may become the non-profit activist, then take a job in a gis consulting firm, then move back to activism, and so on. Conservationists have created their own professional associations, which are directed by activists and comprise individuals across sectors. From conversations with various employees, it appears that conservationists have exerted significant influence in directing technology of the Environmental Systems Research Institute (esri), in producing company goals, including programming tracks at gis conferences and in creating hardware/software donation programs (esri is the major supplier of gis software). These individuals might have material impact by emphasizing software development that supports low-end computing environments, inexpensive versions of software, less frequent and upwardly compatible versions, and goal-oriented (instead of technique-for-technique's-sake-oriented) technology.

Tulloch (2002, 200) skilfully articulates the benefits of this revolving door of mutual influence:

> In many cases, ngos are providing political and technical support for the development of systems at the municipal level. This was evident when the [New Jersey State Mapping Advisory Committee] smac produced a state guidebook for parcel mapping: the volunteer editor/coordinator and many of the contributors were ngo employees. The ngo contributors were individuals whose involvement is largely fueled by the combined efforts of the [New Jersey Department of Environmental Protection and Energy] njdep and the [New Jersey Nonprofit gis Community] ngc [which assisted New Jersey ngos in adopting gis].

There is every reason to be cynical about this infiltration. The major gis vendor, esri benefits from this positive public face even as it supports less "correct" sectors such as military governments and oil industries. One also might predict that by buying into the technology, conservationists will become technocrats and less tolerant of internal dissent (see Sieber 1997; Craig and Elwood 1998). Nonetheless, this influence appears to have created more conservation capacity in gis.

rewriting code

Rewriting the code takes a largely material approach to rewiring gis and involves modification to or extensions of existing software. On a small scale, Torregrosa (personal communication, 2000), a practitioner and conservationist, has rewired ArcInfo to address some functional deficiencies in handling temporal maps and riparian zones. She also wrote macros – snippets of programming code – that allowed her to structure another person's experience of the software so that one could interact with the software in a similar manner each time. Although these are modifications, macros and scripts can allow one to thoroughly change the manner in which gis functions and appears. At a larger scale, The Nature Conservancy, a U.S. ngo, has built on esri software and has written its own spatial decision-support system (sdss) (www.natureserve.org). The system is designed for policy makers to run land-use scenarios that combine ecologically sensitive areas with physical, social, and economic factors. It might be unusual for an ngo to create an sdss; however, the need was driven by a perceived gap in existing applications to "depict conservation values" (The Nature Conservancy 2003). The gap can be functional – one might need a better land-use tool – but it may better reflect a desire to engineer code that meets an activist's perspective.

Rewriting the code shares many discursive components with infiltrating the cyborg. The inclusion of non-profits, like the inclusion of any group (even computer scientists), introduces different assumptions, values, expertise, and knowledge into the coding. Additionally, researchers and practitioners can share these snippets of code or larger modifications with other activists (e.g., through listserves). Rewriting the code delves deeper into the technology to influence the discourse of the programmers. One must exercise caution in this problem-solving through coding, avoiding seduction by the simple elegance of bits and bytes to ignore the messy beauty of participation.

Other material aspects include modification of the user interface to address difference. Harris (2002) has developed a birds-eye viewer in his projects because he finds some people cannot conceptualize their community from a two-dimensional planimetric map. Bosworth, Donovan, and Couey (2002) have implemented five different interfaces for accessing information about the city of Portland, Oregon. These user interfaces comprise varying amounts of gis, from a Web gazetteer, to a CD thematic mapping package, to a robust spatial analysis software. The staged giss allow more people to participate in the process because the user interfaces are tailored to individual and group needs and map- and data-handling literacy. Al-Kodmany (2002a) has explored a wide variety of approaches to visualization and digital annotation of public comments and envisions Web gis moving from one-way information dissemination to two-way interactive communication to three-way public–public communication. In both these augmentations, the goal is to increase software transparency and usability for greater communication and participation.

rebuilding gis

The approaches described above present opportunities to expand gis. However, they do not adequately address core issues in multiple views and geometry. Creating a gis/2 has consisted of working with the technology "as is" and fixing any gaps. Rebuilding gis takes a systems-design approach and utilizes current trends in computing science. A prime difference is that, instead of incorporating emergent technologies under a one-size-fits-all, bulky solution, this approach de-constitutes the components of gis. Figure 4 shows a preliminary design for gis /2. In this design, groups would maximize software innovations, many of which have public domain interfaces, so that they could model and visualize different ways of knowing, contextualize information, and mix and match components as needed. The information might or might not be graphic, digital, or geographic. This might be considered a "retro" gis, a return to a community IS of which gis may be a small part.

Information Models: "Integrating" Different Ways of Knowing

One can always represent difference with paper and pencil. However, if one chooses computing as an avenue, then accommodating multiple views and geometries detailed above needs to be represented using a computing method with a higher level of abstraction than that of a traditional gis with its points, lines, and polygons. Information models, through a language such as Unified Modelling Language (uml), offer one option. The uml is now considered a standard modelling notation (Object Management Group 2003). It provides the syntax to model the functions, structures, and behaviours of a system. The result is a diagram of data characteristics and relations: a "meta" model (data entry and management is described in the next section). The meta model can contain computerizable and non-computerizable components (i.e., information and actions referred to, but existing outside of, the meta models), and geographic and non-geographic components. A model need not be of lakes and towns – it could be a social relationship or the Kretzmann and McKnight topology above.

Groups and individuals can define what features, descriptions, actions, and relations comprise each of the objects (technically, classes of objects). The villages in the Orlove example can be related, not just by geographic distance, but also by kinship ties. Cities and roads can be left out. This model can instruct the rendering component in the representation of the village that suits its residents, not the state.

To demonstrate that a non-profit model can actually be constructed, Figure 5 shows a model developed by the Conservation Fund, which is based on esri's data model (Allen and Christensen 2001). This model for land trusts incorporates business practices (e.g., trust management) and biodiversity information. Instead of focusing on feature geometry, Allen and Christensen have developed a model based on the context of individual land holdings and complexities surrounding donations of land parcels not to heirs but to non-profits. The use of uml in the rebuilding approach varies from the esri model because it allows for the standardization of an information model to an Opengis-compatible representation (Opengis is a consortium of gis companies that work together to develop publicly available interoperability standards, open interfaces, and protocols). It also offers tantalizing possibilities of creating new geometries through another standard called the Geographic Markup Language (gml).

It should be noted that the "unified" in uml does not mandate encapsulation and integration. Not all things in the model need be modelled, or integrated. Some components may still be in digital form (e.g., .wav files) but sit outside the models. Some non-computerizable components, such as cul-

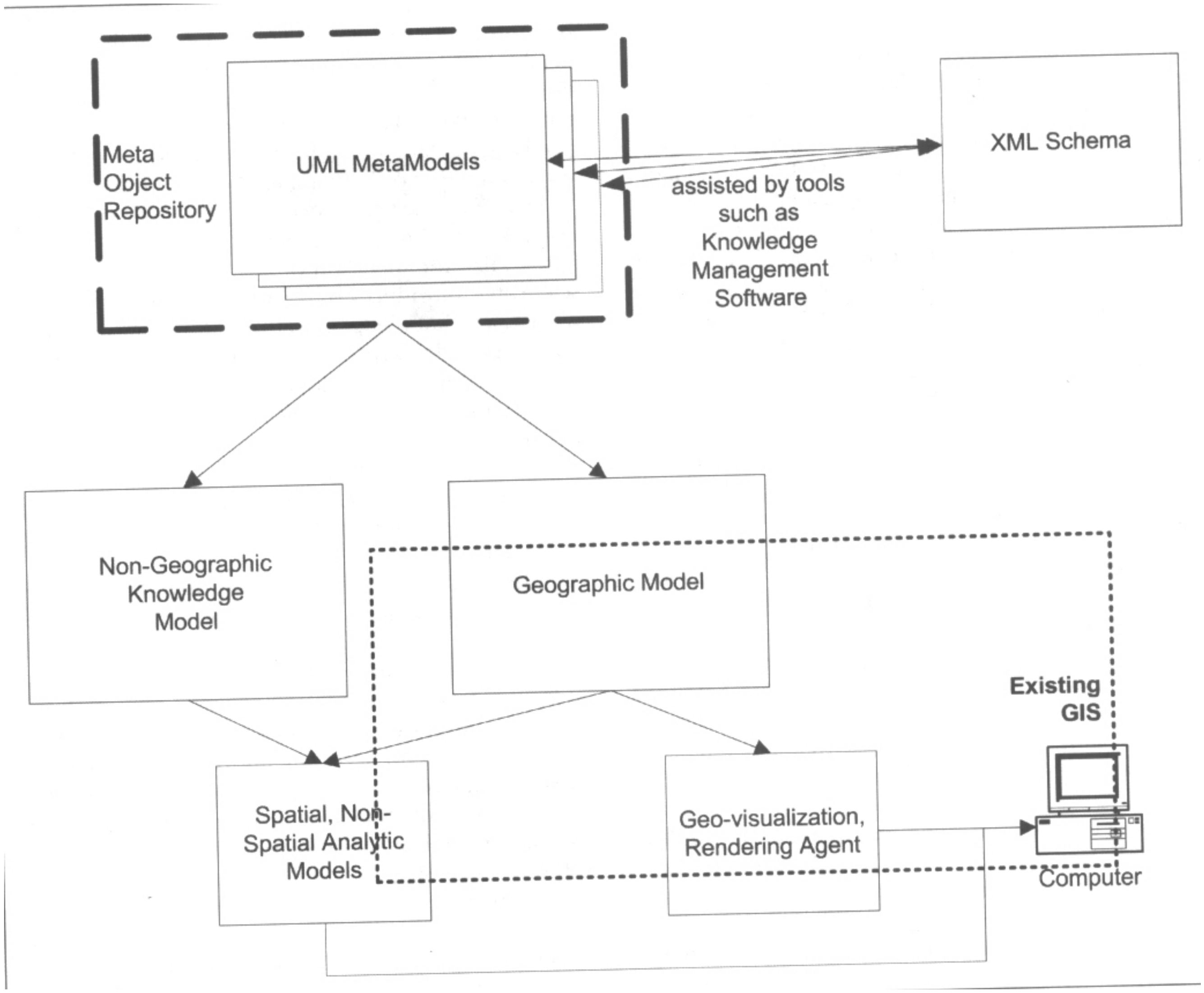

Figure 4: Methodology for GIS*/2.*

tural practices, can be referenced without necessarily being "indexed." Additionally, the use of data modelling here appears ontological; indeed, it is impossible to avoid ontological questions when one proposes to model world views. I am not proposing a single ontology that, to Chrisman (2000), produces a world of universals. This line of thinking reproduces existing problems in traditional gis rather than fixing them and matches the historic trends towards optimization and standardization. Instead we have multiple ontologies, as many as the context requires.

User-Defined Tags: Attributing Stories of Difference

eXtensible Markup Language offers one way to minimize the loss of richness of narrative and to preserve difference through attribution. It is similar to html, in that it is a tagged or markup language, although it offers more flexibility because the tags can be user-defined and the description/representation is separate from content. The esri software currently supports xml in a limited capacity to configure map display and to collect metadata. The xml has much broader utility to rewire gis. In this approach xml would be used to tag data in straight text (e.g., a narrative) or features/attributes in databases. It could also be used as a library tool to catalogue text and non-text databases (e.g., pictures, audiotapes and videotapes, and museum collections).

eXtensible Markup Language could be used to tag stories with user-defined tags; for example, tagging speakers with class, kinship, and power-relations, objects with sacred use or cultural status. This information need not be sliced and diced into a relational or object database but can remain as text. Because content is separate from representation, tagged information could be displayed as text on a webpage or as spatial images, as annotation or attribution. It also can allow multiple definitions, data redundancies, and language. Outliers can be preserved because each user can identify items of importance. The xml can be used to create multiple and temporal (transac-

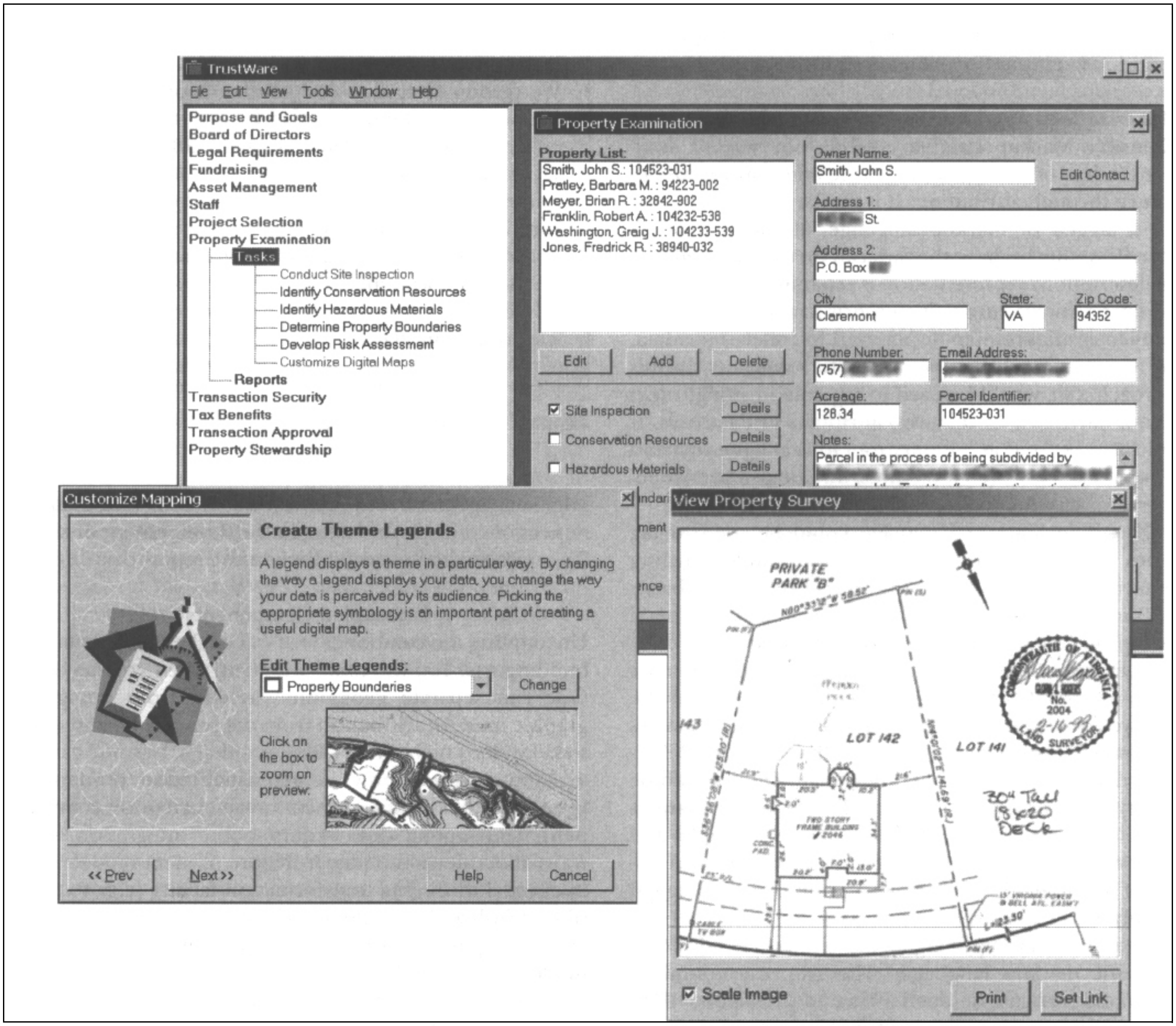

*Figure 5. Land Trust Data Model. (*Source: *Allen and Christensen 2001, used by permission)*

tional) metadata, to preserve the history of an issue. Figure 6 shows a sample of xml-tagged narrative.

eXtensible Markup Language is often referred to as a "semantic markup language." However, the computer cannot differentiate between a <sacred site> and a <H1> tag. Moreover, xml does not of itself enable blind interchange or information reuse. A section of text or an attribute may be labelled as <sacred>, but the meaning is not necessarily transparent. Therefore, we should not look upon xml as a magic bullet without some kind of community- or stakeholder-specific standardization or ontological underpinnings. If we focus excessively on those underpinnings we may repeat the problem of over-generalizing community knowledge. Conversely, xml has immediate utility for a community because it is contextual and can be nuanced.

The uml and xml can work in concert. An xml schema can be generated from the uml to tag the components of the meta model. An xml schema is the "shared vocabulary" of the group, represented in tags, subtags, and parameters of tags. Data are tagged within the xml document that match the shared vocabulary. Getting people to jointly determine the tags and then tag consistently will be problematic in any organization (Butler and others 2000). Therefore, stakeholders would need to participate in defining the tags. Tools, such as knowledge-management software, can be used to find coincidences of concepts and assist in the development of tags. That information is stored back in the repository.

Uncoupled Components

Uncoupling the components of gis is a key strategy in rebuilding gis. You use what you need, when you need it. One can separate geographic models from non-geographic models, attribution from gis rendering, and one stakeholder's meta model from another's. In some cases, a group may need only the geo-visualization/rendering agent. In others, it might focus on an attribution component. Uncoupling does require some integration and translation along the way. In Figure 5, meta models are integrated through a transformation facility (e.g., extensible stylesheet language transformation, or xslt). They are then split into a non-geographic and a geographic model (the dotted lines representing traditional gis). These can be linked to an analysis or rendering agent.

This is not the first time loosely coupled our uncoupled models have been advocated for analysis of public policy (Klosterman and Xie 1997). Loosely coupled models presume that "no single software tool or technology can – or will – adequately serve the needs of planners and that planners will have to adapt current (and future) technologies to meet their needs" (Klosterman and Xie 1997, 175). By combining, recombining, and augmenting components, groups can participate in the construction of a gis more suited to their needs. It is possible to insert ppgis at various levels of the model development. Participants may initially discuss issues, processes, and consequences to be included. They also need to consider whose views should be included and how those views are characterized by class, gender, race, and technical literacy. They can choose what is modelled and computerized, how many of the methods are appropriate, who learns them, and what should be the role of support institutions such as universities.

Integration of models must be negotiated carefully within the context of the application and by the stakeholders; otherwise, valuable differences could be lost or absorbed. In addition to learning the components, someone must learn the translation tools. Interfaces for components must be developed to increase ease of use. Single models that result from the repository are shown in Figure 5. It is not necessary to recombine them into a single model; multiple geographic and non-geographic models can be generated. Multiple models will inevitably complicate representation, but rendering may need to be subsumed to the messiness of pluralism. The methodology could be adaptive, although practical constraints will limit system development and data collection. The system may be more participatory but it may not be easier.

Lest the reader think that these are impossible methods to learn, one must remember that html rapidly diffused and is now used by grassroots and other activist organizations around the world; interfaces made tagging effortless. Grassroots groups in some of the poorest countries use gis. Admittedly the methods in Figure 5 represent a higher level of abstraction than those currently employed by most grassroots groups, and thus a distancing from simpler models. However, groups have been quite inventive when they felt a need to adopt, and thus adapt, a technology.

```
<part_of_our_day>
We <group exclusive="yes" gender="women"
name="Maasai Mara"/>
collected <action>collection</action> herbs
<type>for_headaches</type>
in the forest grove.
<site name="forest grove">
<publicized_location value="no">forest grove</
publicized_location>
</site>
</part_of_our_day>
```

Figure 6. A sample of XML-tagged narrative.

Conclusion

Many have called for a new and more inclusive gis. This paper attempts to frame and model it. The paper begins with the current limitations of gis in representing the needs and views of communities and non-mainstream organizations, such as conservation non-profits. Four approaches are presented, which integrate the material gis tool with a broader discursive gis process of participation, organizational action, and coding. Three of these approaches focus largely on the discursive and modify traditional gis to accomplish their objectives. A fourth more material approach for a gis/2 is proposed, one that is unconstructed, more flexible, allowing participation in system design. These four approaches are part of an evolution toward integrating different media types, capturing different ideas of space and time, allowing for different social practices, and representing and preserving conflict and difference.

Ultimately, a multi-vocal and contradictory gis/2 is a messy technology. The community association "map" may be overlaid on the artist's rendering. Completing definitions of neighbourhood may warp, ebb, or flow, depending upon the viewer or the season in which it is viewed. Incompleteness may vie with structure. New gis applications may be delightfully chaotic, or at least unnerving to the traditional gis developer. Problem definition and interoperability and reconciliation (if at all) as well as legitimacy and valuation become a matter of debate instead of optimization. This paper provides substance to the discussion about the creation of a more inclusive gis.

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Notes

1. I would not necessarily attribute this to the difference between Western and non-Western science. There is interesting work on how native people use the same methods (hypothesis testing, generalization) as Westerners in their pursuit of greater understanding of the environment (Wenzel 1999).
2. There are many other diagrams and charts used to describe com-

munity relations. For example, Chambers (1994) provides an overview of the methods and diagrams in participatory rural appraisal (par). The example cited in the text and par are used by academics but are also extensively used by community organizations.

References

Aberley, D., ed. 1993. *Boundaries of Home: Mapping for Local Empowerment.* Philadelphia: New Society Publishers.

Aitken, S.C., and S.M. Michel. 1995. "Who Contrives the 'Real' in gis? Geographic Information, Planning and Critical Theory." *Cartography and Geographic Information Systems* 22/1: 17–29.

Al-Kodmany, K. 2002a. "E-Community Participation: Communicating Spatial Planning and Design Using Web-Based Maps." Paper read at the First Public Participation Conference, New Brunswick, NJ.

———. 2002b. "gis and the Artist: Shaping the Image of a Neighborhood through Participatory Environmental Design." In *Community Participation and Geographic Information Systems*, ed. W.J. Craig, T.M. Harris, and D. Weiner. New York: Taylor and Francis. 320–29.

Allen, T., P. Morrison, and L. Swope. 1998. *Conservation Technology Support Program Grant Recipients Status Review: Report of Survey Responses.* Winthrop, WA: Pacific Biodiversity Institute.

Allen, W.L. III, and J. Christensen. 2001. "Managing a Land Trust with Geographic Information Systems." Paper read at the Annual esri Users' Conference, 9–15 July, San Diego, CA.

Annis, S. 1992. "Evolving Connectedness among Environmental Groups and Grassroots Organizations in Protected Areas of Central America." *World Development* 20: 587–95.

Barndt, M. 1998. "Public Participation gis: Barriers to Implementation." *Cartography and Geographic Information Systems* 25/2: 105–12.

Bosworth, M., J. Donovan, and P. Couey. 2002. "Portland Metro's Dream for Public Involvement." In *Community Participation and Geographic Information Systems*, ed. W.J. Craig, T.M. Harris, and D. Weiner. New York: Taylor and Francis. 125–36.

Butler, T., S. Fisher, G. Coulombe, P. Clements, I. Grundy, S. Brown, J. Wood, and R. Cameron. 2000. "Can a Team Tag Consistently?" *Markup Languages: Theory and Practice* 2/2: 111–25.

Casey, L., and T. W. Pederson. 1995. "Urbanizing gis: Philadelphia's Strategy to Bring gis to Neighborhood Planning." *Proceedings of the Environmental Systems Research Institute User Conference.* Available at http://gis.esri.com/library/userconf/proc95/to150/p107.html.

Chambers, R. 1994. "The Origins and Practice of Participatory Rural Appraisal." *World Development* 22: 953–69.

Chrisman, N.R. 1987. "Design of Geographic Information Systems Based on Social and Cultural Goals." *Photogrammetric Engineering and Remote Sensing* 53: 1367–70.

———. 1997. *Exploring Geographic Information Systems.* New York: John Wiley and Sons.

———. 2000. "Building gis without Foundations: Ontology from a Social Practice Perspective." Paper read at giscience Conference, 28–31 October, Savannah, GA.

Convis, C., Jr., ed. 2001. *Conservation Geography: Case Studies in GIS, Computer Mapping, and Activism*. Redlands, CA: esri Press.

Craig, W.J., and S. Elwood. 1998. "How and Why Community Groups Use Maps and Geographic Information." *Cartography and Geographic Information Systems* 25/2: 95–104.

Craig, W.J., T.M. Harris, and D. Weiner, eds. 2002. *Community Participation and Geographic Information Systems*. New York: Taylor and Francis.

Curry, M.R. 1998. *Digital Places: Living with Geographic Information Technologies.* New York: Routledge.

Fischer, F. 1990. *Technocracy and the Politics of Expertise.* Newbury Park, CA: Sage Publications.

Ghose, R. 2001. "Use of Information Technology for Community Empowerment: Transforming Geographic Information System into Community Information Systems." *Transactions in GIS* 5/2: 141–63.

Gould, P., and R. White. 1986. *Mental Maps*. Boston: Allen and Unwin.

Haraway, D.J. 1991. "A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century." In *Simians, Cyborgs, and Women: The Reinvention of Nature*. London: Free Association Books. 149–81.

Harris, T. 2002. "Geo-visualization Approaches to Participatory eia Decision Making." Paper read at the First Public Participation Conference, New Brunswick, NJ.

Harris, T., and D. Weiner. 1998. "Empowerment, Marginalization and 'Community-Integrated' gis." *Cartography and Geographic Information Systems* 25/2: 67–76.

Harvey, F. 2000. "The Social Construction of Geographical Information Systems." *International Journal of Geographical Information Science* 14: 711–13.

Hasse, J.C., S.T. Engle, and S. Milne. 2000. "Tourism, Community Development and gis: Cases from New Zealand." Paper read at the Annual Meeting of the American Association of Geographers, 4–8 April, Pittsburgh, PA.

Heckman, L.A. 1998. *Methodology Matters: Devising a Research Program for Investigating PPGIS in Collaborative Neighborhood Planning.* Santa Barbara: National Center for Geographic Information and Analysis.

Hodgson, D.L., and R.A. Schroeder. 2002. "Dilemmas of Counter Mapping Community Resources in Tanzania." *Development and Change* 33: 79–100.

Jordan, G.H. 1998. "A Systems Based Framework for the Evaluation of a Geographic Information System for Community Forest Resource Assessment." Paper read at gis and Society Conference, Minneapolis, MN.

Klosterman, R.E., and Y. Xie. 1997. "Retail Impact Analysis with Loosely Coupled gis and a Spreadsheet." *International Planning Studies* 2/2: 175–92.

Kretzmann, J.P., and J.L. McKnight. 1993. *Building Communities from the Inside Out: A Path toward Finding and Mobilizing a Community's Assets*. Evanston, IL: Center for Urban Affairs and Policy Research.

Kyem, P.A.K. 2000. "Embedding gis Applications into Resource Management and Planning Activities of Local and Indigenous Communities: A Desirable Innovation or a Destabilizing Enterprise?" *Journal of Planning Education and Research* 20/2: 176–86.

Krygier, J.B. 2002. "A *Praxis* of Public Participation and Visualization." In *Community Participation and Geographic Information Systems*, ed. W. Craig, T. M. Harris, and D. Weiner, 330–45. New York: Taylor and Francis.

Laituri, M., and L. Harvey. 1995. "Bridging the Space between Indigenous Ecological Knowledge and New Zealand Conservation Management Using gis." In *Nature Conservation: The Role of Networks*, ed. D. Saunders, J. Craig, and E. Mattiske, 122–31. Chipping Norton, Australia: Surrey Beatty and Sons.

Latour, B. 1987. *Science in Action.* Cambridge, MA: Harvard University Press.

Leitner, H., S. Elwood, E. Sheppard, and others. 2000. "Modes of gis Provision and Their Appropriateness for Neighborhood Organizations: Examples from Minneapolis and St. Paul, Minnesota." *URISA Journal* 12/4: 43–56.

Longley, P.A., M.F. Goodchild, D.J. Maguire, and others. 2001. *Geographic Information Systems and Science.* NY: John Wiley and Sons.

Mangkaja Arts Resource Agency. 1999. "Canvassing the Country." Available at http://www.users.bigpond.com/Mangkaja_Arts/webpage/canvassing.html.

Marston, S. 2000. "The Social Construction of Scale." *Progress in Human Geography* 24/2: 219–42.

The Nature Conservancy. 2003. "NatureServe: Information Technology and Tools." Available at http://www.natureserve.org/prodServices/dss.jsp.

Obermeyer, N.J. 1998a. "The Evolution of Public Participation gis." *Cartography and Geographic Information Systems* 25/2: 65–66.

———. 1998b. "hud's Community Connection for Local Empowerment." Paper read at ncgia Special Meeting: Empowerment, Marginalization and Public Participation gis, Santa Barbara, CA. Available at http://www.nciga.ucsb.edu/varenius/ppgis/papers/index.html.

Object Management Group (omg). 2003. omg Unified Modelling Language Specification, Version 1.5. Available at http://www.omg.org/docs/formal/03-03-01.pdf.

Orlove, B. 1993. "The Ethnography of Maps: The Cultural and Social Contexts of Cartographic Representation in Peru." *Cartographica* 30/1: 29–46.

Pickles, J., ed. 1995. *Ground Truth: The Social Implications of Geographic Information Systems.* New York: Guilford Press.

Poole, P. 1995. "Indigenous Peoples, Mapping and Biodiversity Conservation: An Analysis of Current Activities and Opportunities for Applying Geomatics Technologies." Biodiversity Support Program Discussion Paper Series. Washington: wwf, The Nature Conservancy, World Resources Institute.

Putnam, R. 1995. "Bowling Alone: America's Declining Social Capital." *Journal of Democracy* 6/1: 65–78.

Ramasubramanian, L., and R.E. Sieber. 2000. "Conflict and Concurrence in gis: Neighborhood Planning for Social Change." Paper read at American Association of Geographers Session Annual Conference, 4–8 April, Pittsburgh, PA.

Rambaldi, G., and J. Callosa-Tarr. 2002. *Participatory 3-Dimensional Modelling Guiding Principles and Applications*. Los Baños, Phillipines: ASEAN Regional Center for Biodiversity Conservation.

Rundstrom, R.A. 1995. "gis, Indigenous Peoples, and Epistemological Diversity." *Cartography and Geographic Information Systems* 22/1: 45–57.

Sawicki, D.S., and D.R. Peterman. 1998. "Understanding the Breadth and Depth of ppgis Supply." Paper read at ncgia Special Meeting: Empowerment, Marginalization and Public Participation gis, Santa Barbara, CA. Available at http://www.ncgia.ucsb.edu/varenius/ppgis/papers/sawicki.pdf.

Schroeder, P. 1996. "Criteria for the Design of a gis/2." Paper read at Specialists' Meeting for ncgia Initiative 19: gis and Society, summer 1996. Available at http://www.spatial. maine.edu/~schroedr/ppgis/criteria.html.

Schuurman, N. 2002. "Women and Technology in Geography: A Cyborg Manifesto for gis." *Canadian Geographer* 46/3: 258–65.

Sheppard, E. 1995. "gis and Society: Towards a Research Agenda." *Cartography and Geographic Information Systems* 22/1: 5–16.

Shiffer, M.J. 1998. "Planning Support Systems for Low-Income Communities." In *High Technology and Low-Income Communities: Prospects for the Positive Use of Advanced Information Technology*, ed. D.A. Schön, B. Sanyal, and W.J. Mitchell. Cambridge, MA: mit Press.

Sieber R.E. 1997. "Computers in the Grassroots: Environmentalists, gis, and Public Policy." PhD diss., Rutgers University.

——. 2000a. "Conforming (to) the Opposition: The Social Construction of Geographical Information Systems in Social Movements." *International Journal of Geographical Information Science* 14/8: 775–93.

———. 2000b. "gis Implementation in Grassroots Organizations." *Urban and Information Systems Association Journal* 12/1: 15–29.

———. 2002. "Geographic Information Systems in the Environmental Movement." In *Community Participation and Geographic Information Systems,* ed. W.J. Craig, T.M. Harris, and D. Weiner, 153–72. New York: Taylor and Francis.

———. 2003. "Public Participation gis across Borders." *Canadian Geographer* 47/1: 50–61.

Stonich, S.C., and K. Cisna. 1998. "Information Technologies, ppgis, and Advocacy: Globalization of Resistance to Industrial Shrimp Farming." Paper read at ncgia Special Meeting: Empowerment, Marginalization and Public Participation gis, Santa Barbara, CA. Available at http://www.ncgia.ucsb. edu/varenius/ppgis/papers/index.html.

Tulloch, D. 2002. "Environmental ngos and Community Access to Technology as a Force for Change." In *Community Participation and Geographic Information Systems*, ed. W.J. Craig, T.M. Harris, and D. Weiner. New York: Taylor and Francis. 192–204.

Turnbull, David. 1999. "gis and Indigenous Knowledge: Place, Space, Narrative and Technologies of Knowledge Representation and Assemblage." Paper read at Intersections: Society, Technology and Geographic Thought, 29 April–1 May, University of Kentucky Workshop.

Uvin, P., and D. Miller. 1996. "Paths to Scaling-Up: Alternative Strategies for Local Nongovernmental Organizations." *Journal of the Society for Applied Anthropology* 55/3: 344–354.

Wenzel, G. 1999. "Traditional Ecological Knowledge and Inuit: Reflections on tek Research and Ethics. *Arctic* 52/1: 113–24.

Résumé : Un nombre croissant de groupes activistes à but non lucratif et de peuples traditionnellement marginalisés sont

en train d'adopter le sig comme outil de changement social. L'utilisation qu'en font ces groupes est examinée minutieusement par des théoriciens qui s'inquiètent du fait que le sig comporte un mécanisme d'information trompeuse, de déroutement, de contrôle exclusif et de surveillance. Cette critique n'a pu ralentir l'adoption du sig et, au cours de la dernière décennie, les chercheurs ont enquêté sur l'utilisation et la valeur de cette technologie au sein de divers groupes de citoyens et à but non lucratif. Un grand nombre de ces nouveaux usagers réclament un sig d'un nouveau genre, appelé sig/2. Ce dernier doit pouvoir représenter différentes mesures ou visions des lieux et intégrer le savoir local, pouvoir accueillir les distinctions culturelles et multilingues ainsi que préserver – plutôt que réduire – la friction, le désaccord, la redondance, voire l'erreur.

Dans cet article, je soutiens que l'on doit « recâbler le sig », c'est-à-dire, s'attaquer au code et au processus de codage de façon directe pour bâtir un sig/2. Un survol de la documentation sur l'utilisation et la valeur du sig dans les mouvements sociaux, les groupes d'activistes à but non lucratif et les regroupements de citoyens illustre les limites du sig actuel et les éléments nécessaires à la réalisation d'un sig/2 qui serait plus inclusif. Je présente quatre approches, qui ont un cadre matériel et discursif. Trois d'entre elles modifient le sig actuel pour en faire un sig/2. La quatrième est une façon d'aborder la conception de systèmes qui intègre deux innovations informatiques: le langage de modélisation unifié (uml) et le langage de balisage extensible (xml). Ce prototype est sensibilisé aux besoins des organismes de mouvement social, de groupes à but non lucratif ou de regroupements de citoyens. Ces quatre approches, utilisées séparément ou conjointement, servent d'avant-projet pour une discussion plus approfondie du recâblage du sig.