

# **Outline of Theme Proposal: Spatial Semantics for Automating Geographic Information (GI) Processes**

Femke Reitsma, Alia Abdelmoty, Werner Kuhn

## **1. Theme Topic and Brief Description.**

It is a commonly quoted statistic that up to 80% of information is spatially referenced in some way. Yet the spatial aspect of much of that information is unusable due to its latent semantics and wide range of largely incompatible data formats. The semantics are the meaning of the geographic information, such as the type of information it is, what real world things it represents (e.g. buildings, land cover, rivers, etc), and what the spatial relationships and characteristics of those things are (e.g. that one building is north of or adjacent to another).

Broadly, the topic of this theme is to express the semantics of geographic features and their spatial relationships in order to automate geographic information processes. Formalising and expressing the semantics of geographic information is critical for doing large scale scientific computing that crosses disciplines which involve geographically dispersed resources, expertise and knowledge. Consider, for example, an emergency response to a border-crossing hazard such as a nuclear power plant disaster. Such a scenario would require the harmonisation of data from different countries, expertise from across the globe and distributed computing resources to model the pollution plume and support decision making. Another example is the development of ever larger and more complex global climate models, which increasingly involve spatial data sets sourced from a range of public and private institutions in an array of different formats, model components from numerous research groups, and distributed knowledge from research partners across the globe. Essentially, expressing spatial semantics is key to furthering collaborative eScience and GRID environments which involve geographic information.

Currently, discovering, processing, analysing and visualising geographic data requires experts that understand the meaning of that data and can intelligently accomplish these tasks. For example, integrating remotely sensed imagery and GIS (Geographic Information System) landcover data for decision supporting workflows requires experts to understand and manually reformat and analyse the data. Expressing the semantics of geographic data in computable form will enhance data and knowledge discovery, improve integration of different types of spatial information, support data harmonisation, automate procedures for processing, analysing and visualising geographic information and ultimately facilitate decision making for eScience. The array of applications of this research is incredibly broad as geographic information is ubiquitous in many aspects of our current information society. Specifically we have three focussed projects to develop and test this research, namely case studies in modelling interoperability, data and resource integration and data harmonisation, as is discussed below. While we recognise the topic is very large, we aim to focus through the progression of the theme and following the recognition of specific research challenges that emerge.

## **2. Proposed leader(s) with brief description of their areas of specialisation.**

Werner Kuhn and Femke Reitsma will co-lead the theme, both providing 3 months of FTE effort each. Femke will be in Edinburgh for the duration and will commit time fairly evenly spread throughout the year, where Werner will put input into the project in more focussed lumps of time. Alia will be responsible for developing and running one of the use cases proposed, in collaboration with the Welsh e-science centre. She will be involved in the development of the theme activities and in writing research reports and joint research proposals. Alia will spend a total of 6 weeks in Edinburgh, split in periods to coincide with involvement in the proposed activities.

Dr. Werner Kuhn has been a professor of Geoinformatics at the University of Muenster (Germany) since 1996. He leads the Muenster Semantic Interoperability Lab (MUSIL: <http://musil.uni-muenster.de>), a group of a dozen researchers pursuing the idea of semantic reference systems for geographic information. The current research projects of MUSIL address the ontological nature of geospatial observations, the semantic annotation of geoprocessing services, spatio-temporal modelling of trust in social networks, handling of quality information in schema mappings, and similarity measures for georeferenced information. Most projects are funded by the German Science Foundation (DFG) and the European Commission (recent projects: GIPSIE, ACE-GIS, BRIDGE-IT, SWING). Werner's own research focuses on foundational ontologies for space and time. Between 1998 and 2000, Werner was the Technical Director Europe of the Open Geospatial Consortium. He holds a PhD in Surveying Engineering from the Swiss Federal Institute of Technology (ETH) in Zurich and was a post-doctoral researcher at the US National Center for Geographic Information and Analysis (NCGIA) and the Technical University Vienna.

Dr. Femke Reitsma works at the intersection of informatics and the geosciences, specialising in the field of geographic information science (GISc). She took up a position as a lecturer in GISc in the School of Geosciences at Edinburgh University in 2004, shortly after which she completed her PhD at the University of Maryland on a new data model for representing geographic processes. Within this broader focus of representations of geographic information, her research has also included the expression and use of semantics for geographic information. By working at the interface of the informatics and geosciences disciplines, Femke has acquired essential skills that cross this boundary and enable her to communicate research topics between these two communities. Femke is a collaborator on two JISC funded projects with EDINA for the development of a metadata portal and scoping of a geospatial repository for academic use. More recently she was awarded the Edward Clarence Dyason Universitas 21 Fellowship, in order to develop research with colleagues at Melbourne University. Femke has also been directing the MSc in Geographical Science Programme at Edinburgh University since August 2005.

Dr. Alia I. Abdelmoty is a lecturer in the School of Computer Science, Cardiff University. Her principal research activities are in the areas of spatial databases and their management including, qualitative spatial and spatio-temporal reasoning; geographic information retrieval; designing, building and integrating geographic ontologies and general tools and techniques for realising the geo-spatial semantic web. Modelling and reasoning in large geographic databases was the subject of some of her earlier work on the EPSRC funded project 'Deductive and Object-oriented

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databases'. Alia acted as a co-investigator on a previous EPSRC grant related to the development of multiscale spatial databases and was recently a co-investigator on the EC project SPIRIT (Spatially-aware information retrieval on the internet 2002-2005), which is dedicated to the construction of web search engines for accessing geographically-specific information. Currently, she is a co-investigator on the EC FP6 project TRIPOD, due to start in January 2007. TRIPOD builds on and extends the geographic information retrieval work carried out in SPIRIT. The problem of discovering and modelling semantics of geo-referenced data is central to Alia's research activities. Significant related contributions include the development of automated methods for qualitative spatial representation and reasoning with different spatial relationships, designing and building Place ontologies and designing and implementing spatial rule mark-up languages and frameworks for reasoning over geo-ontologies.

Alia Abdelmoty, Werner Kuhn and Femke Reitsma will have monthly communication (e.g. video conferences or Access Grid) regarding the progress of the theme.

### **3. Relation to e-Science.**

The theme will support the use of geographic information for e-Science applications and is important for maximising the potential of eScience research that deals with spatial information on the GRID, particularly for GeoScience research. By automating the composition of geographic information, new infrastructures can be developed to support large scale and collaborative research involving geographic information.

#### **a. Please describe the application areas that would benefit from the outcomes of this theme.**

The outcomes of this theme will support all those engaged in using geographic information, across the full spectrum of GeoScience research (e.g. climate change modelling to location based services), those who use geoscience models and geographic information tools to advance their knowledge, as well as applications using geographic information (e.g. Google maps or car navigation systems).

#### **b. Please list the technical areas that would be engaged and developed as a result of the theme.**

Methodologies for using, discovering and evaluating GI semantics, the Semantic Web, GeoScience modelling, strategies for building, maintaining and integrating geo-ontologies, techniques and tools for supporting GeoScience research on the (semantic) grid, eScience.

### **4. Are there other similar projects to the proposed theme? What would be their relationship to/involvement in this programme?**

In early 2007 a NeSC Workshop on "European Geoinformatics" will be run to explore the issues of an appropriate language and ontology for geoscience data and knowledge. This workshop, organised by John Laxton of the British Geological

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Survey, will complement the theme agenda and will form a foundation for some of the following workshops and research that will be developed under this theme.

SPIRIT (Spatially-Aware Information Retrieval on the Internet)<sup>1</sup> is a research project that designed and implemented a search engine to find documents and datasets on the web relating to places or regions referred to in a query, and was funded through the EC Fifth Framework Programme. As part of the theme, Alia Abdelmoty, who was a Co-I of the SPIRIT project, will provide invaluable expertise and research upon which the theme will build.

SWING (<http://www.swing-project.org/>) is an EC 6<sup>th</sup> Framework Program project targeting the combination of semantic web and geospatial technologies. The main goal is to advance service description and discovery technology to capture the semantics of geospatial services and support their composition to complex processing chains. The MUSIL group at Muenster is primarily in charge of ontology development. Other teams include DERI, SINTEF, and the French Geological Survey (BRGM).

Grid OGC Collision. The JISC e-Infrastructure<sup>2</sup> programme has recently funded two projects (starting Oct 2006) under the general title Grid OGC Collision. SEE-GEO (led by EDINA at the University of Edinburgh) will demonstrate secure access to OGC web services in the context of Shibboleth and the UK National Grid Service. NeSC, NCESS and MIMAS are partners in this project. SAW-GEO (led by the University of Newcastle) will develop a semantically aware workflow engine for geospatial web service orchestration. EDINA is leading the OGC liaison in respect of both these projects.

Through our collaborators and use cases (as described below), we also have links to many other relevant groups and projects such as MOTIIVE, INSPIRE, GMES, OGC, GEON, W3C and OGF. These links will provide avenues for the dissemination and uptake of the results of this theme. This proposal also stands within the context of the OGF/OGC liaison via EDINA, where geo elements within the UK e-Infrastructure are being developed using best practice and the Grid OGC Collision projects (e.g. SAW-GEO), as well as the GEON project, for which Werner Kuhn participated in the GEON kick-off meeting in San Diego.

### **5. Identify a focus that will ensure the effort is most likely to be productive i.e. a specific test application domain/current unsolved research challenge.**

Three use cases will be researched in order to develop the theme and practically demonstrate its utility.

#### **5.1 Data and Resources Integration**

One of the significant and perhaps common challenges facing e-science application domains is the need to interoperate over diverse sets of legacy databases and applications and to make sense of a mass of diverse, incomplete and often incompatible data. The problem is exemplified in the BDWorld project (Jones et al, 2005) that aims to build a GRID to support scientific biodiversity-related research.

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<sup>1</sup> <http://www.geo-spirit.org/>

<sup>2</sup> [http://www.jisc.ac.uk/programme\\_einfrastructure.html](http://www.jisc.ac.uk/programme_einfrastructure.html)

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The limited geographic scope of the majority of specimen locality data sources necessitates the collation of data from multiple sources. This creates issues associated with taxonomy (how to ensure all specimens of a particular species concept are retrieved). Ontologies are proposed as tools for mediating the differences in vocabularies and terminologies. The majority of such data and resources are geographically referenced in some form. This suggests the utilisation of geographical location information as key for mapping and discovery in this domain.

In collaboration with the BDWorld project team in Cardiff and the Welsh e-Science centre, we aim to study the design of base geo-ontologies and associated geo-semantics that can complement the developed frameworks and support the effective resource discovery and integration on this GRID.

### 5.2 Modelling Interoperability

Earth system science deals with complex systems that pose many significant geographic information challenges. As depicted in the classic Bretherton diagram of biospheric cycles (Figure 1), modeling the earth system involves numerous interacting components, each of which can be further dissected into sub-components that are studied by specialists in a wide range of disciplines. All of these components require geographic information as input and generate it as output.

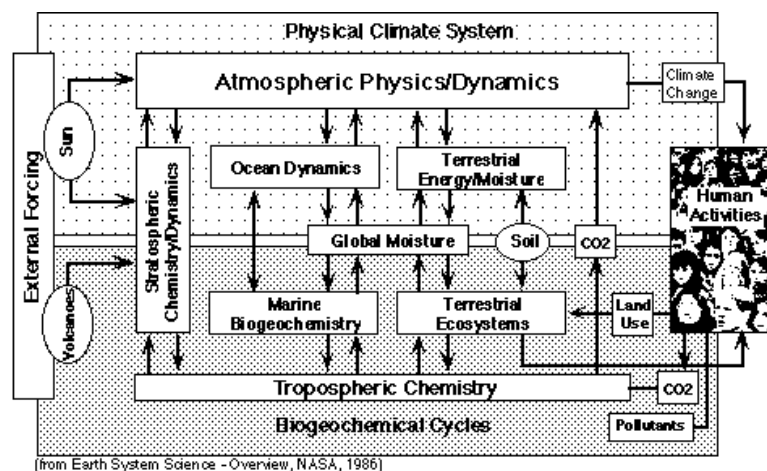


Figure 1. The Bretherton diagram

Source: Earth Systems Science Overview: a program for global change, NASA 1986

From this description, problems of data, model and model simulator interoperability are clearly evident (Reitsma and Albrecht, 2005). There exists a wide diversity of modeling approaches, such as models based on differential equations or stochastic methods. Furthermore, in terms of simulator interoperability, there are a wide range programming languages and software in which models are developed. For example, it is difficult to automate the interoperability of a FORTRAN model of thermohaline circulation with an ice sheet model in C++ if the equations, variables, scale, or geographic extent described in one do not match those of the other. These problems largely derive from a common lack of explicit semantics in representing models, spatial data, and scientific knowledge in general (Mackay, 1999). In order to develop the potential of e-Science for modeling physical systems we need to express and utilize those semantics.

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This use case will involve the development of an appropriate framework for representing model components and their interoperability. Building on this theory we will aim to create a small prototype in or to test and further develop the theory with the re-expression of a very simple model that represents some small part of the global climate (i.e. one composed of but a few simple interacting processes) such that the model, the GeoScience knowledge, and the spatial data as input all exploit the potential of the semantic information currently latent in their description. This will allow us to utilise the semantics to automate the geographic information processes involved in modelling the climate. A specific model will be identified within the first month of the theme in consultation with Dr. Matt Williams who has expertise in climate modelling and is a collaborator on the project, however, currently JULES – Joint UK Land Environment Simulator<sup>3</sup> (submodel of future improved Hadley Centre model HadGEM2) and the MITgcm<sup>4</sup> model are being considered.

### 5.3 Data Harmonisation

This theme will also exploit as a use case, work taking place in relation to the INSPIRE initiative examining the cost benefits of achieving data harmonisation using open interoperability standards (principally OGC and ISO TC211). In collaboration with EDINA, we will examine the utilisation of geographic data semantics to support automation of harmonising land-sea data. This work will build on the outputs from the multi partner EU funded INSPIRE Pilot Projects, particularly MOTIIVE (Marine Overlays on Topography for Annex II Visualisation and Exploitation)<sup>5</sup> as EDINA are the partner in this project responsible for deploying the framework demonstrating data harmonisation in practice. The latter is being achieved using extensions to key standards which will allow Feature Type Catalogues to be hosted and queried within OGC registries.

### 6. Please list any people who have agreed to actively collaborate.

Core people that are likely to be funded as visitors and will form the core of research partners:

Alia Abdelmoty	Lecturer	University of Cardiff
David Medyckyj-Scott	Team Manager	EDINA
Joshua Lieberman	OGC and W3C Liason	Traverse Technologies
Alex Hardisty	Manager of WESC	Welsh eScience Centre

The following people have indicated their willingness to participate in events as part of the theme and their interest in developing collaborative research:

	<b>Name</b>	<b>Position</b>	<b>Organisation</b>
<b>UK</b>	Jessica-Chen Burger	Research Fellow	Informatics, University of Edinburgh
	Michael Rovatsos	Lecturer	Informatics, University of Edinburgh
	James Reid	EDINA	EDINA

<sup>3</sup> <http://www.jchmr.org/jules/>

<sup>4</sup> <http://www-paoc.mit.edu/cmi/default.htm>

<sup>5</sup> <https://www.seegrid.csiro.au/twiki/bin/view/Marineweb/MOTIIVE>

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	Austin Tate	Professor	Informatics, University of Edinburgh
	Stephen Potter	Research Fellow	Informatics, University of Edinburgh
	Terry Dawson	Lecturer	Geosciences, University of Edinburgh
	Mathew Williams	Senior Lecturer	Geosciences, University of Edinburgh
	John Laxton	Researcher	British Geological Survey
	Chris Jones	Professor	Cardiff University
	Tony Cohn	Professor	University of Leeds
	John Goodwin	Researcher	Ordnance Survey
	Vlad Tanasescu	PhD student	Knowledge Media Institute at the Open University School of Geography, The University of Nottingham
	Mike Jackson	Professor	University of Leeds
	Brandon Bennet	Lecturer	University of Leeds
	Andrew Wolf	Researcher	CCLRC eScience Centre The Informatics Collaboratory Of the Social Sciences (ICOSS), University of Sheffield
	Robin Smith	GIS Analyst	Welsh eScience Centre
	Richard White	Lecturer Head of the British Atmospheric Data Centre (BADC) at CCLRC	
	Bryan Lawrence	Director of NeSC,	NERC DataGrid NeSC, University of Glasgow, University of Edinburgh
	Malcolm Atkinson	Professor	
<b>Rest of Europe</b>	Rob Lemmens	Assistant Professor PhD student and researcher	ITC – Enschede Bremen University
	Sebastian Hubner	Lecturer	University of Zurich
	Ross Purves	Professor	University of Zurich
	Robert Weibel	Professor	EPFL
	Stefano Spaccapietra	Associate Professor	University. L'Aquila
	Eliseo Clementini	Professor	University of Hannover
	Monika Sester		
<b>North America</b>	Joshua Lieberman	Business	Traverse Technologies
	Lola Olson	Directs GCMD	NASA
	Fred Fonseca	Assistant Professor	Penn State University
	Max Egenhofer	Professor	University of Maine
	Jim Hendler	Professor Section Manager in the High Performance Computing Section	University of Maryland The Aerospace Corporation
	Craig Lee	Professor	George Mason University
	Liping Di	Geological Digital Data Expert	Geological Survey of Canada and member of GEON project
	Boyan Brodaric		

**7. Sketch of who is probably working in the area, and/or might be interested.**

**UK:** EPSRC, NERC, e-Science centres (e.g. NeSC, CCLRC, Reading e-Science centre, NIEeS, Welsh e-Science Centre), Digital Curation Centre, JISC, EGEE, Ordnance Survey, EDINA, British Geological Survey; **Europe:** EC funded INSPIRE, ESA; **North America:** NASA, NSF, NGA, GITA, GEONgrid.org, Geoide, Global Change Master Directory (GCMD), Global Land Cover Facility (GLCF);

**International:** W3C, Open Geospatial Consortium (OGC), Open Grid Forum (OGF);  
**Vendors/Commercial:** ESRI, Intergraph, MapInfo, Small World, Oracle, Microsoft, IBM, IDRISI, Google, Sun, Bentley Systems, Leica Geosystems Geospatial Imaging, GIS consultancies (e.g. Informed Solutions, Know Edge Consortium).

### **8. Identify the current key research challenges(s) in the area.**

The following key challenges provide the context for the research to be undertaken by the theme.

The structure of spatial data is well defined with metadata standards such as ISO 19115 Geographic Information Metadata standard<sup>6</sup>, and spatial data standards, most notably GML 3.0<sup>7</sup> (Geographic Markup Language). Despite research using ontologies to reason over metadata for data discovery and for interoperability among spatial services (for example Bernard *et al.*, 2004; Klein *et al.*, 2004), there are no standards for expressing the formal semantics of spatial data or the metadata describing that data (Bernard *et al.*, 2005). Yet following the specifications of metadata standards does not guarantee interoperability as there remain too many degrees of freedom (Bernard *et al.*, 2005). As a result, the discovery and use of spatial data is limited as current approaches for retrieving geographically referenced information are not able to reason about complex spatial relationships (Stuckenschmidt *et al.* 2001; Tomai and Kavouras 2003). Furthermore, recent work by Probst (2006) in analysing an OGC standard for observations and measurements (O&M) has revealed semantic inconsistencies due to the lack of formal semantics, making it difficult for those implementing these standards to automate the interoperation of services within an e-Science framework.

Issues surrounding spatial data compound these problems. Spatial data form one of the primary inputs for models, and as with all other types of data, its volume continues to grow at an explosive rate (Lu *et al.* 2003). Yet there is a worldwide trend of declining use, management, and content of national clearinghouses for spatial data, due to a dissatisfaction of the spatial data community with the functional capability of these portals providing spatial data (Crompvoets *et al.* 2004). These functional limitations largely revolve around difficulties in data discovery due to the lack of semantic representation.

A global spatial data infrastructure (GSDI's) that integrates national spatial data infrastructures (NSDI) is often proposed as a solution, however it supports a limited range of data types and as a standard is far from being realised. Furthermore, the tools that utilise this spatial data, such as GIS and traditional GI tools are limited to specific data formats and structures. Beyond the need for advances in functionality for geoportals, enhancements can be made for automating spatial data retrieval and use by utilising its semantic content. Adding geospatial semantics to the Grid, provides researchers with access to large distributed datasets and distributed processing, where information is "understood" by the machine such that processes can be automated.

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<sup>6</sup> [http:// www.isotc211.org](http://www.isotc211.org)

<sup>7</sup> <http://www.opengis.org/docs/02-023r4.pdf>

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More recently Spatially-Aware Information Retrieval on the Internet (SPIRIT)<sup>8</sup> aims at designing and implementing a search engine for finding documents and datasets on the web relating to places or regions referred to in a query (Jones *et al.* 2002). The novelty of this theme is that it extends beyond the representation of the semantics found in the metadata to that in the data itself (Kuhn 2003, Hirimatsu and Reitsma 2004), moving beyond a semantic geospatial web for spatial query to one which supports e-Science using geographic information (c.f. Egenhofer 2002). Furthermore, in order to do e-Science parts of geospatial information need to receive semantic specifications in order to solve problems of interoperability in geographic information services, as well as defining the semantics of geo-services (Kuhn 2005).

As mentioned in the introduction, the volume and ubiquity of geographic information is huge, and yet without an expression of its geographic semantics its use for e-Science is hampered. Without geographic information semantics we require expert intervention at many steps of data processing, analysis and use, rather than the automation of these processes. Unfortunately the dominant languages for representing geographic information and its semantics (e.g. GML and OWL) is limited in its representation and reasoning potential (Abdelmoty *et al.* 2005). Formalising, expressing and utilising the semantics of geographic information are critical for e-Science to progress in its use of geographic information.

### **9. What are the plausible outcomes (deliverables) from the theme? Journal papers, books, reports? Will they be entirely theoretical, or will there be some experiments and/or software produced?**

- Workshops to develop the theme and disseminate findings, involving:
  - Workshop sessions that generally inform and develop the theme for a wider audience
  - Specialist presentations and lectures
- Journal papers to disseminate findings
- A proposal for at least one follow-on research project
- A website describing the theme and populated with relevant material
- Demonstrating software and architectures provided on the web for use and further development. For example:
  - Demonstration of spatial reasoning techniques for the derivation of some implicit semantics in geo-ontologies.
- A set of reports, including one describing the main findings of the theme case study, and another discussing the new key future research challenges and summarising the results of the theme
- Co-hosting of 1 week summer school on the Geospatial Semantic Web for PhD and postdoctoral students, supporting knowledge transfer and the dissemination of findings
- A workshop following the summer school will be held in order that students may build upon their knowledge gained at the summer school and develop research to support the other theme deliverables of the project (e.g. journal papers and reports).

### **10. Sketch of the kind of events (focus/scope) proposed and who would participate.**

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<sup>8</sup> <http://www.geo-spirit.org/>

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We will host a number of workshops covering topics that may include: spatial/geosemantics, geoontologies, geo dimension of e-Science, geoservices, interoperability, geo-semantic discovery, SDIs.

Participants will include researchers from the GeoSciences and Informatics, as well as those from industry (e.g. OGC). The primary participants to be included are listed above in point 6.

### **11. What difference will be generated by running the theme for 6 or 12 months?**

The theme involves bringing together a range of research areas and we expect that a 12 month period would allow us to make significant progress in the proposed research and support the development of follow-on research proposals. This could not be achieved within 6 months.

### **12. Is the topic of the theme so specific that it can really all be "tied up" in 6 or 12 months time, or should there be some follow-on? If so how might the follow-on be funded? (e.g. some of the people that have been active in the theme might make a proposal to EPSRC).**

The theme is broad enough in scope that there will be many avenues for follow-on research, however 12 months should prove enough time to make significant progress on the theme. We will develop a proposal to a research council extending the work conducted in the theme.

### **13. Are there opportunities for co-funding from other sources?**

The National Institute for Environmental eScience, as discussed with the director Martin Dove, has agreed to fund a workshop as part of the theme. We are currently still in discussion with Keith Haines, who directs the Reading e-Science Centre, about possible co-funding. If the proposal succeeds, we will also propose to the CCLRC eScience Centre for extra funding via Andrew Wolf, a collaborator on the theme.

### **14. Please provide a high level project plan with milestones and the resources being applied for.**

The first month will be used in planning the theme, organising advertising materials for the theme and workshops, setting up communication channels, identifying visitors and developing the website. Femke Reitsma (co-theme leader) will be in Edinburgh for the duration of the project and Werner Kuhn (co-theme leader) will be present in Edinburgh for two periods of time: approximately 5 weeks from early May to mid June and 4 weeks in July. Werner may also be able to visit for a short period in March or April. Theme visitors will include Alia Abdelmoty and other key persons indicated in the list of collaborators in section 6 above.

We will run three workshops, spread throughout the year. The first two workshops will cover existing cutting edge research in the development and application of spatial semantics for automating geographic information processes. The topics of these two

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workshops will be defined in the first month of the theme, as developments in this field are moving too quickly to predict a relevant specific topic for 2007. The final workshop will be developed in response to the first two workshops, aiming to present the research investigated by the theme and look towards the future in proposing prospective research agendas and developing collaborative research proposals to be submitted to NERC or EPSRC. We aim to send out the call for participation for the first two workshops within the first month to allow as much lead time as possible and maximise the ability of participants to attend. The call for the final workshop will be sent after the second workshop, gauging from the first two workshops some of the future research topics and areas of collaborative research development that will form part of the content of this final workshop.

We will co-host the annual Vespucci Institute summer school in Florence, Italy from 10-15<sup>th</sup> of June 2007<sup>9</sup>, an annual summer institute in geographic information science that has the Geospatial Semantic Web as its theme for 2007. Werner Kuhn (Co-TL) is co-organising this summer school and will utilise the results of the research undertaken in this theme and the content of the workshops as material for introducing the next generation of researchers in geographic information science to this field of work. Co-hosting with the Vespucci Institute has the advantage of engaging with an established school with strong connections to industry and government institutions, where the brightest minds can engage in and test the research of the theme in a critical context. The use cases developed in the theme will be part of its practical components and selected theme leaders/participants will be asked to co-teach.

We will also run a workshop following the summer school for those students from the school that are actively engaged in relevant research. This will feed knowledge back into the theme and the UK eScience community, where the students will actively engage with the theme through research.

One of the co-theme leaders will aim to attend a workshop as part of the GEON project<sup>10</sup> in the U.S., the UK e-Science All Hands Meeting 2007 and other relevant meetings such as the Conference on Spatial Information Theory (COSIT'07) in September 2007, and the workshop on the Grid OGC Collision projects to be held at OGF20 in Manchester, 7-11 May 2007. Depending on progress and results, we aim to present results of the project at one of these meetings. The details of these visits and conferences will be finalised during the planning phase of the theme in the first month.

In research, we aim to develop the theory and implementation architecture for expressing the semantics of spatial metadata and data. As an applied focus we aim to use an existing climate model to test the expression and use of the semantics of spatial metadata and data for automating modelling processes and the input of appropriate spatial input data. A prototype will be developed that tests the theory and methodology developed in the theme using an existing climate mode, which we expect to be completed by the end of October for the final workshop. The results of the methodology and prototype development will be submitted for journal publication and to relevant conferences.

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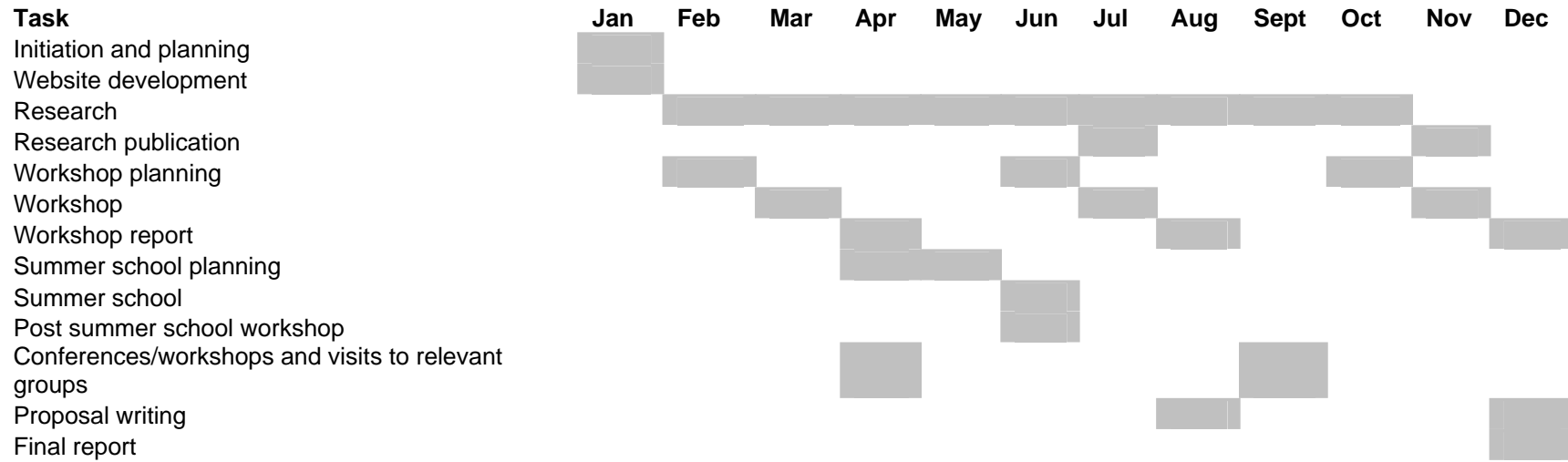
<sup>9</sup> <http://www.geospatialpartners.com/vespucci/school.html>

<sup>10</sup> <http://www.geongrid.org/workshops/>

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Below is Gantt diagram that presents a model timeline of activity. This proposed timeline is an idealisation and will change in response to conference timings, opportunities that may arise and any problems that may surface.

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**15. Budget and Justification of Resources**

The budget is provided in the table below. We request 0.25 salary costs for the theme leaders, Werner Kuhn and Femke Reitsma, as well as travel and accommodation compensation for Werner Kuhn, who aims to be resident in Edinburgh for 3 months. Funds are also requested for theme investigators for conference/workshop registration, travel, and accommodation in order to effectively disseminate and promote the findings of the theme. We aim for one person of the investigator team to attend on conference each, the details of which will be identified once the theme is underway. Costs for the two workshops include advertising, a budget for supporting key visitors to present at the workshops and the costs for workshop infrastructure (the third workshop will be funded by NIEEs). Support for the PhD and postdoctoral students to attend the Vespucci Institute Summer School and a follow on workshop at NeSC in Edinburgh is requested, where they will learn about the findings and developments of this theme and develop this area of research further as part of the workshop. Furthermore, we aim to support two postgraduate students in short term research projects in order to develop and implement the research undertaken in the theme.

Werner Kuhn - Theme Co-leader	0.25 FTE for 12 months (including on costs of 25%)	
	Travel between Muenster and Edinburgh 4 return trips (flight + train)	1,000
	Accommodation in Edinburgh (3 months)	4,000
Femke Reitsma – Theme Co-leader	0.25 FTE for 12 months (including on costs of 25%)	
Conference/Workshop travel + accommodation + registration		1,500
Budget for visitors to collaborate		5000
Production of posters/advertising		3000
Workshop & meeting costs (largely speaker costs)		10000
Summer School co-hosting and post-school workshop		12000
Postgraduate student support		10000
Total		76549

**References**

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## Outline of Theme Proposal: Spatial Semantics for Automating Geographic Information (GI) Processes

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- Jones, C, R Purves, A Ruas, M Sanderson, M Sester, M van Krevels, and R Weibel. 2002. "Spatial Information Retrieval and Geographical Ontologies: and Overview of the SPIRIT Project." Pp. pp. 387-388 in SIGIR 2002: Proceedings of the 25th Annual International ACM SIGIR Conference on Research and Development in Information Retrieval, August 11-15, 2002, Tampere, Finland: ACM Press.
- Jones, A.C., White, R.J., Gray, W.A., Bisby, F.A., Caithness, N., Pittas, N., Xu, X., Sutton, T., Fiddian, N.J., Culham, A., Scoble, M., Williams, P., Bromley, O., Brewer, P.W., Yesson, C., Bhagwat, S., (2005) "Building a Biodiversity GRID" Lecture Notes in Computer Science, pp 140-151. Springer-Verlag GmbH.
- Klein, E, U Einspanier, M Lutz, and S Hubner. 2004. "An Architecture for Ontology-Based Discovery and Retrieval of Geographic Information." Pp. 179-188 in 7th Conference on Geographic Information Science (AGILE 2004).
- Kuhn, W (2003) Semantic Reference Systems. *International Journal of Geographic Information Science*, Guest Editorial. 17(5): 405-409.
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- Lu, C T, Y Kou, H Wang, S Shekhar, P Zhang, and R Liu. 2003. "Two Web-based Spatial Data Visualization and Mining Systems: Mapcube & Mapview." in International Workshop on Next Generation Geospatial Information. Cambridge (Boston), Massachusetts.
- Mackay, D S. 1999. "Semantic Integration of Environmental Models for Application to Global Information Systems and Decision-Making." *ACM-SIGMOD* 28:13-19.
- Probst, F. (2006). An Ontological Analysis of Observations and Measurements. 4th. International Conference on Geographic Information Science (GIScience), Münster, Germany.
- Reitsma, F, and J Albrecht. 2005. "Modeling with the Semantic Web in the Geosciences." *IEEE Intelligent Systems* 20:86-88.
- Stuckenschmidt, H, C Schlieder, U Visser, T Vögele, and H Neumann. 2001. "Spatial Reasoning for Information Brokering." Pp. pp. 568-573 in Proceedings of the Florida Artificial Intelligence Research Society Conference (FLAIRS), Key West, FL.
- Tomai, E, and M Kavouras. 2003. "Pivotal Issues in Designing Geographic Ontologies." in Workshop on Fundamental Issues in Spatial and Geographic Ontologies. COSIT'03, Ittingen, Switzerland, 24-28 September 2003.

# WERNER KUHN

## Curriculum Vitae

22 October 2006

### PERSONAL

#### *Personal Data*

Date of Birth: 24 August 1957  
Place of Birth: Zurich, Switzerland  
Nationality: Swiss  
Home Address: Kleihorststrasse 32, D-48151 Münster, Tel. +49 251 79 14 11  
Languages: German, English, French (all fluent), Italian and Spanish (conversation), Czech (basics), (basics).

#### *Present Position*

Full Professor (C4) of Geoinformatics and Digital Cartography  
Institute for Geoinformatics, University of Münster  
Robert-Koch-Str. 26-28, D-48151 Münster, Germany  
Email: [kuhn@ifgi.uni-muenster.de](mailto:kuhn@ifgi.uni-muenster.de)  
URL: <http://ifgi.uni-muenster.de/kuhn>  
Tel. +49 251 83 34707  
Fax +49 251 83 39763

#### *Previous Positions*

- *Associate Professor* (C3, Sep 1996 to Nov 2003), Institute for Geoinformatics, University of Münster.
- *Dozent* (June 1995 to present), Department of Geoinformation, Technical University Vienna, Austria. Supervising Graduate Students: <http://www.geoinfo.tuwien.ac.at>.
- *Assistant Professor* (August 1991 to August 1996), Department of Geoinformation, Technical University Vienna, Austria. Research, teaching, and consulting on GIS.
- *Adjunct Professor* (August 1991 to present), Department of Spatial Information Science and Engineering, University of Maine, USA. Supervising Masters and Ph.D. Students.
- *Post-doctoral Research Associate* and *Cooperating Assistant Professor* (June 1989 to July 1991), National Center for Geographic Information and Analysis (NCGIA) and Department of Surveying Engineering, University of Maine. Interdisciplinary research, advising graduate students, teaching, consulting.
- *Graduate Research and Teaching Assistant* (May 1982 to July 1984 and October 1985 to May 1989), Prof. R. Conzett and Prof. Dr. A. Carosio, Institute of Geodesy and Photogrammetry, Swiss Federal Institute of Technology (ETH), Zurich. Graduate research, teaching.

#### *Visiting Positions*

- *Visiting Scientist*, Meaning and Computation Laboratory (Prof. Goguen), Department of Computer Science and Engineering, University of California at San Diego (October 2002 – April 2003).

- *Visiting Assistant Professor* (September 1984 to August 1985), Department of Civil Engineering, University of Maine. Teaching and graduate research.

### ***Current Professional Roles***

- *Leading a group* of twelve researchers and junior faculty in geoinformatics: Research projects on semantic interoperability: <http://musil.uni-muenster.de>. Teaching courses on geoinformation modeling, spatial reference systems, digital cartography, spatial databases, interoperability, and research methodology. Consulting on usability and interoperability.
- Co-organizer of the *International Summer Schools* of the Vespucci Initiative (2003): <http://www.vespucci.org>.
- Member, *Scientific Committee of BRGM* (French Geological Survey).

### ***Past Professional Roles***

- International Representative, *Research Management Committee of GEOIDE* (Geomatics for Informed Decisions) Network, Canada (2001 to 2003): <http://www.geoide.ulaval.ca>.
- *Department Chair*, Institute for Geoinformatics, University of Münster (1998 to 2002).
- *Technical Director, Europe, Open GIS Consortium* (1998 to 2001, non-remunerated). Consulting industry on interoperability standards in GIS: <http://www.opengis.org>.
- Elected Member of the *Council of AGILE* (Association of Geographic Information Laboratories in Europe): <http://www.agile-online.org>; 1998 to 2002).

### ***Education and Academic Degrees***

- *Dozent für Geoinformationswesen* (Venia legendi for Geographic Information Science), Technical University Vienna, Austria, June 1995.
- *Dr. sc. techn.*, ETH Zurich (Swiss Federal Institute of Technology), May 1989  
Thesis (in German): "Human Interaction with Spatial Information Systems - From Constructing to Editing Geometric Models". Advisors: Prof. R. Conzett and Prof. Dr. A. Carosio (Surveying Engineering) and Prof. Dr. Hans-Peter Frei (Computer Science).
- *Dipl. Verm. Ing. ETH* (Diploma in Surveying Engineering), ETH Zurich (May 1982).  
Thesis (in German): "Computation of the first gravimetric geoid for Switzerland."
- *Matura* (Graduation from High School), Mathematisch-Naturwissenschaftliches Gymnasium (MNG), Zurich, September 1976.
- Rudolf Steiner Schule Zürich, April 1964 to March 1972.

### ***Certified Courses***

- MIT Summer Course on Abstraction and Specification in Program Design, by John Guttag and Barbara Liskov (June 1985).
- Law, journalism, and language courses at the University of Zurich (1978 to 1979).
- Certificat de Langue et Culture Françaises, Association Française, Avignon (1980).

### ***Awards***

- Education Award, University of Münster (2004).

- Travel Grant, NATO Advanced Research Workshop (March 1994): "Cognitive Aspects of Human-Computer Interaction for Geographic Information Systems", Palma de Mallorca, Spain.
- Travel Grant, NATO Advanced Study Institute (July 1990): "Cognitive and Linguistic Aspects of Geographic Space", Las Navas del Marqués, Spain.
- Travel Grant, NATO Advanced Study Institute (July 1987): "Theoretical Foundations of Computer Graphics and CAD", Il Ciocco, Italy.
- Award for best Diploma Thesis in 1982, Schweizerischer Verein für Vermessung und Kulturtechnik (SVVK).

### ***Professional Society Memberships***

- Association for Computing Machinery, ACM (1982 to present).
- Gesellschaft für Informatik, GI (German Association for Computer Science; 1982 to present).
- Institute of Electrical and Electronics Engineers, IEEE, Computer Society (1989 to 1999).
- Österreichische Computer Gesellschaft (Austrian Computer Society; 1992 to 1996).
- American Congress on Surveying and Mapping, ACSM (1989 - 1992).

## RESEARCH

### *Current Research Program*

My research centers on the question *how the meaning of geoinformation is mapped* from one context to another. Typical contexts are human activities, professional disciplines, and technical systems. Contexts are represented in human minds, data models, user interfaces, business models, laws and regulations. I pursue this question in the practical settings of

- information system interoperability
- information integration
- user interface design
- electronic commerce.

My research group, the Muenster Semantic Interoperability Laboratory (MUSIL, <http://musil.uni-muenster.de>) concentrates on establishing and implementing the notion of *Semantic Reference Systems* for the production and use of geoinformation. We integrate methods from the geosciences, computing sciences, cognitive sciences, and category theory.

### *Past Research*

- *GI Semantics*: Semantic data models, semantics in data transfers, meta data, semantic interoperability, mappings between data models, feature-attribute catalogues, formal ontologies, semantic translation.
- *GIS Interoperability*: system architectures, interface specifications, international standards harmonization (ISO, OGC, CEN), reference model design, service chaining, data integration, location-based services, mobile data collection, economically viable production of geoinformation.
- *GIS User Interfaces*: usability engineering, usability testing, conceptual modeling, formalization of metaphors, 3d interaction techniques, semantics of interface operations, interactive visualization; application domains: geophysics, landscape ecology, landscape planning, urban planning, transportation and logistics.
- *Software Engineering*: algebraic specifications, interface specification languages, object-oriented design and programming, functional abstraction.

### *Research Grants Acquired in the Past 5 Years (figures indicate IfGI funding only)*

- European Commission, IST programme: SWING project on Semantic Web services INteroperability for Geospatial decision making. With SINTEF, DERI, IONIC, JSI, BRGM. 2006-2009, 575 k€.
- German Science Foundation (DFG): SeReS project (Semantic Reference Systems), 2004-2006, 134 k€.
- German Ministry of Education and Science (BMBF) and German Science Foundation (DFG), Geotechnologien-Programm: Semantic Interoperability through Geoinformation Services; Co-PI with Lars Bernard, with TZI Bremen and DELPHI, 2002-2005, 210 k€.
- European Commission, IST programme: ACE-GIS project on service chaining, with Norwegian NMA, SINTEF, IONIC, E-BLANA, INESC-ID, University Castellon; 277 k€.
- European Commission, IST programme: BRIDGE-IT project on access to GI, with 10 European Partners, 240 k€.

- German Ministry of Education and Science (BMBF): FLUMAGIS (GIS support for river catchment management); Co-PI with Ulrich Streit, and partners Gerd Schulte, Elisabeth Meyer, Ulrich Petschow, Krönert, Uhl, 2002-2005, 600 k€.
- Minden-Herforder Verkehrsgesellschaft mbH, MHV (Minden-Herford Regional Transportation Agency): Integration of gravity models into GIS for public transportation network planning; PI, 2002, 6 k€.
- University of Münster, Internationalization Program Award: eduGI.net (International Network for Education in Geographic Information Science), 2001-2002, 65 k€.
- German Science Foundation (DFG): 3d interaction techniques for geosciences; Co-PI with Klaus Hinrichs, 2000-2002, 320 k€.
- European Commission, Joint Research Center: PreANVIL - Design of A Networked Virtual Interoperability Laboratory; with John Rowley, Martin Ford, Andrew Frank, Michael Gould, Yves Reginster, 2000-2001, 3 k€.
- Ministry of Science, North-Rhine-Westphalia: Innovation project VuGIS (GIS for transportation planning), PI, with Michael Wegener, Christian Holz-Rau, Ulrike Grabski-Kieron, Clemens Portele, 1999-2002, 430 k€.
- MobileGIS Ltd: Ontologies for Mobile Services, PI, 2000-2001, 90 k€.
- Ministry of Economic Affairs, NRW: GEOBASIS (Interoperability Standards for Geobase data), PI, 1999-2000, 25 k€.
- State Chancellery of North-Rhine-Westphalia: Reference Model for the NRW Geospatial Data Infrastructure (GDI), PI, 2000, 222 k€.
- European Commission: GIPSIE (GIS Interoperability Project Stimulating the Industry in Europe), Co-PI with Andrew Frank, 1998-2000, 140 k€.
- Open GIS Consortium (OGC): GIPSIE-PLUS (Enabling European OGC Participation), PI, 1998-2001, 144 k€.
- Bundesanstalt für Wasserbau (German Water Authority, BAW): WAGIS (Methodology to develop a feature-attribute catalogue for a Waterway GIS), PI, 1998-1999, 17 k€.
- City of Hamburg Environmental Agency, for Bund-Länder Arbeitskreis Umweltinformation (BLAK): Organisation of an international workshop on “Open Environmental Information Systems”, PI, 1998-1999, 22 k€.
- Hessian Surveying and Mapping Agency (HLVA): ATKIS and OpenGIS, PI, 1998-2001, 340 k€.
- US National Science Foundation (NSF): SIP – Semantic Interoperability Project; NSF Seed Funding 1998, Co-PI with Francis Harvey, 1.6 k€.

## ***Publications***

- HABILITATION

*Semantics of Geographic Information*. Geoinfo Series, vol. 7., 1995: Department of Geoinformation, TU Vienna, Austria. 108 pp.

- PH.D. THESIS

*Interaktion mit Raumbezogenen Informationssystemen - Vom Konstruieren zum Editieren Geometrischer Modelle* (Human Interaction with Spatial Information Systems - From Constructing to Editing Geometric Models); ETH (Swiss Federal Institute of Technology), Thesis No. 8897. Published as *Mitteilungen 44*, Institut für Geodäsie und Photogrammetrie, ETH Zurich, December 1989.

- ARTICLES IN REFEREED JOURNALS

1. Klien, E., M. Lutz, and W. Kuhn (2006). Ontology-based discovery of geographic information services— An application in disaster management. *Computers, Environment and Urban Systems*. 30(1): 102-123.
2. Kuhn, W. (2005). Geospatial Semantics: Why, of What, and How? *Journal on Data Semantics* (Special Issue on Semantic-based Geographical Information Systems, Spring 2005, LNCS 3534): 1-24.
3. Raubal, M. and W. Kuhn (2004). Ontology-Based Task Simulation. *Spatial Cognition and Computation*. 4(1): 15-37.
4. Kuhn, W., 2003.. Semantic Reference Systems. *International Journal of Geographical Information Science, Guest Editorial*, 17(5): 405-409.
5. Brox, C., Bishr, Y., Senkler, K., Zens, K. and Kuhn, W., 2002. Toward a Geospatial Data Infrastructure for Northrhine-Westphalia. *Computers, Environment and Urban Systems* 26(1): 19-37.
6. Kuhn, W., 2001. Ontologies in support of activities in geographical space. *International Journal of Geographical Information Science* 15(7): 613-631.
7. Fuhrmann, S., Schmidt, B., Berlin, K. and Kuhn, W., 2001. Anforderungen an 3D-Interaktionen in geo-virtuellen Visualisierungsumgebungen. *Kartographische Nachrichten* 51(4): 191-195.
8. Frank, A.U. and Kuhn, W., 2000. Langages de spécification pour SIG ouverts. *Revue internationale de géomatique* 9(Février): 135-152.
9. Pundt, H., Bernard, L., Kuhn, W. and Streit, U., 2000. Das Modul Digitale Kartographie im neuen Studiengang Geoinformatik der Universitaet Muenster. *Kartographische Nachrichten* 50(1): 17-21.
10. Harvey, F., Kuhn, W., Pundt, H., Bishr, Y. and Riedemann, C., 1999. Semantic Interoperability: A Central Issue for Sharing Geographic Information. *Annals of Regional Science - Special Issue on Geo-spatial Data Sharing and Standardization* 33(2): 213-232.
11. Hölbling, W., Kuhn, W. and Frank, A.U., 1998. Finite-Resolution Simplicial Complexes. *GeoInformatica* 2(3): 281-298.
12. Kuhn, W., 1997. Approaching the Issue of Information Loss in Geographic Data Transfers. *Geographical Systems* 4(3): 261-276.
13. Rugg, R., Egenhofer, M. and Kuhn, W., 1997. Formalizing Behavior of Geographic Feature Types. *Geographical Systems* 4(2): 159-180.
14. Raubal, M., Gaupmann, B. and Kuhn, W., 1997. Teaching Raster Operations with Spreadsheets. *Journal of Geography* 96(5): 258-263.
15. Buyong, T.B. and Kuhn, W., 1992. Local Adjustment for Measurement-Based Cadastral Systems. *Journal of Surveying Engineering and Land Information Systems* 52(1): 25-33.
16. Buyong, T.B., Frank, A.U. and Kuhn, W., 1991. A Conceptual Model of Measurement-Based Multipurpose Cadastral Systems. *Journal of the Urban and Regional Information Systems Association URISA* 3(2): 35-49.
17. Frank, A.U., Egenhofer, M.J. and Kuhn, W., 1991. A Perspective on GIS Technology in the Nineties. *Photogrammetric Engineering and Remote Sensing* 57(11): 1431-1436.

- PAPERS IN REFEREED CONFERENCE PROCEEDINGS

1. Soon, K., and W. Kuhn. Formalizing User Actions for Ontologies. in *3rd International Conference on Geographic Information Science (GIScience)*. 2004. Baltimore MD, USA: Springer-Verlag, Lecture Notes in Computer Science 3234: 299-312.

2. Kuhn, W. and Raubal, M., 2003. Implementing Semantic Reference Systems. M.F. Gould (ed.), *6th AGILE Conference on Geographic Information Science*, Lyon, France. AGILE: in press.
3. Kuhn, W., 2002. Modeling the Semantics of Geographic Categories through Conceptual Integration. M.J. Egenhofer and D.M. Mark (eds.), *Geographic Information Science-Second International Conference (GIScience 2002)*, Boulder, Colorado. Springer-Verlag, Lecture Notes in Computer Science 2478: 108-118.
4. Timpf, S. and Kuhn, W., 2002. Granularity Transformations in Wayfinding. C. Freksa, C. Habel and K.F. Wender (eds.), *Spatial Cognition 2002*, Tutzing, Germany. Springer-Verlag, Lecture Notes in Computer Science: in press.
5. Brox, C. and Kuhn, W., 2002. eduGI.net - International Network for Education in Geographic Information Science. M. Ruiz, M. Gould and J. Ramon (eds.), *5th AGILE Conference on Geographic Information Science*, Palma de Mallorca, Spain. AGILE: 155-158.
6. Wölbing, O., Bishr, Y., Kuhn, W., Asher, M. and Sachser, N., 2000. Applying GIS for Investigations in Behavioral Biology. J. Strobl, T. Blaschke and G. Griesebner (eds.), *Angewandte Geographische Informationsverarbeitung XII (AGIT'2000)*, Salzburg, Austria. Wichmann.
7. Kuhn, W., 1999. An Algebraic Interpretation of Semantic Networks. C. Freska and D.M. Mark (eds.), *Conference on Spatial Information Theory (COSIT'99)*, Stade, Germany. Springer-Verlag, Lecture Notes In Computer Science 1661: 331-348.
8. Riedemann, C. and Kuhn, W., 1999. What Are Sports Grounds? Or: Why Semantics Requires Interoperability. A. Vckovski, K.E. Brassel and H.-J. Schek (eds.), *International Conference on Interoperating Geographic Information Systems (Interop'99)*, Zurich. Springer-Verlag, Lecture Notes in Computer Science 1580: 217-229.
9. Möltgen, J., Schmidt, B. and Kuhn, W., 1999. Landscape Editing with Knowledge-Based Measure Deductions for Ecological Planning. P. Agouris and A. Stefanidis (eds.), *Integrated Spatial Databases - Digital Images and GIS*, Portland, ME. Springer-Verlag, Lecture Notes in Computer Science 1737: 139-152.
10. Kuhn, W., 1996. Handling Data Spatially: Spatializing User Interfaces. M.-J. Kraak and M. Molenaar (eds.), *Advances in GIS Research - 7th International Symposium on Spatial Data Handling (SDH'96)*, Delft, Netherlands. Taylor & Francis, II: 877-893.
11. Timpf, S., Raubal, M. and Kuhn, W., 1996. Experiences with Metadata. M. Molenaar and M.J. Kraak (eds.), *Advances in GIS Research - 7th International Symposium on Spatial Data Handling (SDH'96)*, Delft, The Netherlands. Taylor & Francis, II: 815-827.
12. Frank, A.U. and Kuhn, W., 1995. Specifying Open GIS with Functional Languages. M.J. Egenhofer and J.R. Herring (eds.), *Advances in Spatial Databases (SSD'95)*, Portland, ME. Springer-Verlag, Lecture Notes in Computer Science 951: 184-195.
13. Kuhn, W., 1994. Defining Semantics for Spatial Data Transfers. T.C. Waugh and R.G. Healey (eds.), *Advances in GIS Research - 6th International Symposium on Spatial Data Handling (SDH'94)*, Edinburgh, Scotland, UK. Taylor & Francis: 973-987.
14. Haunold, P. and Kuhn, W., 1994. A Keystroke Level Analysis of a Graphics Application: Manual Map Digitizing. B. Adelson, S. Dumais and J. Olson (eds.),

*Conference on Human Factors in Computing Systems (CHI'94)*, Boston, MA. ACM Press: 337-343.

15. Kuhn, W., 1993. Metaphors Create Theories for Users. A.U. Frank and I. Campari (eds.), *Spatial Information Theory: A Theoretical Basis for GIS (COSIT'93)*, Elba. Springer-Verlag, Lecture Notes in Computer Science 716: 366-376.
  16. Haunold, P. and Kuhn, W., 1993. A Keystroke Level Analysis of Manual Map Digitizing. A.U. Frank and I. Campari (eds.), *Spatial Information Theory: A Theoretical Basis for GIS (COSIT'93)*, Elba. Springer Verlag, Lecture Notes in Computer Science 716: 406-420.
  17. Egenhofer, M.J. and Kuhn, W., 1992. Visualizing Spatial Query Results: The Limitations of SQL. E. Knuth and L.K.Wegner (eds.), *Second Working Conference on Visual Database Systems*, Budapest, Hungary. North-Holland, IFIP Transactions vol. A-7: 5-18.
  18. Kuhn, W., 1991. Are Displays Maps or Views? D. Mark and D. White (eds.), *10th International Symposium on Computer-Assisted Cartography (Auto-Carto 10)*, Baltimore, Maryland. ACSM, 6: 261-274.
- EDITED BOOKS
    1. Frank, A. U., and Kuhn, W. (eds.), 1995. *Spatial Information Theory - A Theoretical Basis for GIS (International Conference on Spatial Information Theory, COSIT'95)*. Springer-Verlag, Lecture Notes in Computer Science 988.
    2. Frank, A.U., Kuhn, W., Hoelbling, W., Schachinger, H. and Haunold, P., 1997. *Gofer as used at GeoInfo/TU Vienna*. Vienna, Austria, Department of Geoinformation, Technical University Vienna. GeoInfo Series vol. 12.
    3. Kuhn, W. and Timpf, S. (eds.), 1995. *COSIT'95 Doctoral Consortium*. Department of Geoinformation, Technical University Vienna. GeoInfo Series vol. 9.
  - BOOK CHAPTERS
    1. Egenhofer, M.J. and Kuhn, W., 1999. Interacting with Geographic Information Systems. M.F. Goodchild, D.J. Maguire, D.W. Rhind and P. Longley. *Geographic Information Systems, Principles and Applications*. New York, Wiley. 1: 401-412.
    2. Frank, A.U. and Kuhn, W., 1999. A specification language for interoperable GIS. M.F. Goodchild, M.J. Egenhofer, R. Fegeas and C.A. Kottman. *Interoperating Geographic Information Systems (Proceedings of Interop'97)*. Norwell MA, Kluwer: 123-132.
    3. Bishr, Y., Pundt, H., Kuhn, W. and Radwan, M., 1999. Probing the Concept of Information Communities - A First Step Toward Semantic Interoperability. M.F. Goodchild, M.J. Egenhofer, R. Fegeas and C.A. Kottman. *Interoperating Geographic Information Systems (Proceedings of Interop'97)*. Norwell MA, Kluwer: 55-71.
    4. Hitchcock, A., Wölbling, O., Kuhn, W., Pundt, H., Elfers, C., 1999. The OpenGIS Guide - Introduction to Interoperable Geoprocessing: Deutschsprachige Zusammenfassung. M. Bock, Greve, K., Kuhn, W. *Offene Umweltinformationssysteme - Chancen und Möglichkeiten der OpenGIS-Entwicklung im Umweltbereich*. IfGI prints 7: 197-218.
    5. Kuhn, W., 1997. Austrian Interface for Digital Exchange of Geographic Data (ÖNORM A 2260). H. Moellering and R. Hogan. *Spatial Database Transfer Standards 2: Characteristics for Assessing Standards and Full Descriptions of the National and International Standards in the World*. Oxford, UK, Elsevier: 87-94.
    6. Kuhn, W., 1995. 7±2 Questions and Answers About Metaphors for GIS User Interfaces. T.L. Nyerges, D.M. Mark, R. Laurini and M.J. Egenhofer. *Cognitive*

*Aspects of Human-Computer Interaction for Geographic Information Systems*,  
Kluwer: 113-122.

7. Kuhn, W., 1992. Die Benutzerschnittstelle als Schlüssel für die Verwendbarkeit von Geographischen Informationssystemen. O. Günther, K.-P. Schulz and J. Seggelke. *Umweltanwendungen Geographischer Informationssysteme*, Wichmann: 217-221.
  8. Kuhn, W. and Frank, A.U., 1991. A Formalization of Metaphors and Image-Schemas in User Interfaces. D.M. Mark and A.U. Frank. *Cognitive and Linguistic Aspects of Geographic Space*, Kluwer: 419-434.
- EDITED SPECIAL ISSUES
    1. Fuhrmann, S., Kuhn, W., Streit, U., 2000. Special issue on Geoscientific Visualization. *Computers & Geosciences* 26 (1).
  - ARTICLES IN NON-REFEREED JOURNALS AND MAGAZINES
    1. Kuhn, W., 2002. Semantic Interoperability - the next big standardization challenge. *GIM International*. 16(9): OGC Column.
    2. Brox, C. and Kuhn, W., 2002. GI Marketplaces - Tools of new business models in the GI market. *GeoInformatics* 5(March): 34-37.
    3. Fuhrmann, S., Kuhn, W. and Streit, U., 2000. Guest Editorial, Special Issue on Geoscientific Visualization. *Computers and Geosciences* 26(1): 1-3.
    4. Timm, C. and Kuhn, W., 2000. Konzepte zur Nutzung von Geobasisdaten. *Nachrichten aus dem öffentlichen Vermessungsdienst Nordrhein-Westfalen*(1).
    5. Brox, C. and Kuhn, W., 1999. Business Networks im Geoinformationsmarkt. *GeoBIT* 8(99): 17-19.
    6. Hitchcock, A. and Kuhn, W., 1998. Your Continent Needs You. *GIS Europe*(3): 18-19.
    7. Haunold, P. and Kuhn, W., 1995. Die Analyse von manuellen Digitalisierungsabläufen. *geo-News*(3): 8-9.
    8. Buyong, T.B., Frank, A. and Kuhn, W., 1995. Konceptualni model visenamjenskog katastra zasnovan na mjerenjima. *Geodetski list* 49(72.4): 271-364.
    9. Kuhn, W., 1994. Zur Verwendbarkeit von Geographischen Informationssystemen (GIS). *Umwelt Technologie Aktuell*. 5(2): 88-93.
    10. Haunold, P. and Kuhn, W., 1993. Die Analyse von manuellen Digitalisierungsabläufen. *Eich- und Vermessungsmagazin*(70): 37-40.
    11. Kemp, K.K., Kuhn, W. and Frank, A.U., 1993. Making High-Quality GIS Education Accessible: A European Initiative. *Geo Info Systems*. 3(4): 50-52.
    12. Kuhn, W. and Egenhofer, M.J., 1991. CHI'90 Workshop on Visual Interfaces to Geometry. *ACM SIGCHI Bulletin*. 23(2): 46-55.
    13. Kuhn, W., Jackson, J.P. and Frank, A.U., 1990. Specifying Metaphors Algebraically. *ACM SIGCHI Bulletin*. 23(1): 58-60.
    14. Kuhn, W., 1988. Interaktion: Dialog mit Werkzeugen des Informationszeitalters. *Vermessung, Photogrammetrie, Kulturtechnik* 86(11): 607-612.
    15. Kuhn, W., 1985. Zur Entwicklung Interaktiver Programme und Systeme. *Vermessung, Photogrammetrie, Kulturtechnik* 83(2): 44-49.
  - PAPERS IN PARTIALLY OR NON-REFEREED CONFERENCE PROCEEDINGS
    1. Kuhn, W. *Elements of a Computational Theory of Location*. in *7th AGILE Conference*. 2004. Heraklion, Greece: Crete University Press: 165-168.

2. Kuhn, W. *Semantics of What? (Position Paper)*. in *Specialist Meeting on Spatial Webs*. 2004. Santa Barbara CA: National Center for Geographic Information and Analysis (NCGIA).
3. Kuhn, W., and M. Raubal. *Implementing Semantic Reference Systems*. in *6th AGILE Conference on Geographic Information Science*. 2003. April 24-26, 2003; Lyon, France: Presses Polytechniques et Universitaires Romandes: 63-72.
4. Mark, D.M., W. Kuhn, B. Smith, and A. Turk. *Ontology, Natural Language, and Information Systems: Implication of Cross-Linguistic Studies of Geographic Terms*. in *6th AGILE Conference on Geographic Information Science*. 2003. April 24-26, 2003; Lyon, France: Presses Polytechniques et Universitaires Romandes: 45-50.
5. Kuhn, W., 2002. Modeling the Semantics of Geographic Categories through Blendings. S.N. Lund and M. Turner (eds.), *The Way We Think - Research Symposium on Conceptual Integration*, Odense, Denmark. University of Southern Denmark.
6. Brox, C. and Kuhn, W., 2002. eduGI.net - Formal Establishment of the International Network for Education in Geographic Information Science. EUGISES 2002, Girona, Spain: [http://www.giscampus.com/eugises2002/pdf/4\\_3.pdf](http://www.giscampus.com/eugises2002/pdf/4_3.pdf)
7. Brox, C. and Kuhn, W., 2001. Marketplaces for Geographic Information. M. Konecny (ed.), *4th AGILE Conference on Geographic Information Science*, Brno, Czech Republic. AGILE: 487-500.
8. Berlin, K., Fuhrmann, S., Schmidt, B. and Kuhn, W., 2001. Ansätze zur Optimierung der 3D-Interaktion in Geowissenschaftlichen Visualisierungsumgebungen. J. Strobl and F. Dollinger (eds.), *Angewandte Geographische Informationsverarbeitung (AGIT'2001)*, Salzburg, Austria. Wichmann.
9. Kuhn, W., 2000. Ontologies from Texts. M.J. Egenhofer and D.M. Mark (eds.), *1st International Conference on Geographic Information Science (GIScience 2000)*, Savannah GA.
10. Bishr, Y. and Kuhn, W., 2000. Ontology-Based Modelling of Geospatial Information. T. Sarjakoski (ed.), *3rd AGILE Conference on Geographic Information Science*, Helsinki, Finland. AGILE: 24-27.
11. Möltgen, J. and Kuhn, W., 2000. Task Analysis in Transportation Planning for User Interface Metaphor Design. T. Sarjakoski (ed.), *3rd AGILE Conference on Geographic Information Science*, Helsinki, Finland. AGILE: 124.
12. Rüter, C., Kuhn, W. and Bishr, Y., 2000. An algebraic description of a common ontology for ATKIS and GDF. T. Sarjakoski (ed.), *3rd AGILE Conference on Geographic Information Science*, Helsinki, Finland. AGILE.
13. Timpf, S. and Kuhn, W., 2000. Functional Specifications of Multilevel Highway Navigation. M. Alpuente (ed.), *9th International Workshop on Functional and Logic Programming (WFLP'2000)*, Benicàssim, Spain. Universidad Politècnica de Valencia: 480-485.
14. Gerding, G., Rüter, C. and Kuhn, W., 2000. Advantages of using Functional Languages in specifying GIS Operations. M. Alpuente (ed.), *9th International Workshop on Functional and Logic Programming (WFLP'2000)*, Benicàssim, Spain. Universidad Politècnica de Valencia: 418-426.
15. Brox, C., Kuhn, W. and Bishr, Y., 2000. Conception of a Geospatial Data Infrastructure in Northrhine-Westphalia, Germany. *Urban Data Management Conference*, Delft, The Netherlands. UDMS: CD.
16. Bernard, L. and Kuhn, W., 1999. Mit der Geoinformatik von der Berechnung zur Exploration von Modellen. H.H. Blotvogel, J. Ossenbrügge and W. Gerald

- (eds.), 52. *Deutscher Geographentag: Lokal verankert - weltweit vernetzt*, Hamburg. Franz Steiner Verlag: 579-586.
17. Fuhrmann, S. and Kuhn, W., 1999. Interface design issues for interactive animated maps. *Proceedings 19th ICA/ACI International Cartographic Conference, August 14-21, Ottawa, Canada*: 875-884.
  18. Möltgen, J., Schmidt, B. and Kuhn, W., 1999. Landschaftseditierung und wissensbasierte Maßnahmededuktion für die ökologische Planung. B. Schmidt and C. Uhlenkücken (eds.), *Visualisierung raumbezogener Daten: Methoden und Anwendungen (2. GeoVISC-Workshop)*, Münster, Germany. Institut für Geoinformatik, IfGI Prints vol. 6: 157-172.
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  21. Fuhrmann, S. and Kuhn, W., 1998. The design of everyday maps. *ICA-Workshop on Multidimensional Web Visualization to Explore Spatial Data*, Warsaw, Poland.
  22. Pundt, H. and Kuhn, W., 1998. Dependencies between Semantics and Data Quality - An Example from the field of Mobile Geocomputing. *1st AGILE Conference on Geographic Information Science (AGILE'98)*, Enschede, The Netherlands. ITC.
  23. Rüter, C., Kuhn, W. and Pundt, H., 1998. Einsatz von Geobasisdaten in der Nahverkehrsplanung. J. Strobel and F. Dollinger (eds.), *Angewandte Geographische Informationsverarbeitung (AGIT'98)*, Salzburg. Wichmann: 298-304.
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  27. Kuhn, W., 1996. Formalizing Spatial Affordances. *Specialist Meeting, NCGIA Research Initiative 21 on Formal Models of Commonsense Worlds*, San Marcos, TX. NCGIA.
  28. Kuhn, W. and Frank, A.U., 1996. Toward Usable Spatial Information. P. Waldhäusl (ed.), *XVIIIth Congress of the International Society for Photogrammetry and Remote Sensing (ISPRS'96)*, Vienna, Austria. ISPRS.
  29. Frank, A.U., Haunold, P., Kuipers, G. and Kuhn, W., 1996. Representation of Geometric Objects as Set of Inequalities. K.H. Hinrichs (ed.), *12th European Workshop on Computational Geometry (CG'96)*, Münster, Germany. Department of Computer Science, University of Münster: 51-56.
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  31. Pundt, H. and Kuhn, W., 1996. Usability Aspects of Data Acquisition Tools for Environmental Decision Support Systems. B.J.M. Secher and J. Frahm (eds.),

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  33. Kuhn, W., 1995. Pictures that show us the Way - Geographic Information Systems and Visual Languages. *Keynote Address: 11th International IEEE Symposium on Visual Languages (VL'95)*, Darmstadt, Germany: 292-293.
  34. Kuhn, W., 1995. Semantics of Geographic Data - Approaching a Neglected Issue. Konecny (ed.), *Workshop on Current Status and Challenges of Geoinformation Systems*, Hannover, Germany. IUSM Working Group on LIS/GIS, University of Hannover, 16: 73-86.
  35. Kuhn, W., Haunold, P. and Frank, A.U., 1994. The GIS User Interface as a Major Economical Factor: A Case Study in Manual Map Digitizing. *FIG*, Melbourne, Australia, 3.
  36. Kuhn, W., 1993. Was ein GIS lernen muss, um seine Benützer zu bedienen. N. Bartelme (ed.), *Grazer Geoinformatiktage '93*, Graz, Austria. TU Graz, *Mitteilungen der Geodätischen Institute der Technischen Universität Graz*, Folge 76: 23-30.
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  38. Kuhn, W., 1993. Various Perspectives on Interface Metaphors. J. Harts, H.F.L. Ottens and H.J. Scholten (eds.), *4th European Conference and Exhibition on Geographical Information Systems (EGIS '93)*, Genova, Italy. EGIS Foundation, 1: 456-463.
  39. Frank, A., Kuhn, W. and Egenhofer, M., 1992. Geographic Databases: The Issues and Some of the Solutions. *5th International Symposium on Spatial Data Handling (SDH'92)*, Charleston SC. IGU, 1: 91-103.
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  41. Kuhn, W., 1992. Approaching GIS Needs in the New Democracies. J. Harts, H.F.L. Ottens, H.J. Scholten and D.A. Ondaatje (eds.), *3rd European Conference and Exhibition on Geographical Information Systems (EGIS '92)*, Munich, Germany. EGIS Foundation, 1: 464-473.
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  44. Kuhn, W., 1991. Let metaphors get rid of their WIMP image! D.M. Mark and A.U. Frank (eds.), *Specialist Meeting of NCGIA Research Initiative 13, User Interfaces for Geographic Information Systems*, Buffalo NY. NCGIA, Technical Report 92-3.
  45. Petersen, J.K. and Kuhn, W., 1991. Defining GIS Data Structures by Sketching Examples. *ACSM/ASPRS Annual Convention*, Baltimore MD. ACSM, 2: 261-269.

46. Buyong, T. and Kuhn, W., 1990. Local Adjustment For A Measurement-Based Multipurpose Cadastre Systems. *XIX Congress of FIG*, Helsinki, Finland. FIG, 3: 19-27.
  47. Buyong, T. and Kuhn, W., 1990. Local Adjustment For Cadastral Measurement Databases. *ACSM/ASPRS Annual Convention*, Denver CO. ACSM, 1: 153-164.
  48. Kuhn, W., 1990. Editing Spatial Relations. K. Brassel and H. Kishimoto (eds.), *4th International Symposium on Spatial Data Handling (SDH'90)*, Zurich, Switzerland. IGU, 1: 423-432.
  49. Kuhn, W., 1990. From Constructing Towards Editing Geometry. *ACSM/ASPRS Annual Convention*, Denver CO. ACSM, 1: 153-164.
  50. Kuhn, W. and Frank, A., 1990. Human Interaction with GIS/LIS: Editing Geometric Models. *XIX Congress of FIG*, Helsinki, Finland, 3: 419-434.
  51. Kuhn, W. and Frank, A.U., 1990. Metaphors and Image-Schemata in an Algebraic Framework. B. Nickerson (ed.), *3rd UNB Workshop on Artificial Intelligence*, Fredericton NB. University of New Brunswick: 145-153.
  52. Kuhn, W. and White, R.M., 1988. A Constraint Language for Geometric Constructions. *3rd International Seminar on Trends and Concerns of Spatial Sciences*, Laval University, Québec, Canada.
  53. White, R.M. and Kuhn, W., 1987. Combining a Least Squares Adjustment with a Direct-manipulation Human Interface. *ACSM Spring Conference*, Baltimore MD. ACSM.
  54. Conzett, R. and Kuhn, W., 1986. PRIMA: Ein Werkzeug für Matrizen-Operationen. *XVIII Congress of FIG*, Toronto, Canada. FIG, 5: (510.4).
  55. Frank, A. and Kuhn, W., 1986. Cell Graphs: A Provable Correct Method for the Storage of Geometry. *2nd International Symposium on Spatial Data Handling (SDH'86)*, Seattle, WA. IGU: 411-436.
  56. Kuhn, W., 1986. LIS and the User - Looking for Easier Ways to do Geometric Constructions. *XVIII Congress of FIG*, Toronto, Canada. FIG, 3: (305.2) 30-32.
  57. Kuhn, W., Späni, B. and Frank, A., 1983. Ein anpassungsfähiges Konzept für die Datenaufbereitung mit Kleinsystemen. *XVII Congress of FIG*, Sofia, Bulgarien. FIG, 5: (513.1)14-24.
- CONFERENCE TUTORIALS AND WORKSHOPS
    1. Kuhn, W., Bishr, Y. and Hitchcock, A., 1999. OpenGIS - What's on the bookshelf for Europe? *Tutorial at Interop'99*. Zurich, Switzerland.
    2. Kuhn, W. and Pundt, H., 1997. OpenGIS und Europa. *Workshop at AGIT'97*.
    3. Kuhn, W. and Blumenthal, B., 1996. Spatialization: Spatial Metaphors for User Interfaces. Vancouver, BC, ACM.
    4. Kuhn, W. and Frank, A., 1994. Object-Orientation and Geographic Information Systems. University of Zurich.
    5. Kuhn, W., 1993. Spatial Data Models and the User. *Urban Data Management Systems (UDMS) Conference*, Vienna, Austria.
    6. Kuhn, W. and Frank, A.U., 1993. Spatial Metaphors for User Interfaces. S. Ashlund, K. Mullet, A. Henderson, E. Hollnagel and T. White (eds.), *INTERCHI'93 Conference on Human Factors in Computing Systems*, Amsterdam, The Netherlands. ACM: 220.
    7. Frank, A.U., Kuhn, W. and Egenhofer, M., 1992. Geographic Databases: The Issues and some of the Solutions. G. Gottlob, C. Delobel and A. Pirotte (eds.), *Conference Tutorials, Extending Database Technology (EDBT'92)*, Vienna, March 23-27, 1992, Tutorials.

8. Frank, A.U., Kuhn, W. and Mark, D.M., 1991. Special Interest Group on Geographic Information Systems. S.P. Robertson, G.M. Olson and J.S. Olson (eds.), *CHI'91, ACM Conference on Human Factors in Computing Systems; Reaching Through Technology*, New Orleans, LA. ACM Press: 485-487.
  9. Kuhn, W. and Egenhofer, M.J., 1990. Workshop on Visual Interfaces to Geometry. *ACM Conference on Human Factors in Computing Systems (CHI'90)*, Seattle WA.
- INVITED PRESENTATIONS  
(not updated)
    1. Kuhn, W., 2000. Von Metadaten zu Ontologien für Geoinformation. Universität Klagenfurt, November 30, 2000.
    2. Kuhn, W., 2000. Wissenschaftliche Begleitforschung für das Projekt "Geodaten-Infrastruktur NRW". BWO Dresden, February 23, 2000.
    3. Kuhn, W., 1997. Zur Weiterentwicklung der kartographischen Theorie für die Computerkartographie. Free University Berlin, June 12, 1997.
    4. Kuhn, W., 1997. OpenGIS - Die Idee und das Consortium. *GIS'97*, Wiesbaden, Germany, February 19, 1997.
    5. Kuhn, W., 1995. Keynote Address: Pictures that show us the Way - Geographic Information Systems and Visual Languages. *11th International IEEE Symposium on Visual Languages (VL'95)*, Darmstadt, Germany, September 9, 1995.
    6. Kuhn, W., 1990. Eine Algebraische Formalisierung von Metaphern in Benützerschnittstellen. *Seminar in Computer Science*, University of Siegen, November 15, 1990.
    7. Kuhn, W., 1990. A Language for Constraint-Based Design. *Seminar in Computer Science*, New Brunswick. University of New Brunswick, October 10, 1990.
    8. Kuhn, W., 1990. Recent Innovations in GIS Technology. *Invited Opening Address, Mid-America GIS Symposium*, Overland Park, KA, May 1, 1990.
    9. Kuhn, W., 1989. Human Interaction with GIS - Research within National Center for Geographic Information and Analysis. *Annual Meeting of the New England / St. Lawrence Valley Association of American Geographers*, Boston, USA. Boston University, Fall 1989.
    10. Kuhn, W., 1988. Geometrisches Konstruieren und Modellieren. Geoprocessing Group, Swiss Computer Graphics Association, Zurich, Switzerland, January 29, 1988.

For 48 technical reports as well as 18 other publications and presentations, please consult my homepage at <http://ifgi.uni-muenster.de/~kuhn> (currently under revision).

# TEACHING

## *Teaching Approach*

My teaching centers around information modeling for geospatial information, applying methods from

- object-oriented design and programming
- usability engineering and testing
- interoperability standards
- cartography and information visualization
- business process reengineering.

To maximize the lifespan of student knowledge and skills, my courses

- emphasize methods
- use tools as vehicles for demonstrating methods
- keep close ties with research in multiple disciplines
- demonstrate problems and solutions through real-world case studies
- use internationally recognized text books and publications.

## *Courses Taught (most of them in English and German)*

- Reference Systems for Geospatial Information (2003 to present)
- Object-oriented modeling of geoinformation (1991 to present)
- Software Engineering (1994 to 1997)
- The Role of Ontologies in GIS (1999)
- Digital Cartography (1996 to present)
- GIS Project Seminar (2001 and 2002)
- Multimedia GIS (1997)
- GIS for Citizens (1997)
- Geoinformation Sources (1996 to 1999)
- GIS User Interfaces (1995)
- Spatialization in User Interfaces (1996)
- Temporal Data in GIS (1995)
- Research Methodology (1990, 1997 to present)
- Geometry and Computer Graphics (1989 to 1991)
- Adjustment Computations and Parameter Estimation (1984 to 1985)
- Geodesy (1984 to 1985)
- Field Surveying (1982 to 1984)
- Physics for Chemistry Professionals (1979 to 1980)
- Various post-graduate courses on GIS for practitioners (1992 to present)

### ***Post-Doctoral Students***

- Dr. Yaser Bishr (April 1998 to December 2000).

### ***Completed Ph.D. Theses Supervised (as First Advisor)***

- Angela Schwering: Semantic Similarity Measurement including Spatial Relations for Semantic Information Retrieval of Geo-Spatial Data. University of Münster, September 2006.
- Michael Lutz: Ontology-Based Discovery and Composition of Geographic Information Services. University of Münster, February 2006.
- Christoph Brox: Electronic Marketplaces for Geographic Information. University of Münster, October 2005.
- Sven Fuhrmann: Facilitating Wayfinding in Geovirtual Environments. University of Münster, March 2002.

### ***Doctoral Students Currently Supervised (as First Advisor)***

- Mohamed Bishr: A Spatio-Temporal Model of Trust.
- Sven Schade: Quality Information in Semantic Mappings.
- Eva Klien: Automated Annotation of Geoinformation Resources.
- Krzysztof Janowicz: Similarity Measures in Description Logics.
- Florian Probst: Reference Systems for Measurement Information.
- Jörn Möltgen: User Interface Design for GIS in Transportation Planning.
- Catharina Riedemann: Data usability and data integration.

### ***Ph.D. Theses Supervised (as Advisory Committee Member)***

(not updated)

- Ahmed Talaat: GIS in Transportation Planning. University of Dortmund, in progress.
- Jean Brodeur: Semantic Interoperability. Université Laval, 2003.
- Benno Schmidt: Architecture of Visualization Systems, University of Münster, 2002.
- Hartwig Hochmair: Navigation in physical and web spaces. Technical University Vienna, 2002.
- Martin Raubal: A Simulation of Wayfinding Behavior at Airports. Technical University Vienna, 2001.
- Lars Bernard: Integration of GIS and dynamic atmospheric models. University of Münster, 2001.
- Ale Raza: Design and Implementation of a Temporal GIS to Support Multiple Applications for Sustainable Urban Development of Karachi. ITC Netherlands, 2001.
- Andreas Blaser: Sketch-based user interfaces for GIS. University of Maine, 2000.
- Kathleen Hornsby: Modeling change in GIS. University of Maine, 2000.
- Andrea Rodriguez: Semantic similarity mappings in geoinformation. University of Maine, 1999.
- Matthias Bluhm: Optimizing the collection of geodata for environmental information systems. University of Münster, 1997.
- Albert Remke: Mobile Geodata Collection. University of Münster, 1997.

- Taher Buyong: Measurement-based Multipurpose Cadastral Systems. University of Maine, 1992.

***External Examiner on PhD and Habilitation Theses***

- Masaru Mori: Semantic Analysis of Spatial Expressions in Japanese. University at Buffalo, 2002.
- Doris Dransch: Activity Models for GIS Interaction. Habilitation, Free University of Berlin, 2002.
- Harry Uitermark: Ontology-Based Data Integration, University of Twente, 2001.
- Kristin Stock: Semantics of Heterogeneous Spatial Databases. Queensland University of Technology, 2000.
- Liou Jaek: Object-oriented approach to land information process reengineering. ITC Netherlands, 1999.
- Yaser Bishr: Semantic Interoperability for Geographic Information. ITC Netherlands, 1998.
- Andrew Turk: GIS Interaction Modeling. Melbourne University, 1993.

## SERVICE

### *Editorial Board Memberships*

- Spatial Cognition and Computation (since 2002).
- The ISPRS Journal of Photogrammetry and Remote Sensing (2001-2002).
- International Journal of Geographical Systems (since 1999).
- Interacting with Computers (1992-2002).

### *Conference Organization*

- General Chair, Fourth International Conference on Geographic Information Science (GIScience), Münster, September 2006.
- Program Co-Chair, Conference on Spatial Information Theory (COSIT), Ittingen Switzerland, September 2003.
- Co-Organizer for Europe, Second International Conference of Geographic Informations Science, GIScience 2002.
- Co-Chair, ESF/EURESCO Conference on GeoVisualisation, Albufeira (with Menno-Jan Kraak, 2002).
- Co-Chair, Program Committees, COSIT 1995 and COSIT 2003.
- Member, Permanent Program Committee of COSIT (Conferences on Spatial Information Theory, 1992 to present).
- Member, Program Committees, several international conferences in the GIScience and Computing Sciences field (1991 to present).

### *Networking*

- Responsible for the *AGILE Research Agenda* (1998 to 2002).
- Initiator, *AGILE Working Group on Data Usability* (1999).

### *Reviewing*

- Regular research *proposal reviewer* for the German Science Foundation (DFG), the European Commission's 5<sup>th</sup> and 6<sup>th</sup> Framework Programmes, the Austrian National Bank, the Swiss National Science Foundation (SNF), the US National Science Foundation (NSF), the Canadian Research Council (CNR).
- Regular reviewer for the International Journal of Geographical Information Science (IJGIS).
- Regular *external reviewer* of tenure and promotion cases at universities in Germany, Austria, Switzerland, USA, Canada, Australia.
- *Book reviewer* for MIT Press and Wiley.

### *Education*

- Co-Founder, Vespucci Initiative for the Advancement of Geographic Information Science (2003).
- Organizer and principal teacher of the 1<sup>st</sup> International Summer School of eduGI.net in Münster (2002).

- Initiator and leader, eduGI.net program for the internationalization of geoinformatics curricula (2001 to present).
- Member, Committee for Teaching and Student Affairs (KLSA), University of Münster (1998 to present).
- Member, Committee for Teaching and Student Affairs (ALSA), School of Geosciences (FB14), University of Münster (1998 to present).
- Chair, Committee for the development of the Geoinformatics curriculum at the University of Münster (1997 to 1999).
- Member, working group for the development of a new curriculum in Surveying Engineering, ETH Zurich (1987 to 1988).
- Chair, committee on the use of computers in teaching and administration, Institute of Geodesy and Photogrammetry, ETH Zurich (1985 to 1989).

### ***Standards Committees***

- Author of the Harmonization Strategy for OGC and ISO/TC211 (1997).
- Member, Austrian *Delegation to CEN/TC287*: European Standardization in the field of Geographic Information (1991 to 1996).
- Member, *Austrian Standards Committee* for Surveying and Geoinformation (1991 to 1996).
- Member, *INTERLIS* Design Team, Switzerland (1987 to 1989).

### ***Industry Board Memberships***

- Intergraph Education Network Board (2002 to present).
- Endoxon Board of Directors, Switzerland (2001 to 2002).
- Intergraph Geospatial Users Community, Executive Board (2000 to present).

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## Employment:

- |                     |   |
|---------------------|---|
| Sep 2004 - present  | Lecturer in GIS at the Institute of Geography, University of Edinburgh                            |
| Sep 2002 - Aug 2004 | Teaching and research assistant at the Department of Geography, University of Maryland.           |
| Sep 2001 - Aug 2002 | Teaching and research assistant at the Department of Geography, University of Wisconsin-Milwaukee |
| Jan 2000 - Aug 2001 | Teaching and research assistant at the Department of Geography, University of Auckland            |

## Education:

Ph.D. Geography (2004), University of Maryland, College Park

MSc with First Class Honours (2001), Geography, Auckland University

BSc Honours with First Class Honours (2000), Geography, Auckland University

BSc with First Class Honours (1999), Geography, Auckland University

## Publications:

8. Reitsma, F. Representing Process in GIScience. Under revision/resubmission in Journal of Geographical Systems.
7. Reitsma, F. and R. Dubayah (2006). Simulating Watershed Runoff with a New Data Model. Hydrological Processes. Forthcoming.
6. Reitsma, F. and J. Albrecht (2006). A Process-oriented Data Model. To be published as a chapter in Drummond, J., Billen, R., Forrest, D. and João, E. (eds) 2006, *Dynamic & Mobile GIS: Investigating Change in Space and Time*. Taylor & Francis
5. Reitsma, F. and J. Albrecht (2005). Implementing a New Data Model for Simulating Processes. International Journal of Geographic Information Science 19(10): 1073 – 1090.
4. Reitsma, F. and J. Albrecht (2005). Modeling with the Semantic Web in the Geosciences. IEEE Intelligent Systems 20(2): 86-88.
3. Reitsma, F. and S. Engel (2004). Searching for 2D Spatial Network Holes. Computational Science and Its Applications -ICCSA 2004 Conference, Assisi, Italy, May 14 – 17 2004, Proceedings, Part II: Lecture Notes in Computer Science 3044 Springer: pp. 1069-1078:
2. Reitsma, F. and T. Bittner (2003). Scale in Object and Process Ontologies. In W. Kuhn, M. F. Worboys and S. Timpf (eds) *Spatial Information Theory: Foundations of Geographic Information Science*, COSIT'03, Ittingen, Switzerland, pp 13-30. Vol. 2825, Springer Lecture Notes in Computer Science. Berlin.

1. Reitsma, F. (2003). A Response to Simplifying Complexity. *Geoforum* 34(1): 13-16.

### Reviews:

Reitsma, F (2005). GIS Basics by Stephen Wise. *Transactions in GIS*, 9(3): 449-450.

### Conferences and Workshop Posters and Presentations:

Reitsma, F (2006). Analysing the nen: analysis of a process-based data model. Abstract and Poster presentation at Fourth International conference on GIScience, Munster, Germany 20<sup>th</sup> – 23<sup>rd</sup> September 2006.

Reitsma, F and K, Hiramatsu (2006). Exploring GeoMarkup on the Semantic Web. 9th AGILE International Conference on Geographic Information Science: shaping the future of Geographic Information Science in Europe, Visegrád, Hungary, 20-22 April, 2006.

Rider, C and F. E. Reitsma (2006). PastureSim: A Visualisation Tool for Pasture Management. GISRUK'06, Nottingham 5-7 April, 2006.

Bose, R and F. Reitsma (2005). Advancing Geospatial Data Curation. Conference on Ensuring Long-term Preservation and Adding Value to Scientific and Technical Data (PV 2005). The Royal Society, Edinburgh 21-23 November.

Reitsma (2005). A New Process Data Model and its Application. GISUK'05, Glasgow April 6 – 8 2005.

Reitsma (2005). A Process Oriented Data Model. Association of American Geographers Annual Meeting, Denver, Colorado April 5-9, 2005.

Hiramatsu, K. and F. Reitsma (2004). GeoReferencing the Semantic Web: ontology based markup of geographically referenced information. EuroSDR/EuroGeographics workshop on Ontologies and Schema Translation Services, 15-16 April, Paris (<http://www.laser-scan.com/euroedr/invitation.htm>).

Reitsma (2004). Ontologies for Modeling Geographic Processes. Association of American Geographers Annual Meeting, Philadelphia.

Reitsma (2004). Time and Change in GIScience Modeling (as part of a panel). Association of American Geographers Annual Meeting, Philadelphia.

Reitsma (2001). Presented at Conference on Spatial Information Theory (COSIT'01) PhD colloquium, Morro Bay, California.

### Other Conference and Workshop Attendance:

2006: Attended NIEeS workshop on “Genie modeling with GRID” 26<sup>th</sup> – 27<sup>th</sup> June 2006, Cambridge, UK

2005: Attended workshop on “The Place of GIS in the Curriculum”, Leicester. Organised by the Higher Education Academy Subject Centres for Geography, Earth and Environmental Sciences (GEES) 11<sup>th</sup> May 2005.

2003: Attended the International Spatial Cognition Summer Institute, Bad Zwischenahn, Germany, 24 August – 6 September. (<http://www.cosy.informatik.uni-bremen.de/iqn/ISCSI/index.html>)

2002: Invited to the Research Workshop on Action-Oriented Approaches in Geographic Information Science, Holden, Maine.

2002: Attended ICPSR Summer Program in Quantitative Methods at the University of Michigan.

2002: UCGIS Summer Assembly - student paper and poster.

## Awards:

2005: The GIScRG/Ordnance Survey Prize runner up for Young Researchers  
2003: University of Maryland Goldhaber graduate student travel award  
2003: NASA graduate student summer program  
2002: 2<sup>nd</sup> place in the UCGIS Summer Assembly poster competition  
2002: University of Wisconsin-Milwaukee Graduate Travel Award  
2002: University of Auckland, Geography Department Kenneth B Cumberland Prize – jointly received for best Masters Thesis  
2001: Mary-Jo Read Graduate Scholarship at the University of Wisconsin-Milwaukee  
2001: University of Auckland Faculty of Science Postgraduate Tuition Fees Bursary  
2000: University of Auckland Faculty of Science Postgraduate Tuition Fees Bursary

## Funding

*Edward Clarence Dyason Universitas 21 Fellowship* \$6,400 AUD  
2005-2006

Melbourne University

Fellowship for travel and accommodation to work with Matt Duckham at Melbourne University

*COSIT'05 Doctoral Colloquium* \$5,000 USD  
2005

ESRI USA

As COSIT'05 Doctoral Colloquium organiser, I raised funding to assist postgraduate students travelling to COSIT'05 conference

*Scoping a Geospatial Repository for Academic Deposit and Extraction (GRADE)* £2,000  
2005 - 2007

JISC

Collaborating institution for prototype development

*Go-Geo! Portal and Geospatial Metadata Development Programme* £2,000  
2005 - 2006

JISC

Collaborating institution for prototype development

## Professional Service and Membership:

- Scientific Programme Committee for the AGILE 2007 Conference
- Doctoral Colloquium organiser for Conference on Spatial Information Theory (COSIT'05). Ellicottville, NY, September 14-18, 2005.
- Reviewer for: Transactions of British Geographers, Transactions in GIS, International Journal of Geographical Information Science
- Member of Association of American Geographers (AAG)
- Member of Association of Geographic Information (AGI)

## Professional Development:

- 2005: Developing Leadership Skills. A course run by the City of Edinburgh Council - Corporate Services Personnel, 15/09/2005- 17/09/05.
- 2005: Time Management for Researchers. A course run by Human Resources at the University of Edinburgh, 18/05/2005
- 2005: Postgraduate training for Science and Engineering, University of Edinburgh. Single day workshop.
- 2004: Stage one of Edinburgh University's professional Certificate in University Teaching. Week long workshop.

## Teaching

- 2006 *Geoinformatics*
  - University of Edinburgh
  - Course development and delivery (1.0), MSc in GIS
- Geovisualisation*
  - University of Edinburgh
  - Lab development (0.2), MSc in GIS
- Environmental Modelling*
  - University of Edinburgh
  - Course organisation and delivery (0.8), MSc in GIS
- Spatial Modelling*
  - University of Edinburgh
  - Course delivery (0.2), MSc in GIS
- Research Design and Project Management*
  - University of Edinburgh
  - Course organisation and delivery (0.3), MSc in GIS
- MSc eScience*
  - University of Edinburgh
  - Guest lecture
- 2005 *GIS in the Field*
  - University of Edinburgh
  - Course support (0.2), MSc in GIS
- Object Oriented Software Design*
  - University of Edinburgh
  - Course development and delivery (0.3), MSc in GIS
- Spatial Modelling*
  - University of Edinburgh
  - Course development and delivery (0.2), MSc in GIS
- Research Design and Project Management*
  - University of Edinburgh
  - Course organisation and delivery (0.3), MSc in GIS
- Environmental Modelling*
  - University of Edinburgh
  - Course development and delivery (0.6), MSc in GIS
- 2004 *Geographic Information Systems*
  - University of Maryland
  - Course development and delivery (1.0), 2<sup>nd</sup> year undergraduate
- 2002: *One day GIS Workshop*
  - University of Chicago Urban Planning Department
  - Course development and delivery (1.0), MSc

## Supervision

(\* indicates primary supervision)

### **Current PhD:**

\*James K Batcheller (start date 2005). Multi-granular approaches for overcoming barriers to geospatial asset exploration and exploitation using geospatial metadata.

\*Conrad Rider (01/09/2005). Agent based modelling of landscape responses to farm management practises and global change. Studentship funded by the David Kinloch Michie Bequest and the Torrance Bequest.

### **MSc:**

2006 \*Anna Kostikova. Comparison of logistic regression, neural networks and raster-based analysis for habitat modelling: a case study with musk oxen. MSc in GIS, University of Edinburgh (awarded £400 pounds in small grants competition).

\* Stephan Kamps. Network Holes. MSc in GIS, University of Edinburgh.

\*Catherine Schroeder. Space Syntax in the Third Dimension. MSc in GIS, University of Edinburgh.

\* Jacky Wang. Visualisation of Forest Landscapes: Visualising and Assessing Recent and Future Policy-Driven Woodland Expansion in a Valued Landscape on the Isle of Wight. MSc in GIS, University of Edinburgh.

Felicity Jarvis. A 3-D depth and temperature 'spatial envelope' to predict the present and future distribution of coral reefs around the Galapagos Islands. MSc in GIS, University of Edinburgh.

2005 Shane Engel. Using Spatial Network Holes as an Indicator for Vehicle Accessibility. MSc in Geography, University of Maryland.

Lisa. Anderson. The Application of Glacial Modelling to Diamond Exploration in Northwest Territories and Nunavut, Canada. MSc in GIS, University of Edinburgh.

Chris. J. Donaldson. Interpolating Daily Rainfall: An investigation of accuracy and reliability of geostatistical interpolation methods that incorporate supplementary datasets. MSc in GIS, University of Edinburgh.

Suneet. F. Kamath. Can vehicle telematics be used to improve the quality of route planning? MSc in GIS, University of Edinburgh.

K. E. Kanasiadis. Stand-Level Forest Classification by means of Multiresolution Segmentation and Object-Oriented Image Analysis. MSc in GIS, University of Edinburgh.

Eli. D. Lorimer. The Space-Time Trajectory Realizing Hagerstrand's Vision of a Cube. MSc in GIS, University of Edinburgh.

Paul. S. Radikonyana. What are the most important factors presently restricting the wider adoption and more effective use of GIS in Developing Countries? MSc in GIS, University of Edinburgh.

Michael. M. Steven. Generalising Ordnance Survey height data to cartographic contours at 1:50 000 scale: the depiction of steep terrain. MSc in GIS, University of Edinburgh.