CAN BRAINWARE Keep Up With TECHNOLOGY?

Smart and sharp minds are required to analyse the real world problems and to create solutions through competent use of geospatial technologies. However, the numbers of such people have not yet grown enough.

By Prof Josef Strobl

Higher education in technology-related fields faces continually changing challenges. Geoinformatics as the methodology behind 'GIS' is no exception, as it is confronted with rapid progress in the areas of sensors for data acquisition, data management, real time analytics and visual interaction paradigms, and an increasing prevalence of cloud computing covering all of this.

Ever-changing technologies influence the required problem-solving competences in application domains, but they also impact learning processes and environments. Online Learning Management Systems (LMS) have greatly facilitated distance learning and the role of massive open online courses (MOOCs) is in the process of being established (*Page 43*). Prevalent high bandwidth access has all but removed the distinction between local desktop and remote cloud-based resources, and communication paradigms shift from one-to-many 'broadcast' and bilateral exchanges to participative discourse conducted across social media.

Not only technologies impact our teaching and learning ecotopes, but also policies and societal developments. Open data, open source software and open content publishing jointly lead to the emergence of open educational resources (OER) easing access to higher education, but also require a modification of education's business models. The sometimes posited divide between open and proprietary approaches in practice often is much less critical: both schools of thought thrive as long as an open mind is in control, and education will always need to look and work across any such borders.

GIS framework

Traditional textbooks suggest a combination of hardware, software, data, orgware and qualified people (brainware) as the components required for successful GIS frameworks. Right now, the distinction between the first three is rapidly going away, as cloud-based transparent infrastructures provide high-level services integrated across machinery, code and geospatial data.

This leaves the tightly inter-connected organisational and people aspects, traditionally addressed through educational programmes. This 'brainware' component is widely perceived as the key bottleneck limiting broader dissemination and pervasive successful implementation of geospatial approaches. Initiatives like the 'Body of Knowledge' (*http://www.aag.org/bok*) and the GeoTechCenter (*http://www.geotechcenter.org*) have been and still are addressing the challenges for educators in a rapidly advancing and seriously interdisciplinary domain, but with limited success: a shortage of geospatial experts qualified beyond mere button-pressing skills is still frequently highlighted by industry representatives.

First, it might be helpful to agree on conceptual views like understanding geographic information systems (GIS) as a technology implementing the methods of geoinformatics, and geographic information science, or more traditionally geography together with some computer science and planning as the 'sciences behind GIS'.

Looking at these quite diverse academic 'worlds', it used to be close to impossible not to decide on concentrating on one or another focus for the delivery of study programmes. These can have a strong computing component — explore the background and processing of sensor data streams in depth — starting from a 'spatial view' conceptual geographic foundation or targeting one or another application domain. Within all of these sectors, again the future role of a learner needs to be defined, as needs of engineering / technology specialists will differ from conceptually oriented designers, communicators and operational managers.

It is advisable not to promote a distinct separation of institutionalised learning pathways according to these or other roles, as experience shows that many people thrive from challenges along individual strengths and preferences: some geographers turn out to be excellent software developers, some coders thrive as 'natural managers', and an application domain expert will evolve as a great 'spatial thinker' with an impressive conceptual mind for geographic analyses. Still, roles like the ones mentioned above are helpful for structuring and differentiating educational pathways.

As requirements in geospatial industries and application domains evolve due to the impact of new technologies and progress in involved disciplines, learning frameworks need to keep an eye on the needs in professions and the job market. Thus demand analyses like performed in the GI-Need2Know initiative (http://www.gi-n2k.eu) serve as important instruments not only in re-defining the scope and priorities in geospatial curricula and syllabi, but also support decisions about learning methods, building of 'soft' skills and the different levels of technology competences.

Any given higher education programme will not be able to pursue a catch-all approach, but either aim at offering a clear emphasis among these alternatives, or provide substantial leeway for differentiated development of individual students. How target groups and professional roles are addressed through programme design clearly is a fundamental decision to be taken up front: a clearly defined focus (e.g. geospatial software design and development) does not mix well with the support of alternative tracks and pathways within one programme, or with 'open space' in the curriculum for individualised development of preferences, competences and skills.

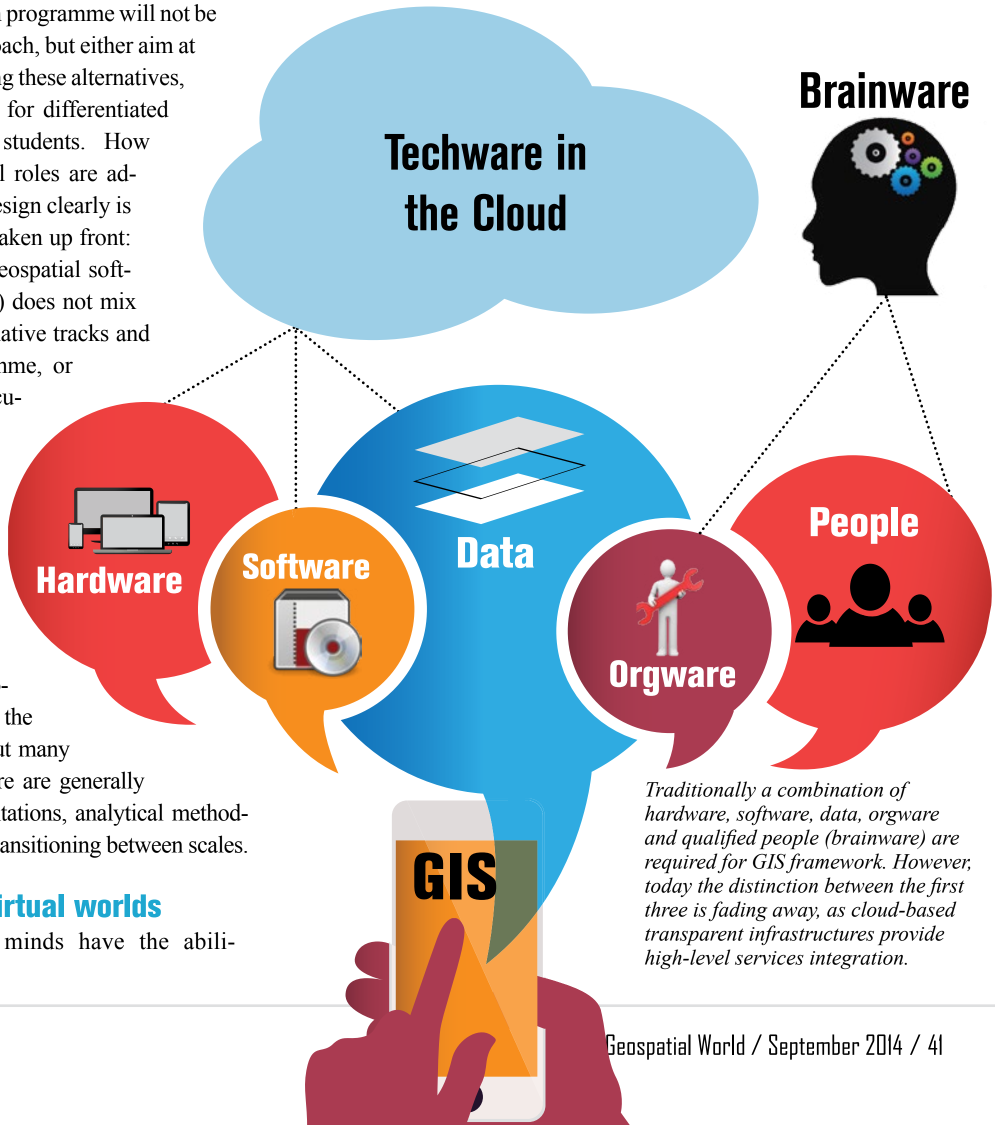
Nonetheless, geospatial education would not deserve a distinct category and name if it was not for an agreed common core of largely conceptual foundations. These today are widely debated across the above mentioned initiatives, but many aspects of such a common core are generally agreed — like spatial representations, analytical methodology, geovisualisation or the transitioning between scales.

Connecting real and virtual worlds

More generally, geospatial minds have the ability to tightly connect the real and virtual worlds. Spatial thinking, analyses and management will shuttle across the interface between the physical and social environment and its digital representation, enabling quantitative methodologies to digitally process sensor data for better decisions in our world.

This conceptual framework now has taken hold in numerous disciplines and industries, which before were only marginally working with explicitly spatial information. The term 'geospatial revolution' has been coined to represent the universal introduction of a spatial paradigm, an explicitly spatial perspective into the professional practice of a wide array of disciplines.

The value added through this spatialisation is increasingly recognised in academic and thus educational institutions. Many traditional university environments are organised, e.g. as faculties, along the lines of science, arts, engineering, law etc. A spatial perspective, though, is either required or needs to be supported by many if not all disciplines. Any 'spatial



Traditionally a combination of hardware, software, data, orgware and qualified people (brainware) are required for GIS framework. However, today the distinction between the first three is fading away, as cloud-based transparent infrastructures provide high-level services integration.

As the requirements in geospatial industries evolve due to the impact of new technologies and progress in involved disciplines, learning frameworks need to keep an eye on the needs in the job market

thinking and competence' perspective therefore will likely suffer from being dominated by natural, social or technical science environments.

A transversal, cross-disciplinary approach reaching across these boundaries of paradigms and departments thus is a promising step taken by universities worldwide. The University of Southern California's Spatial Sciences Institute, Harvard's Center for Geographic Analysis, University of Salzburg's Interfaculty Department of Geoinformatics and others share the common trait of having established themselves as transdisciplinary institutes not hemmed in by the either — or of legacy frameworks.

This might ultimately be the true 'geospatial revolution': not only bringing geospatial competences to a huge array of application domains, but also to create and leverage spatial thinking within its own academic and organisational domain. Built upon and around geographic theory, including simple but powerful foundations like Waldo Tobler's first law or approaches to location theory. Why the discipline of geography in most places has not managed to establish a generic spatial perspective would be a different conversation; but today spatial sciences or geographic information science make promising headway.

Returning to today's brainware needs: academic, just like professional programmes, need to be set up outside and beyond established tracks: access to graduate studies shall be transparent and open from virtually all backgrounds. Minors or academic certificates are important complements enhancing a variety of major subjects. Geospatial problems are only successfully tackled with skills mixed or combined from different disciplines. And, tech skills are indispensable, but the understanding what we do with them, and why, is the more critical qualification.

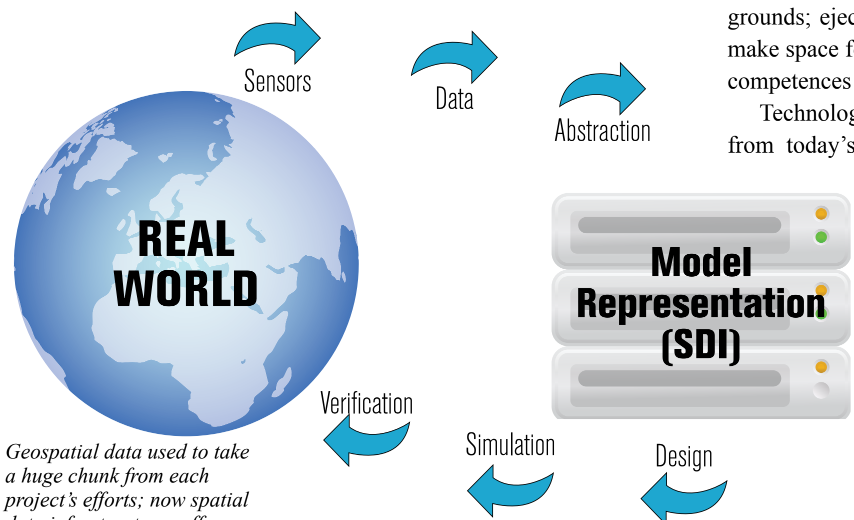
Summing up

Summarising, three major challenges in academic 'geospatial brainware development' are identified as major issues to be addressed by educational initiatives and programmes:

- Emancipation of spatial sciences and geospatial education from and beyond the constrained natural, social, technical or engineering backgrounds.
- Growing competences with a long half-life and generic transferability, geospatial tool sets are a requirement just as reading and writing, but not ends in themselves.
- Interfacing the real world with its virtual representations as the conceptual and technical challenge geospatial graduates have to be prepared to meet.

On a more practical level, educators face additional challenges, like: keeping up with technologies and their backgrounds; eject established course content from curricula to make space for new developments; and develop the body of competences based upon a body of knowledge.

Technology has progressed by leaps and bounds, and from today's perspective does not leave so much to be desired. Geospatial data used to take a huge chunk from each project's efforts, now spatial data infrastructures offer many ready-to-use representations. Analysing real world problems, though, and creating solutions through competent use of geospatial technologies requires smart minds, and their numbers have not yet grown enough.



Geospatial data used to take a huge chunk from each project's efforts; now spatial data infrastructures offer many ready-to-use representations

Prof Josef Strobl, Chair,
UNIGIS International Distance Learning Programmes – www.unigis.net'
josef.strobl@sbg.ac.at