B Planning and Design

20 years of quantitative geographical thinking

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In 1996, Denise Pumain set up the online journal *Cybergeo*. When she first proposed this, the web was in its infancy and I remember thinking that this was a very high-risk proposal in a world where the notion that we might communicate our ideas across wide-area networks was still a novelty. In 1986, email was virtually unheard of apart from a few geeks like ourselves who used computers in universities that were beginning to be networked to each other as well as connecting to the rest of the world through arcane but perfectly workable yet slow email systems such as BitNet. By the early 1990s, internet-based resources could be captured across the ARPANET and NSFnet that formed the rudimentary internet, but it took Tim Berners-Lee to devise a hypertexted system of web links and, perhaps more importantly, the development of graphical user interfaces such as MOSAIC from the National Center for Supercomputing Applications at the University of Illinois to really provide the take-off for the beginning of the world wide web. Denise's proposal for an online journal in a world where the net was barely known and where we had no idea how a network of networks would play out with respect to different languages, seemed incredibly ambitious. This was an era when reportedly Bill Gates went on record in 1993 saying: 'The Internet? We are not interested in it'. In 1996, he followed this up by reportedly saying that had you told him in 1994 that world wide web addresses would be appearing on the side of taxis, he would have thought you crazy!

Fast forward 20 years and on 26 May 2016 (see http://cybergeo2016.sciencesconf.org/), I found myself in Paris with Helen Couclelis at the 20th anniversary of *Cybergeo* with both of us delivering celebratory speeches on the fact that not only had the journal survived for two decades but it had flourished as well. Only in hindsight can we say that it was a model for many other journals and in one very positive sense, it was in the vanguard of traditional hard copy journals which have fast moved during this time to the *Cybergeo* model. It is hard to portray what it was like 20 years ago when it came to the world wide web although the *Way Back Machine* (http://archive.org/web/) gives us a glimpse of what that world was like, largely from a US perspective one might say. Clearly, web pages were evolving very fast and there was real momentum to provide as much content of a traditional kind in the form of a digital resource that could be delivered time and again without any degradation. Moreover, the process of submitting an article was still rather traditional in that articles that might be published online were first sent by email at best but also physically in hard copy digital media to the editorial office, then uploaded locally to desktop machines and eventually embedded into a web service that enabled the article to be displayed online. The process was cumbersome to say the least. It took another 10 years at least before online submission looked as though it might become routine and only in the last five years has this been the case.

This journal *Environment and Planning B* is a good example of the transition to the digital world that all journals have almost now completed. In 1996, I had just returned from the

United States to set up CASA, and the way the journal was run then was the same way it always had been since its inception in 1974: hard copy articles were submitted by potential authors, we chose referees and still sent them letters requesting their participation, we received comments in the regular mail, and once the article was accepted, we physically communicated it to Pion the publishers where it was edited once again and communications with the author continued in the traditional way. Email had begun to supplement communications in 1996 but only just, and by the late 1990s, manuscripts were being shipped digitally as attachments. But it was only in 2003 that we set up our own web site and the management of the journal locally moved in-house to our own systems which held us in good stead until Pion adopted the *Scholar One* system in 2011. Only recently since Sage acquired the journal, can we truly say that we are now completely digital. An example of how this transition has affected our workflow and output is that my editorials such as this one no longer have the hard and fast constraint of being multiples of two pages of the hard copy journal which was our rule-of-thumb when hard copy dominated. I still try and meet this as it is good discipine (although I have not achieved this here). But this world is passing and we all wonder how long the hard copy will remain. Books probably yes, but journals, probably no.

Cybergeo faced none of these constraints and from the word go it prospered. To an extent, I think its positioning in France being led by Denise Pumain and closely linked to her CNRS Cities group and to the deep network of geographers that she was part and parcel of as well as the international links that her group fostered were instrumental in providing the context for success. Moreover, the fact that articles were/are printed in French, English and Spanish worked very well in terms of broadening its range. The scope of the journal too has helped for although Denise's group are essentially quantitative geographers, they are first and foremost geographers and in that way have enabled many varieties of geographical thinking to be represented in *Cybergeo*. The success of the journal is impressive and among the many statistics that characterise its use and popularity, in 2014, the number of articles downloaded reached a million (Pumain, 2015). The web world of course is full of hyperbole such as this but by any stretch of the imagination, this is quite an accomplishment for a journal that has always been freely available – it is the oldest open access journal in the social sciences – and is the product of a labour of love as well as a commitment to a view that broadens our horizons through the study of geography.

Cybergeo published four invited articles (https://cybergeo.revues.org/27428) to celebrate its 20th anniversary. The articles in many senses reflect the changing themes of quantitative geographical thinking – I hesitate to leave out the adjectives 'quantitative' and even 'geographical' for the obvious reasons that my own reflections on the last 20 years are limited to the quantitative. The articles reflect in the best geographical way how the world has changed but of course to draw an arbitrary line at 1996 and consider everything after that as being representative of changes in our geographical perceptions does not do justice to trends that have been apparent for much longer. But 1996 did mark the beginnings of the internet and a sea change in how we began to communicate in ways that were far beyond the technologies produced by earlier industrial revolutions, notwithstanding the fact that the mechanical and electrical revolutions of the early and late 19th century paved the way. This of course was made possible by the convergence of computers and communications and by the inexorable force of Moore's law which for more than half a century has dominated the increase in speed and memory and the consequent decrease in costs of computation in all its forms. By 1996, the mobile phone was well under way in terms of becoming the ubiquitous device of the early 21st century and when smart phones emerged soon after, the convergence was complete. Putting on one side for a moment the

cost of such technologies to the entire global population including the poorest, to all intents and purposes we have entered the era of communications where anyone can be connected to anyone else, anytime, anywhere. It is this that has spurred the success of *Cybergeo* and the fact that everyone who wishes to download its papers is now able to do so.

To an extent, this move from local to global with everyone now being a global citizen in the sense that they are able to access information everywhere, again notwithstanding regulations that control access and privacy, combines with the notion that the world has moved from small to big in terms of data. The rise of 'big data' which Goodchild (2016) discusses in his *Cybergeo* celebratory paper has been largely due to data from sensors which are embedded into the local environment. These generate incessant streams of data (or at least archive such incessant streams) which on a fine temporal scale become bigger than anything we have been able to manage so far. However, this is not simply the product of passive sensors but involves active sensing which in turn is associated with those who motivate their use. Essentially, big data depends as much on the number of users – the population – who generate such data and by generation this means the active use of sensors and computers to enable information to be produced and used for multiple purposes. Combined with an increasing amount of data from any single sensor, the deployment of multiple sensors which are used time and again for a variety of purposes explodes these big data sets. In short then, big data is exploded into ever bigger data once users are added to the data.

This is a world that has moved from being largely place-related to one which is increasingly global. Information is now being procured from places which are very different and distant from where that information is received. Agnew (2016) in another of the celebratory papers shows that although the internet and instant communications are affecting political movements and thus all kinds of decision making about communities, the influence of the net on place is subtle and complex. Place is being augmented and changed but by no means rendered less significant by the rise of the information technologies that now underpin the material world. This is a world that has moved from the simple to the complex. Complexity theory has paralleled the development of computing these last 70 years since the digital computer was first invented, and now these technologies are driving the very systems that we seek to understand and control with the same tools that are forcing their evolution.

Big data has directly introduced time into quantitative geography. Temporal thinking has always been integral to the field with Hägerstrand's (1970) ideas about time budgets articulating the need for this perspective many years ago, but it was space that triumphed during the last century in that time was harder to observe and change itself appeared somewhat slower. Temporal data were in some sense too rich to measure easily and comprehensively. But with big data, the focus, for example on the city, is fast moving from the long and medium term to the short term, from decades and years to minutes and seconds, where the cycle is diurnal rather than seasonal or decanal. This is changing the entire focus of research reflected in not only quantitative geography but also in all the cognate disciplines and inter-disciplines that define this new world. If you examine the articles in *Cybergeo* over this entire period, it is easy to see these trends, but the struggle to understand this new world is also evident. There is little doubt that these 20 years have seen a sea change in many if not most domains of science and social science. The switch from a world based on energy to one on information is nowhere more apparent than in the way we communicate our own ideas about the world for our communication

reflects the very world we are studying. In 1996, the world was largely conceived in material terms – in terms of the transmission of energies – but the translation from atoms to bits as Negroponte (1995) so cogently defined it in back then, has changed what we study and how we might control, manage and design it as well as our abilities to communicate it to ourselves and others.

The transitions that are implied here – small to big, simple to complex, slow to fast, local to global – all collapse to a dramatic simplification of the material world to binary dichotomies that ultimately are representable as zeroes and ones. But these transitions also work the other way around and can interact with anything and any other device reflecting the move from big to small and complex to simple. In fact, this means that our language is not good enough to represent these forces for change that combine and reinforce one another in subtle as well as complex ways. The world of publishing which is the world of information once again provides the exemplar.

For at least a century and certainly since the Enlightenment, perhaps from classical times and even prehistory, we have had to abstract to make sense of our human actions and how these influence the construction of the material world. The way we communicate these ideas to one another is now part and parcel of this abstraction. Increasingly, we can demonstrate our theories, models, our experiments and indeed information about the material reality that is the ultimate focus of our interest in the media we use to communicate these ideas to ourselves and those affected by our knowledge. If I want to demo a model, I can do it within the pages of a journal. I can link the article to many other sources and demonstrations, to the very computer programs that are used to construct the analysis, and to visualisations of the impact of our ideas on the future if that is our focus. I can provide the reader with the material and media of the scientist and the analyst as well as the designer and the user of that which is designed. In short, the world of information in which the article is embedded is much more than this: it is the actual analysis itself and increasingly during this century we will see the way we communicate our ideas change to embrace this much wider paradigm of understanding and action.

We are not there yet but all the elements of this kind of communication are being put in place quite rapidly. I have not yet seen an article that seamlessly allows me to connect up with the data that it uses, the software that performs the analysis and visualises the output, and the various other links that relate to the legacy that is brought to bear on the research in question. But this is clearly possible. Currently, the links are in place as most people reading this editorial know for they are probably doing so online. In a recent article that my group published in the journal *Royal Society Open Science* (Arcaute et al., 2016), all the data and supplementary material are linked to the article. All the citation data are continually refreshed while even the referees' reports for the original article are online. All that is missing is the software for running the models and visualising the outputs and in time, doubtless these will come. This is a very different world in which to do research and communicate it and even engender design than the one that we have come from. *Cybergeo* led the way and continues to do so and it stands a testament to how information technologies can open our research to everyone. It is interesting to speculate where our world and *Cybergeo* will be in another 20 years in 2036.

Michael Batty

References

Agnew J (2016) Is there a post-place politics? Les SIG à l'ère des Big Data. *Cybergeo: European Journal of Geography* (Online). Available at: https://cybergeo.revues.org/27544 (accessed 31 May 2016).

Arcaute E, Molinero C, Hatna E, et al. (2016) Cities and regions in Britain through hierarchical percolation. *Royal Society Open Science* 3: 150691. Available at: http://dx.doi.org/10.1098/rsos.150691 (accessed 3 June 2016).

Goodchild MF (2016) GIS in the era of Big Data. Les SIG à l'ère des Big Data. *Cybergeo: European Journal of Geography* (Online). Available at: https://cybergeo.revues.org/27647 (accessed 31 May 2016).

Hägerstrand T (1970) What about people in regional science? *Papers of the Regional Science Association* 24: 6–21.

Negroponte N (1995) *Being Digital*. New York, NY: Alfred A. Knopf.

Pumain D (2015) Adapting the model of scientific publishing. *Cybergeo: European Journal of Geography* [Online], Editorials, Online since 06 May 2015. Available at: http://cybergeo.revues.org/26957 (accessed 3 June 2016).