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The Surveying Revolution of 1550-1650: Implications for the Current Geospatial Revolution — Part II

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Abstract

The period 1650-1950 was hardly a lull in the development of surveying and mapping. The rate of change was slower than 1550-1650 and change was far more incremental, but critical developments were made. A significant amount of statistical theory, especially regarding errors, was developed from the work of Delambre and Méchain on the survey of the Paris meridian 1792-1799, leading to the development of least squares adjustment (Alder, 2002). Newton and Leibnitz developed differential and integral calculus. Instruments and computational methods improved, and geodesy was a major driver of mathematical development until the early 19th century (Alexander, 2010). New map projections were developed, the problem of determining time and hence longitude was resolved, and the telegraph introduced the first 'Internet' to the world, together with co-ordinated timing.

During those three centuries, however, the fundamental ideas and methods of surveying remained largely intact. Instruments improved, rather than undergoing total change. Methods were refined and advanced, rather than totally overturned. Change was constant, but steady and consistent. The revolutionary days of 1550-1650, when everything had been overthrown and replaced, were safely in the past. Reviewing the history of surveying only for the period 1650-1950 would lull one into a false sense of stability in surveying, in the same way that the period from around 100 to 1550 AD would seem to present stability and continuity.

Even arrival of the Industrial Revolution, beginning around 1750, made relatively little impact on how surveying was done. Industrial technology allowed improvements in surveying instruments, but triangulation was the key geodetic technology, while traversing increased in importance for local surveys as distance measurement equipment improved. Industrialization pushed a need for more surveying, but the work was along similar lines to that practiced for many years.

During the period 1650-1950, the main emphasis was on the 'better, faster, cheaper' mantra. Equipment improved, but mostly incrementally. Wild's T2 theodolite was a marked improvement on previous instruments, but it still only turned angles. Rods gave way to chains and then tapes, and finally invar tapes allowed very high precision taping, but the process of distance measurement remained much the same. Levels improved and evolved, allowing automatic leveling of the line of sight, and micrometer reading of the leveling rod, but the process of leveling remained much the same. Optical systems improved, especially with the driver of the

arms race between Germany and Britain prior to World War I, but this became an incremental advance for surveying. Industrial efficiency allowed the price of equipment to drop, as well as making it more widely available, but the process of surveying remained much the same.

The technology changes that occurred in surveying equipment during this period were largely what could be described as 'sustaining.' Christensen (1997) describes incremental changes in technology as sustaining technologies, contrasting them with major changes, which involve disruptive technology.

In essence, surveying remained a process by which the real world was broken down into a small subset of objects that allowed straightforward measurement. Surveying was concerned with defining boundaries, the points of change, whether these were ownership boundaries, attribute boundaries or slope boundaries. In a largely 2-D representation of reality, these boundaries were lines, which were broken down again to a string of points. Measurements were made to these points and were largely based on the measurement of angles, distances and elevation differences. This approach, focused on the measurements, is largely analytical: things are broken down into simpler pieces for further consideration.

During long periods of slow incremental change, there is no driving need for major changes in thinking and technology. Technology can be slowly improved, but radical changes rarely occur. Technological change sustains the current model of how things are done. As a consequence, there is no need for a major change in how people think about the technology, or how they use it. Changes in use are incremental.

For surveying in particular, the emphasis on measurement meant that the thinking involved was almost completely analytical. Technological change did not take people very far from the fundamentals of measurement, so there was no need to shift thinking to a different style. Problems that arose, such as dealing with errors, could be dealt with by breaking the problem down into smaller pieces, each of which could be dealt with individually. Thinking that aimed to integrate concepts across the panoply of measurement technologies and approaches was far less common than thinking that burrowed into individual concepts and explored them in more detail.

The revolution in surveying that began after World War II, and which for convenience has 1950 as a rough starting date, started as an accelerating pace of development. The technological improvements that occurred were initially sustaining: the better, faster, cheaper approach. However, many other technologies were developing in the wings, and these were the disruptive technologies. These were based on very specific areas of disruptive change: massive and rapid data collection; data integration across formats; and major computational support for the process.

While the initial appearances of the new and disruptive technologies can be traced back over 150 years, they were not widely seen as being disruptive. It took time, maturity, and other technology merging with them to produce the real disruption.

The disruption started about 60 years into the revolution, a time that mirrors the same arrival of disruptive technologies in the previous revolution. Although the times may be rather arbitrary, there was a period of around ten years when the big changes occurred in the previous revolution. We are in the middle of that ten year period in the current revolution.

The real changes that a disruptive technological revolution initiates are not those in the technology itself. They are the changes in the thinking of the people who use it. This is where the real revolution happens, and it can happen very quickly.

This presentation will build on some earlier work on this subject (Hazelton, 2012), and attempt to give some ideas about where the present revolution is heading.

The primary contribution of this paper will be to provide a different frame to think about the rapid rate of change in the surveying and geomatics disciplines, so that we can think ahead about how to prepare students to careers in this field.

References

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