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The Application of Real-Time Kinematic GPS for National Large Scale Detail Capture

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Introduction

Ordnance Survey captures topographic detail and other related information at three basic scales 1:1250 in urban areas, 1:2500 in rural areas and 1:10 000 in mountain and moorland areas. As in all survey organisations a range of data capture methodologies are used dependant on the nature of the program, the physical environment and economic drivers and efficiencies. For ground based detail capture photogrammetric techniques are widely used to meet longer term revision cycles but Ordnance Survey still relies primarily on ground-based capture technologies to provide the major part of its Continuous Revision program allied to its six month currency targets. The value of a substantial field based survey organisation to capture large scale detail continually proves its worth through both meeting the challenging production targets set but also in capturing and validating the complex geography and thematic data now needed to meet the wide and varied needs of the Geographic Information Market.

Ordnance Survey has always been innovative in applying new technology to surveying and started evaluating GPS for geodetic operations in the mid-1980s, culminating in its wide-spread use for control work in the early 1990s. This is expressed today through the Passive and Active GPS Networks providing a National GPS Framework as well as the new Definitive GPS Transformation and National Geoid Model introduced in 2002, all part of the Digital National Framework.

During 2002 Ordnance Survey introduced a major program of investment for large scale field data capture. Based primarily around the implementation of Real Time Kinematic GPS equipment and with a total investment budget in excess of £3 million, this program delivered efficiencies in data capture of in excess of 40% and have allowed Ordnance Survey to remain at the forefront of the use of technology in GI data capture. This paper will review the methodologies used to roll out such a major program of change within such an aggressive time frame and will detail the actual efficiencies and benefits gained by this highly successful project.

Planning For Success

A major contribution to the success of such a substantial investment is good programme management with a clear understanding of the outcomes and deliverables of such a project. Within Ordnance Survey, a specific team with responsibility for planning, implementation and measurement of objectives was set up under the banner of **GPS*i***, meaning GPS Implementation. This had been prefaced by an earlier RTK Trial Prototype running from November 2000 to July 2001. This trial had four main objectives:

- Assess Operational Efficiencies
- Evolve Standard Operating Procedures
- Develop Plans for an Implementation Project
- Assess Health & Safety Issues

The prototype had also clearly identified the cost-benefit arguments for undertaking a multi-million pound investment. It also helped more fully characterise the broad operating parameters for the overall GPS*i* Program to follow. At the earliest stages it has also been understood that such an investment would also have an impact in Manpower Planning Terms and that these impacts should also be dealt with up-front – recognising the balance between the fixed costs in salaries and new data capture needs.

Project Headlines

- Total Investment budget in excess of £3.5m
- 30 Field Groups – 68 offices
- 400 Field Survey Staff
- 250 Operators trained + 30 Production Managers
- 278 Leica System 500 GPS receivers
- 62 Leica TPS 300 Series Reflector-less Total Stations
- 300 Leica DISTO Pro
- Planned Completion Date September 2003

During the RTK prototype, improvements of around 25% had been identified in actual production rate terms as an efficiency gain. This is quite a substantial number when an organisation has in rough terms on an annual basis 400 man years of resource being utilised. It was also recognised that the technology itself was only part of the solution to recognise increased efficiencies and that a substantial element was more about process redesign and better management information and control.

A close relationship given the nature and size of such an investment was also required from the primary supplier and in this case Ordnance Survey had already entered into a strategic supply relationship with Leica. This allowed for a high level of support and expertise to be available throughout the implementation, which itself was characterised by few technology problems outside the odd issue with radio frequency interference – more allied to a congested UK radio frequency band and some longer range impacts of the ionosphere!

The Road to Lean

As the GPS*i* project started to gain momentum in the early adopter groups the recognition of major gains through process redesign were further reinforced. The way that GPS capture was scheduled in parallel with conventional working practices, and also alongside other technology initiatives such as the Collection of Data from External Sources (CODES), started to reinforce need for review of standard operating procedures and more effective capture and transferral of best practise. By late 2001 major changes to a wide range of production activities was identified as being critical to improving the delivery, quality and performance of the Data Capture organisation as a whole.

This need was addressed by the creation of a new Lean Management Team within the Data Collection and Management Division, with the responsibility for reviewing end-to-end process design and making recommendations and changes to 'lean-up' entire production areas and activities. This team and its principles were now at the core of the GPS*i* program and a new level of sophistication was applied to operating procedures and project design. In support of this the inclusion of practical and experience driven suggestions from the field users themselves were incorporated with a new ease and flexibility into best practice – resulting in a much higher degree of ownership and strong sense of team from all parties involved in the program.

The Organisational Environment

As the GPS technology rolled out throughout the organisation it was very clear from day one that the field-based surveyors were committed to its success. This follows a well-trodden path with the surveyor at the vanguard of many new technologies – in many senses GPS would not have come of age in the 1980s if it wasn't for the geodetic community. What does need to be recognised though is with the scale of efficiencies and benefits that a widespread use of RTK GPS brings is the clear realisation, by the staff themselves, that it takes fewer surveyors to undertake the task. The challenge facing all businesses though is that technology is difficult to un-invent and that as a leading survey organisation it is necessary to adopt these quickly and effectively to further reinforce the value and increase the relevancy of your business.

Much in life and business is also about timing – with major organisational and cultural changes well under way within the organisation – a strong supporting vision and direction from the top down had set the clear agenda of flexibility, speed and need. Structural changes were also ongoing within the Data Collection and Management Division including towards the end of the program a major field restructuring resulting in a new Regional Structure of 11 Geographies based around Government Operating Regions rather than the pre-existing

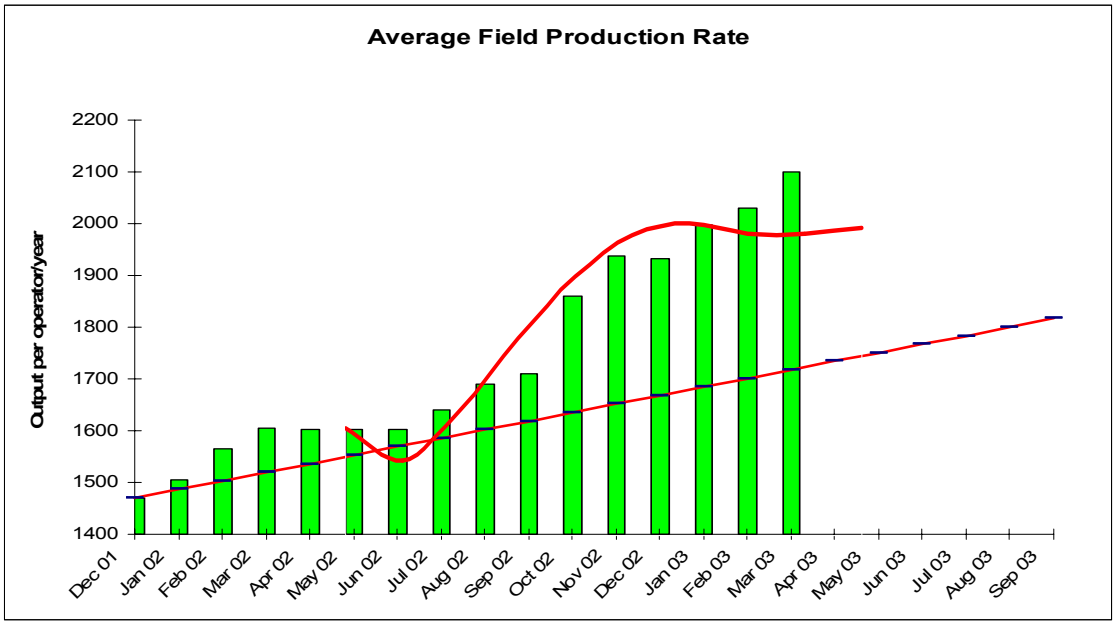
30 Field Groups. This redefinition was complementary to the GPS*i* investment, providing simplified management structuring more suited to a post-GPS environment.

'The Proof of the Pudding Is In The Eating'

A key element to any successful program is project management with clarity of objectives, definable milestones and measurable outcomes. In Ordnance Survey production effectiveness is measured in terms of both production outputs (surveyed units) and currency (up-to-date-ness of the data). By recognising the value in both pure efficiency terms of the technology alongside the ability to redesign processes and adopt best practice – the GPS*i* project delivered well above expectations.

Headline Statistics

- 40% Increase in productivity
- 25% Improvement in currency
- 15% Reduction in Production Variation Between Groups
- Completed Six Months Ahead of Original Schedule – April 2003



The graph above plots actual output rates per surveyor/year with the green bars representing actual achieved rates, the red straight line the predicted/projected rates at the project outset and the curvilinear red line the actual achieved rates as a rolling average.

The results confirm that RTK GPS technology is clearly an exceptional survey tool but that it can also be applied across a large organisation undertaking a complex mix of survey activity and still deliver the promised benefits. The scale of this implementation of real-time RTK data capture for detailed topographic work has probably been unmatched at this stage in either the government or private sector and shows clearly the benefits that this technology can deliver. But what should not be underestimated is the need to fundamentally review the capture methodologies and processes to realise these gains. The investment in RTK GPS equipment was also matched by ancillary investment in laser ranging devices and reflector-less total station technologies to facilitate offset and hidden point capture.

The Next Steps

With RTK GPS now in routine operational use the next stage of Ordnance Survey investment is to implement a supporting infrastructure taking advantage of the wide area or 'networked' RTK techniques. Rather than relying on a local base station servicing a local surveyor, continuing trials are ongoing networking data together from multiple, geographically dispersed, sites, allowing for modelling of GPS errors across Great Britain and allowing access to this data through a GPRS cellular infrastructure. This will allow for reduced costs, increased resilience, greater range and no local reference station set-up or management time. Furthermore Ordnance Survey is also undertaking work to more closely align ground based capture and Digital photogrammetric and remote capture to truly harness the strengths and capabilities of both techniques in a more integrated fashion.

Trials networks have been run in the North of England and with good potential, though with some practical and reliability issues to overcome, it is hoped than an active infrastructure will be in place and operational through 2004. It is also of interest to Ordnance Survey that this family of technology is also capable of delivering decimetre level code based GPS solutions suitable to many survey activities and offering a lower cost, lower accuracy simpler to use alternative to full RTK GPS capability.

In a broader sense with efficiencies gained from these programs resources are now being targeted at new data requirements and their associated maintenance regimes. The newly released Integrated Transport Network with Road Restriction Information, part of OS MasterMap® is a good example.