MANAGING THE TRANSITION TO SUPPORTING THE PRODUCTION OF DIGITAL GEOGRAPHIC PRODUCTS IN MILITARY SURVEY

Major General C N Thompson

Director of Military Survey, Ministry of Defence
Elmwood Avenue, Feltham, Middlesex TW13 7AE

ABSTRACT

Since the early 1970's Military Survey has been increasingly involved in meeting the demand for digital geographic data required to support a wide range of defence applications including navigation and weapons systems, command and control information systems, and training simulators. The data, in the form of elevation matrices and vector or raster feature data, is required to varying densities and accuracies covering a wide range of equivalent map scales, and particularly between 1:50,000 and 1:500,000 scales. The diversity of applications of the data also presents severe problems in developing a range of digital products which will satisfy a wide range of defence needs.

The increase in demand for digital data has not been matched by a comparable reduction in requirements for conventional maps and other graphical products. It has not therefore been possibly simply to transfer resource from conventional to digital products. There have also been problems, common in most organisations, that the introduction of new technology and production methods are not without difficulty. Additionally, there are a variety of constraints on the organisation with increasing pressure to reduce manpower and other costs, and inflexibilities in the recruitment, classing and grading of staff on a more-or-less fixed salary structure.

The paper discusses some of the problems associated with the introduction of instruments and processes to support the production of digital products. It will cover the main managerial concerns and issues surrounding the transition to a new digital production system. It will also outline attempts to achieve a better definition and rationalisation of customer requirements, and describe the main technical concepts by which productivity is to be optimised.

INTRODUCTION

Military Survey is a branch of the Royal Engineers. Its role is to provide the Armed Services with the land maps, aeronautical charts and other survey data which they require in peace and war. It is essentially a role that depends on peacetime activities similar, in many ways, to those of the Ordnance Survey. The area of responsibility for Military Survey is however worldwide, with geographic information collection and standard series production work carried out on a continuous basis. In an emergency or war situation the whole emphasis is re-directed to rapid response tasking. To give an

indication of the Military Survey operation we currently have to meet specific requirements for some 15-20,000 printed maps and charts and hold stocks of over 30 million sheets. The range in scale of product stretches from town plans, through 1:50K and 1:250K to 1:500K and 1:1M. There is now a significant requirement for digital geographic products amounting to perhaps 20 per cent of their paper equivalent and increasing rapidly.

Military Survey has been involved in the production of digital data for more than 15 years, with development work stretching back to the early 1960s. This has been a period of evolution with digital systems, and the requirements on which they were based, arriving on an ad hoc basis. The ideal, certainly perceived early on, to develop along the long held principle of survey of going from the whole to the part was just not possible due to the sheet size of the projects that would have resulted, the funding problems and not least the technology itself which was insufficiently advanced.

To date in Military Survey the most significant digital production system was developed to meet a defence requirement for Digital Terrain Elevation Data (DTED) and Digital Feature Analysis Data (DFAD) incorporated in the Digital Landmass System (DLMS)(1). This project was conceived in the early 1970's to provide continuous radar navigation scenes in advanced aircraft simulators, but now has much wider applications. The second system, Production of Automated Charts Europe (PACE)(2), was designed partly to satisfy a defence requirement for up to date air information, and partly to achieve economy of map and chart production. This saving was possible due to the range of related products that existed over the central European area. Our success in meeting these two programmes has relied extensively on the Laser-Scan Fastrak automatic digitising system(3) which has been progressively developed, and tailored to the needs of these two programmes.

I believe we have now arrived at the time when we have to consider the full implication of the technology we have so readily embraced. There is no indication that the defence requirement for paper maps will diminish, while there is the certainty that the requirement for digital geographic data is increasing exponentially. There will continue to be pressure on resources; therefore not only do we have to consider the impact of technology on the requirements of our users, we have to apply that technology to enable considerably improved production efficiency and higher standards of service to the defence user.

In mapping the transition from map production to supporting the production of an increasing range of digital geographic products requires that we:

a. identify and analyse the defence requirement for digital geographic information.

b. design and develop appropriate digital products.

c. establish standards for the exchange of data and digital products.

d. develop and implement appropriate production capability, the "multi-product operation".

In addition, of course, there are the many other management initiatives that have to be taken in developing and implementing any new technology system. In this paper I will not be discussing matters such as the defence procurement system or training for example.

THE DEFENCE REQUIREMENT

When we talk of the defence requirement for geographic information we look fundamentally at the terrain, and the impact that the terrain can have on military operations. The terrain is not only the land surface but the natural and manmade features on or beneath the surface. All these we can describe by attribute or attribute value, and we can also add related military or air information pertinent to the conduct of the battle. The schematic of the terrain in Figure 1 illustrates this concept. The military therefore requires knowledge about the terrain in one or more of the following forms:

a. in descriptive form such as a map or display where the image is clear and unambiguous to the human eye.

b. as discrete positional data, where the relationship established between two points or a number of points is unambigious, as in navigation systems or elevation models.

c. as relational terrain data, enabling its analysis and evaluation with other data pertinent to the conduct of military operations.

The emerging applications for the use of digital geographic information can be summarised under the following four headings:

a. **Navigation and Guidance.** The requirement here is for positional data and map displays which support the navigation of the air or ground vehicle, and which will be linked to the integral navigation system of the vehicle which may include terrain referenced navigation systems.

b. **Surveillance, Targetting and Weapons.** The requirement in the first instance is terrain data to support surveillance of the battlefield for the acquisition of targets. Once identified the relative position of the target to the weapons system must be determined. Additionally terrain data is required in planning the siting of some weapons systems.

c. **Command, Control and Communications.** The state of the art in information technology itself is driving this requirement for army and airforce command and control systems. The need extends from simple background map displays to the sophisitication of terrain analysis databases.

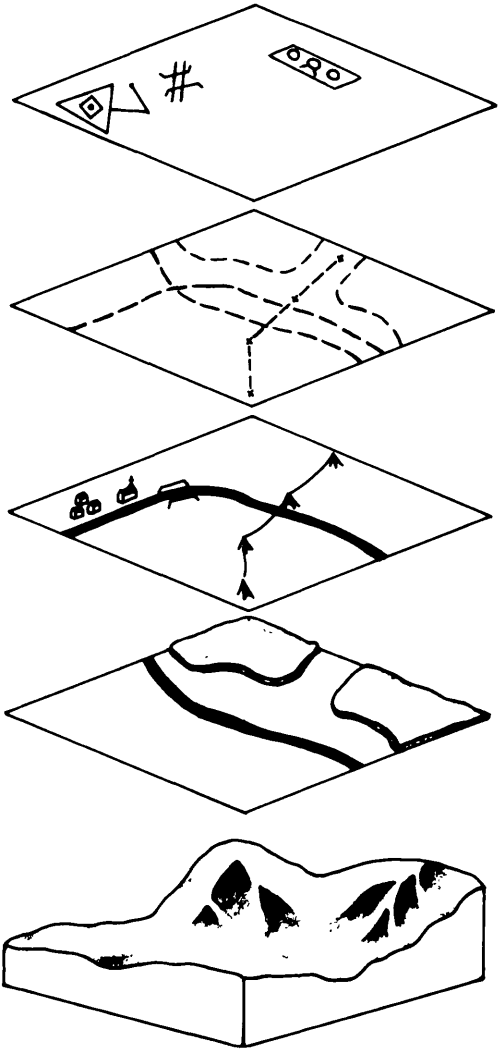

Figure 1 - Terrain Data

d. **Training Simulators.** The use of simulators for training (eg the Tornado simulator for which DLMS was developed) offers better training at reduced cost for many

weapons systems and battle group trainers. The data required includes elevation data, map displays and radar or visual simulation.

Additionally we have our own need to apply the digital technology to provide the digital data required and to improve our production efficiency, as for example with the PACE programme.

A major element in defence requirements is the need for interoperability - of weapons systems and command and control systems, within battle groups, within and between the Services and between nations, such as in the NATO alliance. In the geographic field this manifests itself in the need to establish, nationally and internationally, standards for mapping and now digital geographic information. This I discuss later.

DIGITAL GEOGRAPHIC PRODUCTS

The digital geographic products that we are now producing or designing for future use derive directly from the requirements for geographic support. They can be categorised from the simple to very sophisitcated database products. These are discussed below.

Map Displays. For most evolving systems a simple background display is requested. Data storage capacity is a limitation, as is the availability of data over large areas. Expedients have been adopted, such as projected map images or video maps, and there is a multiplicity of products emerging. These are inflexible as compared to a fully digitised map where there are options for selection of data to be displayed.

Elevation Data. Terrain elevation data is probably the most readily available, and is used in a wide variety of applications. It is relatively easily produced from contours or by direct photogrammetric compilation, is easily structured (or modelled) and manipulated to produce, for example, obscuration diagrams and perspective views.

Feature Data. Both the natural and manmade features, on and below, the ground surface are included. Features can be digitised as point, line or polygon, with the addition of a feature attributes. Such data is readily used for displays and map replication. For more complex applications data needs to be structured.

Radar/Visual Simulation. This requires elevation data and feature data. The latter can be selective as in the case of radar simulation, when only radar significant features need be incorporated in the product data base that can be generated. However the coding of the features is based on a complex specification. For visual simulation all visible features will, presumably, need to be digitised. Such a product data base will need to handle radar and other types of simulation as well.

Terrain Analysis. Todays terrain analysis maps are inflexible, limited in application and difficult to use. They are therefore not greatly used and their importance is overlooked. The creation of a digital terrain analysis data base will overcome the major problem of accessing and evaluating all types of information about the terrain in real

time. More extensive feature types and attributes will need to be incorporated than for other applications, and the data will need to be properly structured. This is a demanding relational database application.

The examples of digital geographic products I have given above will, I hope, serve to illustrate the wide range of applications that have to be satisfied. Many users are already developing their own variants and there is the danger of a proliferation of digital geographic data that it will not be possible to support in the future. This reinforces the need for data standards. It also places priority on defining the range of products that it will be possible to support, and defining the production capabilities required. These matters are discussed in the concluding two sections of this paper.

Given that the necessary data standards will be defined and agreed, there remains the need to establish the range of products that can be produced and maintained by Military Survey. As we have seen these range from simple graphic displays to complex relational databases. It we are to succeed we have to look at our whole production process so that we can achieve the required product range within the constraints of available resources. The solutions we are proposing centre around optimising our use of digital technology, and developing the use of the multi-use database concept. This is discussed in the concluding section.

DATA EXCHANGE STANDARDS

The need for digital data standards is now universally accepted. How we are to achieve them is another matter. Such standards are going to be needed for digital work within organisations, and between organisations; and on a national basis and also internationally. There will be the need to exchange data between organisations, and although this can be arranged on a one to one basis many problems will be eased if a universally recognised standard can be agreed. There are also important implications for equipment manufacturers so that interfaces between equipment and systems of different manufacturers can be easily interfaced, and in the defence field so that weapons and other systems can be supported by the appropriate geographic data.

There are already a number of initiatives taking place in Military Survey, and with our NATO partners, as described in reference(1). The Ordnance Survey has now set up its Working Group into Digital Data Standards, and on a national basis data standards is a matter of active concern to the governments

Committee of Enquiry into the Handling of Geographic Information in the United Kingdom (the Chorley Committee). From all this activity one can look for positive results in the not too distant future.

For its part Military Survey started a Data Structure Study in 1984 which reported in May 1985. The aim of the study was to develop a structure capable of supporting advanced military requirements. The results of the study have provided the basis for defining some of the essential features required of a data exchange standard. The study also addressed the need for economy of production.

The main results of the Study were for a database system, based on 3 functional elements, to be developed. These elements are:

a. **Spatial data** - edge/node structure.

b. **Attribute data** - the data that describes the spatial data.

c. **Source ID data** - in a multi-product environment the maintenance of data integrity is considered essential. The Source ID data is designed to provide a full audit trail capability to support this requirement.

Two additional systems, a Geo Cell Management System and a Toponymic Database were also recommended to provide the management support needed for data maintenance.

A major conclusion of the Study was that such a database system is capable of development to support the Military Survey requirement for digital geographic data production. The concepts for such a multi-product operation are discussed in the final section.

THE MULTI-PRODUCT OPERATION

In conventional map production in general, for each product that we produce we have a separate production flow-line. There may be similar operations performed on a number of flow-lines, but in essence from the appropriate source material we extract information, cartographically process it and end up with a map product. This is illustrated at Figure 2. Different products may be related to each other, for example deriving smaller scale maps from larger scale maps, but nevertheless this requires a different process and production flow-line. Similarly we may modify a product as in the case of overprinting additional information eg at powerline and obstruction information for helicopters printed on a 1:50,000 map base. This procedure is manpower intensive, it is expensive and very time consuming. This is particularly so for a family of scale related products where there is no

possibility for all the maps to be produced within a short period of time, but rather over a number of years for a particular area.

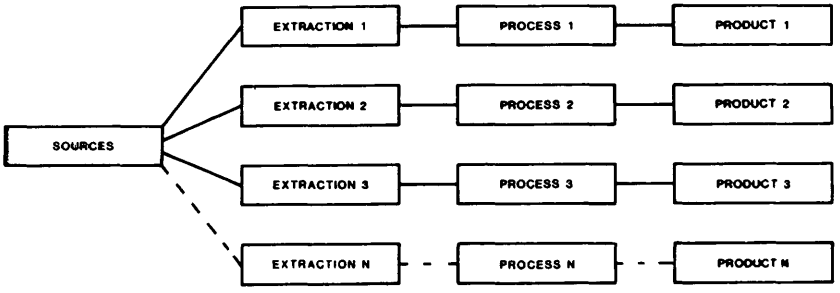

Figure 2 - Conventional Map Production Flow

In the future we are not only going to have to maintain production of map products but also digital products. Many of these digital products will relate to the map product and will be extracted from information on the map products. Nevertheless this is a significant additional workload and to approach it by adding further production proceses and flow-lines would involve an enormous increase in resources. Furthermore, it would be extremely difficult to achieve the required consistency of content and currency across a product range produced in this way. Therefore the system proposed for the future provision of digital geographic data by Military Survey had led us to look at the concept of the multi-product operation shown in Figure 3. The concept of a multi-product operation is that of capturing and storing a database from which many different products can be derived. The Military Survey multi product data base might be one scale free source data base or, more likely a series of scale related data bases. The concept envisages supply of data or data products to a number of user systems each requiring digital geographic data. Between the Military Survey data base and the user system a transformation process will be necessary, which will manipulate the data and output it in a form that the user system can accept directly. The concept is illustrated at Figure 5.

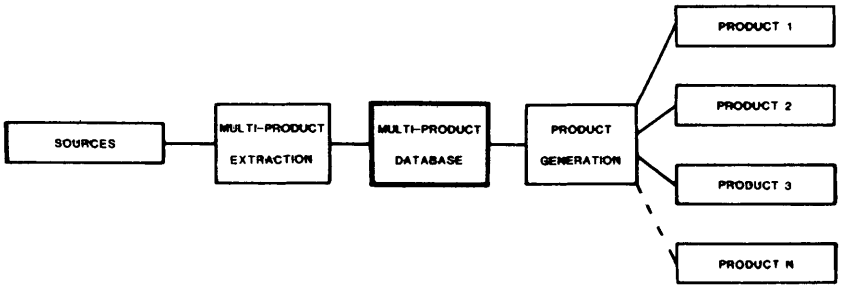

Figure 3 - The Multi-Product Process

The user system will be a type of defence system that requires digital geographic data in a particular format. The user system might consist of just one equipment or application for which a specific product would have to be produced and supplied, or it might consist of a number of user systems or equipment which could be supported by a single digital product. In terms of the system diagram at Figure 4 this does not matter but it may well influence how the data is physically supplied. Therefore there will be many different user systems, some of which will be able to accept the same data sets and others that will require totally different data.

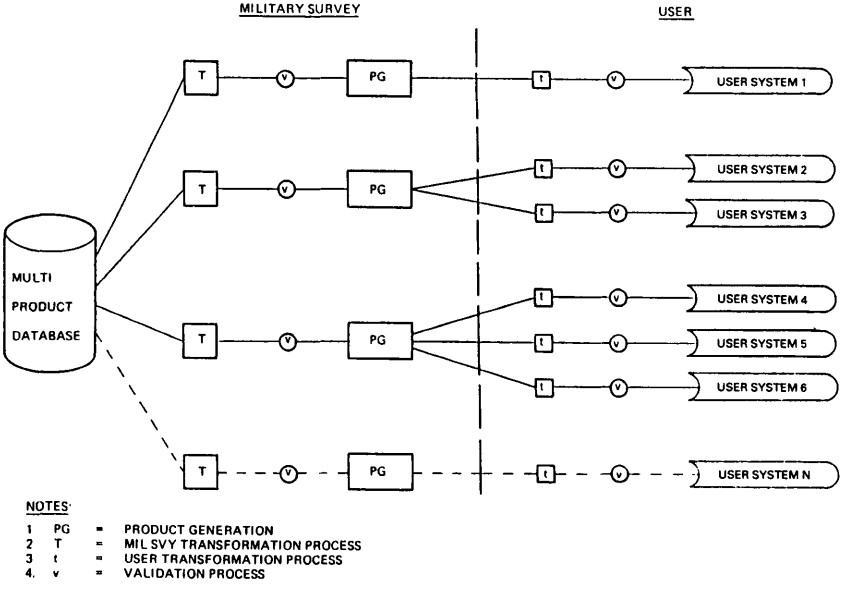

Figure 4 - Multi-Product Operation Supply System

To bridge this gap between the Military Survey data base and the user system we have to consider the transformation process, or processes, which will be required. In the concept shown at Figure 4 we envisage that transformation of data will occur at two stages. Firstly will be the transformation of data after extraction from the Military Survey multi-product data base and conversion to a specific product, or as we are called it "product generation standards" (PGS). The PGS is then available to the user system and a second transformation is performed to convert the data into the specific form required of the user system. The main variations on this basic theme are illustrated in Figure 4. An alternative concept would be to produce a single Military Survey digital product which is then passed to the user to make this own extraction and transformation to specific systems. We have discarded this approach.

In carrying forward the multi-product concept, the problem will be how to arrive at the "ideal" range of Product Generation Standards. To some extent it will be an evolutionary process, as is the case at the present time with the products that we are already supplying. However if the necessary economy in production resources is to be achieved it is essential that this matter be addressed sooner rather than later. The Military Survey Data Structures Study established the feasibility of the multi-product operation approach. As a follow on to this Study Military Survey are now undertaking a number of Technical Design Studies which will lead to the development of the Military Survey data base and, then to the definition of a number of product generation standards required to meet existing and perceived user requirements. Once these product generation standards are defined they can be adopted by users for the design of their systems, and this in itself will encourage progress towards standardisation. Present plans are for the Technical Design Studies to be completed during 1986, followed by development of the Military Survey data base for implementation during the latter part of 1988.

CONCLUSIONS

In this Paper I have outlined the major problems facing Military Survey management in moving from the era of conventional map production to the production of digital geographic data. The major management issues centre around what users require, the development of appropriate digital products and digital generation standards, and at the time establishing standards for the exchange of data and digital products. The major challenge now is the development and implementation of a multi-product data base for Military Survey to support the multi-product operation.

I have not discussed in this Paper management issues which fall in the domain of normal project management. These include such things as training. These should not be overlooked, and

it remains a major management responsibility that such things are done thoroughly if one is going to succeed in the main objective of introducing the new concepts of production which I have indicated.

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