

## INTRODUCING NEW TECHNOLOGY - A MANAGER'S PROSPECTIVE

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### ABSTRACT:

New technology can be a double-edged sword capable of augmenting significant production improvements with one edge only to be cut by the other edge when procedures and philosophies of an older technology are retained. The implementation of a new technology therefore presents a very challenging task for the program manager who must protect significant capital investments and achieve demonstrated improvement to the overall process. Proper motivation and training are essential to the success of implementing any new technology. This paper will present the challenges, rewards and drawbacks of new technology from the manager's point of view.

### KEY WORDS:

Photogrammetry, Global Positioning System (GPS), Geodetic Control, Analytical Plotters, Workstations, Navigation, Kinematic Positioning.

## 1. INTRODUCTION

Within the last 18 months, the Coast and Geodetic Survey's (C&GS) Photogrammetry Branch has introduced two significant technology changes that have had positive affect on the production of national mapping programs. These technologies include the Integrated Digital Photogrammetric Facility (IDPF) and two practical applications of that include the Global Positioning System (GPS) for aircraft navigation and control of aerial photography. These technologies have been introduced and placed into full production within the last 18 months. Each of these technologies has radically changed the methods by which aerial photography is collected and processed into base maps to support the Nautical Charting Program. Each change has come at a great capital investment which had to be measured against it's potential for success and adaptation by the existing workforce. The cliché "you can lead a horse to water but you can't make him drink" is certainly appropriate when dealing with the introduction of new technology. All the new technology in the world would be wasted if not introduced to the workforce in a manner that stimulated interest and promoted appropriate training requirements.

## 2. DESCRIPTION OF THE NEW TECHNOLOGIES

### 2.1 Integrated Digital Photogrammetric Facility

C&GS Coastal Mapping Program, managed by Photogrammetry Branch, compiles highly accurate maps from aerial photography in support of several NOAA programs including: the Nautical Charting Program, Coastal Ocean Program, and the Marine Sanctuary Program. These maps are compiled using the highly automated IDPF designed and developed by the C&GS Nautical Charting Research and Development Laboratory (Figure 1 (Snyder,1990) and Figure 2). At the heart of IDPF are five analytical plotters linked together in a cluster network. IDPF is fully integrated to a relational database that enables aerotriangulation of metric photography, digital stereo compilation, and superimposition of previously compiled digital map information in the stereo model. All of these functions are contained within a MicroVAX workstation connected to each analytical plotter. There are presently five such workstations on a cluster network. Two additional workstations perform aerotriangulation off-line of IDPF. Two of the clustered workstations are physically located within a few feet of the database while three other workstations are located several hundred miles away. The two off-line workstations are digitally compatible to IDPF such that their processed information can be assimilated into IDPF without modification of format or interpretation.

### 2.2 Global Positioning System

Aerial photography and geodetic control survey points are the principal sources of raw data used by IDPF for the production of maps. The photography records the details of the earth's surface on film while the geodetic control is used to establish the scale and orientation of the photography and the resultant map. Classic geodetic control has been established by theodolites and electronic distance measuring instruments that require line of sight between instrument stations for measuring angles and distances on the surface of the earth. The requirement for line of sight has always been a limiting factor for providing adequate geodetic control for aerial photogrammetric surveys. The geodetic control dictated the location of the flight lines thereby compromising photographic coverage and its geometric strength. Most often the flight lines for obtaining the photography were compromised to use existing geodetic control. This compromise came at the expense of aerotriangulation and compilation accuracy and efficiency. GPS requires only a line of sight to satellites orbiting high above the earth and thereby has allowed the geodetic control to be established where it will maximize mapping efficiency and accuracy.

Photogrammetry Branch has also demonstrated the ability to use GPS to directly measure the camera station parameters to relative accuracies of better than 10 centimeters (Lapine, 1990a). This capability results in a significant reduction for the need of ground-based geodetic control for the mapping process.

GPS has also been integrated into the aircraft navigation system used during the photographic mission. The instantaneous position of the aircraft as determined by GPS can be tracked on a digital map display at the navigator's station. Flight lines designed by office planners are superimposed on the digital map. The aircraft is navigated along each flight line by adjusting the autopilot in order to keep an icon, representing the aircraft's position, centered on the programmed flight line. Prior to this technology, flight lines were approximately navigated by comparing mapped images against the ground as viewed through a modified bomb sight. Considering normal operating altitudes of 25,000 feet and the generalized nature of small scale maps, navigation was an art at best. Re-flights were the norm in order to capture the required imagery for mapping. In areas such as Alaska, one might expect only 6 to 10 days out of a possible 90 day field season to capture the required photography. One line missed due to poor navigation could result in a total loss for the season.

# INTEGRATED DIGITAL PHOTOGRAMMETRIC FACILITY (IDPF)

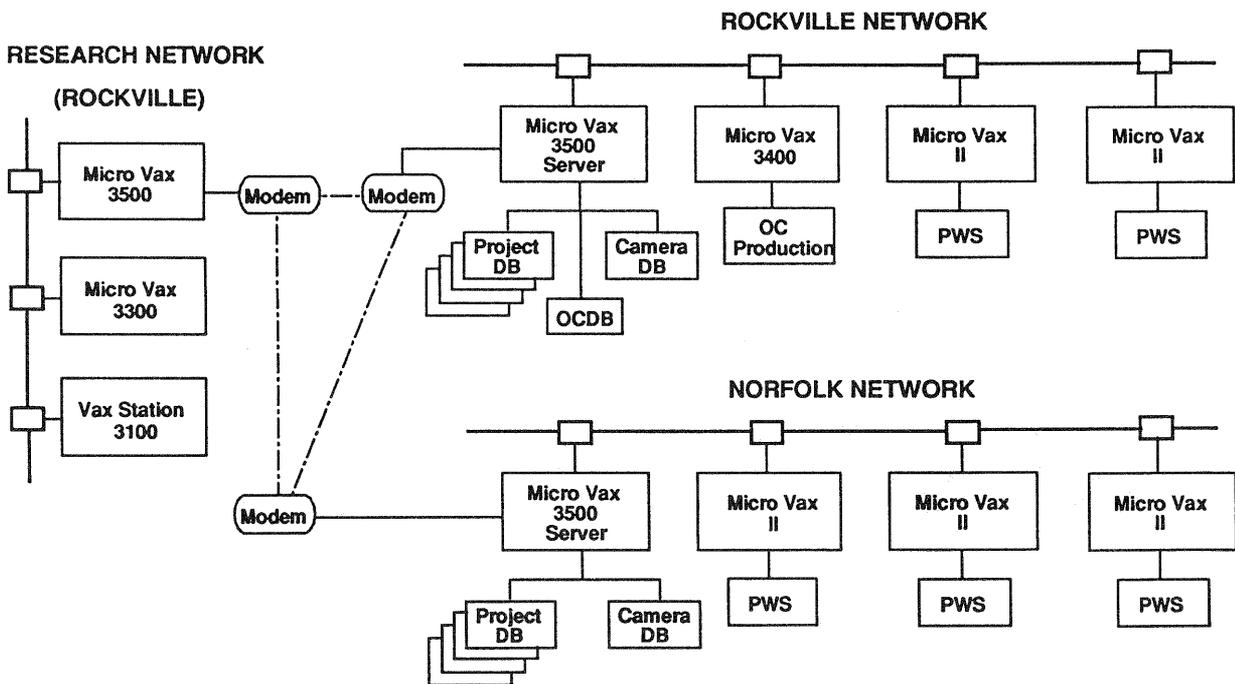


Figure One

The system has recently allowed the potential for navigation over submerged benthic communities for which no map is available for visual navigation. Improved aircraft navigation has already shown the potential of reducing flight time by up to 20 percent because of the more accurate navigation.

The development of these technologies during the last 18 months, has benefitted NOAA and the Nation by using existing program resources augmented by IDPF and GPS to respond to an ever growing need to map larger areas of the nation's wetlands and coastal regions. The technology is also being passed on to industry in order to enhance their needs to provide mapping services to the nation.

### 3. IMPLEMENTATION OF IDPF TECHNOLOGY

IDPF has been under development for the past several years using two workstations located in Rockville, Maryland. During this time period, personnel familiar with the established analog techniques were used to trouble shoot and evaluate the performance of the system. These individuals were part of an exclusive team and therefore it comes at no surprise that they championed the effort. Their motivation came from a desire to succeed. In the meantime, the rest of the analog instrument operators in Rockville and Norfolk had to be content with looking on with detached interest. They had no investment in the success or failure of IDPF.

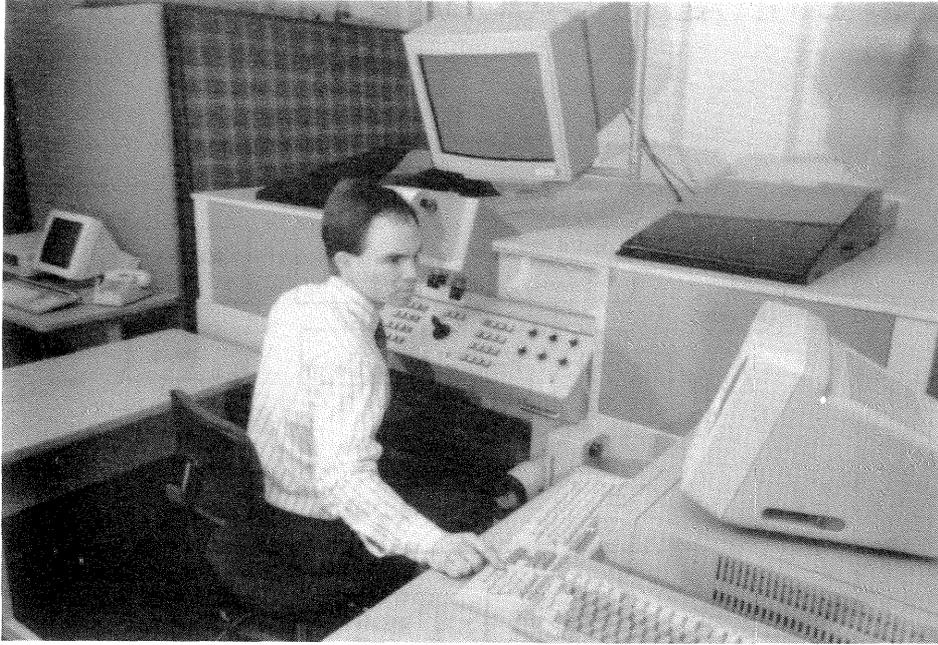
During the summer months of 1990, a pilot project consisting of a portion of the Patuxent River in the vicinity of Solomon's Island was chosen for aerotriangulation and compilation using existing analog instruments and IDPF. The pilot project was performed by two senior compilers. The compilers were given their choice of plotter within the respective regimes and sufficient time necessary to complete their work. Both instruments were completely cleaned and calibrated prior to the beginning of the project.

The final compilation from analog and IDPF systems were carefully compared with no discernable differences in quality or accuracy. IDPF produced somewhat more detail due to its improved magnification attributes, however the detail in general was chosen commensurate with the mapping scale. The pilot project provided sufficient evidence that IDPF would meet or exceed production standards established for coastal mapping.

On October 1, 1990, IDPF was certified for production. All analog compilation in progress would continue until completed. All new projects would be performed on IDPF. This management decision turned out to be wise from the standpoint of training. As analog jobs were completed, those compilers were phased into training for IDPF. As this process continued, more compilers were available for maintaining acceptable production levels and to support continued training of new compilers. One full year was required before all compilation was being performed on IDPF.

The above accomplishment became a significant milestone in itself. It has been suggested that at best only a majority of the non-automated workforce can be successfully converted. Photogrammetry Branch converted 100 percent of it's workforce! The fact that productivity levels remained high while training was being conducted is indicative of the potential for improved performance through automation.

Almost daily, new uses for IDPF were discovered. For instance, the analytical plotter has 9 inch by 18 inch stages. It was discovered that two adjacent strips could be aerotriangulated simultaneously. The larger stage also meant that photographs of different emulsions (natural color for detail and black and white infrared for land water boundary features) could be mounted simultaneously in order to extract planimetry from both emulsions in the same geographic area. It was further discovered that different scale photography could be viewed in stereo using different zoom scales in the optical train.



Integrated Digital Photogrammetric Facility - Workstation  
Figure Two

The compilers were disturbed by the fact that they had to focus on the stereo model as well as re-focus their eyes to view a distant monitor in order to change cartographic codes during compilation. It was discovered that the super-imposition feature could be modified to display cartographic codes in the stereo model, while changes could be effected through control keys located on the analytical plotter. This modification meant the compiler did not need to look away from the instrument during compilation.

Some of these features were implemented without further software enhancements. Others were implemented in very short order due to the powerful, yet adaptive nature of IDPF's software design. C&GS research staff are responsible for building such flexibility into the IDPF environment. This group was very attentive and can be commended for such foresight.

The adaptability of the compilers cannot be overlooked either. Proper motivation and training resulted in the successful implementation of a very expensive high risk investment in technology.

The sum total of success came at some expense. Using analytical plotters requires the aerotriangulation of all photography used in a digital compilation process. In the past, only the color photographs were aerotriangulated in preparation for graphic compilation. High and low water shorelines were traced from ratio infrared photography to a graphically compiled manuscript. In the analytical process a manuscript is not produced during compilation. Only digital files are created, therefore, the need to aerotriangulate all photography used in compilation prior to viewing in stereo on the analytical plotter. Sufficient production has not been accomplished to judge if the increase in efficiency compensates for the additional aerotriangulation effort. One thing for sure, two additional workstations have been brought on line to produce sufficient aerotriangulation to maintain compilation production schedules.

Another major hurdle, yet to overcome, is digital communications between workstations and the database, particularly the remote workstations. High speed data transfer is expensive and not easily achieved. Digital data is also quite volatile. Proper storage and data management requires a full time database manager. With present power management facilities, it is often necessary to suspend data collect during thunderstorms.

Lastly, workstation technology powerful enough to manage a cluster network is costly to maintain as the majority of the software is licensed by the vendor. Each upgrade must be purchased as a set of five licensed pieces.

#### 4. IMPLEMENTATION OF GPS TECHNOLOGY

GPS technology was first implemented for the purpose of establishing geodetic control for aerial photography. Field parties were given the instrumentation with little or no training. The success of the original surveys rested heavily on the user friendliness of the receiver's design. Within months, a 50 percent improvement in field productivity was achieved. Morale, ingenuity, and productivity all improved as GPS technology was assimilated into the survey process. GPS is now used to establish 90 percent of all geodetic control used by Photogrammetry Branch. Projects have been performed which heretofore would not have been possible considering current human and financial resources. Improvements in personal computer technology was necessary to handle a hundred fold increase in data. Personnel were trained to perform automated processing while GPS data sets continued to be collected. Once again, efficiency increased allowing training and production to coexist during a period of expanded geodetic activity.

GPS was next employed in a kinematic technique using a combination of two receivers. One receiver is located on a known geodetic control



Lastly, management must maintain the motivation long enough to allow the technology to become fully accepted into the working environment.

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