Keynote Address

Major General William L. Nicholson, III, USAF, Director, *Defense Mapping Agency*

It is indeed a pleasure for me to address the members and guests of these two professional societies meeting here in your annual convention.

As you know, I'm a "newcomer" to the Defense Mapping Agency. I arrived this past July . . . succeeding (Lieutenant) General Abner Martin. I note that "Ab" was your keynote speaker two years ago. If I might borrow a line from his talk, I too feel "greatly honored for the opportunity to meet with the outstanding professionals who have provided so much to mapping, charting, and geodesy." Not only am I a newcomer to DMA, but I'm a newcomer to the fields of "MC&G" as well. I've used our products on many occasions throughout my career . . . but with little thought to *where* they came from, or *how* they came to be! I assure you that in the few months I've been at DMA, I've developed tremendous respect for your professions, and your technological achievements.

Your work is extremely important. And you've fostered phenomenal technical progress, progress which is contributing significantly to our national defense and to the economic and environmental well-being of our society as a whole.

I'd like to look in some detail at several of what I'll call "milestones of progress" in the MC&G community. Two we have passed. The others are yet before us. I've selected them because I believe they mark—or will mark—points of significant change in the way we do our business. They represent plateaus of progress in the MC&G field which will have significant—purposeful—and lasting impacts on our "way of life" in both the military and civil sectors of our society.

The first milestone of progress occurred in the Sixties—not so long ago really when you think about it. It was during that period that your professions, particularly the photogrammetrists, harnessed the emerging technology to develop the first generation of analytical plotters such as the "UNAMACE"—or Universal Automatic Map Compilation Equipment—and the AS-11. Both have been workhorses at DMA. The intent of course was simply to expedite the production of topographic data in our traditional map compilation process. But what really occurred is that you opened the door to what today has become a highly sophisticated process for the collection of terrain elevation data. From those initial efforts to apply analytical methods to what previously had been a very tedious, labor-intensive, time-consuming manual compilation process, we have progressed to new generations of highly reliable and responsive plotters.

And, where has that brought us? Well, as many of you are already aware, that digital terrain elevation data, originally intended only as a by-product of our topographic process, has become a widely demanded product. Today, our Armed Forces are placing ever increasing reliance on digital terrain data to "smarten-up" the new generations of weapons systems.

The Cruise Missile system, for example, will use a new guidance and control technique we call TERCOM. It deeply involves DMA and our capability to produce digital terrain data. The data we generate—tailored along pre-planned flight paths—will be stored on-board the missile in the form of elevation reference scenes. The missiles will "sense" terrain scenes enroute—and provide an error signal to update the inertial navigation system. Incidentally, the correlation techniques used in the missile—and, indeed, in several other weapons systems—have their roots in the correlation technology you employed in those early analytical plotters.

The Cruise Missile is a *big* program . . . and providing all those "digits" for all those preplanned flight paths is a tremendous program within DMA.

There are many other examples I could cite. Aircraft cockpit displays of digitized data as an aid to navigation, shipboard displays, or terrain data for the commander in the field.

But it doesn't end there. There are a growing number of applications throughout our entire community. Witness the techniques and equipment used today for major project planning. That is, locating highways and pipelines, flood control and impoundment analyses used in designing major water resource projects, techniques used for earthwork computations, and microwave line-

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of-site determinations, to name just a few.

So, from those early plotters you developed less than twenty years ago we have progressed today to techniques and equipment for producing terrain elevation data at fantastic rates. We have the ability to recreate or "model" large areas of the face of this globe of ours almost instantaneously when compared to the way we used to do it. The ability is proving invaluable in helping us resolve a wide range of problems we face daily as we strive to live in greater harmony with the world and its resources.

The second "milestone" or "plateau" of progress I'd like to address occurred fairly recently in the area of point positioning: the breakthrough made by the surveyor community to a moving base, or inertial, surveying capability.

We've seen truly remarkable changes in surveying techniques and equipment over the past two decades. The old transit and steel tape have given way to highly accurate laser and infra-red beam devices.

But, I believe we passed a milestone of even greater significance with the successful fielding of an inertial positioning system. Several years of effort have been devoted by both the military and civil MC&G sectors to perfect a reliable inertial measuring device which may eventually solve the total problem of geodesy, that is, positioning, gravity, and deflection determinations.

We adapted components and technology originally developed for use in inertial navigation systems for high performance aircraft into an Inertial Positioning System—or "IPS." IPS-1 was developed and placed in operation by DMA in 1975. It consists of an inertial measuring unit, a data processing unit, and a control display unit. We have it mounted in a Chevrolet Blazer and in a helicopter. It's operable by a two-man team, day or night, and in all weather conditions. We are realizing positional accuracies on the order of 1.5 feet over distances of 40-50 miles. We have "IPS-2" undergoing field test and evaluation now. We expect it to provide accuracies in the 0.5 to 1 foot range. As you know, a number of other mapping organizations are making regular use of this technology today. Reports indicate that users are experiencing tremendous cost benefits. You surveyors have finally gotten yourselves that "little black box" you've been wanting all these years.

Our purpose in DMA, of course, is to develop a system that will help us meet the survey requirements of the many advanced weapons systems currently under development. Most notable on the horizon is the MX system you have undoubtedly all heard about. The mobile basing concept envisioned for that system will place a heavy surveying requirement on DMA.

"IPS" alone is not the total answer, but we're looking to it for a significant amount of help.

Now, the ultimate in a truly "moving-base" survey system would be the linking of an IPS-type device to the upcoming NAVSTAR Global Positioning System, or "GPS." GPS is a DoD program which is primarily being developed for Defense-oriented navigation. It will consist of a constellation of 18 to 24 high altitude navigation satellites in three orbital planes. The satellites will be spaced in such a way that signals can be received in the air, on the ground, or at sea from at least five or six of the satellites at all times. The implications of continuous, real time, highly accurate navigation are obvious.

Although GPS is being developed primarily as a navigation system, it offers tremendous potential as a means by which we could conduct geodetic and surveying tasks. We are currently developing a GPS-compatible geodetic receiver. Our goal is a lightweight, field portable receiver that will deliver high quality survey control—to within less than a 3-foot accuracy—in a matter of a few hours observation by a one- or two-person team. The results thus far have been excellent.

We believe the marriage of a GPS geodetic receiver and the IPS will eventually occur. The ramifications of this hybrid system could be significant. However, the advances in an integrated geosurvey system are difficult to predict at this time.

So, as a result of the breakthroughs we've already seen in inertial surveying, and the progress visible on the horizon, I believe the science of surveying is about to undergo a revolution. The ability to rapidly move cross country—or simply fly over an area—and determine horizontal and vertical position accuracies on the Earth to the degree of precision we see in the inertial equipment now coming on the scene will have dramatic impact on the way we install geodetic and cadastral control in the future.

My third "milestone," driven primarily by the cartographers, is the development of a *supra*continental "cartographic" data base. We have yet to achieve such a base, but we're well down the road toward that goal.

Just as the computer made such devices as the analytical plotter the key to an entirely new way of dealing with terrain elevation data, so too is it opening other major "doors" to us. The strides made in recent years in harnessing computer technology to many functions in both the photogrammetric and cartographic areas of the map making process are well known. As a result, we are capable of producing vast amounts of MC&G data in digital form.

When we marry that ability with the exploding computer technology available for accessing and manipulating those "digits," we begin to understand the ever-increasing shift from conventional map products to direct use of the digital data, and thus the need for ways to organize, manage, and exploit these growing masses of data.

The result is establishment of digital data bases. Thus, MC&G information stored in digital format could be readily available for "call up" to support a variety of support needs in a timely fashion.

The ability could not have arrived at a more opportune moment. There is increasing awareness of the important role reliable, current MC&G data can play in improving the efficiency and effectiveness of a variety of vital activities throughout our society. In the military, focus is on the improvement in the accuracy of our weapons systems through greater use of MC&G data in guidance and control. In the civil sector, it's in the improved management of our Earth resources and enhancement of our total environment.

At the same time our ever-increasingly dynamic world demands increasingly dynamic responses in meeting its challenges. That old static, "encyclopedic" map sheet is becoming less capable of satisfying the dynamic MC&G needs of today.

We entered the world of digital MC&G data bases in 1974 when we began to compile what we called the Digital Radar Landmass Simulation Data Base, or DRLMS. It was to serve as the DoD standard for support of aerospace radar simulation.

Today, we call it the Digital Landmass System, or DLMS. It is the framework "data base" to support a wide variety of correlation type sensors, navigation systems, and a growing number of simulators. Two examples:

• The Army's Pershing II Missile, much discussed in the news lately, employs a technique of radar reference scene correlation during its final stages of flight to "home-in" on its target. DMA-generated digital data will be used to create radar reference scenes. These scenes will be stored—in digital form—on board the missile. As the missile approaches the target area, it will sense a series of radar scenes. Each scene will be correlated with the predicted scene, and appropriate course adjustment signals sent to the missile's guidance system. You can easily see the implications such a technique has on the size of payload needed to assure the desired damage to the target as well as the cost implications.

What you may or may not see as readily, however, is the amount of digital MC&G data needed to support such a system.

The Pershing II's operating area will approach 1,500,000 square miles. To provide the missile a "target-of-opportunity" capability, we will need digital terrain and radar data over the entire area. That means a data base with elevations on roughly a 100 metre (or about 300 foot) grid, plus hundreds-of-thousands of feature data "digits."

• In addition, the expanding use of simulators as cost-saving devices to "experience" our pilots and navigators—and I mean not only those in the air, but also those who operate on the sea—require that we "digitize" large areas of the face of the Earth. Only then will they be afforded realistic simulations.

As a result, our currently validated requirements for DLMS digital data—and that means known demands to support known systems such as the Pershing II and the radar simulators for our B-52s, F-111s, and others—exceeds 18,000,000 square miles.

You can see I'm talking about *a lot* of digits!

And I must emphasize that the examples I have just cited address only one class of digital MC&G data: that which is radar significant. There are others.

The ideal then is a single "cartographic" data base that is structured to serve as many needs as possible. We are a long way from achieving such a "universal" data base—if, indeed, it is even possible. But DLMS demonstrates both the desirability and feasibility of a supracontinental MC&G data base—and we believe we are on the right track to achieve that goal.

And, that brings me to my final milestone: The need to develop an "all-digital" MC&G production process.

I have spoken of the tremendous strides that have been made in the capabilities to digitize MC&G information, and the increasing demands for that information directly in digital form throughout all sectors of our community.

If we are to have the flexibility and responsiveness to provide our customers the MC&G information they want, when they want it, in the form they need it, all at a prospectively affordable cost, we need to move as quickly as possible toward an all-digital production process.

Why the need?

The demands being placed on us dictate data bases on the order of 10^{15} bits. And, while we've made great strides in automating the compilation and cartographic processes, just to digitize that 18,000,000 square miles of DLMS data I previously mentioned will require something on the order of 2000 man-years of effort.

Clearly we need to improve our ability to handle fantastic amounts of digital data in a more timely manner. Despite the maturity of some of our processes, we are still in "digital infancy" when you look at our total production capability.

But, the the problem is not limited to DMA. The needs for improvement exist throughout our entire MC&G community.

Major challenges remain in the areas of feature extraction, data management, and product transmission and display.

The new technologies we are seeing in correlation-type sensors, in navigation systems, and in simulators require that our data bases contain static and time-varying feature data. Included are such things as texture, thermal properties, road patterns, and population and traffic density patterns, to name a few.

Extraction of feature data is a rapidly growing task. Unfortunately, it is still largely a manual process: very labor intensive, very slow, very costly, and becoming more costly each year.

Between now and 1985, DMA is planning to expend some 25 to 30 million in R&D and procurement to "break the ice" in moving to "semi-automate" the process.

We will begin operating this year with a digital inter-active system that will enable us to exploit Landsat Scanner data. It's the result of a technology transfer project with NASA's Earth Resources Laboratory. We have found that we can use Landsat-type data to meet our current production standards for landscape feature extraction.

In our development activities we are seeking a Computer Assisted Photo Interpretation System, or CAPI. CAPI would be an integrated photo interpretation and mensuration work station under computer control, using unrectified photography. The feature analyst will have the capability to classify and digitize all DLMS feature types with this system; however, we intend to use it primarily for extraction of non-landscape type features.

Other hardware in near-term R&D includes a Voice Data Entry System which will enable the analyst to record feature descriptors without breaking his eye-contact with the stereo model.

In addition, there will be several study efforts programmed through the mid-Eighties which concentrate in the areas of pattern recognition and image understanding and the automation of these processes. The results of these studies will determine the additional hardware and software design needed for an automated feature extraction system.

By the mid-Eighties, we expect to be well along in an interactive feature extraction process. But full or near-full automation is at least 10-15 years away. While we don't expect to remove the "PI" completely from the loop, we do intend to automate as much of the redundant, mundane, and labor intensive processes as possible.

Data management poses another major challenge to attainment of an "all-digital" system. However, we see a number of R&D efforts aimed at development or improvement of data storage and manipulation techniques. Convincing demonstrations have revealed that the optical video disk can store tremendous volumes of digital data. Simultaneously, the older magnetic recording technology is exhibiting continued improvement.

Other improvements which appear attractive are parallel processors, new ideas in memory organization and memory hierarchies, and distributed processing techniques.

The expanding availability of communication satellites, the advent of fiber optics, and the capabilities for processor-to-processor and long-haul data communications enable transmission of ever-increasing amounts of data. Our challenge is to structure a system for transmitting our digital data . . . so that we can be responsive in providing current data.

And then there's the matter of producing that age old paper map product. It will still be in demand for years to come throughout our entire community. If you remember, we entered the "digital world" to improve the map compilation and color separation processes for producing that map.

DMA is nearing completion of the development of a digital Laser Platemaker which will provide us the capability to produce large format press plates directly from tapes of digitized data. We hope to be able to "write" a press-ready plate in about 30 minutes.

New, fast techniques are emerging for

printing directly from digital input to paper. It will be a long time before this technology would overtake the lithographic, or offset, printing techniques for producing large quantities of products. But as our community moves closer to an all-digital process, and the ability to archive and rapidly access vast amounts of data in digital data bases, the demand for large quantities of map sheets is expected to decline. I believe we will be printing products in smaller quantities because we will have the flexibility to keep our digital data bases current, we will have the ability to rapidly access just the MC&G data that the customer really needs, and we will have the ability to tailor a product to fit his needs, quickly print it, and get it to him. Or, better yet, we will transmit the "digits" to him, and he can print them, or display them, as best suits him.

To attain such a process will enormously benefit our entire community, and will indeed be a significant milestone of progress.

I have every confidence that this last milestone is attainable. As I said at the outset, through the dedicated efforts of many of you here today, and your fellow professionals, you've fostered some truly phenomenal technical progress in our community of mapping, charting, and geodesy.

Our nation owes you no small debt of gratitude for your contributions to its strength, whether your efforts are, or have been, in the military or civil sector.

I solicit your continued foresight and dedication to such "purposeful progress."

Conference/Workshop and Exhibit

Thermal Infrared Sensing Applied to Energy Conservation in Building Envelopes (Thermosense III)

Radisson South Hotel
Minneapolis, Minn.
2–5 September 1980

The four-day seminar will be conducted by the Society of Photo-Optical Instrumentation Engineers (SPIE) and cosponsored by the American Society of Photogrammetry, with the cooperation of the American Society of Heating, Refrigerating, and Air Conditioning Engineers. The purpose of the meeting is twofold:

- To encourage communication through a transfer of technology and information among the technical and nontechnical communities concerned with the use of thermal infrared sensing technology in building envelope energy auditing and conservation programs, including those already involved in such programs and those planning programs on behalf of government agencies, municipalities, utilities, corporations, construction companies, etc., and
- To provide a forum for the exchange of ideas and capabilities among technologists involved in R&D activities, engineers, manufacturers of instrumentation, measurement service organizations, training institutions, and those in the scientific and technical community responsible for developing measurement criteria and standards for equipment performance and measurement programs.

The program will consist entirely of invited papers grouped into five sessions: A tutorial-review-poster workshop, residential programs, commercial and institutional programs, standards and training, and trends in thermal sensing. The conference will conclude with an interactive session between the audience and selected speakers, which will focus on issues, problems, questions, and concerns developed during the course of preceding sessions.

Additional information may be obtained from

SPIE
P. O. Box 10
Bellingham, WA 98225