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Computational Photogrammetry

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ONE OF THE VERY REAL miracles of our time is the development and use of computational capability in the last two decades. This astonishing development has taken place in less than the span of one professional career. I recently found reference to an article in a 1954 issue of Business Week. In a "gee whiz" story commenting on the computer industry, it confidently predicted that 50 large computers would be required by U. S. industry within the foreseeable future. Today over 100,000 are in service and each of them is larger and more complex than the ones Business Week was talking about.

The American Society of Photogrammetry was not the first, but neither was it the last, to recognize the impact which this new computational capability would have on our profession. In 1961, at the initiative of Professor Sumner Irish of Princeton University, an informal group was put together to consider what should be done, and in 1962 the Committee on Computational Photogrammetry appears for the first time in the yearbook issue of PHOTOGRAMMETRIC ENGINEERING. Most of the men who participated in that formation are in the audience today. In the intervening years, the annual symposia which this committee has organized have contributed substantially to the development, extension, and general acceptance of computational techniques within our profession.

Largely under the aegis of this committee we now have a variety of well documented observing and mensuration techniques, and computer programs for camera calibration, single-photo resection, individual stereo model intersection, the sequential and simultaneous strip triangulations, adjustment programs for strips and groups of strips, and programs for strips and groups of strips, and complete simultaneous block adjustments. We have attacked and largely defeated the major problems of solving the large matrices which arise in our solutions. We have investigated and formulated the constraints which will be available to us when metric quality photography is obtained from orbiting space vehicles. Our computational capability has been extended to the real time solution of photogrammetric equations in instruments like the Analytical Plotter and the Unamace. Undoubtedly, there are additional refinements yet to be made, but I venture to suggest to you that the principal problems of point by point computation of photogrammetry are pretty well in hand. Now at the beginning of a new decade is an appropriate time for us to raise our sights to a totally new category of problems. Let us look at some of these problems.

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Within the life span of 200 million people now living in the United States, this nation will consume from the earth:

$6\frac{1}{2}$ quadrillion gallons of water
$7\frac{1}{2}$ billion tons of iron ore
$1\frac{1}{2}$ billion tons of aluminum ore
1 billion tons of phosphate rock
100 million tons of copper and so forth

There are now 3.4 billion people in the world. By the end of the century the population will grow to 7 billion—some say 6, some say 8—but in any event more than the planet can sustain at our present levels of productivity. In thirty years—within the lifetime of most of us in this room—water usage will triple, energy requirements will triple, we will have to build as many houses and construction facilities as now exist.

THESE ARE COSMIC problems, and as a consequence of them, we are a troubled nation, faced with a multitude of critical decisions, each of which lays legitimate claim to our limited stock of attention, competence, and resources. And the problems are inextricably related. They are not amenable to individual solutions. We must solve them *all* if man is to survive as a species on this earth. The problems are *ours*. If we do *not* solve them our children probably, and our grandchildren certainly, will be the last generation to inhabit this planet.

The annual meeting of the American Association for the Advancement of Science (AAAS) recently concluded in Boston. Amid the welter of papers describing the accomplishments of man's most dramatic technological decade, there was a large measure of agreement on three momentous trends:

1. Some numbers can now be put on man's pollution and population crisis—which add up to one crisis because the two go together. Increasing population will inevitably swamp anti-pollution efforts, unless we succeed in developing an overlapping series of closed recirculatory systems.
2. Both science and general society must face the fact that man's survival is going to be costly—in dollars, pounds, francs, marks and rubles—and we will not survive unless we are willing to start paying the bill.
3. Scientists and engineers must take moral stands and not limit themselves to saying "We are only the tool makers, and society must decide how to use us."

We must undertake a national commitment to provide *all* people with the opportunity to improve the quality of their lives. It is a momentous commitment but an absolutely essential one.

I AM REMINDED of the story of the small boy walking across the Irish countryside and faced by a series of stone walls surrounding each property. Whenever he came to a wall too high to try he took off his hat and tossed it over the wall; then he had no choice but to follow it.

We have thrown our hat over many walls in the past decade, including the wall of interplanetary space. We must now throw it over the walls of social justice, political coexistence, and environmental salvation.

What has all this to do with photogrammetry and particularly with computational photogrammetry? We are a small society—6,000 people out of 200 million in this country. Computational photogrammetry represents a few hundred out of that 6,000. What can we do to affect the solutions to these mind-boggling problems?

I submit to you that photogrammetry has a major contribution to make. If our population will double and our resource requirements will triple in the next generation, how will we find the energy sources, how will we locate the materials, how will we plan the living spaces and the open spaces essential to man's satisfactory life? Quite clearly we have a staggering task of new discovery, development, and distribution. Surely there is no better way of approaching this task than through the measurement and interpretation of aerial photographs and other imaging sensors which fall within this Society's competence.

BUT MORE THAN simple engineering is required. The discovery, exploitation and distribution of materials must be accomplished without degrading the quality of our environment, for society must also provide against excessive noise, air and water pollution, upsetting heat and water cycles, etc. We must preserve the landscape, the waterscape and the seascape. Man must exercise exquisite judgment and make Solomon-like tradeoffs in deciding how much and where to take from his environment and how to leave the environment in the taking and using, for take and use he must.

If the earth shall provide the materials for the survival of society, then a prudent society must provide an understanding of the earth and a continuing inventory of current and potential resources. Decision makers are continually plagued with a lack of information and substantive facts on which to base action, and even more with a vacuum of information on how a decision on one problem affects the myriad of overlapping and intertwining problems. The complexity is indicated by the fact that from the top of the Empire State Building one can see over 1,200 individual and separate political entities. Think how many of these will be concerned about a decision regarding the traffic pattern at La Guardia airport.

EVERY PROBLEM HAS at least seven aspects: political, social, legal, economic, technical, esthetic, and operational. We are pretty astute at handling technical and operational problems, but relatively naive when it comes to the other aspects. To assist us in these decisions, we must develop new techniques for information gathering systems and, even more critical, a more astute knowledge of how to utilize the information we gather. Topographic maps, which have been our classical concern, are only one of the information systems with which we must be concerned. Digital and graphical data banks are a new tool which we must learn to handle.

Quite clearly, these information systems will depend largely on inputs from photogrammetry and its allied disciplines. Your committee for this meeting has wisely included a panel on requirements for data banks. Computational techniques will be essential in handling the data base—that is, the valuable information that does not change; the data bank—the valuable information that is time dependent; and data *bunk*—which is the useless information that can so easily overwhelm the other two categories.

MOST ASSUREDLY IT would be fatuous to expect that photogrammetry is going to solve all the world's ills. But each of us may take some comfort in the knowledge that our work is surely contributing to meeting the nation's needs.

In closing let me tell you about the group of passengers who boarded a super jet for a transatlantic flight. When they were all comfortably seated, a voice came over the speaker system:

> "Ladies and gentlemen, you are about to take part in an historic trip. When this aircraft leaves the ramp it will be completely under the control of a digital computer. No pilot or copilot are aboard. The take off, mid-course navigation, and landing will all be controlled by the most advanced solid state computer. But there is absolutely no cause for alarm. The analysis has been performed by the most competent aeronautical engineers, the program written by outstanding mathematicians, and the technique has been thoroughly tested, and completed checked out—and completely checked out—and completely checked out. . . ."

I trust that by the end of this week we will all be completely checked out on the current status and future trends of computational photogrammetry.

Membership Application

I hereby apply for Corporate Membership in the American Society of Photogrammetry and enclose **$15.00** ☐ dues for ______ (year), or **$7.50** ☐ for period 1 July to 31 December, and **$**______ for a ______ Society emblem and/or membership certificate.

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First Name | Middle Initial | Last Name | Title

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Mailing Address (Street and No., City, State, Zip Code and Nation) | County

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Profession or Occupation | Present Employment

☐ Reg. Prof. Engineer

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Position or Title

☐ Reg. Land Surveyor

☐ Other Societies (List)

(Please print or type on the lines above)

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Date | Signature of Applicant

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Date | Endorsing Member

(Endorsement desired but not necessary)