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Title: Photogrammetric Research and Development in the U.S.A.

Abstract

This paper is based on the responses to the questionnaire received from commercial firms and governmental agencies in the U.S.A. Most organizations which responded to the questionnaire indicated some level of research and provided limited data on that research. Most commercial firms are not seriously involved in any research effort. Some governmental agencies indicated they were no longer involved in photogrammetric research and development. Individual commercial firm expenditures for research and development ran from a low of \$20,000 to a high \$12,000,000 per year, the high figure being associated with a pseudo-governmental agency. Individual agency R&D budgets covered a range of \$100,000 to \$20,000,000. Non-governmental organizations reported as few as one or two people involved in research and development activities and as many as 285. Governmental research and development staffs ranged in size from four to over 450. Most research and development work in the U.S.A. is related to remote sensing.

Background

In preparing the following report, the first task accomplished was the development of a list of commercial firms and U.S. Federal agencies having some involvement with either photogrammetry or remote sensing. The most complete list of commercial firms uncovered was the list of Sustaining Members of the American Society of Photogrammetry. As the project progressed, it was discovered that this list was far from complete. In fact, to this date no group, organization or individual in the United States of America really knows how many U.S. commercial firms are involved with photogrammetric and/or remote sensing activity. Once the preliminary list of commercial firms and governmental agencies was complete, each organization on that list was asked to participate in the survey. I.S.P. questionnaires "D" & "E" were sent to approximately 150 commercial organizations. Subsequent to the initial and two follow-on mailings, the author has uncovered at least 30 additional commercial firms in the photogrammetric business. Unfortunately, time constraints prevented his asking them to complete a questionnaire. Copies of these questionnaires are appended to this report.

The task of uncovering which U.S. Federal agencies were involved with photogrammetric and/or remote sensing activities was less difficult. Ten U.S. Federal Agencies were identified as possible respondents to the I.S.P. questionnaires. A few agencies may have been missed, but the

author is confident that all of the Federal agencies having a major interest in this area of research and development were contacted. No attempt was made to contact State or Municipal agencies. Many of these are known users of photogrammetry; however, none are believed to be performing serious research in this area.

Commercial Involvement

Of the approximately 150 commercial organizations contacted, 34 made some response to the questionnaire. The majority of those choosing not to respond were small production-oriented firms. It is reasonable to assume that none of these are performing any significant degree of research. Of the 34 firms responding, 20 claimed some level of involvement in this type of research. Because of the proprietary nature of their work, many of commercial respondents were understandably reticent about revealing much of their individual research activity. To the degree that the responses received can be generalized, digital image analysis as related to the use of LANDSAT Imagery is receiving more attention in the U.S. commercial sector than is any other single research activity. The second most active area of commercial research is digital cartography and computer assisted photogrammetry. Some minor activity was reported with regard to research intended to improve analytical bridging techniques as well as camera platforms used at high altitude. Two firms, in the form of a joint venture, reported heavy research involvement aimed at the improvement of synthetic aperture radar (SAR). The major U.S. manufacturers of surveying and mapping equipment, Kelsh and Keuffel & Esser, understandably generalized their research interest as photogrammetric instrumentation. Firms choosing to address the question relating to size of R&D staff reported a total of 362 people involved. Of these 35% of these are degreed and 41% were reported as technicians. These figures may not be too meaningful, as several of the major firms chose not to discuss the size of their work force. The total reported commercial expenditure for photogrammetric research was \$420,000 (U.S.). For remote sensing this figure was \$1.8 million (U.S.). Again these figures are only illustrative as more than one major respondent indicated that, "no figures can be made available because of company policy." No meaningful generalization could be drawn from the section of the questionnaire relating to equipment. In summary, U.S. commercial sector involvement in research and development activities is restricted to a handful of major firms. Most of these are concentrating their efforts on projects related to remote sensing. With few exceptions U.S. commercial mapping firms appear to be content with the state-of-the-art as it now exists for little effort and few resources are being devoted to research intended to better their competitive position.

Governmental Involvement

Of the ten federal agencies contacted only six reported any significant interest in photogrammetric and remote sensing research. Major research and development activity was reported in the following areas: analytical photogrammetry, planimetric and topographic digital mapping, photogrammetrically determined boundary locations, the use of remotely sensed data for census work in developing countries, nautical charting

and current surveys, LANDSAT Imagery analysis and the use of coherent optical techniques for automated mapping systems. A total of 574 individuals were reported involved in some aspect of research and development or R&D project management. Of these 53.5% were degreed and 31.5% were technicians. The total reported annual budget for Federal research and development was \$47.4 million (U.S.) Of this sum 18.1% went to photogrammetry, 45.6% to remote sensing with the balance to other related but unspecified work. Among governmental agencies the largest single R&D budget, \$3.3 million, for photogrammetry was reported by the Topographic Division, U.S. Geological Survey. This was followed closely by the photogrammetric R&D budgets of the U.S. Defense Mapping Agency, \$2.9 million, and that of the U.S. Army Engineers Topographic Laboratory, \$2.3 million. The largest expenditure on Remote Sensing research was reported by the Wave Propagation Laboratory of the Environmental Research Labs (ERL), \$4.9 million. The EROS program of the U.S.G.S. was second at \$4.5 million. Again no meaningful generalization could be made regarding the type and value of equipment devoted to research.

Pseudo-Governmental Involvement

The Environment Research Institute of Michigan (ERIM) has been classified as a pseudo-governmental agency for the purposes of this study. This classification was given because ERIM is a not-for-profit organization. This organization specializes primarily in research and development relating to active and passive airborne and satellite systems. Its photogrammetric activities are related to non-graphic caliber cameras for film viewing. Its remote sensing equipment consists of two remote sensing aircraft owned by ERIM, two others owned by the U.S. Federal Government and three airborne multi-spectral scanners. Other equipment includes coherent side looking radars and digital image analysis systems for radar and airborne or satellite multi-spectral scanners. ERIM's R&D staff is by far the largest of any single organization, either governmental or commercial, within the U.S. Of its 285 employees 48.8% are degreed and involved in remote sensing R&D. Another 29.4% are classified as technicians. ERIM's total R&D budget is \$12 million (U.S.) annually. Of this \$11 million (U.S.) is devoted to the remote sensing program and one million dollars is devoted to other non-specified research.

Summary

R&D expenditures in excess of \$61 million are being made by both the U.S. Federal and private sectors. The bulk, 55.8% of this money is being devoted to research and development aimed at improving the utility of remotely sensed satellite data. While all groups combined are expending some \$14.6 million per year on photogrammetric research, less than \$0.5 million of this work is being funded by the private sector. The large majority of the practitioners of conventional photogrammetry, as it has been known for the last three decades, are obviously satisfied with the tools and procedures available to them, for few resources are being devoted to this activity. The single largest source of R&D spending is the U.S. Defense Mapping Agency with an R&D budget of some \$20 million. As most of this was categorized as other, the percentages

shown above may be deceptive for D.M.A.'s efforts may well be as oriented toward photogrammetry as remote sensing.

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Questionnaire D: Organizations with Photogrammetry Research & Development (R & D) activities; Public Agencies, Private Enterprise; Equipment.
 Organisations avec des activités de recherche et de développement (R & D) en photogrammétrie; Organisation publiques; Entreprise privée; Equipements.

Name & Address of Organization	Type		Names of Units with Ph-R & D	Specialization	Equipment Equipements				Remarks
	Public	Private privée			Photogrammetry Photogrammétrie		Remote Sensing Téléédétection		
					Items (Types) (numbers)	Value U.S.\$	Items (Types) (numbers)	Value U.S.\$	
Nom et adresse de l'organisation			Noms des unités avec R & D en Ph	Spécialisation	Instruments (Types) (nombres)	Valeur \$E.U.	Instruments (Types) (nombres)	Valeur \$E.U.	Commentaires

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Questionnaire E: Organizations with Photogrammetry Research & Development (R & D) activities, Staff - Finance.

Organisations avec des activités de recherche et de développement (R & D) en photogrammétrie, Personnel - Finance.

Name of Organization	Total Number of Employees	Total annual budget or turn-over	Ph - R & D Staff Personnel de R & D en photogrammétrie				Annual Expenditures for Ph - R & D U.S.\$ Dépenses annuelles pour R & D en photogrammétrie \$E.U.			Remarks Commentaries
			R & D personnel with University degrees (number)	Technicians (number)	Auxiliary Personnel (number)	Specialization	Photogrammetry	Remote Sensing	Others	
			Personnel de R & D avec degrés universitaires (nombre)	Techniciens (nombre)	Personnel auxiliaire (nombre)	Spécialisation	Photogrammétrie	Télédétection	Autres	

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