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DEPARTMENT OF THE AIR FORCE
OFFICE OF THE SECRETARY

MEMORANDUM

19 February 1970

General King, SAFSP:

A copy of the Interim Report of the Committee on [redacted] Recovery Systems is forwarded for your information.

ROBERT K. GEIGER
Captain, USN

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14 FEB 1970

MEMORANDUM FOR THE DEPUTY SECRETARY OF DEFENSE

SUBJECT: Interim Report of the Committee for [redacted] Recovery of Imagery

Attached is a copy of the interim report of the committee which we set up under Dr. Fubini to advise us on the technical feasibility, cost, and implementation of photographic satellite readout systems.

The interim report has been prepared to furnish information to you for the forthcoming meeting of the Executive Committee. In brief, the committee believes there are enough serious technical problems and uncertainties in both approaches -- solid state array and tape storage camera -- that we should not at this time significantly increase the effort or tentatively commit ourselves to system initiation. Some minor increases in funding amounting to [redacted] are recommended for specific technical areas.

The committee is attempting to formulate by May 31, 1970 its final report. The interim conclusions may be changed at that time; for example, significant technical progress may be evident by then such that we could start a readout system by the end of the year.

The committee wishes to change the name of the committee to the Committee on [redacted] Recovery of Imagery. The term [redacted] implies that targets can be observed in [redacted] whereas a satellite may require [redacted] days to be in a position to observe selected targets and several hours to report results.

Dr. Fubini has briefed you next Wednesday,

We recommend that you sign the attached letter of transmittal forwarding the interim report to interested parties.

John L. McLucas
Director
National Reconnaissance Office

Gardiner L. Tucker
Assistant Secretary
(Systems Analysis)

Atch
Memo Schlesinger/DuBridge/Helms/
Froehlke/Foster, w/Interim Rpt
Committee on [redacted] Recovery
Systems

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INTERIM REPORT OF THE COMMITTEE ON [redacted] RECOVERY SYSTEMS

16 February 1970

I. INTRODUCTION

Although the committee has not completed its investigations nor drawn final conclusions or recommendations, this interim report of the status of the committee's deliberations is submitted for information. Some of the interim findings presented below may change in the next few months.

II. FINDINGS CONCERNING SYSTEM POSSIBILITIES

A. Film Readout Systems. Of all the possible technologies to meet the USIB requirements, the film readout is the only one that should be considered for immediate system initiation. While there are some technical risks, they are small. A lower resolution and much narrower band system was tested in the Lunar Orbiter a few years ago. Some components of higher performance have been in continuous use on the ground. On the other hand, insufficient data exist on the method of ground reconstruction and on wide band scanning and recording technologies. There are also questions on the life of the film camera. A system might be available in three or four years.

For these reasons, in the absence of an urgent national need, it seems that other technologies should be examined before initiating a system whose life is limited by consumables, although consumables for two years seem possible if reliability is achieved.

B. Solid State Array Systems. The solid state array system is attractive because it offers possibility for long life. The managers of the developments are managing the early phases excellently; nevertheless, the committee believes that there are a number of major technical uncertainties and problems whose seriousness apparently has not been fully recognized. Some of the uncertainties are:

(1) technical difficulties in building the large optics required;

(2) the complexity and size of the ground processing;

(3) the reliability risk of the complete system, and in particular risks associated with the large number of active components in the array, its electronics, and electro-mechanical components; and

(4) the necessity for very wide bandwidth data relay systems requiring as yet unproven components.

The solid state array system requires a [redacted] mirror of high optical quality. The optical quality needed is beyond the present state of the art, although it is believed that with sufficient emphasis on manufacturing and testing techniques the required optical quality could be demonstrated in a few years.

The system requires close to one million spaceborne active circuits. While the reliability of each of the solid state components is high, the overall reliability of the system is still very uncertain. In addition, there are a few moving parts such as the [redacted] for pointing control and the antennas which must be continually slewed. In order to reduce these uncertainties such that system design can start, more work is needed in: (1) collecting data on candidate components (particularly LSI), (2) analyzing related empirical data, (3) examining redundancy techniques, and (4) evaluating impact of unreliability on scene information.

The solid state array system requires a data link having a capacity of more than [redacted] per second of information. Further, the satellite-to-satellite relay would operate at [redacted] requiring development of new transmitters, receivers, and antennas. The antenna requirements tax the present state of the art because of the need for high gain, tight dimensional tolerance, accurate pointing, and the ability to operate with large thermal gradients.

The present design of ground processing systems is complex and probably quite expensive. Although in its early conceptual design stage it requires two facilities, each having 20 million active circuits, it may be possible to reduce the complexity by changing to non-real time processing. Until a simpler, more practical design is available, it would not be wise to initiate large scale efforts.

Because of these technical uncertainties, the committee does not believe that enough data on solid state array subsystems have been acquired to validate:

(1) schedules

(2) cost,

(3) performance,

(4) reliability, and

(5) degree of possible growth.

The time required to achieve a workable solid state array system is not firm. The members are inclined to believe that it would require at least five years before an initial operating capability, but this judgment is made in the absence of important milestones and experimental results. In the final report the committee will review additional experimental and analytical results and hopes to define what milestones need to be reached and what progress may be expected.

C. Tape Storage Camera. Emphasis to this date has been on development of individual camera components. While component specifications have been met or exceeded, the problem now is to integrate the components into a camera system and to prove conclusively that the photocathode/tape can survive in an environment with moving parts, bearings, and lubricants.

If the integration and testing of the camera system are successful (providing long life could be achieved), the result is a camera which is similar in many respects to current film systems. Thus, spacecraft systems and optics much like those in use with current film systems can be used with the resulting high confidence in performance.

This development has not proceeded to a point where a detailed satellite system design should be considered. The time for a system based upon a photoemission type tape storage camera to an initial operating capability is longer than either a film scanner or a solid state array; perhaps seven years is a reasonable estimate. The uncertainties which need to be resolved prior to system design will be described in greater detail in the final report.

D. Comparisons Between Solid State and Phototape Camera. Comparisons between the solid state array and the phototape camera as image transducers are not very useful. They are fundamentally different devices and lead to different system design trades. Thus, comparisons need to be made on a system basis.

There is high confidence that the solid state array transducer can eventually be built after the present uncertainties have been resolved. If built, the array could form the basis of an ultimate coarse-fine system. Its characteristics lead to a large spacecraft, large optics, severe attitude control specifications, and a high data rate.

Conversely, successful development of the phototape camera is not assured. However, if the development does succeed, it permits the use of essentially current, flight-proven technology in optics and other spacecraft subsystems, operation at a relatively low data rate, lighter satellites, cheaper boosters, and considerable simplification in the capabilities and numbers of data relay satellites.

E. Alternative Approaches. There are other approaches which appear interesting and deserve consideration for funding on a small scale. It is believed that a system based upon the return beam vidicon or variants may be feasible in five or six years. It is likely that the committee will conclude that this possibility should be investigated at a relatively low level of funding. The degree of this support should depend upon the urgency of the requirement and budgetary policy.

III. DISCUSSION

The urgency assigned to this development in the solid state area has been mostly based on an assertion that the opportunity is great and the Government should commit promptly to an aggressive program. This committee recognizes that often a system start can give a program an impetus which helps solve difficult problems. Further, one can err by delaying a system start and confining work to laboratory experiments. But there are many ways a program can fail, one is by large apparent cost growth caused by poor initial knowledge, another is by disappointing performance caused by arbitrary system design decisions too early in a program. These errors can kill a program even if the concept is sound.

A major management concern is whether the overall budget will bear the addition of a new very expensive system. Almost every part of the NRO has managed to devise a second generation system which is complex and expensive and very much better in capability. But in every case there is now at least some question as to whether the increased capability is worth the increased cost. At present we use a broad area, low resolution system for indicating areas of interest (as well as considerable direct intelligence) and a small area, high resolution

system for more detailed intelligence. In order to avoid undue proliferation of systems, it seems desirable that any new system which is brought in should be able to assume one of these roles, if not immediately, in growth versions.

IV. PRELIMINARY CONCLUSIONS

If there were an urgent need, a film system with a year's life would be a reasonable solution. It may even be that a realistic cost analysis would show advantages for the film system over as much as a ten-year period. While the committee is not charged with analyzing or questioning requirements, it finds that systems capable of [redacted] recovery or responding to crisis were not supported in the past. If a true urgency does not exist, it would seem prudent to develop subsystems for [redacted] recovery system in an orderly way, that is by requiring more definitive information on cost, schedule, milestones, performance possibilities, and growth than available at this early stage of the program. These more definitive estimates must await the resolution of several technical problems. In addition, adequate real imagery (to be specified in the final report) should be obtained and fully processed to hard copy out before committing to any large engineering effort. Until such adequate imagery has been obtained and demonstrated, technical uncertainties have been at least partially resolved, and firmer costs, milestones, schedules and performance derived, it is considered premature to start any large system development program.

It is obviously not desirable nor ethical to mobilize industry to devote significant energy to systems prematurely. However, the committee believes that a minor build-up of the rate of effort in the technology of solid state array components and subsystems is warranted. We are not in a position to balance budgetary considerations against urgency so that we cannot recommend specific rates of increase. In the current state of its deliberations, the committee estimates that an increase of about [redacted] spread over the next six months, with an appropriate increase in FY 1971, illustrates the order of magnitude of increase which should expedite the dates when milestones can be achieved and satisfactory results demonstrated. The exact increase would depend upon considerations beyond the committee's charter.

The contractors engaged in solid state array subsystems and studies have recently experienced a large increase in funding; too many large increases in rapid succession would not be desirable.

A system based upon the tape camera with photoemissive cathodes depends upon resolving a number of technical uncertainties. We believe these uncertainties should be resolved as soon as practicable by funding the contractors to permit them to build in the near future a new camera, operating in the visible spectrum rather than the ultraviolet. An increase, totaling of the order of [redacted] dollars, expended over several months, should permit a determination of whether the camera can operate as intended.

The potential of alternate approaches such as new variants of the vidicon or the photoconduction tape camera is interesting enough to warrant considering some further explorations with minimum funding. Rates of perhaps [redacted] for the next six months represent the magnitude of effort which seems appropriate as an initial step.

Not much attention has been given to the utilization of [redacted] recovery system—how many people would be needed, whether the information can be exploited, and how it would mesh with HEXAGON. HEXAGON itself will have severe exploitation and utilization problems not yet fully evaluated.

Finally, before embarking on a large scale system, it seems desirable that the NRO study what savings might be achieved by relaxing the requirements that have been stated by USIB. We refer in particular to the processing delay, target rate, time to reach target, and resolution.

Eugene Fubini
Chairman
Committee on [redacted]
Recovery Systems