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DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON, D. C. 20301



16 AUG 1968

MEMORANDUM FOR THE DEPUTY SECRETARY OF DEFENSE
SUBJECT: HEXAGON

In a letter of 25 July 1968, the Director of the Bureau of the Budget recommended to you, as Chairman of the NRP ExCom, a 30-45 day study of the need for HEXAGON to support FY 69-70 budgets. He also recommended that decisions on [REDACTED] be deferred until studies now under way are complete. His letter is at Tab A.

This memorandum addresses the answer to Mr. Zwick's letter and presents in the attachment at Tab B a brief summary of the issues on HEXAGON.

Additional Studies of HEXAGON

You initiated a joint DDR&E - Systems Analysis photo reconnaissance study in January, 1968. This study is addressing HEXAGON among other issues; no additional studies of HEXAGON should be initiated now. The attachment, Tab B, summarizes the results of our study of HEXAGON so far. The issues left requiring further study are:

- (1) How much additional information will we obtain from the resolution improvements projected for HEXAGON and an Improved CORONA alternative to HEXAGON?
- (2) Are there features of the additional information we will acquire with HEXAGON or Improved CORONA which are worth the additional cost?

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(3) How do possible strategic arms limitation agreements affect the need for HEXAGON or Improved CORONA?

I expect these issues to be clarified in the photo reconnaissance study by November, 1968. It is desirable that a DCI representative participate in the remaining analysis of HEXAGON.

Deferral of Decisions on

I anticipate that you will have sufficient information at the forthcoming ExCom meeting to make a decision on whether or not to proceed on

Recommendation

I recommend you sign the attached letters to Mr. Zwick and Mr. Helms at Tabs C and D. The letter to Mr. Zwick says that studies currently under way are addressing the need for HEXAGON and that the results of these studies will be discussed in a future ExCom meeting. It also says that will be reviewed in the August ExCom meeting and invites him to attend this review.

The letter to Mr. Helms thanks him for forwarding a National Intelligence Resources Board Study of HEXAGON, referred to in Tab B, and asks him for a DCI representative to the HEXAGON portion of the DoD photo reconnaissance study.

General Carroll and Mr. Horwitz agree with this memorandum, the attachments and the letters to Mr. Zwick and Mr. Helms. Dr. Flax has prepared his proposed answer to Mr. Zwick, Tab E.

John S. Foster, Jr.
John S. Foster, Jr.

Attachments

~~HEXAGON~~

~~CORONA~~

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Tab B

MEMORANDUM FOR THE DEPUTY SECRETARY OF DEFENSE
SUBJECT: HEXAGON

The Issue

You have received four letters recently regarding the need for the HEXAGON program.

1. A 7/25/68 letter from Charlie Zwick (Tab A) recommends that the need for HEXAGON be studied in the next 30-45 days in the light of FY 69 and 70 budget pressures and the possibility of improving CORONA resolution. He also recommends deferral of 482 until current studies are completed in the light of budget pressures and the possibility that other systems might be directed against Soviet ABM.
2. A 7/26/68 letter from Al Flax (Tab F) reviews HEXAGON requirements that were developed by the USIB COMIREX Committee during the past two months (Tab G). He feels these requirements express "many new or radically modified concepts." He recommends expeditious completion of a study that you initiated last January of DoD requirements for satellite photography. He feels the study will affect decisions on whether the HEXAGON program should proceed, and on the composition of the entire program of CORONA, HEXAGON, GAMBIT and MOL.
3. A 7/30/68 letter from Dick Helms (Tab H) forwards a study of the HEXAGON program by the National Intelligence Resources Board (NIRB) (Tab I) and supports the NIRB recommendation that the HEXAGON program should continue.
4. A 8/1/68 note from Al Flax (Tab E) proposes a reply from you to Charlie Zwick. It "acknowledges the validity of questions such as the BoB has raised regarding the HEXAGON and , " but recommends that the program continue and no new studies be initiated.

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The Management Options

There are three options:

1. Continue HEXAGON development without initiating additional studies. The COMIREX and NIRB reports support the requirements for HEXAGON. The development is proceeding on schedule. The study already initiated of DoD requirements for satellite photography - will include addressing the issues regarding HEXAGON raised in Zwick's letter. This is not expected to be completed until November.
2. Continue HEXAGON development but do a study conducted jointly by DoD and DCI representatives with the results made available to EXCOM and the BoB. The study could present more crisply the tradeoffs between the resolutions and coverages available from the combination of HEXAGON, GAMBIT and MOL, and from the combination of Improved CORONA, GAMBIT and MOL, or present CORONA, GAMBIT and MOL.
3. Cancel the HEXAGON development. A proposed new camera in CORONA could give considerably better resolution and swath width than the present CORONA at much lower cost than HEXAGON, although it would not approach the HEXAGON resolution. There are about \$300M which could be saved.

DoD Photo Reconnaissance Study Results on HEXAGON

1. Alternative Photo Reconnaissance Programs and Their Costs. The NRO recently completed a review of three alternative satellite photography programs in the FY 69-73 period. GAMBIT-3 would be in all programs but in different numbers depending on the search system used in the seventies. The NRO described an Improved CORONA option in addition to the HEXAGON option. Improved CORONA would have a swath width equal to HEXAGON, a resolution about half as good as HEXAGON, and an orbit life of 18 days compared to 30 for HEXAGON. The costs of these program options are shown in Table I. The costs do not include MOL. The NRO projected equal numbers of MOL flights in all options.

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~~TOP SECRET~~Table IAlternative Photographic Satellite Program Costs

	<u>FY 69</u>	<u>FY 70</u>	<u>FY 69-73</u>
<u>Option I</u>			
Go ahead with H.	\$437	\$418	\$1,773
Do not add Improved C.			
<u>Option II</u>			
Cancel H. Add	309	308	1,442
Improved C.			
<u>Option III</u>			
Cancel H. Continue	309	274	1,320
with C.			

Option I is the present program. From this table you can see that the additional five year costs of Improved CORONA are \$125 million and of HEXAGON, \$450 million. Cancelling HEXAGON now would reduce FY 69 and 70 budgets about \$128 million and \$144 million respectively. Adding Improved CORONA would cost in FY 70 \$34 million. The costs for FY 71-73 are estimates and they are likely to remain so for the near future.

Two other observations should be made on Table I. First, the options are unequal in search effectiveness. After 1971, Option I contains five HEXAGON launches of 30 days each for about 150 days of satellite coverage. Option II contains eight Improved CORONA launches for about 144 days of coverage and Option III contains only six launches of CORONA for 90 days of coverage. When resolution and swath width are taken into account, Option I would annually produce about five times the resolution elements of Option II and about 8 times the resolution elements of Option III.

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Second, the cost horizon in Table I may be too near. If we view HEXAGON and Improved CORONA as optional search satellites for the 1970-1980 period, an analysis of cost of information over this longer period might be more appropriate.

A measure of effectiveness for alternative satellites is the amount of information gathered per dollar. The information content in a photograph of a square mile is related to the resolution elements per square mile. Thus, the expected number of resolution elements per mission is one measure of effectiveness of a system. Table II provides the expected number of resolution elements per mission, their costs, resolution elements per dollar, days on orbit, and nadir resolution.

Table II

Cost Performance Comparisons of Alternative Satellites

	Expected No. Resltn Elmnts per Msn(10^{12})	Cost/ Mission (\$ in M)	Millions of Resltn Elmnts per \$	Days on Orb/Msn	Nadir Rsltn (ft)
HEXAGON	24	\$30	(60)* .8 (.4)*	30	2.5
Improved CORONA	3.4	\$19	(26)* .18(.13)*	18	4.6
CORONA	2.5	\$11	.23	15	7.0

A larger number of days on orbit represents increased probability of obtaining cloud-free photography and covering special targets of opportunity. HEXAGON is expected to have an orbit lifetime growth to 45 or 60 days whereas the Improved CORONA and CORONA could probably only increase their coverage by two to three days each in the future. The four re-entry buckets in HEXAGON (vs. two in the CORONAs) represent further opportunity to get improved timeliness of the take.

From the above, HEXAGON appears to be the dominant system. It is most efficient at gaining access to targets, has the best resolution, and produces more data per dollar. This table does not account for R&D costs.

*These figures apply if the total development cost is included and assumed to be amortized over the first three years of operation.

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HEXAGON is costly in both FY 69 and 70. This fact coupled with the observations of Table II, suggest that an option might be considered in which HEXAGON is delayed somewhat, reducing the FY 69 and 70 costs but which would still bring HEXAGON into our inventory in the early seventies, say 1972 or 1973, rather than late 1970 as now planned. This option would better allow for uncertainty in our future requirements and would reduce near term financial requirements.

2. Usefulness of Improved Resolution

Useful information on photographs does not necessarily increase uniformly with resolution. Our experience indicates that a resolution in satellite photography of six feet is not much better than eight, but three foot resolution is vastly better than six. Between about three feet and six feet the usefulness of improved resolution is not known. HEXAGON nadir resolution will be about 2.5 feet, Improved CORONA about 4.6 feet, and CORONA is about 7 feet. Improved CORONA resolution lies in the region of uncertainty. Further complicating this problem is the fact that resolution degrades with distance from nadir.

HEXAGON nadir resolution is nearly twice as good as Improved CORONA, but HEXAGON is substantially more costly to develop than Improved CORONA. If further study should show that 4.6 foot resolution is almost as good as 2.5 feet, then Improved CORONA might be an attractive option.

3. Value of Intelligence Produced by HEXAGON

The HEXAGON option will provide more intelligence than either CORONA option if we add enough photo interpretation and analysis. The COMIREX study, Tab G, and the NIRB study, Tab I, point out targets that can be analyzed from HEXAGON photography that are denied us with CORONA or Improved CORONA photography. Some of these targets can be covered at high cost with multiple GAMBIT-3 flights. The issue is whether intelligence on these targets is worth the cost of HEXAGON plus the additional interpretation and analysis required. Further study can clarify this problem some, but this issue is a difficult one, and conclusive results are not likely.

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~~TOP SECRET~~4. Impact of Arms Limitations on the Need for HEXAGON

There is some reason to believe that an arms control agreement will impose additional intelligence requirements. The SNIE 11-13-68 on verification discusses a number of ways in which the Soviets might attempt to evade an agreement. Table III shows some of these ways and the intelligence collectors that would be useful for detecting the evasions.

Table IIIPossible Soviet Arms Control Evasions and Collector Mix to Monitor Them

<u>Evasion</u>	<u>Likely Collector Mix, Excluding HUMINT</u>
New Fixed ICBMs	MOL, GAMBIT-3, CORONA, HEXAGON
Mobile ICBMs	HEXAGON, GAMBIT-3
MIRV Testing	SIGINT, RADINT
New SLBMs	NAVAL, GAMBIT-3, MOL
More SLBMs	COMINT, GAMBIT-3
Surface Ship Missiles	MOL, GAMBIT-3, COMINT
New ABM	CORONA, HEXAGON, SIGINT, GAMBIT-3, MOL
Modified ABM	MOL, GAMBIT-3
Tallinn Conversion	MOL, GAMBIT-3

The relative attractiveness to the Soviets of any given way of evading an agreement is hard to estimate since this attractiveness depends at least on Soviet technology, Soviet estimates of the probability the evasion will be undetected and of the leverage a particular evasion has on the strategic balance. We are likely to remain sufficiently uncertain of the attractiveness of possible Soviet evasions that we will wish to monitor most if not all such Soviet options.

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The NIRB has concluded that HEXAGON represents the "best" single source of verification. On the other hand, from Table III and considering the uncertainty that is likely to remain about the choices the Soviets might make among evasion options, we have concluded that there is no best single source of verification, and we do not know if the best mix of sensors should include HEXAGON.

Additional study of this issue will provide some additional insights but probably no conclusive ones.

Summary and Conclusions

In summary, we believe: (1) that some interesting photo reconnaissance program alternatives have been identified and costed as well as can be expected now, but that at least an alternative involving a delay in HEXAGON should be considered, (2) that the usefulness of improved resolution warrants continued study, (3) that the value of additional intelligence produced by HEXAGON should be studied more, and (4) that some additional understanding can be gained of HEXAGON's importance in the presence of strategic arms limitation agreements.

Recommendations

Additional study of HEXAGON should be carried out as part of the DoD photo reconnaissance study you initiated in January. DCI representation on this part of the study is desirable. The results of the HEXAGON part of the study will be given to you in November.

No additional studies of HEXAGON as suggested by Mr. Zwick should be started now.

John S. Foster, Jr.

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WASHINGTON, D.C. 20301

Honorable Charles J. Zwick
Director, Bureau of the Budget

Dear Charlie:

In your letter of July 25, 1968, you proposed that the Executive Committee (ExCom) of the National Reconnaissance Program (NRP) review the need for HEXAGON and raised the possibility of deferring decisions on [REDACTED]

HEXAGON is subject of a DoD study of photo reconnaissance requirements now underway. This study should support decisions on HEXAGON in the fall. I will discuss the results of this study in the ExCom then.

[REDACTED] will be discussed in the August meeting of ExCom. I do not believe any action is in order on [REDACTED] until after that meeting.

My staff will continue working with yours on both HEXAGON and [REDACTED]. You are invited to attend the ExCom meetings when [REDACTED] and HEXAGON are discussed.

Sincerely,

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CONTROL SYSTEMS JOINTLYTHE DEPUTY SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301Honorable Richard Helms
Director, Central Intelligence

Dear Dick:

Thank you for forwarding the National Intelligence Resources Board study of HEXAGON. My staff has found it useful. We have had a photo reconnaissance study underway here since January. We have identified three major issues on HEXAGON on which our study is now focused.

(1) How much additional information will we obtain from the resolution improvements projected for HEXAGON and an Improved CORONA alternative to HEXAGON?

(2) Is the additional information we will acquire with HEXAGON or Improved CORONA worth the additional cost?

(3) How do possible strategic arms limitations agreements affect the need for HEXAGON or Improved CORONA?

I have asked my staff to work closely on the HEXAGON study with the State Department, Don Hornig's office and BoB. Participation in the study by your staff would be very helpful. If you agree, could your representative contact Mr. H. D. Benington at OX 5-7936?

Sincerely,

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