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Outline of Discoverer Development Plan (1961-65)

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Outline of Discoverer Development Plan (1961-65)

This is an outline, and merely records assumptions and recommends further study and development actions without exhaustive justification. The outline is intended as a framework for a comprehensive Development Plan formulation, and is therefore rather broad in context.

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Outline of Covert Satellite Development Plan (1961-65)

I. Introduction

1. It is important to realize that a reconnaissance/intelligence capability is at the most a means to an end in the current and future strategic situation. Such a capability is of importance to our foreign policy only if we can variously: respond to the knowledge gained by appropriate developments in other parts of our strategic forces, justify inaction in various possible areas of action, use the technological developments required to implement and maintain this capability in other useful ways, and, in general, prevent some gross mis-allocation of resources which might otherwise occur because of non-existent, incomplete or misleading information.

2. In the absence of an effective, controlled disarmament situation, perhaps the best alternative one can hope for is the stable deterrence posture -- that is, a posture of mutual possession of relatively secure strategic systems and mutual loss of ability to execute a decisive first strike against the opponent's strategic forces.

3. The creation and effective continuance of a stable deterrent situation depends in turn upon a number of competing factors. For example, some of the factors which tend to destabilize the strategic situation include weapon system characteristics such as: vulnerability to surprise attack, low effectiveness of active and passive defense systems, and reaction systems which make possible a war by accident or miscalculation. Conversely, stabilizing factors include provision of hardened, mobile, hidden and numerous missile launching sites, development of an effective active defense, and provision of a quick reaction but "recallable" missile or other strategic force, capability. To plan effective actions, the nature of the factors present in the strategic systems should be determined.

4. From the U. S. point of view, if the U.S. acquires weapon systems with some or all of the stabilizing characteristics noted, a strategic deterrent can be created. However, new technological developments and/or a relaxation of our efforts to maintain such strategic systems could again weaken this deterrent -- and we must expect that technological developments will continue and that it may require a costly effort to maintain the deterrent. The effort required, its magnitude and characteristics, and the composition of the various responses called for, will be largely determined by our continual estimates of the size, quality and characteristics of the future enemy counterforce and defense capability. These estimates, to be quantitative and useful, will have to be bolstered

as much as possible by hard intelligence obtained by actual observation in a timely way and important portions of such observations can be done from space vehicles. Other most important means of complementing and supplementing space observations exist, of course.

5. Some of the specific results of the development of space observation systems can include additional knowledge on the following typical items:

   a. Evaluation of Capability. By establishing the existence of and following the progress and growth of ICBM launch sites, AICBM installations, missile trains, sea-based missile launches, sites and facilities for more conventional forces, together with information on cities, industrial complexes, other military installations, etc., an estimate of the enemy strategic force strength and composition can be inferred, as well as mapping of the fixed sites. This task, which includes the "search mission," is one which requires continual up-dating of information, and cannot be assumed to have a definite endpoint in time.

   b. Evaluation of Intent. From observations one can make some inferences regarding intent, or a sudden ~~division~~ diversion of emphasis. For example, if the number of enemy missiles deployed on sites, or the number and dispersal of such sites, appears to be too low to take out a major capability such as will be represented by the Minuteman force, we may infer that the enemy is building on their present pattern of development of a counter-deterrent force; -- the assumption being that we will not strike first. On the other hand, if this were to be accompanied by a very appreciable increase in AICBM activity, as evidenced by photo-[redacted] information, our interpretation of the apparent offensive gap would be different. Still other evidences of intent would be furnished by detection of a massive Civil Defense shelter program. In these and similar ways, unusual development avenues, diversions ~~of~~ or absences of capability can suggest intent.

   c. Ancillary developments in other components of the strategic forces.

   The technology involved in the development of effective space observation systems obviously has many carry-overs to other missions. For example, the development of quick response recovery satellite systems with precision de-orbiting capabilities has an immediate application in the development of one possible version of a quick response bombardment system, with "recallable" or "fail-safe" features, proof against making possible a war through accident, miscalculation or premature reaction. It might be possible in this way to develop a "pre-emptive strike" capability. Such a system might work on the receipt of build-ups or warning information by launching satellites carrying weapons into orbit where they are "stored" for a few orbits until less ambiguous information is obtained, whereupon they are de-orbited appropriately to either recover the warhead or attack, (alternatively, a vehicle capable of converting an ICBM trajectory until the very last moment, into a suitably range-extended trajectory, capable of vehicle warhead recovery subsequently, can be considered). In any event, techniques for such a mission have a considerable analogy to those which would have to be developed for a precision de-orbiting observation system.

6. From these and other arguments, the importance of space observation systems can be seen to be of very considerable magnitude. While many other uses for space vehicle systems exist, such as communication, navigation, etc., their use as observation vehicles is of direct, primary interest, and the remainder of this discussion will revolve mainly around that specific application and the factors which arise from the requirements of such a mission.

II. ASSUMED GROUND RULES

1. On the basis of the preceding discussions it is assumed that the importance of observations from space vehicles is evident as a technique of very considerable potential. It is further assumed that irrespective of the developments in the more overt programs such as SAMOS, there will be covert programs for the forseeable future, provided appropriate safeguards and cover techniques are employed. Under these conditions, a covert program is less subject to political and propaganda impediments, and lends itself to more expeditious action.

   The Discoverer program is used here as the prototype of the covert programs, although more general vehicle systems than the current Thor-Agena combination will be considered. It is believed to be important to enlarge the scope of the Discoverer program in this way in order to have available a comprehensive, flexible covert program.

   Specifically, it is assumed that the current program will be, or can be, enlarged to the following three vehicle systems (note, however, that the pad availability problem would for some time favor Thor employment over Atlas if adequate mission capabilities were developable):

   a. The current Thor-Agena combination, with a possibility of improved vehicle performance, will continue to be used. This combination has demonstrated a history of successful performance and has considerable additional growth potential.

b. The Atlas-Agena, or Titan-Agena combination, as used in the Tomas system, can find additional application where large cameras and film capacity are necessary. This combination can perform sophisticated observation tasks for which the Thor-Agena system is inadequate.

c. A new "minimum" satellite system which has a quick response capability, and a capability for launch anywhere. This combination could be a small solid rocket system which, while it does not have the instrument capability of the previous two systems, would have an enormous launch flexibility from hidden and mobile launching sites, and so could be a truly covert system requiring no special cover. One possible version of such a system is described in Appendix A. Another version could be a comparable orbiting system using Minuteman.

2. As important objectives of the covert observation systems the following items can be singled out:

a. The continuance and upgrading of the intelligence capabilities of the systems. This system growth can take many forms - use of higher performance instruments, the development of a stable, reliably performing system for routine observations, provision for a very quick response system capable of global launch and retrieval, etc., to keep pace with the growth of enemy capability.

b. Concurrent development of space science techniques to enlarge the scope of our engineering and research knowledge. In many cases the instrument requirements do not fully use the system capability, and the excess can be used in this way.

c. [redacted]

[redacted]

In general, the provision of adequate cover will in the future need more careful and imaginative planning if we are to expect the covert systems to be viable for the foreseeable future.

d. Maximum survivability to enemy action: We must expect the possibility of enemy counters to our systems in the future, the risks becoming greater as the enemy's techniques become progressively more adapted to this capability. Such action could take many forms - [redacted], actual interception or close approach as in the [redacted] system, an extended AICBM-like capability, etc. These techniques all depend to a greater or lesser extent on detection, tracking and prediction of the actual vehicle's path, [redacted] this could be done on the basis of extremely crude information. Counters to most of these actions exist-e.g., [redacted] Many of these techniques can be tried at an early date to ensure a capability to use them operationally should the occasion arise.

Another important survival measure is the capability for quick response to "demand" recce and at the same time to use short mission durations and hidden or mobile launch sites to prevent routine detection, tracking and prediction. As a general procedure the covert systems should rely heavily on short duration missions; in the case of the "minimum" satellite system, one can combine global launch and retrieval areas with a quick response capability and a mission duration which might last for only one or several orbits.

e. As a goal for the quick response "minimum" systems, it might be feasible to set the following requirements, to be satisfied at low cost:

- Use of small solid rocket systems launched from hidden sites, or mobile sites such as ships or trains (Sea Scout, Minuteman).

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Reliance on information obtainable in one or a few orbits.

A capability to compress the time span of spot or limited area recce, from demand to preliminary evaluation of information obtained after recovery, to 12-24 hour if required.

Provision of a continuous stand-by capability to launch in such operations at arbitrary times.

3. The development of covert observation systems with the three classes of vehicle capability discussed above would provide a comprehensive and flexible reconnaissance tool capable of undertaking a multiplicity of missions. It is believed that the present Discoverer program should grow into all three of these areas, including Atlas-Agena use of large instruments other than the [redacted] system (and the development of the "minimum" satellite quick response system), if Thor growth versions cannot do the job.

The hidden launch possibilities of the Thor systems should also be re-examined again (e.g., special ship launchings).

III MISSIONS

1. The missions which should be undertaken have to do primarily with two major categories, of which only one will be discussed further here:

   a. Monitoring control of a disarmament plan or arms control plan.
   b. Observation of those activities which can change the stability of deterrence.

   Item b. will be the one requiring most immediate attention, and will be discussed in the light of the arguments in I.

2. The principal characteristics of the character of information which can be gained at various resolution levels is somewhat understood now. Some difficulties arise because of the primary requirement of recognising and not only detecting; recognition depends in a complex way on many factors which are not always amenable to analysis. Furthermore, many of the instruments discussed later will use stereoscopic techniques, which improves the recognition at a given resolution level. Consequently only broad statements will be attempted here.

   Some reasonable examples of resolution levels and the corresponding mean dimensions of targets which can be identified and recognised follow. In the case of stereo techniques, one can generally recognise and identify smaller targets at a given optical resolution level, or alternatively one can talk of an effectively better resolving power of a given dual view system. To take a specific example, the present Corona camera has a conventionally defined resolution of about 20'; under good viewing somewhat better;-one should be able with this system to recognise and identify targets with a mean dimension of 40' -80', or perhaps 40'-60'. If one makes a twin-Corona (2C') system capable of stereo pictures, targets of mean dimensions of perhaps 20'-30' might be identified and recognised, corresponding to an equivalent single Corona system resolution of perhaps 6-10 ft. Such correspondences, it must be noted, are of an approximate nature. Further possible refinements of the arguments cannot be discussed here (e.g., the case of multiple pass single photography which has different sun angles and therefore shadow lengths; the different shadow lengths can give the effect of some stereoscopic views; the dependence of all resolution estimates on viewing conditions, graininess of emulsions, etc.) To summarize all this into a simple, and therefore approximate, rule of thumb, which however is generally conservative, we assume that a single camera system resolution level of R' corresponds to the ability to recognise and identify objects with a mean dimension of perhaps 3R' and that a dual camera system (using good stereo techniques) has an equivalent resolution of perhaps R'/2; -with individual circumstances possible permitting deviations in both directions from these assumptions. With this definition in mind, resolution levels will be quoted, and the corresponding translations to single camera recognition and identification levels and the capabilities of stereo systems can be made on the basis of the preceding arguments.

3. Some examples of information attainable at given resolution levels:

   a. 100 ft. - Observe cities, transport systems, industrial and military complexes, larger ships, etc.
   b. 20 ft. - In addition to the preceding get information on components of complexes; runways; sites identified and measured, disposition of military forces, ships, etc.
   c. 10 ft. - Identify large aircraft, missile submarines and ships, base utilization and support facilities, make functional analysis of industry, military, transport facilities, observe above ground launch pads, stands, support equipment, naval ships and units by type, etc.
   d. 5 ft. - Begin technical information gathering on aircraft, large missiles, early warning sites, AAA sites, atomic energy material production, storage and handling of specific weapons, shipboard configuration for missile handling measured, identified and analyzed, level of military activity and training, etc.
   e. 2-3 ft. - Reasonable detailed technical analysis of sites, activities, etc., and technical information on generally known weapons and components.
   f. ½-1 ft. - Detailed technical information, in very fine detail, on new activities, sites, weapons and components, as well as complete information in items of category e.

There are practical problems in trying to relate resolution and information content by a unique 1-1 correspondence, so that the preceding list of items a.-f. is perhaps unnecessarily detailed to classify the operational capabilities of the vehicle systems proposed in II 1. (use of Atlas-Agena, Thor-Agena, and a "minimum" satellite). However, it is important to note the following:

- Information at levels a.-f. will be necessary or desirable in gauging the stability of deterrence as a function of time.

- Information at levels a.-f. is correspondingly obtainable by space observation systems, of one form or other, falling into the three vehicle systems of II 1.

4. Some of the specific observations which it is desirable to make in the context of the discussion of I include the following:

   a. Observation and location of fixed ICBM sites under construction now and in the future. This is the "search mission" capable of being met by the Corona system and the E-6 system. The search should cover at least those portions of the USSR and satellites covered by the transport net at 20' resolution or better with a highly repetitive series of observations. While this highest priority mission is desired thru 1962, any changes in this program as a result of our future ICBM developments (Minuteman, etc.) should be observed, and in any event the sites once located must be kept under surveillance. Consequently, this mission should not be considered to have a finite end-point in time, but should be a continuing requirement.

b. Observation of mobile ICBM's on trains, etc. This should also be a continuing requirement involving higher resolutions.
c. Observation of sea-based long range weapon carriers - submarines, ships, etc. during construction, fitting, port stay, loading, overhaul, etc. This is again a continuing requirement.
d. Observation of active defense sites and then weapon and equipment characteristics - especially the progress of AICBM sites, if any. This is again a continuing requirement.
e. Observation of any massive civilian defense shelter program, or other hardening program, etc.
f. Observation of R & D activities at test sites, etc.
g. Observation of new weapon developments, etc., unusual construction activities, etc.

5. [redacted]

[redacted]

6. [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted]

7. [redacted]

IV. INSTRUMENT DEVELOPMENTS AND TECHNIQUES OF EMPLOYMENT

1. The instrument developments to meet the goals of III 3. will be divided into 3 classes - current developments, proposal developments and possible developments, together with a few pertinent technical characteristics of each. Only recovery payloads are considered.

2. Current developments are those for which firm contracts exist, or for which actual instruments already exist. The following table lists such instruments:

Instrument	Use	Altitude	Focal Length/ f Number	Op.Life/ Booster	Resolution, Nominal (or equivalent Resolution in Stereo Instruments)
a. A*	Map	190 mi.	3"/	4days/ Thor	350 ft./175 ft.
b. C, C'	Reconnaissance	130-140	24"/f 5.0	4days/ Thor	20 ft.
c. C'''	"	130-14	24"/f 3.5	4days/ Thor	10 ft.
d. E-5**	"	160	66"/f 5	30days/ Atlas	5-7 ft./4'
e. E-6	"	(Not known exactly, but comparable to C''' - E-5)		Atlas	7-10 ft. (goal)/4.5'

** E-5 may also be operated in a partial stereo mode.
* A may also be operated in a stereo mode.

3. Proposed developments are those in which definitive technical studies have been made, altho definitive contracts may be in abeyance currently.

Instrument	Use	Altitude	Focal Length/ f Number	Op.Life	Nominal Resolution
a. A* [redacted] (Stereo)	Map	190 mi.	18"/f 5.6	9days/ Atlas	80'-100'/40-50 ft. (equivalent)

More limited payload versions of [redacted] can be flown on, possibly, some Thor Vehicles (VF 2.)

b. Twin C''' (Stereo)	Reconnaissance	130-140 mi.	24"/f 3.5	2-4days/ Thor	10'/5 ft. (equivalent)

It is noteworthy that the Twin C''' will do the E-6 mission - at an earlier date.

4. Possible developments are those which appear developable from the preceding cases, by growth in one of several ways, without requiring new optical inventions. These include use of "Satelloid" missions, and perhaps the possibility of sub-orbital operations.

It has been emphasized that the current program should ~~denote~~ DEVOTE itself mainly to short duration missions (forgoing complete land area coverage per vehicle if necessary). For short duration missions [redacted] it is possible to fly at lower altitudes over the areas of interest, either just accepting the short drag life, or in some cases perhaps applying periodic impulsive orbit corrections to maintain desired orbital parameters. In this way operating altitudes of 100 miles could be managed. At even lower altitudes (60-70 miles) several

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effects would have to be considered. First of all, heating would begin to be significant at the front face of the vehicle and might reach temperatures of 450°-900°F. However, heating of vehicle surfaces parallel to the direction of motion would be essentially negligible at such altitudes, so that in principal vehicles with adequately high temperature tolerances could be flown at these low altitudes. Drag effects and the corresponding orbit adjust requirements would depend very sensitively on the life requirements. For missions requiring only a few orbits, orbital adjustment might be dispensed with, although recovery precision requirements may make adjustment desirable even here. For life of more than a few orbits, orbital adjustment would definitely be required. Neither the temperature nor orbit adjust requirements present unduly complex development problems (some of them are already currently under development). We can assume, therefore, that for short mission durations, altitudes over the interesting areas of 100 miles can be tolerated relatively easily, and that altitudes of about 60-70 miles might be tolerated under some conditions, provided appropriate vehicle developments were undertaken.

These low altitudes and accompanying high resolution would produce some additional vehicle stability problems, problems of IMC, and so on, all of which would have to be properly considered. However, as technical goals, the following general classes of performance seem possible (detailed studies might reveal additional increases over these).

a. On an Atlas boosted vehicle, and with a design recovering only the film and not the instrument (the E-5 recovers both, the TOMAS only the film), the following characteristics might obtain-

Carried On	Instrument Type	Altitude	Op. Life	Resolution/Equivalent Resolution
Agena C (80" diam.)	Twin 66"/f3.5/ Stereo	100 mi.	few days+	2.5'/1.2'
		65 mi.	few orbits+	1.6'/0.8'
Agena B (60" diam.)	Twin 48"/f3.5/ Stereo	100 mi.	few days+	3.5'/1.7'
		65 mi.	few orbits+	2.4'/1.2'

~~Since~~ Some further reductions might be made in the f-(number), if warranted.

b. On a Thor boosted vehicle, performance beyond the projected Twin C''' version would demand a vehicle capability increase. Considering a single example only, the following characteristics might be obtained on an Agena C vehicle (or equivalent Thorad capability) with film-only recovery.

Instrument Type	Altitude	Op. Life	Resolution/Equivalent Resolution
Twin 36"/f3.5/ Stereo	100 mi.	few days+	5'/2.5'
	65 mi.	few orbits+	3.4'/1.7'

More detailed study might show that up to 48" versions could be carried; the parametric studies involved are especially necessary in the Thorad-Agena C possibilities, which may permit vehicles of the capability in a. above.

[redacted]

c. On a minimum satellite, boosted by quick reaction vehicles such as Sea Scout or Minuteman, the performance capabilities would be clearly less than those of the above vehicles. However, performance roughly comparable to that of the contemporary Discoverer program might be achievable in the quick reaction, very short duration missions.

d. Special attention should be given the possibility of diverting Atlas boosted missions to improved Agena and/or Thorad missions.

5. These performance goals of 4. require some compromises in the total mission, of course. Generally, lifetimes would be limited, as would be total swath width, etc., and a number of the technical problems in guidance and control, propulsion, etc. would be accentuated.

However, in principle, the three classes of vehicles described in II. (Thor boosted, Atlas boosted, and minimum satellites) can perform the following classes of missions at the expense in some cases of very short mission durations and/or restricted total coverage per vehicle, with([ ]) indicating currently planned capability: (" means yes)

Equivalent Resolution Capability (as per III. 3.)

	a. 100'	b. 20'	c. 10'	d. 5'	e. 2'-3'	f. 0.5'-1.0'
Thor boosted	"	"	"([C'''])	"([Twin C'''])	"	?(Thorad-Agena C)
Atlas boosted	"	"	"([E-6])	"([E-5]) [E+?]	"	"
Minimum satellite (SeaScout or Minuteman boosted)	"	"	"	"(?)	"(?)	

Even in the case of 0.5-1.0' resolution, the performance appears to be within such fundamental limits as are produced by atmospheric turbulent scattering, etc. at the altitudes in question. In any event, a detailed parametric study consonant with the vehicle capabilities is called for, using f/numbers (in twin versions) as low as 2.5-3.0 and focal lengths of 70-80 inches, for example.

6. By considering somewhat more bizarre possibilities, the basic capabilities of satellite observation could be extended even further into class f. For example, if single picture very high risk photography were permissible, and if precision de-orbiting in remote areas were perfected, a combination readout and de-orbit scheme could be used. In such a system the descending capsule would contain the instrument; the instrument would be exposed after the heat shield release had occurred, and photography would be done at altitudes of only a few miles on the target. The picture might be stored on a solid state storage medium and readout over a period of minutes to the vehicle main body overhead, where it would again be stored and read out over one of our data reception stations. The entire capsule

would be adequately destructed, preferable, after the mission is over. In this way pictures of essentially arbitrarily low scale over a limited area could be obtained. Even night (flash) photography would be possible.

[redacted]

IV. 7. Continued on next page

7. In the mapping mission there do not seem to be any future requirements which cannot be satisfied by the topographical maps which will be produced by the [redacted] system.

8. One technical innovation which seems desirable to investigate is the use of storage media other than film. Specifically, storage on media such as electrostatic tape should be considered. While an electrostatic tape system currently would not have the resolution capabilities of the best film systems, there is reason to believe that the development can proceed to a level such as to be comparable, on an over-all basis, to the best film systems.

   Such a storage medium is currently under study in readout systems. It can also be considered for recovery systems. For such applications, where no satellite readout link is required, there is every possibility of developing resolution capabilities in no way inferior to those of film systems. The following additional benefits will then accrue to the electrostatic tape systems:

   a. Insensitivity to nuclear radiations. A 1 MT nuclear burst will fog conventional film, not specially shielded, at distances of perhaps 400 miles. Against some components of this bomb radiation, shielding would be extremely penalizing in terms of weight or volume. Electrostatic tape, however, should be useful at distances much smaller -- distances at which other parts of the vehicle become comparably critical -- perhaps 5-10 miles.

   b. Ability to work at very low light levels. It is believed possible to develop the tape to a sensitivity of $\sim 10^{-3}$ ft-candle-secs (4 ms exposure). This sensitivity would permit photography at very low light levels corresponding to moonlight or even perhaps starlight illumination levels, thus considerably extending the total time during which photography might be done.

   c. Image enhancement possibilities. Since the picture data is in electrical form part of the time, before the final film record is produced, it is possible to use image enhancement and intensification techniques very readily during that stage. These techniques include contrast stretching of a selected part of the contrast range, differentiation or edge enhancement, and outlining (producing a contour of constant brightness along the locus of a selected gray level), which has proved useful in sharply delineating nebulous objects.

These techniques may be of considerable benefit in increasing the "interpretability" of the photography.

d. Wider temperature limits and ease of handling, etc.

For these reasons, it is felt that the development of the solid state storage devices and their associated instruments would be a very worthwhile program, even in recovery systems.

These storage media can be equally well adapted to the storage [redacted]

9. Other special techniques may be worth further study. For example, in the twin camera stereo systems, it may be possible to pre-treat each of the two films (or tapes) to respond to different spectral ranges and recombine these images in such a way as to gain increased interpretability.

V. SECONDARY PAYLOADS AND MISSIONS

1. [redacted]

[redacted]

2. [redacted]

[redacted]

3. [redacted]

[redacted]

[redacted]

4. One of the biggest single areas for a continuing recovery program is the development of precision de-orbiting techniques. This will be a most useful development for space science in general, of course, and not just for the reconnaissance program. Such a program would justify an extensive series of capsule recovery attempts, and would consequently provide a continuing cover. It would be most desirable for the covert program to sponsor such a development.

Two basic problems are involved here - the ability to actually hit near a pre-planned impact point, or to be able to move this accurately after the launch, and then to come down near this desired impact point with minimum dispersion. Several basic ways exist to meet these requirements (the ultimate goals being the ability to move the impact point by one half the nominal orbit track spacing, and to control the dispersion to roughly that of current bombardment weapons, with initial goals perhaps degraded by a factor of 5):

a. By aerodynamic control during atmospheric re-entry. This may take the form of pure variable drag (to bias the impact point in one direction) or lifting bodies which can change the impact point location in two axes. In addition fine control during re-entry can provide the minimum dispersion around the impact point.

b. By purely extra-atmospheric manuvering. After orbit injection, propulsive corrections can be made to actually realize a pre-planned impact point. The impact point can also be deliberately changed by orbital manuvers, either in the orbital plane (to change period) or out of the orbital plane (to change azimuth also, if desired). After retro-firing the dispersion can be minimized by applying corrective velocity increments during the de-orbit phase, the argument being that if the recovery capsule is properly positioned when it hits the sensible atmosphere, subsequent atmospheric perturbations can be made small (as they are in the ICBM case).

c. By several combinations of atmospheric and extra-atmospheric perturbations.

Because of the several major avenues of approach possible, it would be possible to justify an extensive series of R & D flights to perfect this capability. A substantial number of such flights could be carried on, probably, while the photographic mission is being performed, since many of these attempts would merely result in greater than desired dispersions and would not be completely lost. This would also justify the continued presence of a large recovery force, during the "learning" part of the program.

Once the capability is perfected, the recovery force could be drastically reduced, resulting in greater freedom to select recovery areas (land or water), much lower costs, and a much improved cover capability.

It would seem highly desirable, therefore, for the covert program to continue to engage in an advanced engineering development program to perfect precision de-orbiting. This would involve a continuing program for development of guidance, control, propulsion and aero-thermal components, as well as the development of special techniques of real-time tracking and control during de-orbit, response to "homing" devices to guide to a desired impact point, etc. Provision of much more precise initial guidance would in itself be an important capability, since with precision initial guidance and very short duration missions it would make considerable sense to pre-plan the impact point and let the dispersion control during de-orbit permit the use of a minimum recovery force.

5. [redacted]

[redacted]

[redacted]

6. [redacted]

a. [redacted]

b. [redacted]

c. [redacted]

d. [redacted]

7. [redacted]

8. The requirements for cover, the necessity for it, and the technical ways of obtaining it form a complex problem, as items 1 - 7 have tried to show. A separate detailed effort to plan such cover into the future, to relax it as the occasion demands or warrants, its relation to the various vehicle systems described earlier, and its general future viability would seem to be desirable. A plan covering the more immediate Discoverer future would also seem to be a useful interim guide in this problem.

9. The experience gained in actual firings of Thor boosted vehicles should also now be assessed with the view of re-evaluating ship or remote land launchings of these boosters, comparing the problems involved with those of the "minimum" satellites.

VI. Payload capabilities desirable and available.

1. The previous sections have emphasised that some of the desirable growth versions of the covert program may involve one or several of the following:

   a. Ability to do orbital maneuvering or orbital parameter adjustment.

   b. Development of precision deorbiting techniques.

   c. Ability to carry larger instruments.

   d. Ability to fly dual payloads, one of which may be covert.

   To fully exploit such possibilities an increase in payload weight capability will be most useful. Several ways of achieving such capabilities are possible in the future program.

2. a. As a temporary expedient, fire lower latitude shots out of AMR. This would provide some 200-300 lbs. of additional payload over the current Thor-Agena B firings out of PMR. This extra payload would then be used in one of the several ways mentioned above. Photographic take on such shots would have some utility, especially in winter.

   Another small increase is obtainable by firing at lower altitudes. Ability to use this depends on improving orbital injection guidance accuracy.

   b. A modified Thor booster with additional solid rocket boosting engines can be developed. This has been carefully studied and could be flight tested in one year, resulting in a payload weight increase of about 1000-1500 lbs. (THORAD)

   c. Several improvements for the basic Agena could be made in about 1-1/2 years time to first flight. These changes increase the capability for allmissions by a substantial amount. Two versions of this Agena improvement have been considered:

   -- Mod I - Nitrogen tetroxide UDMH-HZN engine with 80" diameter tanks.
   -- Mod II- " " " " " 60" " "

   Comparative payloads on a 150 mi. altitude polar orbit are as follows, using a standard Thor booster:

Present Agena B	1450 lbs.
Mod II	1875 lbs.
Mod I	2275 lbs.

   The Agena propellant combination remains non-[redacted] (CRYOGENIC) in this change.

   Combinations of [redacted] (THORAD) with improved Agenas are also possible, putting payloads near the Atlas class of booster possibilities.

d. Use can be made of the Atlas booster. This is currently scheduled for use in the E-5, E-6 and TOMAS recovery programs. Comparative payloads in a 150 mi polar orbit are as follows:

Present Agena B	5600 lbs.
Mod II	6100
Mod I	6400 lbs.

These payload capabilities will permit the largest instruments mentioned in IV 4 to be carried, in all cases for Mods I and II, and perhaps, with a curtailed film load, on the Agena B, in addition to some secondary payloads.

e. Use can also be made of the Titan booster. This has been extensively studied in regards to Agena - Titan compatibility. One combination which has been extensively studied is the combination of the Titan SM 68B and the improved Agena. This version of the Titan uses the storable propellants of the improved Agena - $N_2 O_4$ / UDMH-HZN, and the total combination could be flight tested in about 2 years.

Comparative performance in a 100 mile polar orbit is:

Agena B - SM 68B	7600 lbs.
Mod I - SM68B	8400 lbs.

This combination could carry the largest instruments of IV 4, plus a considerable amount of secondary payload. In addition the propellants used would permit some simplification of fueling, handling and operation, generally permitting somewhat quicker response than the Atlas.

3. These classes of vehicles can satisfy the forseeable reconnaissance demands. In particular, the Atlas or Titan boosted vehicles can satisfy the very highest resolution instrument carrying demands, while the improved versions of the Thor system (Use of Thorad and/or Mod I, Mod II Agenas) can do a very creditable reconnaissance job, as is apparent from inspection of IV 4 a,h. (Substitution of Jupiter for the Thor appears possible).

Considerable further study is required in this area when the payload requirements of V are included, to maintain cover, etc. The dual payload requirement, if it is a valid one, sets the net mission requirements. Such studies are especially necessary in the case of Thor-boosted systems, since decisions on keeping production lines open (or reopening them), conversion of war inventory booster, etc. are involved here. Cost operational comparisions with the other two classes of vehicles should be made to avoid unnecessarily duplicative developmental efforts, and to properly evaluate the developable reliabilities of the various vehicles.

4. A special case is involved in the "minimum" satellite vehicles boosted by Sea Scout or Minuteman. In these solid rocket vehicles the emphasis is on:

a. Hidden launchings.
b. Very short countdowns.
c. Essentially unlimited standby capability.
d. Limited area coverage, in most cases.
e. Short mission duration, in most cases.
f. Low dispersion de-orbiting, and the possibility of hidden recovery.

These capabilities and constraints would permit the development of very secure operations, requiring no special cover. The booster type would permit quick reaction "demand" reconnaissance, responsive to rapidly changing intelligence situations, weather openings, etc. Launch costs could be held to much lower values than those of the larger boosters. On the other hand, the resolution and coverage would not be of the same quality as the corresponding items in the larger systems. The comparative intelligence utility of the "minimum" systems to that of the larger systems depends on the kinds of missions undertaken and the constraints imposed on such missions.

The payload capabilities of the Sea Scout might permit putting about a 400 lb. payload on a low altitude orbit. The capability of the Minuteman would be substantially higher. In either case it appears possible to provide a suitable stable platform for photography and de-orbiting missions, (e.g., the "flying platform" of Appendix 1) within these weight constraints. By using short duration missions, or perhaps sub-orbital missions, instruments capable of useful intelligence gathering appear flyable on such devices, as is indicated in IV 5. Additional study is required to properly assess the usefulness of the "minimum" satellite systems which could be available in 1962.

5. In summary, the further development of the three classes of vehicles discussed above to a level capable of meeting forseeable future intelligence demands in limited duration missions does not seem to pose any basic developmental problems.

However, effectiveness and utility studies are desirable to determine the relative emphasis to be put into each of the three major developmental areas, taking into account the class of instruments capable of being orbital in each case, and the needs for the capabilities of these instruments.

The set of studies should also include developmental and cost consideration of the necessary support systems, launch capability and other operationally relevant elements. In particular, pad availability, etc. for the Atlas boosted vehicles must be critically evaluated, and every effort made to establish the growth capability of the Thor boosted vehicles to handle such missions.

VII. Special Studies.

Two special studies should be conducted having to do with systems implications as a whole:

1. Survivability of satellites in the 1961-65 era. Principally the aim of this study should be the determination of the actions which can be taken against these satellites, and the extent to which it is possible and desirable to counter these. In general, the vulnerability of satellites to any enemy action is reduced by:

   a. Use of decoys (radar and optical); use of orbiting chaff, shielding of vital components; use (perhaps) of non-reflective radar and optical coatings (if feasible); geometric cross-section reduction; active techniques under special circumstances. USE OF ORBIT PERTURBATION

b. Replacement of most vulnerable components - film by tape, solar cells by batteries, etc.
c. Short mission duration, complicating detection and not permitting substantial prediction smoothing or application of decoy discrimination techniques.
d. Use of demand launchings from hidden or globally dispersed sites, so no launch warning exists.
e. Precision de-orbiting, so that recovery is not tipped off by massive recovery deployment, and also permits much wider selection of de-oribt areas.

The responsiveness of these techniques to possible enemy action should be studied to the extent that we can determine to what degree (if any) we have to compromise our technical capability because of political or technical impediments.

2. A Complete Mission Systems Study. The aim of this study is to determine the effectiveness and utility, in the 1961-65 era, of the various instrument and vehicle possibilities of IV and VI, based on considerations such as are discussed in I and II. The goal of the study is to determine the developmental avenues which should be pursued vigorously.

This study should go considerably beyond the usual one in which requirements are usually based on technical capability, since many seemingly innocent requirements complicate the systems unduly (e.g., the provision for multi-target roll steering). The possible developmental areas will be quite numerous in the 1961-65 era, and will need de-limiting rather than a complete translation of possible technical capability into requirements.

VIII. General Program Features.

1. As a general rule, the covert program should be done in two concurrent phases, both of which are necessary if the program is to have a maximum initial utility and a vigorous and viable future.

2. Phase a. should be simply to push the use of the equipment currently under way to develop to the maximum a standard, reliable instrument and vehicle, and to make the operational techniques routine and dependable. The present Discoverer system now has a very significant immediate capability which should be allowed to perform routine missions for some time into the future. The various improvement versions of components should be incorporated as they become available, but no attempt should be made to incorporate all possible equipment progressions on this series of essentially operational vehicles.

The kinds of component improvements which can be considered here include the following(a more detailed list can be readily generated):

a. Refinements and improvements in guidance and control techniques and components;
b. Incorporation of C''' as the standard instrument.
c. Incorporation of any features promising to simplify or make more reliable the command, control and general communication functions, and assist in the total operation. [redacted]
d. In general, any improvement which does not perturb the instrument carrying capability of any vehicle now scheduled for this capability. This permits special Ferret gear.
e. R & D flight verification of the effectivness of the full-stereo twins.

[redacted]

3. Concurrently, a program of study and development activity should be carried on, essentially in parallel, to incorporate state of art advances and alternate techniques into the program when these are ripe for exploitation. This phase of activity includes, to some extent, all the considerations discussed earlier in I through VII, and will include the development of precision de-orbiting techniques by actual flight demonstration during the next 1-1-1/2 years, the full engineering of a twin C stereo instrument, development of [redacted], and development of an instrument system for the solid rocket boosters. These could then in turn become operational systems in the 1962-63 period. Booster and/or Agena improvements may at that time produce Thor-boosted capabilities comparable to those of Atlas, which may make possible (and desirable) [redacted] based on Thor.

4. The general aim of this program then is to always have in operation a system or systems unimpededly and routinely gathering data, while a concurrent part of the program is to develop the maximum equipment and capability progression to a stage where it can be inserted into the operational program in turn. In this way one can entertain a maximum equipment progression, without succumbing to the temptation to tamper with a useful operational system which is returning necessary information without the benefit of the latest paper study or laboratory device.

5. The 1961-65 era has been chosen because at least one and perhaps two generations of capability are feasible.

6. Although the emphasis has been placed throughout this discussion on the short missions recovery systems, it is not meant to imply that extended missions readout systems should be discarded.

   In fact, such readout systems come into their own in surveillance activities, especially in multi-sensor payloads (incorporating photo ~~for~~ or tape), ferret, IR and radar) where the multiple intelligence inputs give most vital information exceeding that of any single sensor. It is both impractical and undesirable to attempt to ~~attempt to~~ recover such payloads, in general.

   For this class of activities the readout systems complement the recovery systems in very important ways. In addition, techniques are possible which permit the survival of such vehicles in ~~any~~ an era of increasing anti satellite defense efforts, at least for an interestingly long time.

IX. Summary.

1. The preceding discussion is an outline for a full-fledged study whose aim it would be to chart the desirable course of a covert satellite reconnaissance program into the 1961-65 era.

   This general study would be composed of a number of sub-studies. Each section indicated by a Roman numeral (I - VIII) contains one or several studies which should be undertaken to formulate an intelligent development plan and appropriate hardware action.

   Each section I-VIII contains explicit and implicit assumptions or conclusions. These must each be examined and substantiated or modified, or made more convincing and rational.

[redacted]

2. The part of the total covert program discussed is important, but obviously does not exhaust the possible requirements. Proper awareness of the total program may make some of the studies and development efforts less important or superfluous. One possible example is the development of another covert aircraft system capable of routine overflight.

The relative survivability and effectiveness of such a system vis-a-vis the space observation systems must be put into proper perspective to assess a desirable reconnaissance force composition in the 1961-65 era.

3. Perhaps one of the more necessary studies is a rather general one which is best described as a philosophical, objective and introspective discussion of the "real" requirements and utility of various reconnaissance and surveillance techniques. The perogative of making such a study, or at least asserting conclusions presumably derivable from such a study, is very jealously guarded, but the arguments are mainly assertive and not necessarily persuasive. In any event, if such studies are not continually being updated they are not being responsive to the current situations.

In particular, considering that now and into the forseeable future our foreign policy rests on deterrent and counter-deterrent strategies, and that perhaps all one can hope for, short of arms control, etc., is the achievement and preservation of a stable deterrance, the role of observation systems in meeting those goals ought to be periodically re-evaluated. Some assertions on this are made in Section I, but certainly a more comprehensive appraisal can be made. Very fundamental questions remain - for example, how and where one can respond to information obtained, or how one decides not to react to such information by any unusual division of our own efforts, etc. Since the technical capability of the next five years will permit us to do many interesting and unusual things, but not all such things, in observation systems we should be sure that the proper avenues are being followed and that we are really fulfilling our most vital needs.