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17 February 1969

KEY BACKGROUND MILESTONES  
IN FULCRUM/HEX PROGRAM

A. Getting underway in good old Bureaucratic fashion:

1. June 1963 - DCI convenes Purcell Panel which recommends improvement program for CORONA.

2. October 1963 - DCI asks Dr. Wheelon for CORONA payload improvement proposal.

3. October 1963 - D/NRO convenes Drell Committee for basic CORONA examination.

4. January 1964 - CIA initiates study employing 25 PI's to ascertain resolution required to identify majority USIB targets. Results reflected 2-4 feet would satisfy.

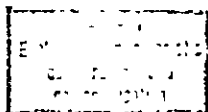
5. February 1964 - CIA funds Itek study to determine feasibility and potential intelligence value of various sensors in satellites.

6. May 1964 - CIA and Itek independently conclude that intelligence needs require CORONA-type search system with GAMBIT resolution. Itek proposes three camera designs, all including 120° scan angle. CIA agrees that twin 60" F/3 camera design most desirable.

7. June 1964 - Land Panel reviews FULCRUM concept; recommends program to prove technical feasibility (film transport-speed and control; mfg. large flats). DCI approves.

8. June 1964 - CIA begins alternate camera configuration studies at PE.

9. July 1964 - Itek undertakes six months intensive feasibility studies on film transport problems and to build camera brassboard.



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### Key Background Milestones in FULCRUM/HEX Program

10. August 1964 - CIA receives informal word that Brockway MacMillan, D/NRO, has started competitive efforts to FULCRUM in behalf of the Air Force at Eastman-Kodak, Fairchild, and also Itek. He also attempted to conduct effort at Perkin-Elmer; however, Perkin-Elmer refused stating they were presently under contract to CIA for similar type design.

11. January 1965 - Briefing at Itek to Mr. McCone, Dr. Land, and DOD personalities. Lindsay advises Mr. McCone privately that Itek held NRO contract for a new search and surveillance system other than FULCRUM. During course of briefing, Mr. McCone pressed Lindsay and other Itek officials as to whether or not FULCRUM represented Itek's most advanced thinking on a search system. Lindsay and staff, after some parrying, affirm their belief that FULCRUM was the final word.

12. 23-24 February 1965 - Land Panel hears presentations from CIA Itek camera design and competitive Air Force Eastman-Kodak and Itek designs. At the conclusion of the presentations when the Land Panel was in executive session, Itek officials informed Dr. Land that Itek was withdrawing from the CIA FULCRUM Program. Variety of accusations which followed on part of Itek were concluded by Bross/Blake investigations to be merely poor judgment on part of Itek.

13. March 1965 - Itek FULCRUM design transferred to Perkin-Elmer, and Perkin-Elmer states they can build FULCRUM system with some modifications.

14. July 1965 - Dr. MacMillan advises Vance and McCone that Eastman-Kodak has been selected for new satellite search and surveillance system. CIA challenges decision. (Of particular interest is fact that during summer of 1966, CIA learned that MacMillan had actually let a contract with Eastman-Kodak for the new search and surveillance system on 22 February 1965, the day before the Land Panel met. During the first part of October 1966, Mr. John Crowley and Mr. Leslie Dirks of CIA, in conversation with Itek officials, learned from Mr. Walt Levison that MacMillan had advised Mr. Lindsay that Itek had lost the competition on 22 February 1965, the day before the Land Panel and the day before Itek withdrew from the FULCRUM Program.)

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Key Background Milestones in FULCRUM/HEX Program

15. August 1965 - Land Panel recommends CIA pursue continued study effort at Perkin-Elmer with competitive camera systems.

16. September 1965 - Perkin-Elmer, after six months internal study of various camera configurations for the FULCRUM Program, selected the rotating bar concept.

17. September 1965 - Eastman-Kodak selected for MOL Program, eliminated from FULCRUM competition and ordered by D/NRO to transfer design and equipment for new search system to Itek.

18. October 1965 - Flax replaced MacMillan as D/NRO.

B. Implementation of New NRP Agreement - Sensor a CIA Responsibility:

1. May 1966 - CIA assumes contract responsibility for all HEXAGON search and surveillance sensor systems; i. e., the two designs at Itek and the rotating bar design at Perkin-Elmer.

2. July 1966 - HEXAGON proposals received from Perkin-Elmer and Itek. Itek bids only on its own design, drops Eastman-Kodak's.

3. August - September 1966 - Proposals evaluated. Source Selection recommendations presented to Dr. Flax.

C. Contracts Awarded:

1. October 1966 - Flax approves Source Selection recommendation and CIA awards contract to Perkin-Elmer.

2. July 1967 - D/NRO awards Integrating and Satellite Basic Assembly contract to Lockheed Missile Systems Company.

3. May 1968 - D/NRO awards Reentry Vehicle contract to McDonnell/Douglas.

4. July 1968 - D/NRO awards Stellar Index Camera contract to Itek.

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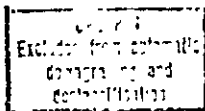
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CAUSAL FACTORS  
IN  
PROGRAM STRETCHOUT

1. Management Problems
  - a. Basic "Agreement for Reorganization of the National Reconnaissance Program", dated 11 August 1965, is too specific and restrictive in that it limits CIA to engineering development of sensor subsystems without any regard to the particular type of system which may be in question. (Para. D.1.d.). This generic assignment of specific responsibilities can and has resulted in unrealistic and arbitrary interface problems.
  - b. November 1965 - The CIA Director of Reconnaissance, in commenting on the D/NRO's management options for HEXAGON, described two basic choices, the first being how to divide the responsibilities and secondly the way in which the Air Force and CIA would collaborate in executing their assigned responsibilities for the program. He recognized the D/NRO's desire to have a single organization to be primarily responsible for overall management and that, if such a single management scheme were chosen, the case for assigning the responsibility to CIA was compelling. The management task force's recommendations to the D/NRO were unanimous that CIA be responsible for the SENSOR MODULE which was defined by the Technical Task Group to include the "recovery vehicle module".
  - c. April 1966 - Stemming from the basic agreement mentioned in Para 1. a. above, the D/NRO rejected the recommendations of his Technical Task Group and assigned only the Sensor Subsystem to the CIA and all remaining portions of the HEXAGON Program to the Air Force. The Sensor Subsystem



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### Causal Factors in Program Stretchout

included the Pan Camera and the "Close In" thermal control. It did not include the Spacecraft Module.

- d. At the 26 April 1966 EXCOM Meeting, D/OSP made an unsuccessful reclama on the responsibility assigned to the CIA and requested that these responsibilities be expanded to include the design and development of a complete center section module. EXCOM supported the D/NRO posture to the effect that the spacecraft be considered a single entity to be developed by the Air Force with "doors" for insertion of the camera which was to be developed by the Agency.
- e. August 1966 - The D/OSP officially informed the D/NRO that it was essential that the interface between the sensor subsystem and the satellite basic assembly, reentry subsystem, and stellar index camera subsystem be defined as early and as completely as possible, and that this was especially true of the thermal interface between the sensor and the satellite basic assembly. It was also essential-- since the two competing sensor subsystems varied considerably in their design concept--for an integrated satellite vehicle concept to achieve an early definition.

### 2. Implementation Problems

- a. The lack of a "complete system" integrating contractor at the inception of the HEXAGON Program, and the piecemeal awarding of major contracts over an extended period; viz:

October 1966: Sensor Subsystem, (Perkin-Elmer);  
 July 1967 : Satellite Basic Assembly and Satellite  
                   Vehicle Integration, (Lockheed);  
 May 1968 : Reentry Vehicle, (McDonnell/Douglas);  
 July '968 : Stellar Index Camera, (Itek).

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### Causal Factors in Program Stretchout

- b. Repeated procrastination of D/NRO in making important decisions and resolving problem areas.

Current examples include:

(1) A revised SOR was never issued, so that common mission descriptions could be jointly addressed.

(2) Software responsibilities for on-orbit targeting is still a moot question.

(3) The need for an attitude determination system to meet NPIC's mensuration requirements has not been resolved.

- c. Parochial Air Force Overall Program Management Attitude.

(1) Motivations never appeared to be toward getting job done.

(2) Many major system decisions made by the Air Force did not indicate a concern for schedule, cost, or system weight, of the total system.

(3) Inability of SBA contractor to meet mid-section deliveries resulted in six-month Program slip. (Went to separate Module anyway).

(4) Air Force program manager refused to rewrite the top system requirement specification after the selection of the winning camera contract to reflect that specific design, and it remains unconcurred in by the CIA Project Director as of this date.

(5) GE's Command Programmer is having development problems, with attendant schedule risk.

(6) Air Force Manager refused to adhere to agreement requiring joint sign-off on system documentation.

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### Causal Factors in Program Stretchout

3. Critical Sensor Subsystem Design and Development Problems
  - a. Manpower Buildup for New Division.
  - b. Construction of New Facilities and Special Test Equipment.
  - c. Sensor Subsystem Design Complexity.
    - (1) Large Optical Element Fabrication
    - (2) Film Transport System
    - (3) Thermal Considerations
  - d. Integration and System Test.

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PROGRAM DEVELOPMENT CYCLE

Four Major Impact Areas:

1. Manpower Buildup for New Division
2. Facilities and Special Test Equipment
3. Sensor Subsystem Design Complexity
4. Integration and System Test

1. Manpower Buildup

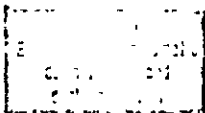
Perkin-Elmer undertook its first large subcontracting effort.

- o Normal manpower buildup problems.
- o Recruiting difficulties in a manpower-short area.
- o Critical skills

2. Facilities and Special Test Equipment

Perkin-Elmer undertook the construction of a new facility exclusively for HEXAGON, using \$10 million of company funds.

- o Government procured large items of major test equipment.
  - o Chamber "A" - 52 foot spherical thermal vacuum chamber.
  - o Chamber "B" - 30 foot cylindrical thermal vacuum chamber.



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- o Chamber "C" - A vacuum chamber for optical element system testing.
- o Chamber "D" - A thermal vacuum chamber for testing optical bars under simulated albedo.
- o A six shaker vibration test station.
- o An acoustic facility for testing the sensor subsystem in the SBA mid-section.
- o An RFI screen room.
- o Complex test consoles for integrating the above test stations with the sensor subsystem in place.

3. Sensor Subsystem Design Complexity

The three-key design aspects which needed to be proven during the design phase have been achieved.

a. Large Optical Element Fabrication: The question of achieving a 1/40 wave for the 36 inch long folding flat mirror has been demonstrated, and the production rate sufficient to meet the launch schedule has also been demonstrated. The system requirement of 1/14 wave was bettered by the first set of optics produced.

b. Film Transport System: The question of whether a film transport system consisting of large supply spools operating at up to 70 inches per second continuously, with an intermittent

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film transport system accelerating the film in the slit area during photography up to 200 inches per second through the looper concept, within the required smear tolerances had to be demonstrated. The film path simulator has proven the feasibility of the interaction of the several key servos to meet the performance objectives. Some of the design tolerances which have been met or bettered are as follows:

- o The film velocity synchronization tolerance at the 200 inch per second maximum value is  $\pm .053$  in/sec. (2 sigma). These tolerances were apportioned in the following manner:

- o Metering capstan angular velocity errors:

- o Torque disturbances  $\pm .028$  in/sec.
- o Transducer Error  $\pm .010$  in/sec.
- o Servo Error  $\pm .016$  in/sec.

- o Metering capstan radius errors:

- o Film Thickness Variations ( $\pm 1.7$  micron)  $\pm .0.3$  in/sec.
- o Runout  $\pm .017$  in/sec.
- o Thermal Effect  $\pm .025$  in/sec.

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- o Combined angular velocity errors due to optical bar tolerances  $\pm .024$  in/sec.
- o Other key tolerances related to film transport system are:
  - o  $747 \text{ in/sec}^2$  for film accelerations by the film drive capstan.
  - o Maximum roller and capstan misalignments - 30 arc seconds ( $1.5 \times 10^{-4}$  radians).
  - o Maximum wander of the film center line on the take-up reels (a maximum length away from the supply reel of 100 feet) - .075 inches.

c. Thermal Considerations: The passive thermal control approach was analyzed in a coarse analytical manner involving approximately 200 nodes and subsequently analyzed for each optical element which was investigated up to approximately 250 nodes each. These analytical results were compared against the sensor subsystem hardware thermal model test results, showing remarkable similarities. The combined defocus budget for the sensor subsystem is  $\pm 10.75$  microns, of which  $\pm 5$  microns were allocated for thermal effects (other key defocus contributors are

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platen roller runout,  $\pm 1.0$  micron; film flutter,  $\pm 2.2$  microns; and film mean unflatness,  $\pm 2.2$  microns). In order to achieve the thermal focus error budget the following approach was taken:

- o The average temperature of the optical bar would be 70 degrees  $\pm 23$  degrees fahrenheit.
- o The optical bar side-to-side differences would be less than 5 degrees fahrenheit.
- o The actual difference through the mirrors would be less than .25 degrees fahrenheit. Radial differences in the refracting elements would be less than .50 degrees fahrenheit.

Final verification of these numbers is scheduled for the integrated thermal model testing to be held this summer.

#### 4. Satellite Vehicle Integration

The take-ups and the forward film path elements are shipped separately to the integrating contractor for assembly and test with the RV's and SBA forward section structure and the sensor subsystem which is delivered installed in the SBA mid-section. This test cycle, involving a final resolution test and an LMSC large thermal vacuum chamber, is a lengthy procedure.

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