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Progress Report on Martin's Titan III Incentives (January 1963 to March 1966)

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PROGRESS REPORT
ON
MARTIN'S TITAN III INCENTIVES
(JANUARY 1963 TO MARCH 1966)

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Three years ago Martin started work on the Phase II contract for the development and test of the Titan III Space Booster. This was the first large aerospace system contract to incorporate multiple incentives for schedule, cost, and technical performance. Now, with the Titan III contract more than 90% complete, this report will evaluate the success of the incentives used and will compare incentive success with program results.

In consonance with the philosophy that the purpose of incentives is to motivate superior performance, this Martin/AFSSD contract contains definitive criteria for the determination of incentive success or failure. The contract also provides for a bilateral incentive monitoring system and requires that this monitoring system operate in a timely manner.[1] By this means, performance is quantatively measured at progressive check points throughout the period of performance. The responsibility for meeting the incentive criteria is assigned ahead of time by Martin's program management to specific individual work leaders whose success or failure is graded virtually at the moment the work is accomplished.

Schedule Performance

The prime schedule concern to the customer, AFSSD, is that the boosters be ready at the launch complex on the date scheduled for launch. To ensure this capability the schedule incentive is structured in two parts. One is the PERT/Time incentive which motivates quality/time performance on critical events leading to completion of the contract milestones. The second part of the schedule incentive, the contract milestones, requires the on-time completion of airborne vehicle and AGE tests at Denver prior to shipment to the launch sites.

PERT/Time Incentive[2]

The PERT/Time incentive consists of 316 Incentive PERT Events (IPE's) which are listed in the contract. The criteria used in selecting the events used as IPE's is that they be significant, definable, and capable of motivating performing groups toward successful accomplishment of the milestones and other program objectives. During the last month of each three-month quarter, the PERT/Time tab runs for the next quarter are "frozen" by Martin and the Air Force through their Incentive Review Monitors, and the "expected date" (date for which there is a 50/50 probability of completing the event) is used to measure the IPE's falling into that quarter. Detailed descriptions of the events, their criteria for quality/technical completion, and expected dates are disseminated in a catalog. The Monitors then use the Catalog description and the "expected date" in scoring success or failure.

The score to date is:

TABLE A. INCENTIVE PERT EVENT SCORING

	Total Events Scored	Events Approved by the Monitors	Events Disapproved
1st thru 11th Incentive Quarters	297	265	32
12th Quarter (Current)	5	5	0
Total to Date	302	270 (89%)	32 (11%)

The reasons for disapproval of the thirty-two events fall into two categories:

TABLE B. REASONS FOR IPE DISAPPROVAL

Time Category (No. of IPE's Disapproved on a Time Basis)	Quality Category (No. of IPE's Disapproved on a Quality/Technical Basis)	Total Disapproved IPE's
25 (78%)	7 (22%)	32 (100%)

Thus of the 302 IPE's scored to date: 25/302 or 8.2% were late; and 7/302 or 2.4% were deficient in quality. (In each case, the disapproval spurred appropriate recovery action -- not early enough to avoid the incentive penalty, but still early enough to forestall serious downstream impact.)

In selecting the IPE's both Martin and AFSSD recognized the fact that success of the engineering activities is a major factor in overall program success. Engineering is "first-in-line". It has to define the hardware before procurement or fabrication efforts can begin. Success in motivating engineering to release complete packages on time enables the procurement buyers to shop more effectively, permits the tool designers to more thoroughly explore alternate producibility concepts, and lessens the production worker's rework and overtime. Further, we believe that the incentives and other program control techniques must be in dynamic operation during the first 25% of the program, for that is where the overall success or failure of the program is established. Therefore, almost 40% of the total number of IPE's were devoted to engineering. The scoring of this coverage is shown in the following table:

TABLE C. ENGINEERING IPE PERFORMANCE

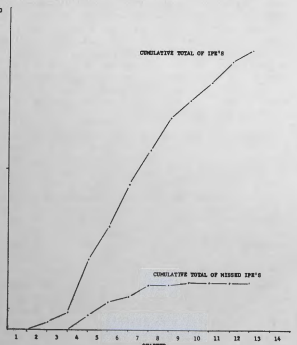
	IPE Coverage* of Basic Design Packages	Total No. of IPE's	No. of Disapproved IPE's	% IPE Success
T-III A/B Engineering	98%	55	1	98%
T-III AGE Engineering	74%	75	2	97%

(*These percentages exclude any redundant events such as "P-41 Umbilicals, Design Engineering Release Complete" in which the drawings were virtually identical to those in a similar and earlier P-40 IPE. Since they offered little motivation all redundant events were replaced by other events which offered more challenge.

In the fabrication area there have been 172 IPE's scored to date. These covered procurement, tooling, assembly, and test activities. In this area we missed 29 IPE's or 16.8%. The fabrication cycle IPE performance miss ratio of 29/172 compared to the engineering IPE performance miss ratio of 3/130 (reference Table C) indicates that meeting fabrication events is considerably more difficult. A considerable amount of "domino impact" (in which missing one event on a PERT subnet led to missing subsequent events on that same subnet) was noted in the fabrication area. Here the process of procurement available, build complete, and test complete forms a tight series arrangement. On the other hand, in the engineering area, the IPE's were predominately design release events composed of several engineering packages in a parallel relationship. For example, basic structure, bracketry, plumbing, and installation drawings might be the four major packages comprising a structures' engineering IPE. If, in order to prepare a drawing for this IPE the structures group needed information that interfaced with part of an IPE that the propulsion group was working, the engineers invariably arranged among themselves to expedite the drawings containing such interface data. This parallel flexibility is much less available among fabrication events whose end items are in a series arrangement and usually physically different. (in the few instances where there was similarity between two items of hardware, in a close time/availability relationship, they were invariably a part of the same IPE.)

Despite this lack of flexibility the motivation generated by IPE's is present in the fabrication area, and as Graph D shows, the cumulative trend of missed IPE's has become level.

GRAPH D. FABRICATION CUMULATIVE IPE PERFORMANCE



Milestones

The second part of Martin's schedule incentive deals with the contract milestones. These are the on-time and successful completion of the combined systems tests of the seventeen space boosters and the tests of the three sets of AGE vans prior to shipment to the field. These major contract delivery dates or milestones were set forth in our proposal in September 1962. They were then "frozen" into the contract when go ahead was received in late December 1962. Milestone performance to date is shown in Table E.

TABLE E. CONTRACT MILESTONE SCORING

	Milestones Scored	Milestones Approved by the Monitors	Milestones Disapproved
AGE Van Sets	3	3	0
Space Boosters	15	13	2*
Totals to Date	18	16	2*

(*Space Boosters 1 and 2)

Changes

The impact of changes on IPE's is easily handled through the application of the criteria via the bilateral incentive monitoring system. The contract provides that in the event a Class I change impacts upon an IPE already fixed in a Quarterly Catalog the monitors will temporarily excuse the event to allow appropriate recovery action by the contractor. Upon receipt of contractual direction to perform a Class I change, the Martin planners "PERT" the change, the revised date is given a critical review by the monitors, and Martin performance is measured against the new PERT expected date. Class II changes impacting on an IPE generate no incentive relief to Martin. The milestones are changed only by a supplemental agreement to the contract. This occurred in mid-program when the remaining milestones were rescheduled in order to accommodate the addition of live payloads to the flight program.

Program Schedule Success

Before leaving the subject of incentives we must recall that the purpose for having schedule incentives is to have the equipment ready at the launch complex on time. This purpose has been met. All Martin Titan III equipment has been ready for customer use at the launch site on his planned launch dates.

Flight Performance

There is an old truism that "the proof of the pudding is in the eating". In Martin's Titan III development contract the largest proportion of the incentive reward or penalty has been placed upon flight performance. This is a two type incentive.

First Flight Incentive

The first type of flight performance incentive is that placed upon successful and on-time launch of the first "A" (core only) booster and the first "C" (core plus solids) booster. This is a reward only incentive and in order for Martin to win we must be on schedule to the contract launch date and the transtage must meet its final orbital window as specified in the contract. As added motivation for proper accomplishment of Martin's role as detailed integration contractor we lose just as much if our associates' equipment fails as we lose if our equipment fails in achieving the specified orbit. The advantage of this type of incentive is that it motivates teamwork.

Space Booster Demonstration Incentive

The second part of Martin's flight performance incentive is assigned to the operation of the Martin equipment in the countdown and flight of the other fifteen vehicles in the program. In this incentive the countdown and flight operation of each vehicle is worth 100 points.[3] At the end of the flight program the points earned are converted to dollars of fee reward or penalty. As the number of vehicles launched increases, the point emphasis shifts toward the successful operation of the final stage. This progressive distribution of points requires improved performance on each of these development flights in order to avoid penalty.

Results

The Flight performance to date is shown in the following table:

TABLE F. FLIGHT PERFORMANCE

Launch No.	Percent of Primary and Secondary Flight Objectives Met	Ratio of Incentives Earned to Incentives Allocated to that Flight
1 "A"	90%	0%
2 "A"	100%	100%
3 "A"	100%	100%
4 "A"	100%	100%
1 "C"	100%	100%
2 "C"	81%	Not Yet Established
3 "C"	90%	Not Yet Established

All countdown points have been successfully earned by Martin.

Indicative of the successful performance of the Titan III "A" vehicle is the fact that the government deleted the fifth core vehicle from the "A" configuration flight program and has reserved it for future use, thus saving $17,000,000 of the taxpayer's money.[4]

The first flight of the Titan III "C" was a complete success. The second and third flights experienced difficulties in the final phases of flight and did not achieve the planned final orbital position.

Changes

The performance of the Titan III "A" on its first two flights encouraged the mission planners to add satellite payloads to vehicle 3 "A" and 4 "A". These payloads were successfully placed into orbit. Then, the success of the maiden flight of the Titan III "C" further encouraged the planners to schedule satellite payloads for all of the remaining Titan III "C" development flights. The use of live payloads with their complex flight profiles necessitated a change in the Space Booster Demonstration incentive to give emphasis to this element of program growth. Therefore, the Air Force and Martin added a satellite orbital insertion measurement to the flight performance incentives.

Cost Performance

Martin's Titan III Phase II contract has already passed the 90% cost commitment and expenditure point. We can confidently state that upon contract completion we will be on the target cost.

Although the cost incentive structure in the contract presented an opportunity for significant cost incentive rewards if the program were underrun, we will not be able to produce the program for less than target cost. On the other hand, we have avoided the penalties inherent if we were to significantly overrun the target cost. This exactitude in meeting the target cost did not come by accident. During Phase I great effort was expended in preparing the detailed engineering specifications, in preparing and testing the PERT/Time/Cost system, in establishing the management plan, in defining the specific detailed items of work in each of the contract tasks, and in preparing the cost estimate for Phase II. Furthermore, once under the Phase II contract we found, as we had planned, that the IPE schedule incentive motivated people to complete their work promptly. As soon as they did they were, in accordance with PERT/Cost, operating on a new cost suffix (and budget) for their next event. The rigid time/completion requirements of IPE's also helped to avoid costly delays and rework downstream on the program. In addition, Martin has an effective cost reduction program in which the Titan III program team was credited with over $80 million in savings during this three year period. An additional sum of over $7.5 million was saved by the Value Engineering program. In fact, but for the IPE's and the cost reduction programs the tight target cost would have been overrun. Furthermore, during this period we experienced a decline in sales at Denver and management had to work vigorously to keep the overhead in line.

Changes

Both AFSSD and Martin management teamed to curb the change activity inherent in a development program. This management effort combined with the excellent program definition obtained during Phase I contributed to our success in holding the cost impact of specification changes to less than 1% of the target cost. These concepts of accurate definition and stringent control were also applied to the modifications of the contract work statement for such items as the addition of live payloads to the flight test program.

Conclusion

Martin's successful experiences on the Titan III program prove that incentives do work towards motivating superior performance. Our experiences also show that success is contingent upon; (1) an excellent degree of program definition; and, (2) the ability of management to bring all their people on board as wholehearted participants.

References

1. "Incentives in Action", R. W. Chapman, AEROSPACE MANAGEMENT, February 1964

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3. "Martin Company Titan III Incentives", Brochure, The Martin Company, Denver, Colorado, 1965

4. "Move Up in Space - Win Points", BUSINESS WEEK, September 25, 1965