N96-70671

Development of the COMmercial Experiment Transporter (COMET)

By Joseph F. Pawlick, Jr.
Assistant Director for Commercial Space Transportation
Center for Advanced Space Propulsion
November 1, 1990

Overview

In order to commercialize space, this nation must develop a well defined path through which the Centers for the Commercial Development of Space (CCDS's) and their industrial partners and counterparts can exploit the advantages of space manufacturing and processing. Such a capability requires systems, a supporting infrastructure, and funding to become a viable component of this nation's economic strength.

This paper follows the development of the COMmercial Experiment Program (COMET) from inception to it's current position as the country's first space program dedicated to satisfying the needs of industry: an industry which must investigate the feasibility of space based processes, materials, and prototypes. With proposals now being evaluated, much of the COMET story is yet to be written, however concepts and events which led to it's current status and the plans for implementation may be presented.

Funding for this program was provided by NASA Headquarters Office of Commercial Programs through the Center for Advanced Space Propulsion Grant NAGW-1195.

This concept would not have come to fruition were it not for the support of Dr. George Garrison, Mr. E.G. Allee and those CCDS members who make up the COMET team. Invaluable assistance was provided by Messrs. N. Bowles and D. Lang of the Department of Transportation's Office of Commercial Space Transportation.

Program Initiation

At the May, 1989 Quarterly CCDS Directors Meeting, Mr. R. Ott, Director of Commercial Development Division of the NASA Office of Commercial Programs (Code C) presented the results of his office's investigation into available spaceflight opportunities for CCDS payloads. While the short range forecast showed a suitable number of flight opportunities, the quantity of commercial payloads for the outyears, were seen to outstrip Shuttle Get Away Special Canister (GAS Cans) and mid deck locker availability. Mr. James T. Rose, NASA Associate Director for Commercial Programs suggested that a "service" CCDS could be created which would investigate, optimize, and provide transportation opportunities to all CCDS's requiring spaceflight support.

While the Directors saw many benefits in such an approach, it was believed that the necessary skills existed within the present 16 CCDS's to accomplish this task. Mr. Rose asked the Directors to present their alternative approaches at the November, 1989 meeting at Houston, Texas.

Based on inputs from the Directors during the ensuing three months, Mr. Rose approved a structure for developing transportation and infrastructure in support of CCDS needs. Dr. Lundquist was nominated as the Chairman of the Commercial Space Services Procurements Subcommittee. Members added to the Subcommittee included Dr. G. Garrison, Director of the Center for Advanced Space Propulsion, Dr. R. Askew, Director of the Space Power Institute, Dr. A.D. Patton, Center for Space Power, Dr. M. Luttges, BioServe Technology, Dr. J. Wallace, Center for Materials for Space Structures, and Dr. A. Ignatiev, Space Vacuum Epitaxy Center.

During the next three months Drs. Garrison, Speer, Mr. E.G. Allee and the author, all of CASP, met with the ELV Subcommittee. These principles evolved:

1. Short programs are more successful than their long lived counterparts.

2. Procurement of systems isn't necessary if only services are desired.

3. The provider must be ultimately responsible for defining system quality and reliability.

4. Shuttle's man rating requirements place extreme demands on commercial experiments and prototypes.

5. The program must result in a U.S. based commercial infrastructure which offers total services to its customers.

6. Commercial approaches to procurement will result in lower costs.

7. CCDS's would be actively involved in the management of the program but not in it's technical decisions nor as contractor "monitors".

A survey of potential CCDS and commercial payloads was accomplished by CASP. Once the scope of physical attributes and experiment support needs were characterized, it became evident that an approach could be formulated which would satisfy the diverse needs of the CCDS's and their commercial partners. A concept of an ELV launched, commercially controlled vehicle which would be recovered on land within the continental United States evolved. If successful, a competitive procurement could yield, low cost service could be provided by U.S. industry. With a strawman approach identified, work areas, costing, and procurement strategies were developed.

At the February, 1990 CCDS Directors Quarterly Meeting, an overview of a three tier support approach was presented to CCDS and Code C personnel. Consisting of a progression of capabilities ranging from a "micro-bus", a system capable of supporting a 200# package of experiments to a 8000# "factory in space", the concept was based on currently designed systems which could be formed into a commercial venture to service the spaceflight needs of the CCDS experimenters. It was proposed that funding would be made available via augmentation to existing grants to fund service contracts. Each participating CCDS would be funded to accomplish it's technical monitoring and contract observation role.

An alternative was presented by Dr. M. Luttges of BioServe, University of Colorado, Boulder. The BioServe proposal consisted of a series of flights which would take advantage of the remaining Discoverer recovery capsules and be launched from a Pegasus ELV. BioServe's selected contractors would procure the hardware and accomplish the first mission in 1991.

Dr. Lundquist's committee was asked to review all aspects of the two plans and present a consolidated approach to Code C for their consideration. Since the BioServe variant provided the same capability as the micro-bus already considered by the Subcommittee, the microbus was eliminated and a plan was prepared which included BioServe's Commercial Interim Recovery Capsule (CIRC), and a mid-range system termed COMET. The high end, factory in space variant was eliminated since emphasis was placed on solving the near term problem of insufficient flight opportunities for CCDS payloads.

Since the two remaining systems would be competing for limited funding in the earlier years, it was decided to proceed with planning for a system which would place at least 6 cubic ft. of CCDS payloads into a 250 to 350 nm. equatorial orbit. Other non-recoverable experiments would be housed in the payload adapter and termed the "Service Module". All aspects of the procurement would be completed by the CCDS's and, if required, NASA would have the opportunity to review the final COMET selections during the subcontract review which would be completed by the Grants Officer prior to contract signature. This consolidated plan was presented to Mr. J. Rose on May 20, 1990. Four days later Mr. Rose notified the COMET Program Manager of his decision to pursue the COMET plan.

Less than two months later, a draft RFP was released, followed two weeks later by a discussion with industry. Less than Three months from it's activation, the COMET Team put out an RFP for all aspects of the program. On October 3, 1990, fourteen prime contractors placed proposals with CASP for COMET's various work areas. Proposal evaluation is being accomplished by the six CCDS's who make up the COMET Management team. A goal of July, 1992 has been set for first flight.

Market Analysis

In a 1989 study commissioned by NASA's Office of Commercial Programs, SAIC Inc. surveyed a number of commercial experimenters to determine the size, type, and requirements of payloads they might wish to put into space. Figures 1 and 2 are extracted from that study and show the weight distribution and number of flights for payloads which could fly between 1989 and 2000. These two figures portray parameters which have great impact on system development: weight to orbit and total potential markets.

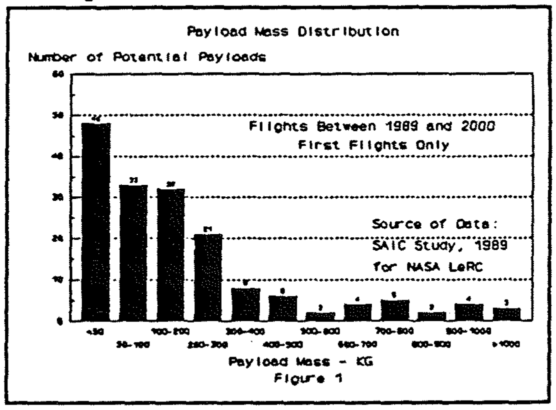

Figure 1

Figure 1 indicates that the largest number of commercial payloads will weigh less than 50 kilograms and that a system capable of orbiting 300 kg. of experiments will be able to service almost 85% of the identified payloads.

Figure 2 shows that a large number of payloads are not single flight experiments. Rather, many are to be refined through successive flights as the decade progresses. Note that the data exhibits a bow wave pattern which seems typical of a schedule for projected systems of any type but in particular, spacecraft and boosters. Of equal importance to the total numbers identified is the indication that some experiments are ready to fly now while many will become ready for flight when flight opportunities are available. SAIC study data further noted that one third of all experiments require recovery. These experiments cannot achieve meaningful results without the final product in hand, id. crystals from a macromolecular crystal growth experiment, layered substrate from epitaxial growth,

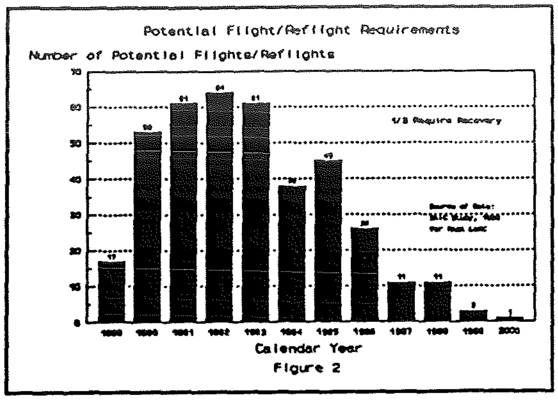

Figure 2

and finished product from materials processing work. Others, not requiring recovery may be on ELV's to satisfy their primary objectives.

While the SAIC statistical sample included CCDS payloads, it was difficult to determine the statistical presence of the CCDS's in the data. Additionally, it was believed that some CCDS's might respond more positively if they were given the opportunity to participate in structuring a commercial space program. CASP initiated a follow-up survey shortly before Christmas, 1989. Results of this survey identified needs for power, thermal, micro "g", and other salient experiment parameters and provided weight and physical dimensions.

Figure 3 superimposes the results of the CASP survey on the weight profile generated by SAIC. Each (1) represents a CCDS payload whose data was taken from this survey and clearly shows that the CCDS requirements are a subset of the larger data base. Given experiment maturation, all portions of the SAIC curve could reasonably be expected to be reproduced by CCDS sponsored payloads.

For example, payloads at the right of Figure 3 represent the University of Houston Epitaxial Growth and Clarkson Crystal Growth experiments. These are most like experiments which can evolve into a commercial "factory in space". In one sense, Figure 3 can be segregated into three major categories of payloads based on their weight and objectives: to the left are those

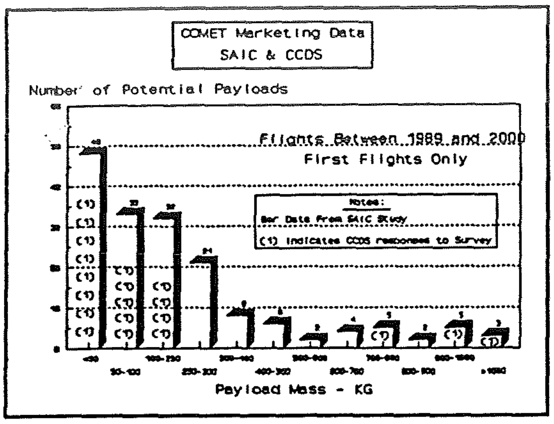

Figure 3

involving commercial experimentation, to the center are those who's goals are to refine the earlier experiments into commercial prototypes, those on the right are directed at commercial production.

It appears that the needs of those commercial payloads which reside on the left of the weight scale might be met with current, "off the shelf" technology. Those in the central area can be satisfied by systems already designed but not flown (within COMET capability) and those to the far right require systems which require Shuttle support or ELV systems which are beyond the weight capability envisioned for COMET. Commercialization will ultimately involve all three segments but funding availability will focus our attention on the first two.

While systems must be capable of supporting commercial spaceflight needs, an industrial capacity in space requires that an infrastructure be developed: one which facilitates the process of getting experiments and prototypes into space, gives investigators latitude to optimize the materials and processes of their experiments, allows them to influence mission planning, interact with their orbiting experiments, gather data when needed, and finally, have access to their experimental apparatus shortly after its return.

Infrastructure must be supported by systems which fulfill the needs of the commercially oriented experiments. Such systems must accommodate the spectrum of commercial payloads at a low cost and acceptable reliability. Reliability and quality need not be dictated since these are, rightfully, requirements of the supplier, not of the purchaser. We expect to bring forth new approaches to support of space systems. Developing an infrastructure along the lines of current aerospace models would force us to repeat many of the less efficient aspects of prior programs: those in which regulation, intricate cost accountability systems and numerous quality checkpoints drown out technical excellence and professionalism.

Since COMET will purchase the services of suppliers rather than their hardware or components, interactions with the supplier will be restrained. In contrast to an aerospace program under government contract, this more commercial approach dictates that providers will insure themselves against failure. In support of this tact, the COMET team's approach will be to review contractor progress to the extent necessary to assure the COMET team of the supplier's ability to meet major program milestones. In depth safety, quality, reliability, and maintainability reviews and procedures can give way to "best commercial practice".

Finally, if the program is to make an impact on the established way of doing business, there must be opportunities for new, emerging, "fledgling" companies to demonstrate their technical prowess.

In summary, a coherent approach to servicing commercial development requires a program, not a project. To be of continuing value, the program must be capable of growth: a growth dictated by products which are derived from experiments in space and lead to production in space. Our continuing objective must be to develop an infrastructure which outlasts current needs, even current vision, and allows this country to move steadily and surely toward a fully commercial approach to accessing space.

Mission Concept

Supporting the diverse elements of space commercialization brings with it a need to serve a wide spectrum of users. Low weight, low power experiments may be all that's required to serve a crystal growth investigation while commercial prototyping of a materials processing technique may greatly increase the levels of power and thermal systems need. To adequately support the broad spectrum of requirements and build on successes, hardware capability must expand to satisfy increasingly larger and more complex payloads. However, regardless of the size of payload, the concept of a CCDS monitored, contractor operated, launch and recovery program provides the most viable method for creating an infrastructure.

To avoid unnecessary program complexity, COMET will make use of expendable launch vehicles (ELV's) rather than Shuttle. The talents of as many as five hardware and one systems engineering contractor will be combined to launch, command, control, re-enter and recover commercial payloads. CCDS members will structure statements of work and evaluation criteria, select the most responsive proposals, monitor contract performance and observe technical compliance.

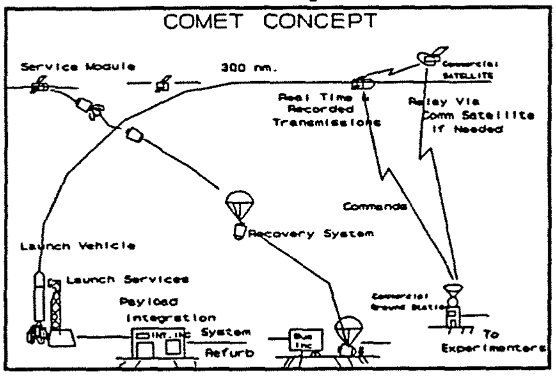

Figure 4

As shown in Figure 4, experiments will be moved directly from investigators to the Payload Integration contractor's facility. They will be matched with other compatible experiments, mated to a payload structure and integrated into a common command and data system. The experiments will be checked out and the payload integration contractor will insure that the built-up payload assembly meets the necessary interfaces with the FreeFlyer.

A checked out payload assembly will be transported to the Recovery System contractor location where the Recovery System (R/S) contractor will mate the payload to the R/S. After subsystem operability is confirmed, the Service Module will be mated to the R/S. The Systems Engineering contractor will assure proper performance of the integrated R/S, Payload, and Service Module checkout. Upon successful completion of these tests, the FreeFlyer will be moved to the launch site where the Launch Vehicle contractor will mate the FreeFlyer to the launch vehicle. Provisions will be made wherein experimenters will have access to their packages up to three hours before launch.

A successful launch will leave the FreeFlyer in an orbit of approximately 300 nm. and at a nominal inclination of 40°. Either of these orbital parameters will be modified to match experiment needs, however, land recovery at a suitable southeast U.S. locations dictates an inclination of at least 38°.

Once in orbit, the Orbital Operations contractor will activate FreeFlyer systems and command the FreeFlyer as required by the experimenters. Data recorders, real time telemetry, and experiment control will be commanded by the Orbital Operations team. Automated power, thermal, and attitude control systems will be provided by the Recovery System and Service Module and will be monitored by the orbital operations team along with experiment health and status.

Upon successful completion of mission objectives (a minimum of 30 days), the R/S contractor will calculate the necessary commands which must be sent to the FreeFlyer to allow the R/S and it's payloads to re-enter and land at the designated landing site. This information will be provided to the Orbital Operations team who, after assuring that payloads are configured for re-entry, will send the appropriate command sequence. After a successful re-entry, the R/S will be maneuvered for a soft landing at a location within the U.S.. Ram Air and other controllable parachute systems have been suggested as suitable devices for allowing steering corrections at the terminal portion of the flight and for controlling landing loads.

If the FreeFlyer has been equipped with experiments in the support module, the orbiting systems will continue to provide data until the systems are de-activated, the experiment goals have been accomplished, or the Service Module re-enters. Minimum life of the Service Module is to be 100 days.

COMET's payloads will be removed either at the recovery site or support area by the R/S contractor. Similarly, the Payload Integration contractor will remove the individual experiments at either the recovery or support areas as requested by the investigator. Both the Recovery System and payload support structure will be returned to the appropriate location for refurbishment and return to the inventory for future flights.

A Systems Engineering contractor will address overall reliability, survivability, and compatibility questions and will assure the technical acceptability of experiments and system changes. This organization will also oversee or accomplish integrated testing of COMET components.

System Description

Since COMET's design will be determined by those selected to provide systems and infrastructure, Figure 5 is only a conceptual overview of major hardware components. COMET's FreeFlyer consists of two functional components: A Recovery System and a Service Module. In basic terms, the Service Module is a satellite, complete with power systems, thermal and attitude control, and experiment sensors. While attached to the Recovery System, the Service Module provides power, telemetry, command and telemetry recorders, and attitude control for its own systems and payloads and those located in the Recovery System.

While many payloads could be characterized in terms of their weight, CCDS Directors have found it more appropriate to express their payload needs in terms of payload volume.

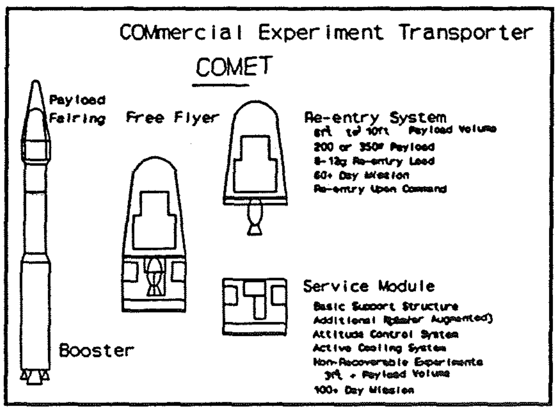

Figure 5

Based on the CASP survey and another, more in-depth view by the CCDS at Battelle, the minimum viable payload capacity is considered to be 6 ft^3 with a strong desire to increase to 10 ft^3 if possible. Note that the "advertised" R/S weight and payload capability are based on an estimate of payload density. While R/S manufacturers quote a density of 80 to 100#/ft^3, we believe a figure of 30 to 50#/ft^3 is appropriate based on experiences of the Consortium for Materials Development in Space (CMDS) in its Consort and Joust programs.

Candidate launch vehicles appear to be in the class of Orbital Sciences' "Taurus", Space Service's uprated "Conestoga" and American Rocket's "AMROC". Each have been designed but not yet flown. Other small launch vehicle manufacturers are expected to propose similarly capable systems.

Likewise, Recovery Systems for the COMET have been designed but not yet flown. Cheops, a recovery system marketed by COR Aerospace, an offspring of Lifesat, (currently entering phase B design), and an uprated Discoverer, are likely designs for COMET's Recovery System. While Lifesat is seen as a candidate, the commercial version must be much less sophisticated and considerably less costly.

Addition of a Service Module on COMET greatly enhances the capability of the FreeFlyer by eliminating R/S weight and housing systems capable of providing virtually an unlimited time in space prior to reentry and recovery. This Service Module design philosophy is similar to that of BIOSAT and Gemini. In these vehicles, the support, or service module, housed major systems: communications, power and conditioning, thermal control, and data/command storage devices. Like BIOSAT and Gemini, COMET will be designed to allow late access to the payload area through access techniques which will be proposed in the contract competition.

Schedule

Contacts with industry indicate that contracts for COMET class system could lead to launch within 18 months after contract go ahead. Potential Recovery System suppliers suggest that their vehicles could also launch within 18 months of Authorization to Proceed (ATP). There is a distinct possibility that systems already in production for micro-sats or other on-going satellite programs could offer a shorter lead time for orbiting systems. However, based on discussions with potential suppliers, many are burdened with a 12 to 16 month cycle for long lead items.

While little testing will be required by our approach, adequate schedule time must be allocated by the hardware contractors to allow both the contractor and COMET Management Team to gain confidence in the system's capability to be successful.

Management Plan For COMET

Management of the program will take advantage of the depth of experience and talent within the CCDS team. A matrixed organization (Figure 6) will be headed by a Program Manager, assisted by a Systems Engineer, and will include a small permanent program management staff. Initial staffing within the Program Management Office includes permanently assigned personnel plus those with specialized talents to assist in the start-up of the program. In most cases these will be detailed from both the University of Tennessee, Arvin Industries and/or Calspan organizations. Legal assistance, for example, is not the product of one individual's time, but rather a composite of legally talented people who will assist in contract preparation and proposal evaluation. Experiences on other multi-contractor endeavors indicates that while lean, the staffing level is deemed adequate for efforts approaching $50M per year provided that government contract monitoring approaches are abandoned.

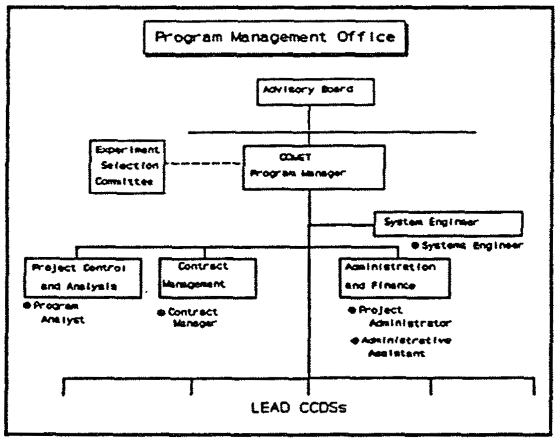

Figure 6

Through their intimate knowledge of the subject area, CCDS's who wish to make a significant contribution to the success of COMET were invited to involve their personnel in a contract observation and technical monitoring role.

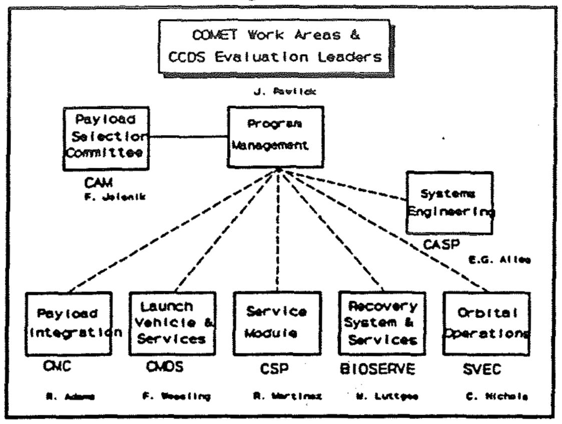

Figure 7

For each of the six major contracts let under the proposed COMET Program, a CCDS was chosen to prepare statements of work, evaluate proposals and provide a technical and contract assessments within the selected work area. These CCDS's, termed "lead CCDS's" were picked from the ranks of interested and experienced CCDS's and are the primary program interface with the contractor. Figure 7 shows CCDS's, which have been selected to make up the COMET Management team.

As a member of the Program Management Organization, the CCDS Monitor at the Lead CCDS's provide a voice within the technical area for formulating plans, defining changes, evaluating status, and determining the future of the COMET Program. As the Program member in closest communication with the contractor, the CCDS Monitor is in the best position to provide assessments of mission preparedness and contractor performance. With the addition of Lead CCDS's and their CCDS Monitors, the management structure becomes one in which CCDS members are directly responsible for the success of the program.

Lead CCDS's will be funded through an augmentation to their respective grants based on a budget provided to OCP by the Program Manager. OCP requires that each CCDS provide budgetary backup to their "bogey" similar to that currently used in requesting augmentation.

An Advisory Council will be formed by the CCDS Directors. Headed by a CCDS Director, the Council will be comprised of other CCDS Directors, and may include members from Code C, the Commercial Program Advisory Council, the Department of Transportation and the Department of Commerce. They will provide overall program assessment and guidance, assist in development of new concepts or areas of interest, and accomplish high level interfaces with Governmental and commercial organizations. Meeting semiannually, the Advisory Council will receive presentations from the Program Manager and Systems Engineer who will present program status and provide an insight into potential opportunities and problem areas.

An Experiment Selection Committee, headed by a CCDS Director, will consist of CCDS Directors representing Material Sciences, Life Sciences, Earth Sciences, and one or more from the "infrastructure" CCDS's (power, propulsion and robotics). They will be joined by members from NASA and industry and together will review proposed experiments to assure their compatibility with the goals and objectives of the commercial space initiative, assess the ability of the experiment to interface with other packages, and assure that the experiment has a reasonable probability of success when flown aboard the COMET. Based on the state of hardware readiness, they will recommend a window for flight and provide their recommendations to the Program Management Office for technical review and scheduling.

As currently formulated, there is no requirement for NASA to take an active role in management of the COMET program, instead they will review final subcontracts and control the flow of systems funding through a well structured and existing grant augmentation process.

Planning and Control

We recognize that planning is not a static process. In order to take advantage of unforeseen opportunities, a process of reviewing and evaluating the effect of proposed changes will be in place and is depicted in Figure 8. Since the need for change may take many paths, an element within the Program Management Office will be the focal point for planning and changes to existing plans. Certainly, the overall cost and schedule effect of changes due to events such as a member CCDS identifying a hardware anomaly, a new concept for

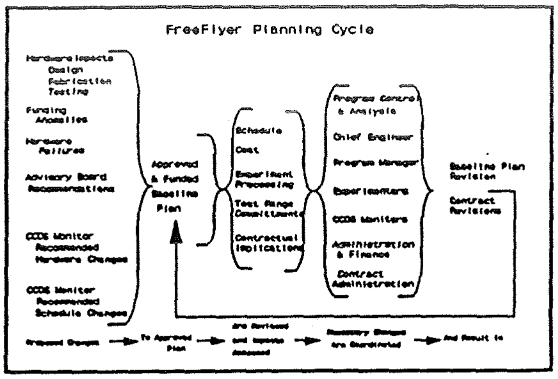

Figure 8

operations, or vendor suggested savings, must be ascertained before action will be taken. Similarly, suggested changes from the Advisory Council must be viewed in light of their effect on the entire program before the selected path is changed.

Proposed changes will flow to Project Control and Analysis where their effect on other work areas will be reviewed for both cost and schedule impact. Upon a successful review, the Baseline Plan will be modified and the program change instituted.

Annual Budget requests to Code C for COMET will be based on the latest revisions to the Baseline Plan. Upon funding of the Plan, it will then be designated the Baseline for the fiscal year.

Technical Management

The Program Office Systems Engineer will assume the responsibility for COMET's technical leadership. In that role the Systems Engineer will interface with the Payload Selection Committee, will provide technical guidance to member or Lead CCDS's, and when required, will assure that the Systems Engineering contractor is prepared to lead integrated systems tests.

Assisted by the Lead CCDS's and in close contact with the Systems Engineering contractor, the Systems Engineer will monitor technical aspects of the program and continuously evaluate the capability of program participants and their hardware to meet objectives. In this role the Systems Engineer will depend on the ability of the

Lead CCDS's to evaluate progress, identify problems, and highlight opportunities within their respective contractors.

Communication

While the Program Management personnel are located in the close proximity of each other, the Lead CCDS's are expected to be somewhat removed. Our approach recognizes this challenge and finds it imperative that modern communication aides be merged with a management philosophy and structure which stresses frequent, open and frank communications between the various team members. We have great respect for the contractors who will be supporting the FreeFlyer. In many instances, they will place the entire future of their company on the success of COMET. We share in their future and will strive to maintain a free-flow of communications consistent with good business practice.

Monthly summaries of activity will be distributed by the Program Management Office based on inputs from all members. Hardware status, launch readiness successes, opportunities, and problem areas will all be highlighted. Information gathering will lean toward informal means. Formal letters (numbered or otherwise) between Program members will be kept to a minimum consistent with good commercial business practice.

An annual summary of activity will be prepared by the Program Office to fulfill requirements of the Grant and Cooperative Agreements Handbook. Similar documents from Lead CCDS's will not be required.

Financial Information

Each of the work area Contractors will submit monthly summaries of project expenditures and financial forecasts. To this, Lead CCDS's will add milestone status, and technical achievements.

Contractor, Lead CCDS's, and program office expenditures will be gathered and maintained at the Program Management Office. Summaries of this information will be made available to all COMET Management Team members monthly along with a brief analysis of variances.

Financial data pertaining to the COMET program which is required by OCP will be generated by the Program Management Office and will include information pertinent to all participants in the program. Budget or expenditure information which concerns data deemed proprietary by either the contractors or Lead CCDS's will not be divulged outside the Program office. Such information will be requested by the Program Office only when needed to substantiate estimates or billings, or evaluate specific problem areas.

Procurement Plan

While it was possible to structure the procurement of the COMET launch vehicle, etc. into a single package, it was preferred to divide the overall project into six major elements. This led to increased probability of competition, and enhances the ability of the COMET team to select the best mix of contractors to accomplish the COMET program. Dividing the work into more compact packages also led to increased participation from smaller, specialized companies whose capital structure may not have allowed them to bid on the entire COMET Program.

Our approach of breaking the procurement into smaller pieces does not, by it's nature, rule out a single contractor or consortium from proposing on the entire effort. Such a proposal would be evaluated using the same criteria as required by each segment of work.

To assure a coherent approach during program startup, procurement goals were established:

a. One launch vehicle and a COMET FreeFlyer would be procured in FY91 for launch in mid FY92. After 1992, launches will be conducted annually until both budget and commercial need dictate a greater rate.

b. Systems Engineering will be initiated in FY91 and continue for the life of the program.

c. A low level of Orbital Operations and Payload Integration will be funded during 1991 for support to be provided to the launch in 1992.

d. Program Management and a number of CCDS's will prepare the RFPs, proposal evaluation, and program structuring in FY90.

While some may be qualified to bid on the contracts, CCDS's and other non-profit organizations or companies will not be considered as prime contractors for the work elements of the COMET. Similarly, we believe that participation of prime contractors should be limited to those in which both control and ownership rests within the U.S.

These guidelines recognize that an objective of the COMET program is to develop a lasting, U.S. based infrastructure for servicing commercial needs in space. It is the COMET Management Teams belief that this goal can be best achieved by qualified U.S., for profit firms.

To take advantage of the economies of an open marketplace, all COMET contracts will be competitively bid using a streamlined variant of the procedure generally followed by governmental agencies and large aerospace firms. We have followed the schedule outlined in Figure 9 in the preparation of statements of work and the RFP. All proposers have been advised that their proposal may be accepted without negotiation or further discussion. Results of the review process will determine whether oral presentations or best and final offers will be requested.

SIGNIFICANT COMET EVENTS
Program Initiation

Event	Date
Concept Finalized	May 20 '90
OCP Authorization	May 24
Draft RFP Issued	July 18
Industry Briefing	July 31
RFP Issued	August 22
Proposals Received	October 3
Evaluations Started	October 5

Figure 9

COMET's procurement plan was activated with the release Announcement of Opportunity was released and respondents provided qualifications and area(s) of interest. A draft RFP approach was selected so that comments could be solicited from industry concerning and evaluated for inclusion into the RFP. As part of the information flow to industry, prospective bidders were invited to a industry briefing conducted at the University of Tennessee Space Institute. Over one hundred representatives from sixty one industrial firms participated.

Questions posed during the review and during the ensuing two weeks were answered and, where appropriate, folded into the RFP. Six weeks were allocated for responses to the RFP and sixteen prime contractors have submitted proposals.

Based on these responses, Lead CCDS's have formed Selection Evaluation teams which include the appropriate legal, contracts, financial and technical personnel. Using evaluation criteria generated during Statement of Work preparation, each proposal will be graded on its managerial and technical approach, cost and other factors. Technical talent, risk, and cost realism will also be viewed by the evaluation teams. The CCDS based Evaluation Teams will weigh each proposal based on it's strengths, weaknesses, and the ability of the proposer to accomplish the COMET mission. These teams will provide their results to the Selection Advisory Council who will consolidate the various proposals onto approaches which would accomplish all COMET work areas. These optimum approaches will be presented to the Program Manager who will determine the Contractor(s) best suited to implement the COMET program.

If required, oral presentations , best and final offers, and negotiations will be then be conducted with contract signing planned before the end of CY90.

After Subcontract approval is received from NASA followed by Grant funding, the contractors will be given Authority To Proceed (ATP) by the Program Manager.

Contracts

To take advantage of the flexibility gained by defining six distinct areas of performance, contract types will vary based on the peculiarities of the area of performance. In general, fixed price contracts may be used where work statements and performance standards are more easily defined, i.e. launch vehicle and services and the FreeFlyer components. Exact levels of support required for

Orbital Operations, Systems Engineering, and Payload Integration are more difficult to define. Contracts written for these would most probably be cost plus fixed fee contracts. These levels of contract effort are envisioned:

a. Launch Vehicle

Contract for 3 launches with an option for 2 additional launches. If exercised, options for the fourth launch would be executed prior to the launch of the third vehicle. Insurance requirements of DOT/OCST must be met by contractor.

b.Recovery System

Contract for three flights with two options for an additional flights. With a projected lifetime of 10 or more refurbishment cycles, the Recovery System would be capable of supporting a continuing experiment load throughout the decade. Insurance requirements of DOT must be adhered to by contractor.

c. Service Module

Three modules will be required on the basic program. At a launch rate of one per year, the program will be at a point to exercise options in late 93 or early 1994 or re-bid the effort. An option for two modules would allow for an increased launch rate as the program matures or continues to sustain a once/year rate through 1996.

d. Systems Engineering

A contract of sufficient length to include start and three launches with two one year options. Initial activity will focus on system integration interface specifications and overall mission assessment. Re-flight insurance will be purchased by the contractor.

e. Orbital Operations and Payload Integration

A contract sufficient to cover startup and three flights with two one year options. Equipment purchases necessary for startup may cause the contracts to be slightly front end loaded however, once operational capability is reached, the dominant cost will be manpower.

Options

COMET will be structured to provide three years of system operation based on a once per year launch rate. Approximately eighteen months before integration of the third COMET begins, a bid or option decision will be made. If options on any of the six efforts are not exercised, the RFP cycle will be separated to acquire the needed capabilities. Options offer the COMET the capability to continue proven systems while offering the ultimate performance incentive, continued sales, to the COMET contractors.

Competition

An over-riding goal of competition is to get the optimum infrastructure and services at the most realistic cost. Our initial market survey indicated that there were at least three potential proposers for each of the work areas. More surfaced when the Announcement of Opportunity was released. We have observed that teaming opportunities abound and smaller "specialty" companies have joined with larger, better endowed firms.

The probability of achieving adequate competition was enhanced by issuing one RFP with six work areas. There were no restrictions on the number of efforts on which a proposer could bid however, should a proposer be awarded more than one effort, all elements of the allied statements of work will be included in resulting contract. Cost realism will be a closely monitored issue for contracts awarded which have multiple statements of work.

Only US or US owned (51% or greater) companies were eligible to compete as prime contractors. Companies who are members of a CCDS were not be ruled ineligible on the basis of their membership, however that CCDS was not be allowed to participate in the evaluation process of their proposal.

Universities and non-profit or not-for-profit companies or organizations were also not allowed to compete as prime contractors since investment of profit is seen as a primary mode of developing infrastructure.

Sub Contract Approval

Since all funding will be in the form of Grant augmentation, contracts which result from this program will be included in CASP's request for augmentation and the provisions for the Grant and Cooperative Agreements Handbook will be followed. Contracts will be issued by the Center for Aerospace Research, and, after CAR and contractor signature, will be forwarded to the NASA Grants Officer for review and approval. After approval of funding by the NASA Office Of Commercial Programs, the Program Manager will authorize the contractor(s) to proceed.

Role of CCDS's in the Contracting & Procurement Process

CCDS's have played a key role in the structuring the COMET program philosophy, distilling its concepts into practical work areas, and evaluating contractor responses in light of our generalized requirements.

Those who desired to take an active part in the program prepared the statements of work for each of the six contracts. As a part of the work statement, they have identified hardware and software concepts, mission requirements, and standards of quality and safety performance for the contractor. These major definitions provided the structure around which the six SOWs were built.

Based on their intimate knowledge of the tasks to be performed, the Lead CCDS's have structure the evaluation guide for the contract they have prepared, review the RFP in it's various stages of completion, and bring together a Selection Panel. This panel will review and evaluate the technical, management, and cost aspects of all proposals received for that effort. They will make recommendations to a Selection Advisory Council which consists of all CCDS's involved in the evaluation process. The Council will bring the various proposals into viable program options, evaluate risks and opportunities, and make recommendations to the Program Manager who will select the COMET Contractors.

Upon signature of the contract, the Lead CCDS will assign a Monitor to accomplish the contract oversight and technical monitoring of the contractors performance. They will evaluate contractor performance, and provide the Program Management Office their assessment of schedule and milestone achievements. If required, the Lead CCDS may be requested to investigate inconsistencies in performance or cost structure, and participate in buy off and critical test activity.

Conclusion

COMET offers a capable system for orbiting and retrieving commercially oriented prototypes and experiments. By integrating and focusing the efforts of as many as six contractors, we have the opportunity to invigorate the commercial space sector while we build expertise within the CCDS community.

Our approach is to free contractors from extensive specs and standards, place the burden of cost efficiency and quality with the supplier and challenge the contractor team to meet or exceed our performance requirements and stringent schedule.

COMET represents the opportunity for Commercialized Space to become a reality. CCDS's will provide crucial planning and contracting service to assure proper stewardship of the grant funding. For it's part, industry will be called upon to provide hardware and develop an infrastructure for the continuing commercialization of space. Structuring the RFP into six distinct work packages brings with it the challenge of integration but the potential of involving a large number of small firms: firms whose future can be assured by the COMET program.

IF we were to envision the COMET program at its most successful end point, hardware and infrastructure will have matured to the point where one of the participants, or a new start, will find it commercially attractive to market and operate COMET without the CCDS Management Team. At that time COMET will have reached its goal.