ESA Industry Space Days

Assessment Report

Sponsors: ESA & Eurospace

Organisation Logistics:

Comité Richelieu

Place : Estec, Noordwijk

Date: 26 / 27 of May 1999

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FOREWORD

1. The ISD Background and Purpose

The first edition of the Industry Space Days (ISD) was held on 26/27 of May 1999, at the European Space Technology Centre (Estec), in Noordwijk, the Netherlands. The event gathered Major Space Groups and SMEs (Small and Medium-sized Enterprises) from the ESA Member States and its Associates. The purpose of the ISD is the following:

- contribute to the opening of the European Space Industry to innovative ideas and technologies developed in other fields of high technology;
- help to enhance Industry competitiveness by the use of SMEs' skills & expertise;

- help SMEs to diversify, to initiate new co-operations and to find new customers.

The organisation of these ISD illustrates one of ESA actions in favour of SMEs and is part of the measures decided by the European Space Agency within its SME Initiative. Indeed, in March 1997, the Council meeting at Ministerial level, gave the European Space Agency the mandate to adapt its industrial policy, in order to guarantee to all industry categories fair access to its activities and programmes. One of the elements of that mandate was to give within the Agency a special place to SMEs. In reply, ESA defined an SME Initiative including a whole set of measures in favour of SMEs and started its implementation end 1998.

In the meantime, the Council at Ministerial level held in Brussels in May 1999 has put the SME initiative on a permanent footing, and invited ESA Director General to propose further measures to ensure a fair allocation of activities among the different categories of firms.

The ESA SME Initiative content is summarised in **Annex 1** to the present document.

The ISD consist in convening SMEs and Major space Groups for pre-arranged working meetings, organised around selected technological topics. These topics and the profile of SMEs to be invited were defined by a Technical Committee nominated by ESA.

Instead of focusing on a specific technology field, the choice for these first ISD was to address all generic technologies applicable to space, and to convene SMEs with innovation potential and the necessary facilities and tools to allow R&D activities .

As the plan is to organise this event on a 2 years interval basis, the next ISD will likely address other type of activity fields and will promote SMEs with other expertise.

2.The ISD Organisers and their Partners

The European Space Agency was the ISD organiser in co-operation with Eurospace, the European Organisation of Space Industry which gave its full support to the event. The European Federation of High-Tech SMEs, under the co-ordination of "Comité Richelieu", its French representative, was in charge of the registration process and the related logistics (meetings planning, satisfaction survey, etc.).

The Technical Committee appointed by ESA to support the ISD definition was composed of relevant experts from ESA, the General Secretary of Eurospace, and a representative of Comité Richelieu.

3.Documentation Produced for the ISD

5 documents were produced for the ISD presentation, the registration process, and the assessment of the event results:

1. Presentation of ISD: Objectives and Methodology
2. Space Technology Outlook & Typical Tasks for High Tech SMEs

3. Registration Form for SMEs
4. Registration Form for Space Groups
5. Catalogue listing the registered companies, and their expertise

The ISD documents edited in preparation of the event were distributed to major space groups and SMEs. This distribution was made on the basis of a preliminary list established by ESA and Eurospace for the major groups, and by the national Delegations to ESA and the European Federation of High Tech SMEs for the SMEs.

In addition, a number of internal documents were produced by Comité Richelieu to support the ISD organisation, and its assessment. Summary of relevant data of these documents is included in the present document which constitutes the **ISD Executive Report.**

This report has been elaborated by ESA, but part of the inputs were provided by Comité Richelieu.

The Executive Report is organised in 3 chapters and 4 annexes with the following content:

4. Special Thanks

The SME Unit of ESA takes this opportunity to thank all the participating companies, and to address special thanks to the following actors who made the ISD possible:

- Mr. Alain Gaubert, Secretary General of Eurospace, for all the support he gave to contact and motivate major space groups to participate to the event.

- Key personnel at Estec who extensively contributed to the definition of these ISD content, supported the ISD exhibition with their respective technologies, and met SMEs.

- The Comite Richelieu and his partners of the European Federation of SMEs, who devoted considerable efforts to the organisation and the promotion of the ISD, namely: VTOe (Austria), Steinbeis Stifftung (Germany), Enterprise Ireland (Ireland0, ICE (Italy), AENTEC (Spain), Senter (The Netherlands), and Nimtech (United Kingdom).

  Four other organisations provided also a valuable support to Comité Richelieu: Creation from Belgium, the Saxony Regional Office for Aerospace from Germany , AIAD and AIPAS from Italy.

- The team of Estec Conference Bureau and Site Services who supported us by many ways and produced an enormous work -within a limited time- to host the ISD to the satisfaction of all.

- the National Space Agencies and National Delegations to ESA who brought their full contribution to ensure the success of the ISD by providing lists of companies to be contacted and very actively promoting the event in their respective countries. Special thanks to CNES and Mr. J.C. Courteille who devoted many efforts to this task.

In conclusion we would like to thank Mr. Dave Dale (Director of the Technical and Operational Support Directorate of ESA) who hosted the ISD at Estec, the representatives of the International Space Station (ISS), of the Meteosat Second Generation (MSG), and of the XMM programmes who supported the ISD exhibition with elements of their technologies and associated Instruments.

CHAPTER 1: ISD FACTS AND FIGURES

1.0 Introduction

Two remarks are to be made with respect to the figures given in this chapter:

- 20 to 30 SMEs' Registration Forms were received too late to be processed, and were not taken into account.

- the number of meetings we refer to in the next sections concerns the number of **pre-arranged** meetings; it does not take into account the non-formal meetings self arranged between the different companies, by themselves.

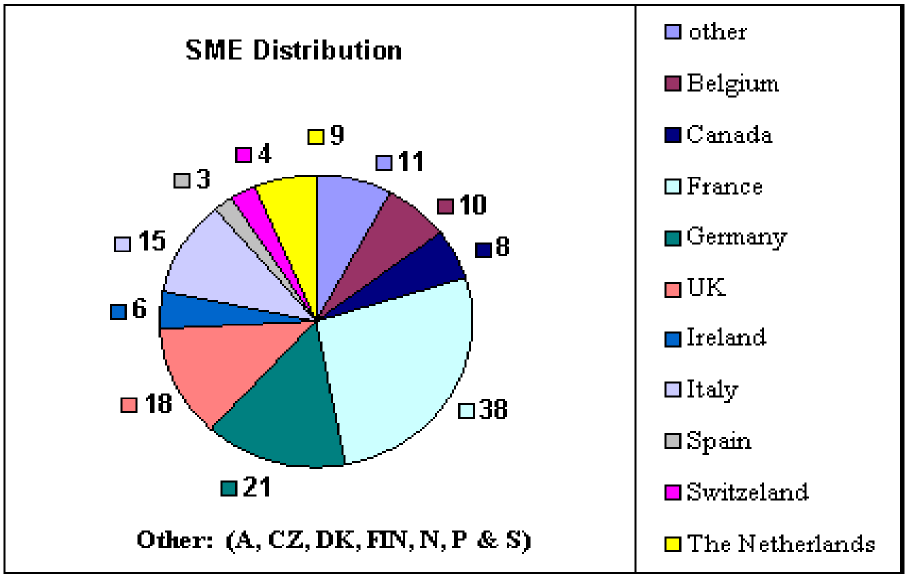
The overall figures concerning the industry participation to the ISD are given below, but for a better insight, the next sections give in more details the data according to the 3 different categories of participants (SMEs, Major Space Groups and Other Organisations) .

  - Total Number of pre-registered Companies: **210**
  - Total Number of participating Companies **187**
  - Total Number of individual participants, about **300**
  - Total Number of working meetings, about **800**

1.1 SMEs Participation

- Number of pre-registered SMEs 160
- Number of participating SMEs: 143
- Number of individual Participants, about 180
- Number of pre-arranged meetings SME/Major Group: 500
- Number of pre-arranged meetings SME/SME : 280
- Average number of Meetings for each SME 6/day

1.1.1 SMEs Geographical Distribution



1.1.2 List of participating SMEs

We have to point out that in view of the nature of the event, it was decided not to be too stringent in the application of the SME definition to the registered small companies, whenever the deviation from the main criteria of this definition was reasonable. Therefore, few of the companies listed below do not fully comply with the SME definition in force within ESA.

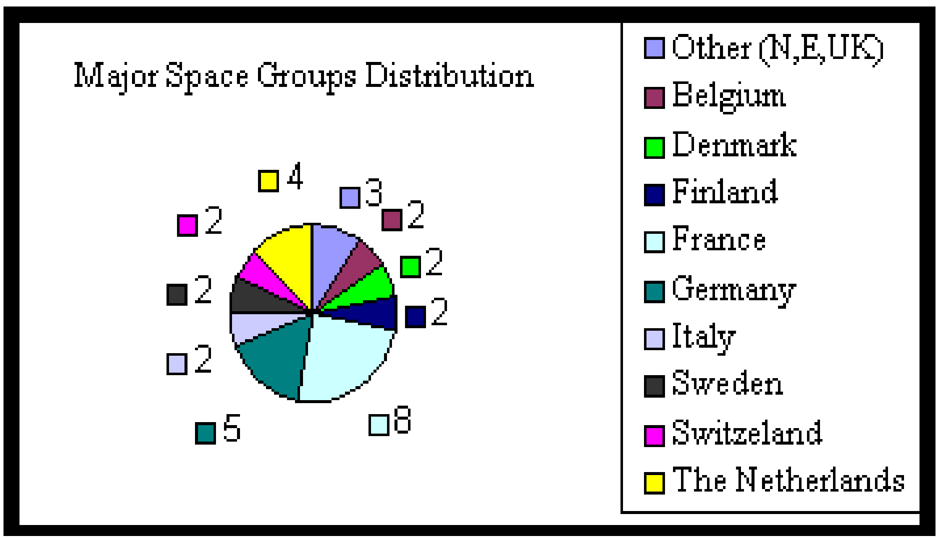
This definition is however fully applied for all ESA procurements and associated studies.

AUSTRIA Electrovac GCS GmbH **BELGIUM** DSP Valley EASICS N.V. Easy Engineering Sprl Eonic Systems, Inc. Laser Power Europe OSTC RTUSI N.V. SAS SEE Verhaert **CANADA** ARC Canada Atlantis Scientific C-CORE Integrity Testing Laboratory Inc MPB Technologies Inc. Neptec NII Norsat International Inc. Telespace LTD **CZECH** **REPUBLIC** CSRC spol. s r. o. **DENMARK** Printca Rovsing A/S **FINLAND** Detection Technology Space Systems Finland Ltd	**FRANCE** ACRI ADV Engineering AER/ATMOSTAT Atermes Axlog AXON AXS Analyse de Structures Bertin Technologies CALLISTO Cedrat Recherche SA C-MAC/CEPE COMAT CS Verilog Cybernetix Dateno Diginext Dynalis SA EREMS ETEP Etablissements. A. Deshors Exavision Groupe DION Hirex Engineering I2E Jehier Spatial Objectif Technologie Optis Optcom Principia Real-Time Consult Reosc Sensorex SESO Soditech TGS Europe Thermocoax TNI Vibria	**GERMANY** Advanced Photonic Systems ART-Photonics GmbH Brockmann Consult Cerobear GmbH ETA MAX SPACE GMBH Fachhochschule Aachen Fraunhofer Institute Nondestructive Testing Hightex Verstarkungsstrukturen GmbH Hypersonic Technology Goettingen IMT Dresden Kayser-Threde Labcontrol GmbH LuraTech GmbH Mühlbauer AG Nema Industrietechnik GmbH Plasma Finish SMT & HYBRID GmBH Socratec GmbH Systementwicklung Raimas Heinze Telegärtner Gerätebau GmbH VCS Nachrichtentechnik GmbH	**UNITED** **KINGDOM** Acsion Industries Inc. Advent Communication Analyticon Limited CENTRONIC Ltd CENTURY DYNAMICS LTD COGSYS ComSym Limited IGG Irvin Aerospace Ltd ISIM International Simulation Ltd L3 Communication Logsys Solutions Ltd Photonic Science Systems Engineering & Assessment Ltd. Sira Electro- Optics Ltd TENET Systems Ltd Vega Technology Ltd WNA Micro Applications	**IRELAND** CAPTEC CEL Composites Testing Laboratory Engineering Solutions International Plasma Ireland Ltd Space Technology Ireland, Ltd **ITALY** Angelantoni Industrie SpA C.A.E.N. Carlo Gavazzi Space SpA DUNE SRL ELCO SPA ELES Equipment srl Eurocontrol SpA GSE srl IDS Ingeneria Dei Sistemi Intecs Sistemi Progres SIA Space Engineering Techno System Developments srl TOP REL srl **NORWAY** Susar Consulting AS Teamcom AS **PORTUGAL** Skysoft Portugal	**SPAIN** AENTEC CESA NTE-SA TECNOLOGICA **SWEDEN** Omnisys Instruments AB **SWITZERLAND** Compania Industrielle Radioaélectrique MECANEX SA RUDOLF BRUGGER SA Welco Technik AG **THE** **NETHERLANDS** 3T BV Argoss Capable B.V. CCM Delft Electronic Products bv Ingenieursbureau Geodelta Leuveco B.V. Polymarin B.V. RDM Technology

1.2. Major Space Groups Participation

- Number of pre-registered Major Space Groups **37**
- Number of Groups who effectively participated: **31**
- Number of individual Participants: **90**
- Number of pre-arranged individual Meetings: **500**
- Average number of meetings for each Major Group: **13** /day.

1.2.1. Geographical Distribution of Space Groups



1.2.2. List of Participating Space Groups

BELGIUM

Alcatel Bell Space N.V.

Praxair

DENMARK

Alcatel Space Industries Denmark

Terma Elektronik AS

FINLAND

Patria Finavicomp Oy

Patria Finavitec Oy, Systems

FRANCE

Aerospatiale Espace et Defense

Alcatel Space Industries

Arianespace

CNES

CS-Systèmes d'Information (CS-SI)

Matra Marconi Space

Pyroalliance

SEP-SNECMA

GERMANY

Daimler Chrysler Aerospace AG

DLR

Dornier Satellitensysteme

Man Technologie AG

UNITED KINGDOM

Defence Evaluation And Research Agency

ITALY

Alenia Difesa - Avionic Syst. & Equip. Division.

Space Software Italia S.p.A. (SSI)

NORWAY

AME Space

SPAIN

CRISA

SWEDEN

SAAB Ericsson Space

Volvo Aerospace

SWITZERLAND

Contraves-Space

Oerlikon Contraves AG

THE NETHERLANDS

ESA-ESTEC

Fokker Space BV

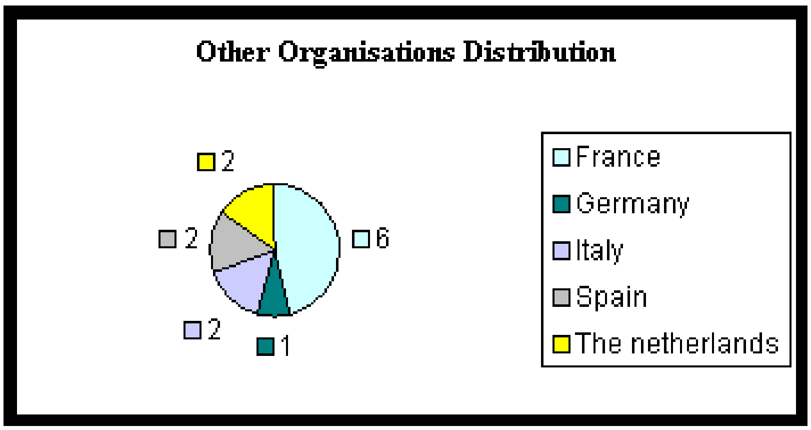
TNO

TNO-FEL

1.3. Other Organisations' Participation

In addition to the Major Space Groups and the SMEs, 20 other participants from 13 organisations were present (the organisers and their partners, and representative of SMEs organisations) and are here counted separately. The meetings which were held between these organisations and the other categories were not recorded and were not taken into account for the different assessments.

1.3.1 Geographical Distribution of Other Organisations



1.3.2 List of Other Organisations

FRANCE Comité Richelieu ESA HO (IMT-I)

Eurospace Novespace

Prospace

Technofi

GERMANY

Regional office for Aerospace

ITALY

AIAD

ICE

SPAIN

AENTEC

INASMET

THE NETHERLANDS

Estec (IMT-CTT)

Senter

CHAPTER 2 : SATISFACTION SURVEY & RESULTS

2.0 Introduction

In order to assess the usefulness of the ISD and the quality of its organisation, each participant received at his arrival a satisfaction survey form with a certain number of questions to be filled in and returned to the organiser. The purpose of this chapter is to give an overview of the results of this survey, and derive some conclusions on the appreciation of the ISDs by the participants.

Few individual quotations are also given.

2.1 Quotations from Participants

From SMEs' Participants:

- Mr. Fraile (Socratec GmbH) : « *it was a great initiative from ESA. Very good !* ».
- Mr. Schwab (Muhlbauer AG) : « *very good meetings ».*
- Mr. Thierschmann (Luratech) : « *should be done every 4 months* ».
- Mr. F. Elbaroudi (AXS) : « *please organize other ISDs* !!! ».
- Mr. D. Nazarenko (Atlantis Scientific Inc.) : « *the other benefit was an opportunity to meet other SMEs with complementary technologies* ».

From Major Space Groups Participants

- Mr. S. Frederiksson (SAAB ERICSSON SPACE) : « better than expected. Some breaks between meetings are needed ».
- Mr. C. Bouzat (CNES) : « *good initiative !* »
- Mr. F. Smolders (PRAXAIR) : « Since the invitation was organised on a short time, it was difficult to make contact in advance, but it was successful for us ».

- Mr. A. Rolfo (CNES) : « good opportunity to meet foreign companies »

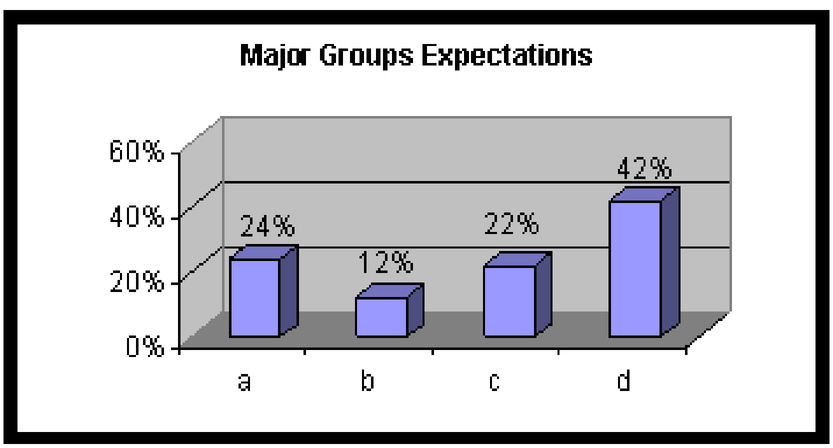
2.2. Satisfaction Survey Results

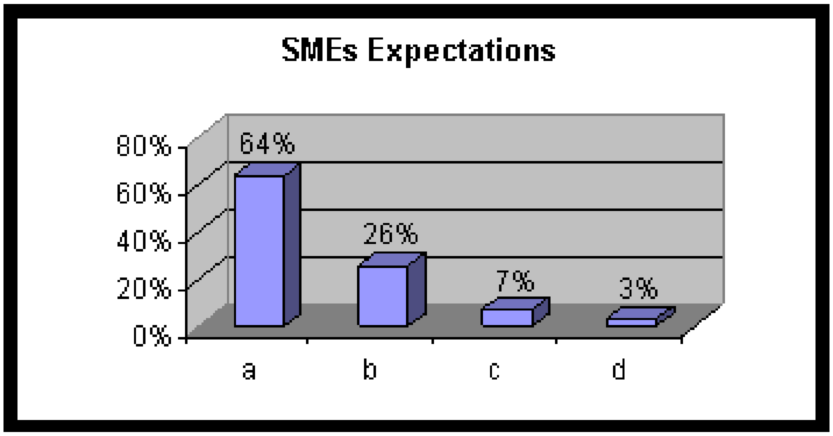
80% of the participating major Space Groups and 43% of the SMEs filled in and handed back their form before leaving the ISD. The detailed replies to the questions part of the survey were analysed and are presented in the following section: for each of the questions, the answers of the two groups (SMEs and Major Space Groups) are plotted within charts and can be compared. Whenever possible, observations on important aspects are also proposed.

2.2.1 What are your expectations from the ISD

a. To find new partners / clients **b.** Market diversification

c. To acquire technologies **d.** To find new suppliers

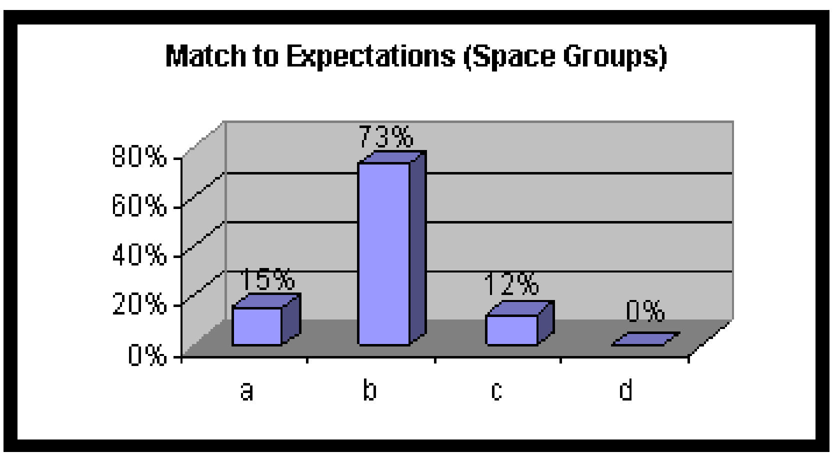


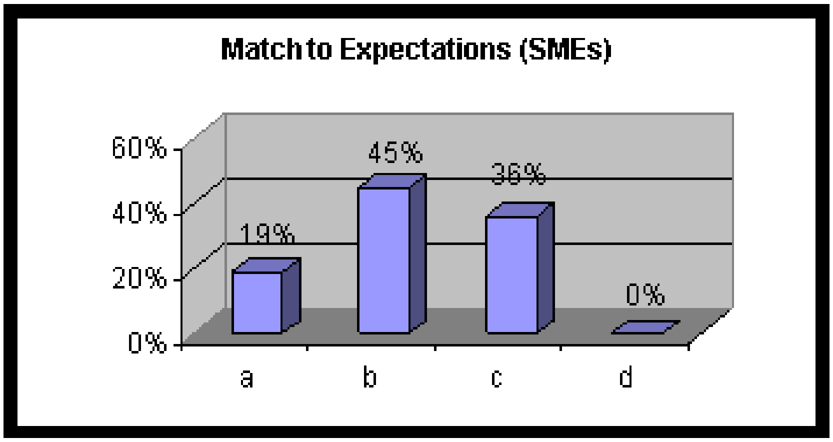


Observation:
We can observe from these charts that the expectations of the two industry groups are perfectly complementary on almost every parameter. This should convince the two groups that these meetings are in the interest of both parties.

2.2.2 How did the ISD match your expectations ?

a: Perfectly **b:** Well **c:** Partially **d:** Not at all





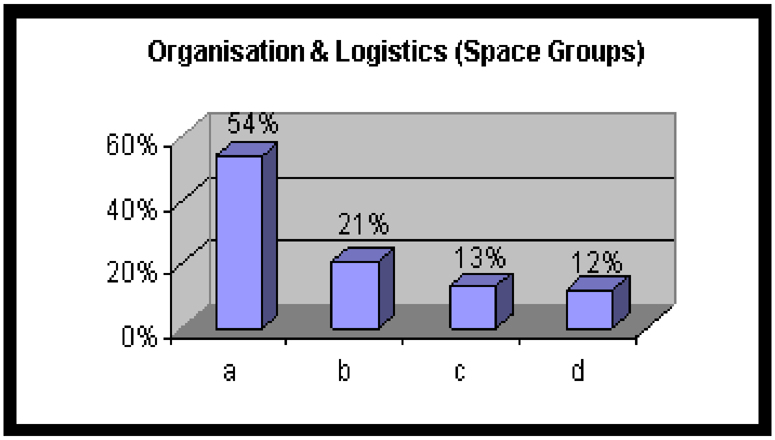
Observations:

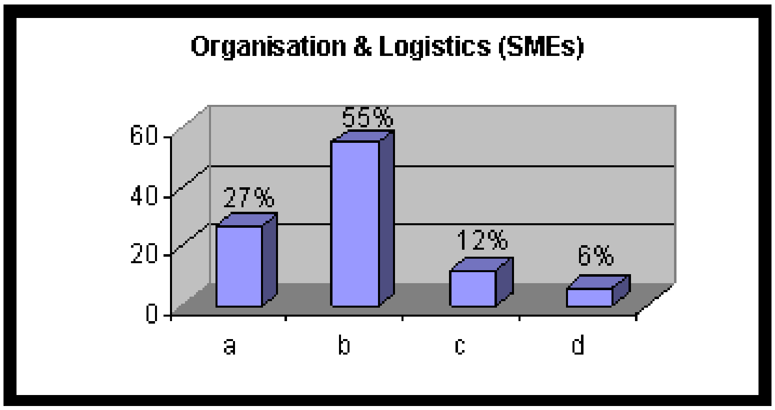
The Satisfaction rates for the two category groups are:
64% for SMEs and **88%** for Space Groups.

The relatively lower satisfaction rate of the SMEs can be explained: the tight schedule of the ISD organisation phase and the fact that many actors had to mediate between ESA and the European SMEs resulted in a frustration of a certain number of these SMEs who had the feeling that they did not have the opportunity to adequately prepare themselves to the meetings with the Space Groups.

2.2.3 Organisation and Logistics Assessment

a: Very good **b:** Good **c:** Average **d:** Unsatisfactory





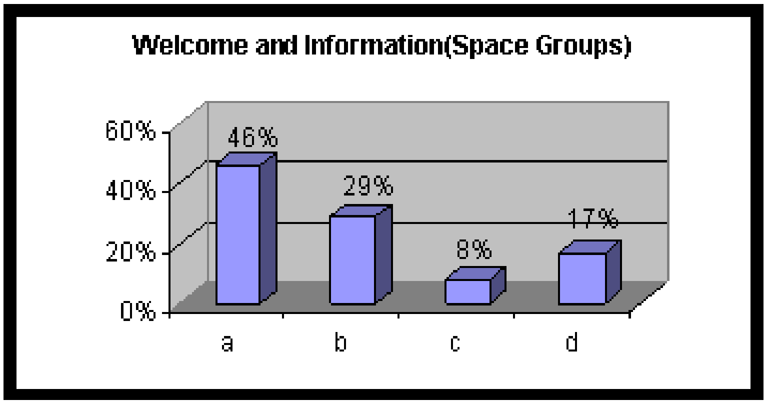
Observations:

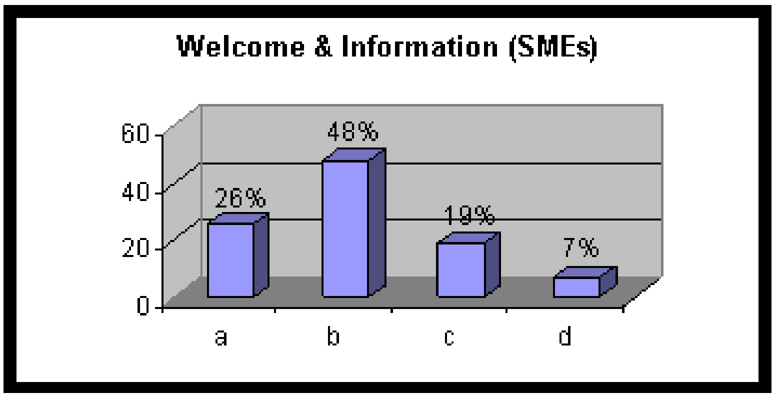
The satisfaction rate of the two groups is similar (82% for SMEs and 75% for Space Groups).

The higher appreciation of Space Groups under parameter a (Very Good, 54% in comparison to the 27% from SMEs), comes probably from the fact that they are already familiar with Estec, ESA, and the proposed logistics.

2.2.4 Welcome and information

a: Very good **b:** Good **c:** Average **d:** Unsatisfactory





Observations

Here too, the tight schedule of the ISD organisation and the involvement of different organisation in the preparation phases impaired somehow the on time delivery of information to companies.

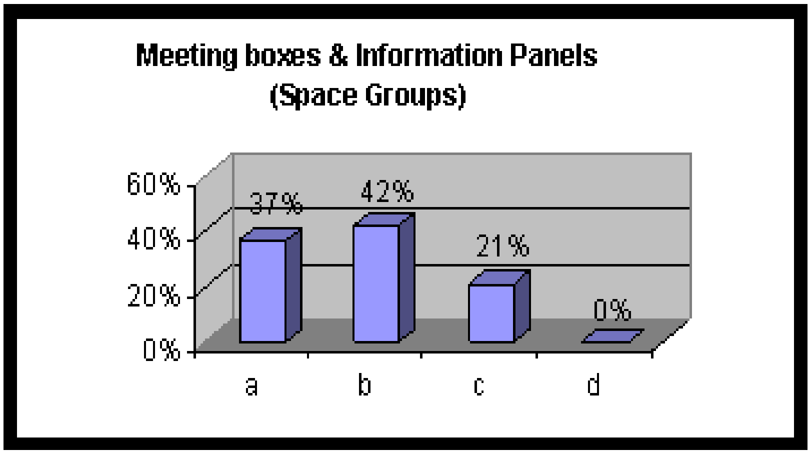
In addition, on the day of May 26th, we had two different events:

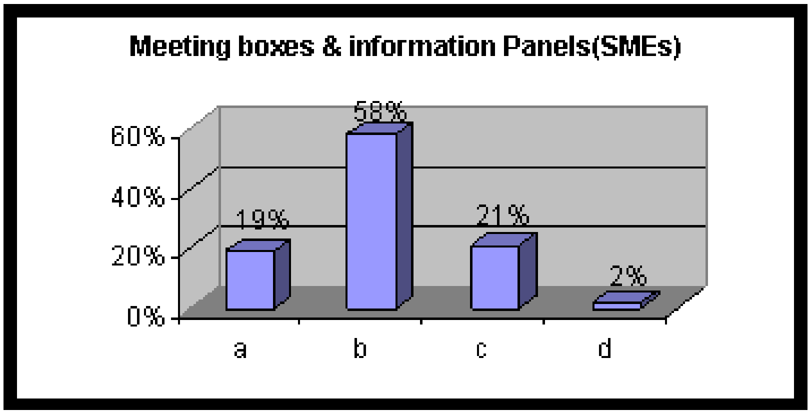
- A workshop reserved to satellite manufacturers and organised on the basis of an invitation list in order to discuss the competitiveness conditions of this specific industry sector, and,
- the Inauguration of the ISD, which was planned at the end of the same day in order not to loose time with the registration process on the second day and focus directly on the planned meetings.

Some of the ISD participants who arrived early at Estec, on the 26th , did not understand that the workshop was a completely different issue. Some of them tried to attend the workshop but were not admitted, and some felt that they missed part of the ISD event, which explains their marking for this parameter.

2.2.5 Meeting rooms, boxes, information panels

a: Very good **b:** Good **c:** Average **d:** Unsatisfactory



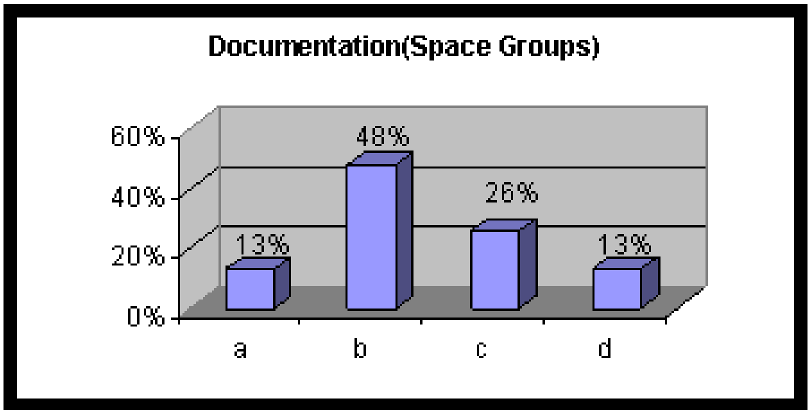


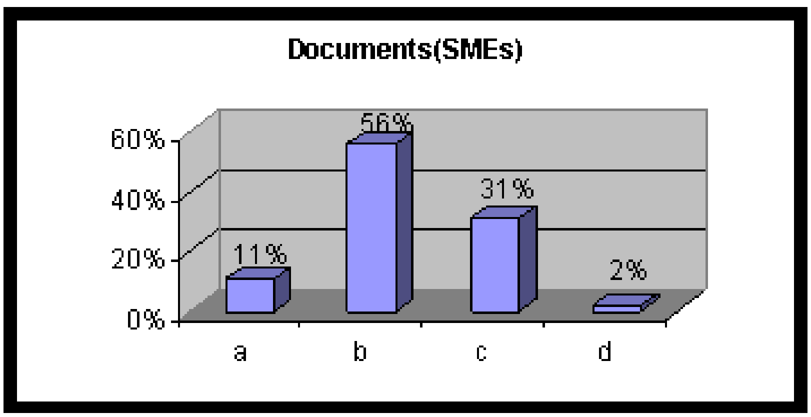
Observation:

Satisfaction rates also high (77% for SMEs and 79% for Space Groups) and equivalent for the two groups.

2.2.6 Documents Handed out to participants

a: Very good **b:** Good **c:** Average **d:** Unsatisfactory





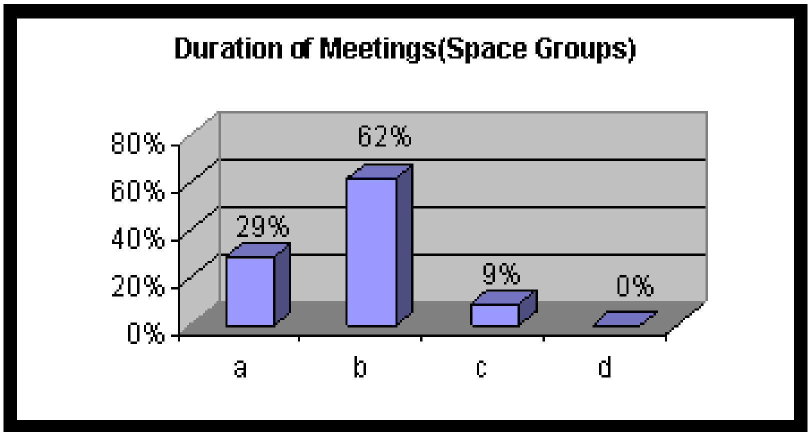
Observation:
The Documentation received was of a different nature than the one distributed normally in symposia etc. Indeed, for the ISD, there was no plenary session, no proceedings, and no presentation material. The available documentation was:

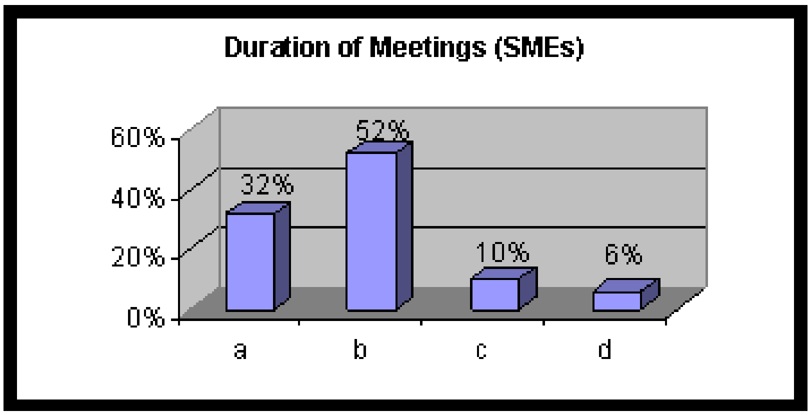
- the catalogue giving the participating companies and their fields of activity
- a map locating the boxes of Space Groups present at the ISD
- the individual meetings' planning for each company
- the Satisfaction Survey Forms

Obviously, this approach was not properly understood by the participants who were expecting a more traditional documentation. We will explain better, and improve this issue to the possible extent, for future ISD.

2.2.7 Duration of meetings

a: Very good **b:** Good **c:** Average **d:** Unsatisfactory



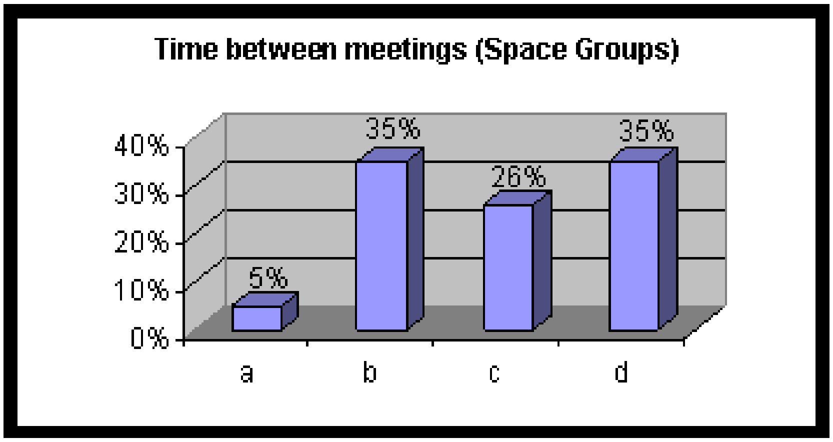


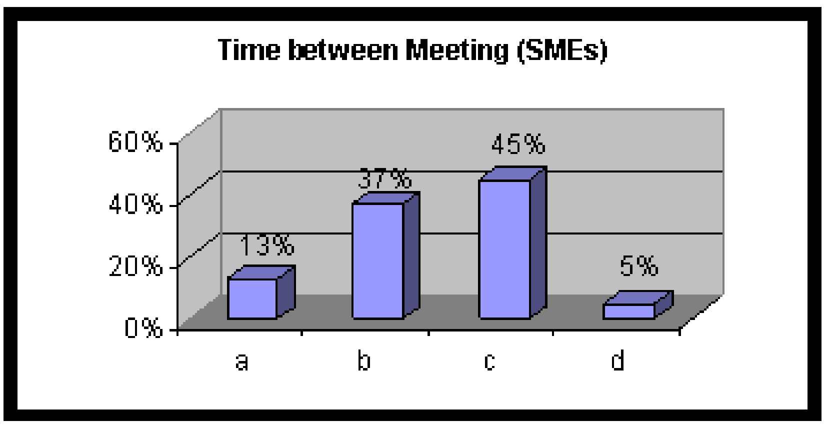
Observations:

Again, the satisfaction rates are very high and similar for the two groups. It is worth mentioning that the pre-arranged duration of meetings in these types of events is 30 minutes. This is considered to be the best compromise between the need to optimise the number of encounters and the need to have fruitful meetings.

2.2.8 Time between two meetings

a: Very good **b:** Good **c:** Average **d:** Unsatisfactory



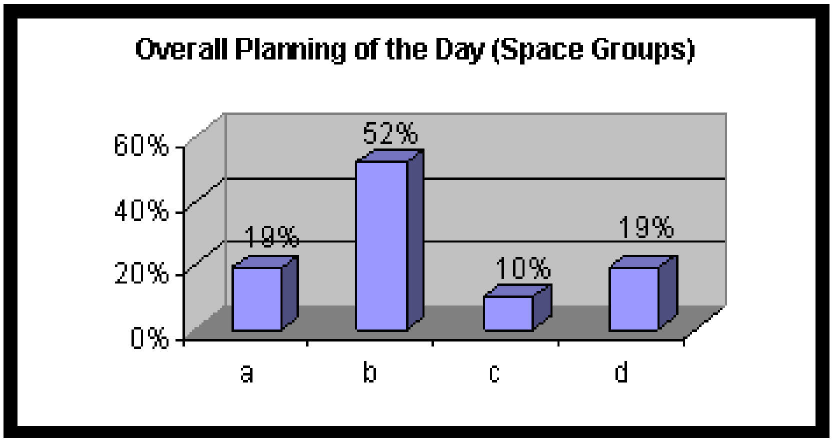


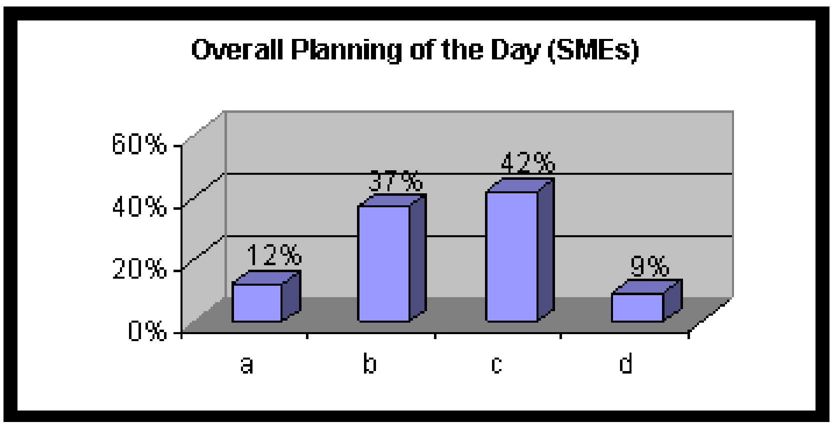
Observation

In this parameter, both categories express clearly that the break time between two meetings was too short. This was even more acute for the Major Space Groups who had -for some of them- up to 16 meetings per day. It is clear that this is a shortcoming we have to be very careful about for the next time. For this first edition of the ISD, we made the choice to group all the meeting within one day, thinking that this would be easier for companies. We will review this for the next ISD.

2.2.9 Spread of meetings during the day

a: Very good **b:** Good **c:** Average **d:** Unsatisfactory





Observation
The observation concerning the previous parameter is valid here to. Some participants expressed the wish to have a two-days event for different reasons:

- they felt they had too many meetings per day
- they need a longer breaks between two meetings
- they wish to have more time for non-formal meetings

The Major Space Groups are the ones who had too many meetings, but the SMEs are the ones who expressed more frustration. They would have appreciated more meetings and more business opportunities.

However, the number of meetings that an SME can have depends on the number of Major Industrial Groups present at the event. The number of these groups, despite the fact that this category responded very well to the ISD invitation, is necessarily lower than in other industrial fields: space activities still represent a small share of the overall industrial activity.

The Major Space Groups overall satisfaction (71%) is very good and opens interesting perspectives for the next editions of ESA ISD.

CHAPTER 3: LESSONS LEARNED & CONCLUSIONS

3.0 Introduction

This chapter is organised in two sections: Section (3.1) which derives the lessons learned and draws the main conclusions based on the discussions and feed-back we received from the participants and directly related to the ISD, and section (3.2) dedicated to some recommendations made to us by different actors and representative of companies during our discussions with them at the ISD or during the registration phase.

3.1 Lessons Learned and Conclusions

3.1.1 Participants' Response to ISD

<u>3.1.1.1 Industry Response</u>

The number of Space Groups and of SMEs who replied to our invitation was beyond the target figures we were working to: we were expecting a maximum number of 80 to 100 SMEs and 20 to 30 Space Groups. We received about 200 applications from Small companies, and 37 applications from Space Groups. In spite of the time constraint, we had a very good feed back. The SMEs reply ratio was > 25%, and the one of Major Space Groups was nearly 40 %. These are very high ratios in comparison to similar events organised in other Industry fields than Space.

The ISD was also the occasion for the participants to give themselves even more time at Estec and plan for additional meetings with Estec Staff, outside the ISD planning frame.

Some Space Groups registered more out of curiosity, but stated at the end of the meeting that they were convinced by the usefulness of the ISD Meetings. Indeed, only 7 Space Groups out of the total number, selected a number of SMEs to meet inferior to 10 . Some of them met up to 16 SMEs.

Most of the companies who participated were asking for other ISD to be organised in the future.

The SMEs who were not selected for the first ISD - or did not manage to register for the deadline- expressed their strong wish to see other ISD, more compatible with their activity profile to be organised. Many requests in this sense emerged from the Applications sector, the Down Stream sector, and the Ground Sector.

This is an indication to ESA that this initiative was well received, but is also another proof that the European space industry do share with us the opinion that its survival not only requires very strong primes -able to face their American counterparts- but also a network of competitive and strong equipment suppliers, and of independent SMEs, which bring the innovation potential, and the necessary flexibility. The dynamic interaction between these three layers is essential, and ESA feels that its role is to make sure that this interaction is to the benefit of the three groups.

3.1.1.2 ESA Staff Response

In general, our colleagues from all activity areas in the European Space Technology Centre (Estec) were rather enthusiastic and each of them did all his possible to make the industry feel at home.

All the technology services of ESA were represented, met their selection of SMEs, and many other meetings between ESA and Industry staff were also organised at this occasion.

Many of them took also the opportunity to inform the SMEs (through exhibition panels, models, mock-ups etc.) on the technologies under development within theirs services.

Many ESA Programmes were also present through the exhibitions of their hardware and their technologies.

Even the Estec Contracts section -in charge of technology contracts- made its contribution : they prepared and made available at the ISD, an Invitation To Tender (ITT) regrouping 3 Announcements of Opportunities (A/Os), all of them of interest to SMEs.

After the ISD, many colleagues reported interesting contacts and finding of new expertise in the SMEs who attended the ISD. New co-operation perspectives were open and need to be pursued to give the expected results.

3.1.2 Time Allocated to ISD Preparation

The time allocated to the organisation of these first ISD was very short: about 3 months to organise the whole event. We knew it will be a serious constraint, but we had to go on and organise the first edition of this event. In addition, two other elements of the ISD organisation method added to this difficulty:

- The specific ISD registration procedure: it consists in pre-arranging meetings between companies who have to choose each other on the basis of the registration forms, transmitted to them after a first selection by the registration responsible who receives all the forms (see **Annex 4** for details on registration methodology). This means an iterative and demanding process to obtain the necessary information from companies and propose to them the right match, in order to optimise the meeting benefit for both sides.

- The SMEs to be invited were to be reached in all the European Member States of ESA and some of its Associates. Therefore, we had to use existing SMEs associations throughout the different European countries. This logistics was relatively heavy and resulted in a lost of time, which, in normal life is perfectly reasonable, but given the short time we had, was critical.

The combination of these 3 elements imposed a short reaction time on all, with the consequence, that many SMEs did not have time to react for the registration deadline. In addition, only part of the European SMEs were contacted. Indeed, the number of European SMEs concerned with the type of activities defined as focus for the first ISD was estimated to be around 500.

Other consequence of the tight preparation schedule: It did not allow for an exhaustive work on the accurate identification of the different Departments and representatives within the Major Space Groups, neither did it allow to explain to them the industrial, technological, and business advantages of the partnership with high tech SMEs. Indeed, as this was the first event of this kind, we had to convince our contacts within the European major groups of the interest of the ISD.

These points will and can easily be improved for the next ISD.

3.1.3 Logistics and Organisation Method

Few difficulties were experienced, mainly on the SMEs side and mainly due to the time constrain, and the fact that many organisations were involved in the mediation with the participants from these companies. The information conveyed to them was insufficient or reached them too late to be useful. We certainly need to simplify and improve the organisation structure for the next ISD.

3.2 Recommendations

3.2.1 ISD Industrial Focus

For the first edition, the ISD Technical Committee who was in charge of the definition of this event focus, made the choice no to select specific technology fields, but to consider all generic technologies of use to space, and to invite SMEs with innovation potential and the necessary tools and facilities to allow R&D activities.

As the plan is to organise this event on a 2 years interval basis, the next ISD will be dedicated to other type of activity fields and will promote SMEs with other expertise. We take note of the interest expressed for the Down Stream applications and the Ground Sector and will carefully analyse these sectors for the identification of the needs and the capacities for the next ISD.

3.2.2 ISD Preparation Time

This element is crucial for the success of this kind of meeting, and as we already pointed out, more preparation time will be planned for the next ISD.

3.2.3 ISD Logistics and Documentation

The organisation logistics should be more centralised for a better efficiency and a better transmission of information to participants.

The Documentation and the necessary information will also be forwarded to participant early enough to allow them to better plan their trips and their self-arranged meetings.

LIST OF ANNEXES

The following annexes, with the exception of Annex 1, were produced during the ISD preparation phase, and are proposed here because they give a supplement of information to this Assessment Report. These documents are annexed without their original cover pages, not necessary here.

Annex 2 summarises within a matrix the technologies proposed as focus for these first ISD, and is an extract from the Registration Forms produced for the ISD.

Annex 1: The SME Initiative at the European Space Agency

Annex 2: The Technological Focus of the first ISD

Annex 3: Space Technology Outlook and Special Tasks for SMEs

Annex 4: ISD Organisation Procedure and its Advantages

ANNEX 1: The SME Initiative at the European Space Agency

1. Why an "SME Initiative" at ESA?

Active encouragement to small and medium-size enterprises (SMEs) to become involved in the activities of the European Space Agency is a new development in the Agency's industrial policy. Proposals along these lines began to take shape in the course of preparations for the March 1997 ESA Council meeting at ministerial level, at which the ministers called upon the Director General to set aside a special place for SMEs in the Agency's activities, with balanced access to its technology activities, by:

a) making firm provision for involving them in definition of the Agency's technology development work plan;

b) tailoring the rules on cofinancing to the size of enterprises;

c) offering SMEs technical support from ESA experts and laboratories as necessary to develop their particular specialties.

ESA has set up its SME initiative with the matching aims of enabling ESA and the European space industry to tap the potential of innovative SMEs and opening up opportunities for SMEs in turn to work more extensively with ESA and space contractors. Every precaution is being taken to avoid further fragmentation of the European space equipment supplier industry.

The initiative was approved by the IPC in March 1998 for a two-year trial period, with funding of 5 million euros. A decision is to be taken at the end of this period on whether to continue with the initiative as it is or to make changes in the light of results achieved and benefits expected.

In order to derive maximum advantage from synergy with other European programmes for SMEs, the definition of these enterprises applied in the ESA initiative is the same as that proposed by the European Commission in its Recommendation 96/280/EC of 3 April 1996, which can be summarised as follows:

SMEs are defined as enterprises which have fewer than 250 employees and annual turnover not exceeding ECU 40 million and are independent of enterprises falling outside the definition of an SME (the definition of the independence criteria is too long to be repeated here).

The initiative is directed towards two types of SME: high-technology SMEs (normally small firms with close links to universities or research laboratories) and subcontractors to large groups.

For high-tech SMEs, the initiative aims in particular to facilitate access to ESA's work plans and procurement plans. This reflects a conviction that they are able to bring an alternative perspective and offer potential for considerable improvement in synergy between space activity and other technical activities. Clear cases in point are: system engineering, software development, signal and image analysis, electronics, and software engineering. High-tech SMEs, especially recent start-ups, can make very valuable contributions to the generation of new ideas and concepts. They have a readiness to take an iconoclastic view which is not to be underestimated, since their ideas might well prove to be valid alternatives worth considering alongside the preferences and options proposed by large groups. With its specific features, both technical and political or strategic, space activity has a certain tendency towards isolation. The SME initiative is seeking, with the very limited resources at its disposal, to help remedy that.

For SMEs in general, the initiative includes various arrangements designed to improve the conditions under which they operate (access to information, access on preferential terms to ESA technical facilities, opportunities for networking with other companies that might become customers or partners, etc.). As will be seen below, many of these general arrangements are beneficial not only to SMEs but to all enterprises working with ESA, although especially to the smaller ones (not necessarily SMEs as such), for obvious reasons.

2. Main Components of the SME Initiative

The main components of the initiative are outlined below:

- **Programme to encourage participation by high-tech SMEs in definition of certain Agency technological activities (ARCoP)**

This programme has been organised along lines similar to those of the "exploratory awards" set up by the European Commission under the fourth R & D framework programme, and continued under the fifth. The aim is to give SMEs the opportunity to carry out feasibility studies or preliminary validations demonstrating application of their technologies, products or procedures to the solution of technical problems encountered in space programmes. Particular encouragement is given to cooperation by SMEs with research centres. Contracts are awarded after evaluation of proposals by the relevant technical departments; the maximum amount is 30 000 euros and the duration of a contract is generally limited to six months.

The arrangements for this programme were partially tested during 1998. In the cases where new SMEs were assisted and introduced to ESTEC technical departments, their capabilities were found to be remarkable and their technologies proved most interesting. The idea of feasibility studies, during which SMEs would be brought into contact with companies already working in the space sector, was therefore very well received by the technical departments concerned.

A number of the technical departments have already made "technology monitoring" standard practice. What is being proposed under the SME initiative is an extension of this practice into new areas, combined with structured access for high-tech SMEs.

- **Special treatment for SMEs in announcements of opportunity restricted to "non-primes" for (cofinanced) commercially-oriented technological development**

A first announcement of opportunity, funded out of the TRP, for (cofinanced) commercially-oriented technological development was launched in 1998 under the pilot phase of the adaptation of ESA's industrial policy as defined in the March 1997 ministerial Resolution. The response from industry was impressive (75 proposals received, 36 of them from SMEs).

Under this announcement of opportunity, proposals from SMEs have two chances of being selected; first in the competition reserved for SMEs, for which there is specific funding, and then, if unsuccessful at that stage, in the open competition for all "non-primes".

A new announcement of opportunities, was issued on the 31st of May 1999, to call for proposals on innovative technologies. The A/O will be funded under TRP, for a total amount of 2.5 MEUROs, from which 800 KEUROs were reserved for proposals from SMEs.

- **ESA technology transfer programme – increased support to SMEs**

High-tech SMEs have been observed to be well placed to exploit the benefits of technology transfer, being dynamic and naturally present in several fields of activity. A technology transfer component has therefore been included in the SME initiative, with the aim of bringing out the best of these enterprises' capabilities.

The distinctive feature of the technology transfer component incorporated into the initiative is that it encourages diversification into sectors other than space (technology transfer within enterprises, in other words). The aim is therefore to assist space SMEs in diversifying into other areas of activity.

- **Training and technical assistance to SMEs**

This component of the initiative has been included in response to an explicit request made by the ministers to the Director General in their Resolution of March 1997. Its content, which is currently being defined, could take two complementary forms:

a. On receipt of a justified request, ESA would make technical facilities available to an SME to assist in solving technical problems (for instance, an electronics firm in need of specific support in structural or electromagnetic compatibility analyses or validations). ESA's main contribution would be to make experts in various disciplines available on an ad hoc basis to SME when they needed them. Since ESA basic activities take priority in the use of its technical facilities, this assistance, although it would be important to some SMEs, would be limited in scale by the availability of the facilities.
b. SMEs are welcome to send staff to ESA technical facilities for short periods of training and familiarization with ESA procedures and techniques such as quality control, testing, preparation of bids, use of different equipment available in laboratories, etc. The procedure here will be relatively simple: the SME identifies its needs in terms of training or use of equipment, and send sends a request to the SME Unit. After approval, the SME Unit makes the necessary arrangements for the coordination with other ESA services and the planning of actions.

- **Preferential access for SMEs to ESA facilities and laboratories**

This component breaks down into two parts:

a) Access for SMEs to ESA technical facilities at preferential rates.
A policy on preferential rates to be charged to SMEs for the use of ESA facilities and laboratories is currently being proposed to the relevant delegate bodies (AFC and Council) in the framework of new rules on third-party use of ESA facilities. It is proposed to charge SMEs at a rate corresponding to the "marginal cost" for all services supplied to them by Agency

experts and laboratories to complement the technical capacities they need to develop their specialties.

b) Improved supply of information about facilities available.
Early action is being taken to improve the supply of information about facilities available (descriptive brochures).

- **Clause to encourage subcontracting to SMEs**

In certain technological procurements conducted on the basis of competitive bidding, the Agency encourages potential suppliers to submit proposals including a significant proportion of industrial work to be subcontracted to SMEs. The key feature is that, when evaluating proposals, the Executive will be looking for an appropriate level of subcontracting to SMEs as a criterion to be taken into account alongside technical quality (as reflected in marking) and price. This is being made clear to bidders in invitations to tender. This measure is being backed up by a new application in EMITS, the electronic mail system used to send out invitations to tender on the Internet, so that potential bidders are informed of SMEs that have relevant capabilities and are interested in subcontract work.

The contract actions envisaged here are those that cover innovative technological activities in which it is considered worthwhile involving SMEs already working in related fields so as to benefit from potential synergy.

A first list of activities was proposed to the IPC in the 1998 TRP work plan. It was unanimously approved by the Committee, which also asked the Executive to identify those in the 1999 plan to which the SME subcontracting clause might be applied. The activities identified by the Executive in the 1999 plan represent 30% of all activities scheduled under the TRP for the year; subcontracting to SMEs could amount to some 8%. Immediately after the IPC approved the plan at its January meeting, industry (and SMEs in particular) were notified via EMITS.

The issue of an Administrative Instruction laying down the procedure for taking the SME subcontracting clause into account in the selection of proposals from industry is pendind.

- **Improved supply of information: creation of a specific "ESA industry homepage" on the ESA website**

The ESA industry homepage, under construction, will serve two main purposes:

a) to give industry in general (and SMEs in particular) access to the information they need in order to take part in ESA activity under the best possible conditions and to expand their involvement; to this end, the information available on the various ESA servers, both internal and external, which is of interest to industry has been drawn together to provide a single source;

b) to give entities that have worked for ESA (industrial firms and research centres in general) opportunities to advertise their products and capabilities, set up links with their own websites, set up forums for discussions among themselves and with the Executive, look for potential partners, etc.).

A first version of the ESA industry homepage will be online shortly.

- **Organisation by ESA of workshops bringing European SMEs into contact with potential customers**

The idea is for ESA to organise events, drawing attendance from across Europe, at which SMEs will be able to meet potential customers (space agencies and firms, prime contractors or equipment suppliers) interested in making contact with smaller enterprises offering innovative approaches that could help them improve their competitiveness.

During the course of 1998 representatives of the Executive attended a number of events of this type, on such themes as signal and image analysis and software engineering. Their impressions were extremely positive, having had the opportunity in a single working day of finding out about technologies and products available from small enterprises which in some cases exceeded the performance standards required for space systems. This experience confirmed yet again that, in certain technical fields, setting up links (via SMEs) with non-space sectors is a way to tap very interesting potential for synergy.

A first workshop is to be held at ESTEC in May 1999, in conjunction with Eurospace (the association of the European space industry) and with technical support from the European Federation of High-Tech Small Businesses, through its French representative, the Comité Richelieu.

- **Creation of an SME Coordination Unit at ESA**

  For the organisation of SME initiative activities, an SME Coordination Unit has been set up in the Industry Liaison Section of the Industrial Policy Office in the Directorate of Industrial Matters and Technology Programmes.

  The Unit is responsible for coordinating the activities described above and also for providing a "one-stop" service to SMEs, giving them more effective access to the Agency's various activities and the specific arrangements being made for them under the SME initiative. It can be contacted at the following e-mail address:

  SME-UNIT@hq.esa.fr

3. Conclusion

The SME initiative at ESA is a first step. Resources are very limited, but this is still an opportunity not to be missed. The initiative will generate new momentum in the direction of standardisation and exposure of the space sector to practice in other sectors, helping SMEs to develop their capacity for innovation and synergy with other technological fields. It adds a valuable new dimension to the Agency's industrial policy. It also adds a persuasive new argument to the case justifying government funding for ESA activities.

The role to be played by SMEs in policy on technological development is an extremely important issue. We entirely agree with the very interesting comment on the subject made by Mr Claude Allègre, the French Minister for Education, Research and Technology:

"We give too much support to research by large enterprises and not enough to research by SMEs. As was pointed out in a report to President Clinton by the US Academy of Science, when private research by large groups is funded by the State it also takes its direction from the State, from technocrats in other words, whereas it ought to take its direction from the market. Except in the case of very large projects, in aircraft design and construction for instance, it is preferable to channel public funding for research into innovative SMEs, with large groups coming in at the subsequent stage to perform the essential role of selecting and developing the results of research by SMEs."

ANNEX 2: The ISD Technical Focus

SP 1 Materials

1.1 ¨ Metal alloys
1.2 ¨ Composites, ceramics
1.3 ¨ Surface treatments
1.4 ¨ Shielding technology
1.5 ¨ Non-destructive control
1.6 ¨ Plastic, rubber

SP 2 Optics and optronics

2.1 ¨ Optical system engineering
2.2 ¨ Optical Components, incl. micro-optics
2.3 ¨ Optical materials
2.4 ¨ Opto-electronic devices
2.5 ¨ Laser systems and technology
2.6 ¨ Optical communication technology
2.7 ¨ Optical instrumentation & sensors
2.8 ¨ Optical interferometry, metrology and aperture synthesis

SP 3 Signal processing

3.1 ¨ Guidance and Control
3.2 ¨ Signal & image processing
3.3 ¨ Sensors
3.4 ¨ Compression, Encryption etc.

SP 4 Radiofrequency systems

4.1¨ RF communication equipment
4.2¨ Antenna & reflector antenna technology
4.3¨ Array antennas & beam formers

4.4¨ Propagation & wave interaction
4.5 ¨ Microwave technology
4.6 ¨ Digital communications

SP 5 Data handling & storage, Space electronics
5.1 ¨ Data handling & data storage
5.2 ¨ Space electronics

SP 6 Energy Generators
6.1 ¨ Solar cells and or Solar arrays
6.2 ¨ Power generators (non solar)

SP 7 Power conditioning & Energy storage
7.1 ¨ Batteries
7.2 ¨ Power conditioning, mngt. & distrib.

SP 8 Software tools
8.1 ¨ Software engineering
8.2 ¨ Software development tools
8.3 ¨ Software evaluation tools
8.4 ¨ Software quality & PA
8.5 ¨ Artificial intelligence1

SP 9 Propulsion
9.1 ¨ Chemical propulsion
9.2 ¨ Electric propulsion
9.3 ¨ Cold-gas propulsion
9.4 ¨ Air breathing propulsion

SP 10 Structures
10.1 ¨ Structural engineering & verification
10.2 ¨ Structural materials manufacture techniques
10.3 ¨ Active structure control

SP 11 Mechanisms & robotics
11.1 ¨ Mechanisms
11.2 ¨ Actuators, motors
11.3 ¨ Relesase devices , Pyrotechnics
11.4 ¨ Tribology
11.5 ¨ Robotics components & systems
11.6 ¨ Miniature mechanical devices

SP 12 Scientific Payload Instrumentation
12.1 ¨ Life Science instrumentation
12.2 ¨ Physical Science instrumentation
12.3 ¨ Diagnostics and monitoring techniques
12.4 ¨ physical and chemical Sensors
12.5 ¨ In-situ science measurement devices

SP 13 Thermal control

13.1 ¨ Th. Ctrl. System design (incl. s/w)
13.2 ¨ Thermal control components
13.3 ¨ Cryogenics

SP 14 Environmental & Life support systems

14.1 ¨ Water recycling systems
14.2 ¨ Waste recovery
14.3 ¨ Air management systems & components

SP 15 Services

15.1 ¨ System studies
15.2 ¨ Technical studies & consultancy on:
15.2.1 ¨ Space projects
15.2.2 ¨ Reliability/ Safety
15.2.2 ¨ Project management
15.3 ¨ Software applications development
15.4 ¨ Environmental testing
15.5 ¨ Components procurement
15.6 ¨ Earth Observation added value data products
15.7 ¨ Training
15.8 ¨ Data collection

ANNEX 3: Space Technology Outlook and Special Tasks for SMEs

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Table of Content

CHAPTER 1 : INTRODUCTION

ESA's covered activities fall into two programme categories: the Optional Programmes, and the Mandatory Programmes. The Optional Programmes are in areas such as Earth observation, Telecommunications, Launchers, Manned Space Flights, and the Member States are free to decide on the level of their financial involvement.

Programmes carried out under the general budget and the science programme budgets are mandatory. They include the Agency's basic activities such as the Basic Technology Research Programme (TRP), the Studies on future projects, activities under shared Investment, Information

Systems and Training Programmes. All the Member States contribute to these programmes on a scale based on their GNP.

This brochure is based on the Agency R&D Programmes which cover basically the technologies needed by the different Space Programmes, during their R&D phases. ESA has grouped its R&D activities into 3 main classes:

Class 1: **Prospective and innovative R&D**: to address new enabling technologies

and concepts for future space missions.

Class 2: **R&D to support space projects**: to study the technical feasibility and to

develop the critical technology elements of well defined ESA and other space

missions in which the European industry can play a role.

Class 3**: R&D to support industry's global competitiveness**: to help European

industry to consolidate and further extend its place in commercial markets,

through a focussed application oriented technology programme.

Depending on their nature, the maturity of the technology and the envisaged application, these 3 classes of R&D are covered by different dedicated programmes such as the TRP (Technology Research Programme), the GSTP (General Support Technology Programme), ARTES (Technology Programmes for Telecommunications), etc.

The objective of the present brochure is not to give a complete overview on the technologies covered by ESA or the European Space Programmes. The purpose is to propose a selection of few representative technology axes, in order to help small companies, many of them not familiar with these programmes, to have an idea on technologies developed for space, and on typical examples of tasks where the contribution of High Tech SMEs could benefit to Space and to Space Industry in general.

SMEs are warned that hardware and software development for space requires special engineering procedures, and careful selection of technologies to cope with space flight conditions and constraints which can be summarised as follows:

- harsh environment such as the thermal conditions, radiation effects etc.
- launch condition with high G loads resulting in vibrations
- Micro-gravity effects modifying or annihilating physical processes based on gravity such as convection or separation techniques based on gravity (weight), etc.
- the lack of crew time combined to the cost of a space mission implies that the use of complex equipment is impossible, and that maintenance or servicing is difficult. This means that the hardware reliability is a key issue.
- limitation of all available resources: power, volume, up-load mass and crew time.
- safety to the crew and equipment are very important issues for manned space flights. Consequently, very stringent rules are applicable for PA/QA, and safety, for both, the hardware manufacturing and any experiment procedure to be followed.

CHAPTER 2: TECHNOLOGIES OF ESA R&D PROGRAMMES

This chapter is only listing the Major and the Complementary Technology Axes, covered by ESA within its R&D programmes, as defined in the so-called ESA Blue Book, for the period 1997-1999. For a more complete view on this programme and the TRP Workplan, see this reference document.

2.1 Major Technology Axes

2.1.1 Components

2. Solar Cells
3. Spacecraft Data Systems
4. Payload Data Processing
5. Antennas
6. Digital Telecommunication Payloads
7. Software Engineering
8. Space Environment
9. Radar Technology
10. Thermal Control
11. High-Accuracy Pointing
12. Electric Propulsion
13. Micro-Nano-Technologies

1. **Complementary Axes**

In addition to the 13 Major Technology axes, complementary axes have been identified in these areas:

1. Material and Processes
2. Product Assurance
3. Automation and Ground Facilities
4. Mathematics and Software
5. Instrument Technology
6. Electromagnetics
7. Power and Energy Conversion
8. Systems/Technologies for Microwave Payloads
9. Thermal Analysis
10. Life Support
11. Mechanisms
12. Smart Structures
13. Pyrotechnics
14. Propulsion and Aerothermodynamics
15. Pilot Projects
16. Ground Systems
17. Payload Data Exploitation
18. Space Systems Engineering
19. Academic Research

CHAPTER 3: Space Technology Outlook & Typical Tasks For Smes

As already explained in Chapter I, the intention of the present section is not to give a complete overview on the technologies covered by ESA or the European Space Programmes. The selection of the 7 (seven) technological fields here proposed is arbitrary and its to help small companies, such as SMEs who are not familiar with these programmes, to have an idea on technologies developed for space, and on typical R&D tasks that an SME can achieve within the context.

1. **ELECTROMAGNETICS & ANTENNAS**

1.1 R&D Activities under this field

<u>1.1.1. Antennas and Antenna Systems</u>:

These activities concern design and development of different types of antennas and related sub-systems:

- low and medium gain, multifeed -shaped- reflectors, active or semi-active array antennas- smart/adaptive antennas.
- Antenna analysis and synthesis software,
- Antenna and radiating payload test techniques (compact and near field ranges, time domain...)
- Technologies for space communications: radar and radiometry, user terminals as well as telemetry and telecommand.

<u>1.1.2 EMC (Electro-Magnetic Compatibility)</u>

This field comprises spacecraft EM environment, charging and discharging, RF-interference, high electrical power handling and electrical hardening against interference of space and ground systems.

<u>1.1.3 EM Wave propagation phenomena</u>

This comprises EM wave propagation relevant for space communication and remote sensing, and electromagnetic aspects of remote sensing (wave interaction, retrieval algorithms).

1.1.4 Sub millimetre and far infra-red instruments

This field concerns different detection instruments and technologies:

- Sub millimetre and far infra-red instruments in the range of : 1mm to 20 micro-m wavelengths
- system design and verification techniques,
- detector and detector array technologies and radiometry for the X-ray, UV, IR and Far-IR.
- Opto-electronics, photonics, quantum electronics, non-linear optics and superconductor technologies.

1.2. Examples of Activities feasible for SMEs

SMEs can perform different design and development tasks in areas such as: TT&C Antennas (S, C, KU band), High gain data link antennas, Antennas modelling design S/W tools, Antenna measurements, Propagation models, Wave interaction algorithms development, MM-wave & sub-millimetre wave antenna technology, Opto-electronics, Active antennas.

Here follow concrete examples of developments already achieved by small companies in this field.

1.2.1 Antenna technology: SOPERA shaped beam antenna

Sopera is the result of a fast track activity to develop a generic shaped beam antenna for LEO satellites. Such antennas are designed to have full earth coverage. To ensure an equal power flux density over the whole visible earth the antenna can be designed to have its minimum gain on boresight (Nadir) and a maximum at the edge of coverage, thus compensating the differential path loss.

The R&D activity was performed with the Agency's METOP programme in mind and resulted in the pre-development of the Sopera antenna. The antenna has now been selected to provide the high data rate link in X-band for the METOP spacecraft. The gain enhancement at the edge of coverage (58 from Nadir) is +5dBi with respect to the Nadir direction. The antenna has application to any LEO-satellite system with obvious opportunities being for large constellations of multi-media satellites operating in Ku and Ka band.

1.2.2 Propagation/Radiometry: Atmospheric Water Radiometer development

Small companies participated to the development of a high precision atmospheric water radiometer which measures the atmospheric noise temperature at 7 different frequencies (in the range 22.235 GHz 54.385 GHz). The instrument system includes a highly stable temperature control system.

Apart from retrieving water vapour and liquid water, it can also retrieve a temperature profile using four oxygen absorption lines.

1.2.3 Opto-electronics - SETIS star Sensor Development

The SETIS sensor, is a CCD-based autonomous optical attitude measurement sensor, capable of locating and tracking stars with high precision, as well as small extended targets such as asteroids or distant planets. Having detected a star pattern in its field of view, SETIS then compares it to co-ordinate information contained in its internal star catalogue memory, and after identifying a pattern match, computes its own pointing direction in inertial co-ordinates. It is thus capable of reconstituting its own orientation (and hence the attitude of the spacecraft) from an initially unknown situation – the so-called "lost in space" scenario.

1. **DIGITAL SIGNAL PROCESSING FOR ON-BOARD DATA HANDLING**

Under this heading, the following sub-fields are addressed:

Payload data handling architectures and interfaces

DSP technologies, processors and ASICs

DSP Algorithms, Data reduction and compression

S/W Development for real time DSP applications

2.1 R&D Activities under this field

Remote sensing instruments and scientific payloads are generating a constantly increasing amount of data. Nevertheless, despite some progress, available transmission data rates from the space segment to the ground segment cannot fulfil high telemetry requirements and on-board data storage and reduction becomes mandatory. This can be achieved by digital signal processing techniques implemented on high performance on-board systems.

A significant effort has been put by the Agency and Prime industrial Companies in the development of building blocks (Processor modules, high speed links and storage elements), with the objective of simplifying the design of processing nodes and interfaces. Flexibility, programmability and scalability have been stressed and although the main elements are now available, additional developments should be undertaken to reach the sought completeness.

2.2. Examples of Activities feasible for SMEs

The following activities, can be feasible by SMEs, however, the list is not exhaustive and synergies with other applications subjected to harsh environments will be considered with attention

- DSP ASICs development, validation and commercialisation

- DSP S/W tools (Real Time Kernel, code generators) development and commercialisation
- Advanced processing techniques mapping on existing processor systems including simulation and optimisation techniques
- Development of boards for Electrical Ground Support Equipment (EGSE) supporting standardised interfaces
- Development of test systems for testing and screening of commercial parts (COTS) needed to customise DPUs (memories, packaging techniques, FPGAs, peripherals)
- S/W design techniques

1. SOFTWARE ENGINEERING AND STANDARDISATION

3.1 R&D Activities under this field

The Software Engineering and Standardisation Axis includes the methods, tools and standards that are necessary to develop on-board software for the space segment. On board software runs on a specific hardware (32 bits computer) in electronic equipment operating in a launcher or an orbiting spacecraft. The Axis includes the software techniques used all over the software life cycle (requirement, design, code, tests and maintenance). It includes the related tools (CASE tools, compilers, Software Engineering Environment). It includes the standardisation aspects related to software engineering, up to the impact of a certification on the software development. Specific needs have been identified as being more useful for the space industry.

Fault tolerant and autonomous software specification (formal methods), design (active redundancy, robustness, schedulability analysis, predictable executives, controlled automatic code generation, language safe subsets) and testing (automatic test generation)

Distributed software architecture (predictable distribution, related techniques (brokers, language, distributed operating systems)

ASIC software engineering (co-design, specific software life cycle)

Architecture reuse, design patterns, frameworks

Interpreted languages

Hard real time object oriented methods

Low cost software engineering environment

Application of software engineering standards, certification, possibly software process improvement

3.2. Examples of Activities feasible for SMEs

SME are believed to be highly beneficial to space industry when they feature specific skills or experience in one of the following domains.

- Critical real time software (new technologies from non-space applications)
- Distributed S/W architecture , ASIC S/W engineering
- Fault tolerance/autonomy/intelligence software specification, design & test
- Interpreted languages (JAVA, JVM, TCl/TK)
- Low cost S/W engineering environment (XML)
- Simulation technology, virtual reality simulation

4. SPACECRAFT CONTROL, DATA & POWER SYSTEMS

4.1 R&D Activities under this field

Identified below are the main technology fields related to Spacecraft Control, Data and Power Systems. All the items listed embrace the needs defined by industry or the Major Axes of the current ESA Technology R&D Programme covering the period 1997-1999.

4.1.1 Spacecraft Control

- Attitude Measurement and Control
- High Accuracy Pointing
- Single Chip Control and Data System (CDS)

- Attitude Sensors
- Solid State Gyros
- Active Pixel Sensor (APS) based Star Sensors
- Algorithms and Software
- Guidance and Navigation
- Relative Position Control of Satellite Constellations
- Surface Landing Control
- Space Vehicle Rendezvous and Docking Control
- Autonomy
- Autonomous Command and Control Spacecraft (i.e. PROBA)
- Related Control and Data System (CDS) hardware and software technologies

4.1.2 Spacecraft Data Handling

- Microelectronics
- High Performance, Low Power ASICs (100,000+ individual gates)
- Customer Off the Shelf (COTS) items with Radiation Hardened Design
- Support ASICs for Sensor Applications
- Computing and Data Storage
- High Performance Failure Tolerant (FT) spacecraft computers (from 31750 instructions per second to 100 million, instructions per second SPARC)
- 10 gigabit solid state recorder
- Single Chip, Integrated Control and Data System (CDS)

4.1.3 Spacecraft Electrical Power Systems

- Electrical Power Generation
- Multiple Junction Solar Cells
- Solar Cell and Solar Array Assembly Technology
- Power Systems and Conditioning
- High Power (>20 kilowatts) and High Voltage (>100 volts DC) Power Distribution
- Electric Propulsion Power Processing Unit (PPU)
- Energy Storage
- Lithium Ion Rechargeable Cells and Batteries
- Fuel Cells and Related Technologies

4.2. Examples of Activities feasible for SMEs

Identified below is a selection of technical tasks related to spacecraft control, data and power systems, where it is considered that High Tech Small and Medium-sized Enterprises (SMEs) could contribute. These tasks can be classified as defining new technologies for space or exploiting new application areas.

4.2.1 Spacecraft Control

- Miniaturised Sensors
- Control Algorithms (Sensor Fusion, Fuzzy Control)

4.2.2 Spacecraft Data Handling

- ASIC Design, High Speed Low Power Electronics Especially Intellectual Property (IP) Cores
- Specialised Real Time Software for small embedded systems

4.2.3 Spacecraft Electrical Power Systems

- High Temperature Power Electronics (For regulator mass efficiency improvement and inner planet exploration)
- Evaluation of Lithium-Ion, Battery Charge Management, Integrated Circuits (e.g. Similar to those as used on commercial un-interruptible power supplies)
- ASIC based Solid State Power Controller (SSPC)
- DC/DC converter Modules

5. PERFORMANCE ANALYSIS TECHNIQUES FOR SATELLITE COMMUNICATIONS

Under this heading, the following sub-fields are addressed:
Semi-Analytical Techniques

Simulation Techniques

Validation Tools

5.1 R&D Activities under this field

A variety of innovative communication satellite systems for mobile, fixed and broadcast services, often based on complex constellations, have been announced in the last ten years and start to be deployed (e.g. IRIDIUM).

The magnitude of the problems implied by this approach is enormous and several aspects (from orbital mechanics, to telecommunications, operations and service guarantee during systems lifetime) need to be concurrently tackled. Despite some progress in commercial products, available off-the-shelf tools are often insufficient to come up with proper integrated models of the entire communication scenario across the space segment and the ground segment. This can be achieved by complementing existing tools (commercial and proprietary) by specific "ad hoc" techniques implemented on high performance Hardware/Software platforms.

A significant effort has been put by the Agency and Prime industrial Companies in the development/customisation of building blocks of end-to-end satellite communication systems simulation facilities, with the objective of supporting the design, validating the performance and preparing tests. Flexibility, programmability and scalability have been stressed and although some elements are now available, additional developments should be undertaken to reach the sought completeness.

5.2 Examples of Activities Feasible for SMEs

The following activities felt to be well suited for SMEs involvement, but the list is not exhaustive and synergies with other applications subjected to similar environments will be considered with attention.

- Semi-analytical Techniques for Performance Evaluation.
- Simulation Packages on specific topics (e.g. Routing, Resource Assignment).
- Validation Tools

6. MECHANICAL SYSTEM AND ROBOTICS

6.1 R&D Activities under this field

Mechanical systems as used in space projects encompass a wide field of technologies ranging from structures, mechanisms, optics, robotics and general instrumentation. Whereas structures and mechanisms usually form an integral part of virtually any spacecraft, optics, robotics and general instrumentation play a key role in achieving the desired mission goals and payload performances.

Considerable development efforts are being made in these technology domains to meet the demanding space mission challenges in science, telecommunications, Earth observation, manned space flights and launchers. Advanced structural concepts are being developed, along with the application of novel materials, evaluation tools and structural control techniques, to enable missions with special requirements to be realised (e.g., high-precision/stability structures, inflatable structures and structures exposed to extreme temperatures). The following paragraphs give briefly the technologies of interest in the different technological areas of this technological axis.

6.1.1 Mechanisms

Enabling mechanical technologies, including actuators, deployment systems, high-stability pointing and scanning, tribology, gradiometry, and mechanical micro-nano technologies or miniaturised mechanical device technologies are being developed for both, scientific exploration and commercial services.

6.1.2 Optics

In the optical domain, the development focus is directed towards advanced techniques of optical system design, engineering and verification; optical component technology, including micro-optics, fibres and passive integrated optics; laser systems; optical aperture synthesis; interferometry and spectro-radiometric imaging.

6.1.3 Automation and Robotics

In the field of space automation and robotics, effort is concentrated on space robot systems (comprising both arm based systems for inspection, servicing and assembly of space system infrastructure or payloads and mobile robots for surface exploration on celestial bodies), and space laboratory automation and payload control systems in manned and unmanned missions.

6.1.4 Microgravity Utilisation field

Finally, technologies are developed to support Physical Sciences and Life Sciences experiments in space, involving high-temperature material science, fluid physics, crystal growth, general biology, plant physiology, radiation biology, biotechnology and human physiology.

6.2 Examples of Activities Feasible by SMEs

In all of the areas mentioned above, there is a wealth of business opportunities for SME's, to participate in space projects with their specific expertise and technologies. Typical examples include:

- Special mechanical products such as deployment devices, motors, actuators, slip rings, bearings, wheels (reaction/momentum/energy storage), pointing and alignment mechanisms ...
- Advanced structural materials
- Mechanical and Optical Miniaturised or Micro/Nano Technology Systems
- Optical interferometry, metrology and aperture synthesis
- Instrumentation for Life Science experiments and diagnostics
- Robot system technology

With their specific contributions, SME's will also play an important role in meeting the new challenges in space systems, which result from a general shift in strategy from long-term, complex and expensive missions to those that are small, inexpensive and fast.

7. ELECTRIC PROPULSION

7.1 R&D Activities under this field

Electric Propulsion involves several spacecraft propulsion technologies used to perform attitude and orbit control of spacecraft, as well as orbit transfer of commercial satellites and interplanetary probes. Compared to conventional chemical propulsion systems, electric propulsion requires a much lower mass of propellant to perform similar operations. This imply a dramatic reduction in the launch cost, as well as the possibility to increase the commercial or scientific payload on the satellite and therefore to increase its revenues.

Electric propulsion technologies include concepts such as ion engines, plasma thrusters, arcjets, etc.

The availability on all types of new spacecraft of substantially increased levels of electrical power, used by the electric thrusters to increase the propellant consumption efficiency, now allows a widespread use of electric propulsion systems. These systems are used mainly on geostationary telecommunication satellites, constellation of commercial spacecraft in low Earth orbits and scientific satellites of different types.

The increasing adoption of electric propulsion generates business opportunities for companies that are able to provide products and services in this field. Following the example of American companies, these business opportunities could materialise also for European SME.

7.2 Example of Activities Feasible for SMEs

Some of the fields of opportunities for the involvement of SMEs in the Electric Propulsion business are the following:

- Electric Propulsion System Components

- Propellant feeding system elements (valves, gauges, pipes, tanks,)
- Electrodes
- Ground services:
- Acceptance & qualification testing of complete EP systems
- Propellant filling equipment & services

CHAPTER 4: CONCLUSION

We hope that despite the fact that this brochure does not cover all the European Space Technologies, it was helpful to small companies to have an idea on technologies developed for space, and on typical examples of tasks where the contribution of High Tech SMEs could benefit to Space and to Space Industry in general.

Several objectives are pursued by ESA with the organisation of these encounters at European level. The most obvious ones are:

- to prompt further opening of the European Space Industry to innovative ideas and technologies developed in other high technology fields,
- to help space industries to enhance their competitiveness by the use of SMEs skills and expertise
- to help SMEs to diversify, initiate new co-operations and find new customers for their products and services

At the occasion of these ISD, you will be invited to fill in a questionnaire assessing the usefulness of the encounters for your company. Please do your best to take the time to provide us with this valuable information.

The present Industry Space Days constitutes the first event of its kind. If the experience proofs to be satisfactory, other ISD will be organised.

ANNEX 4: ISD Organisation Procedure and its Advantages

1. The Industry Space Days Advantages

[1] An efficient access to new contacts : a small company has little opportunity to make new contacts. ISD will guarantee this to SMEs, will allow them to present their skills and products to others, and give them the opportunities to build new business partnerships.

[2] A time-saving tool: from companies' experience, in terms of contacts, the 2 days can represent the equivalent of four years of effort. A company can make hundreds of contacts, have opportunity for initiating ventures, co-operation, or sale/purchase of their products.

[3] An efficient Communication tool: the concept of multi prearranged rendez-vous is new, modern, and fulfils the needs of all companies.

[4] Technology and R&D Agora: In addition to meeting new manufacturing partners, the companies will have the chance to contact most of the R&D and high technology representatives.

[5] Agora for Innovative Technologies: due to the quality of the participants (only High Tech SMEs and major Space Groups), ISD represent the best place to meet innovative technologies.

[6] Market for Technologies, Skills and Products: the number of contacts which will be made possible will guarantee to the

participants the possibility to present and advertise their special skills and technologies.

2. ISD Organisation Method

The ISD consist in the organisation of multi individual Rendez-vous between SMEs and larger Space Groups, around selected technologies, according to the following method:

[1] Definition of Subjects of Interest: A technical Committee nominated by ESA, reviewed the technology fields of interest to the European Space Industry, and proposed a list of subjects from which the participating companies can choose.

[2] Presentation of Expertise and definition of Partnership objectives: On the basis of the proposed subjects, the companies (SMEs or Large Groups) forward the relevant registration form detailing their field of expertise and defining their partnership objectives.

[3] Selection of SMEs: the ESA technical Committee will review the registered SMEs and pre-select the ones having good capacities. The pre-selected SMES will be than forwarded to the Large Groups interested in their specialities, who will select the SMEs they wish to meet.

[4] Time Table of Rendez-vous : The SMEs will receive the names of the Large Groups interested in meeting them. If they agree to meet them, a meeting will be scheduled. About 2 weeks prior to the ISD, the companies will receive a detailed time table for their appointments.

[5] Individual Rendez-vous : During the ISD, the individual meetings between SMEs and Large Groups are held in a strictly confidential environment.

[6] Agora for Informal Meetings: A more open space will be made available to allow different non planned and informal meetings such as SME/SME meetings etc.