Technology Transfer and SMEs

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Introduction

Today around 150 MEuro are spent by ESA every year on Technology Research and Development. Recognising the importance of helping other areas of industry to benefit from space activities, ESA launched its Technology Transfer Programme (TTP) in 1990. The main motivations included:

- Easing the burden imposed on public resources by TR&D by adapting space-engaged technologies, systems, and knowhow for other uses.
- Minimising duplication of research between the space and non-space sectors.
- Providing opportunities for researchers to collaborate with other organisations, both in spin-out and spin-in efforts.
- Maximising the return on investment in space research conducted by ESA for the benefit of its Member States.

Technology Research and Development (TR&D) is a strategic enabling element of any space undertaking, whether commercial or non-commercial. The timely availability of the relevant technologies in Europe is a key factor in ensuring both the competitiveness and independence of the European space industrial fabric. TR&D is also a key element in the implementation of an overall space strategy. Europe has invested more than 150 billion Euro to date in the development of space programmes and their related technology. This investment, channelled mainly through ESA and national space agencies, has made it possible to create a strongly performing industrial base, competitive both in launcher products and services and in satellite markets at the global level.

The Technology Transfer initiative within ESA

The ESA Technology Transfer Programme aims to stimulate space spin-offs, i.e. secondary applications of the latest technological developments for space financed by ESA, its Member States and Canada. The prime objective is to ensure that non-space sectors can also benefit from easier access to advanced technologies. Another objective is to foster technology exchange, whereby space technology developers can learn from other sectors about their specific breakthroughs.

The achievements of space programmes are now so much a part of the economic, social and scientific scene that there is a tendency to forget their importance and the accompanying benefits for the industrial fabric as a whole, There is therefore a compelling obligation to promote the spread of space technology throughout the European Community, with the objective of integrating it into a market economy by adapting it to the latent demand.

ESA has set up a network, the ‘Spacelink Group’, with a correspondent in each Member State and Canada, responsible for:

- Technology Push: Europe-wide extraction and marketing of potentially transferable space technologies.
- Market Pull: determination of market demands in non-space industries and searching for space solutions.

More than 400 potential spin-off technologies have been marketed throughout Europe and Canada by the Spacelink network. More than 70 transfers of space technology to many sectors of industry throughout Europe have already been achieved, and significant economic and social benefits are beginning to accrue. At the end of 1999, space donor companies had received more than 4 MEuro in revenues from transfers, with receiving companies taking in more than 20 MEuro, and a projected turnover of 150 MEuro by the end of the year 2000 in both the space and non-space sectors.

Technology push

Working in co-operation with ESA, the Spacelink partners are responsible for identifying and extracting transferable technologies from within ESA’s technical

establishments and space companies in the ESA Member States. The technologies selected must be well defined in terms of novelty, maturity, applicability, and intellectual property rights. Spacelink promotes these technologies via a catalogue, called 'Impact', with more than 40 000 European companies outside the space industry receiving copies.

Market pull
The Spacelink partners are also responsible for identifying and publicising the potential technology needs of non-space companies. Today, almost 6000 non-space companies have been approached about their technology needs, and more than 400 offers of solutions have been received from space companies as a direct response to these requests for assistance.

Additional support
Recognising that technology matching and licensing is only a part of the transfer process, the Technology Transfer Programme (TTP) and Spacelink are working actively with companies to fund and plan the development work necessary to move the technology closer to market. Not only has the programme helped to secure more than 10 MEuro of European Union support for research funding, but the TTP also selectively provides seed funding to companies, particularly small businesses, to enable them to perform feasibility studies for transfer projects. As part of the Spacelink network, the European Association of Research Organisations (EARTO) also works with potential technology recipients who need assistance in conducting research and completing various studies, including the identification of new non-space applications for space-developed technologies.

Industry initiatives
The TTP has developed industry-specific initiatives to promote exchanges between industry sectors and the space community, with the aim of finding new business solutions using space technologies and knowhow. A recent example of the type of work done in this arena has been an initiative directed at companies operating in harsh environments, particularly offshore oil and gas exploration and production, mining, and tunnelling. Since summer 1997, ESA has invested 1.8 MEuro in the development of the Harsh Environments Initiative (HEI), being led by the C-Core organisation in Canada (see ESA Bulletin No. 99, pp. 20-28). The HEI provides members of the space industry with an opportunity to learn about current and future technical challenges in this sector, and to present space technologies as possible solutions.

ESA initiatives supporting the TTP
Because only a part of the benefits from technology transfer are generated through physical transfers of technology and the licensing process, there are several further initiatives within ESA that contribute to the success of the TTP in areas such as knowledge transfer and collaboration.

The SME initiative
ESA has set up its SME (Small and Medium-Sized Enterprise) initiative with the dual aims of enabling ESA and European space industry to tap the potential of innovative SMEs, and opening up opportunities for SMEs in return 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 ESA's Industrial Policy Committee (IPC) in March 1998 for a two-year trial period. It was put on a more permanent footing by the Council at Ministerial Level's adoption of Resolution 2 in May 1999 in Brussels. The financial resources available for the SME initiative in 1999 were 1.7 MEuro from the General Budget and 0.5 MEuro from the Technology Research Programme (TRP).

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. The initiative is therefore 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 and procurement plans. This reflects a conviction that they are able to bring an alternative perspective and act as vectors of innovation, as well as offer the potential for considerable improvements in synergy between space activities and other technical activities.
- For SMEs in general, the initiative includes various arrangements designed to improve the conditions under which they operate (access to information, access on terms to ESA technical facilities, opportunities for networking with other companies that might become customers or partners, etc.).

Among the different measures contained in the SME initiative, those actions aimed specifically at stimulating and encouraging SMEs as a source of innovation and synergies and technology transfer with other domains are further developed below.

Dedicated action for SMEs on Technology Transfer

The intention of this dedicated action is to foster diversification into other domains for SMEs that have already developed technologies for space applications. The support provided by the Agency is not only financial; depending on the particular circumstances, other types of support (technical, external) are also envisaged. A total 700 kEuro has been devoted in 1999 to this action, which can be complemented with additional means from other programmes, depending on the exact nature and origin of the transfer proposed. All contracts foresee a 50% co-funding by SMEs. ESA funding per contract has been limited to 50 kEuro. In order to broaden the industrial base, SMEs have been invited to submit only one proposal. An Announcement of Opportunity was issued (via ESA's EMITS electronic system) in May 1999, and closed on 29 October.

Thirty proposals were received from SMEs, thus confirming that this action responds to a clear industrial need. Of the thirty proposals received, fourteen have been retained for funding through the SME initiative and four by the Microgravity Programme. The proposals address many different technical domains, including materials (ceramics, composites), software (processing of image databases, evaluation tools), sensors and measurement systems, electronics, mechanisms, etc.

Specific support for unsolicited innovative proposals by SMEs

SMEs are invited to submit, at any time, innovative proposals for feasibility or adaptation studies (ARCOP programme). These activities (30 kEuro maximum) serve as an entry door for new, innovative companies, and the ESA Executive's first action is to put them in contact with companies already working for the Agency in the respective domains. The purpose of this action is therefore to revitalise the space sector with new, promising technical concepts coming from other domains, using SMEs as a source of innovation.

450 kEuro were foreseen in 1999 for this initiative, thus providing the possibility for some 15 innovative actions to be initiated. This initiative has also been announced on the EMITS system, but there is no time limit on applications: SMEs can submit ARCOP proposals at any time, and the industrial response is gradually increasing.

In order to implement the SME initiative effectively, a dedicated unit has been created within ESA's Industrial Policy Office in Paris (SME-Unit@hq.esa.fr).

Benefits from the TTP

Benefits from technology transfer can be wide ranging in nature, from increasing the financial revenues of companies to improving the quality of life of an individual. It is extremely difficult to develop a fully comprehensive list of the benefits accruing today from space technology transfers. This is largely because ESA does not rely solely on licensing, the easiest form of transfer to measure, but offers a broad range of mechanisms and tools that allow organisations to access and exploit European space-developed technologies and knowhow.

Economic benefits

By examining the market potential of transfers that are still in their early stages, ESA has estimated that returns to receiver companies will reach 500 MEuro by 2004. Donor-company returns are also expected to achieve exponential increases during that period.

Spin-off companies

Since the early 1990s, at least two small companies have been formed as a direct result of the TTP, creating employment opportunities for technically skilled employees. They have also been operating profitably within the first three years of start-up. One of the companies was created by an ESTEC engineer with expertise in simulating space missions using virtual-reality software. This software was also used to animate the motion of Hurricane Andrew, giving meteorologists a chance to understand better how the hurricane was formed and behaved.

Taxpayer return

Having calculated the direct economic benefits accruing from the TTP, it is also possible to estimate the indirect returns in terms of the additional taxes paid in the various countries due to the TTP-related growth in business, namely:

- 500 kEuro in taxes paid from donor-company profits
- 2 to 3 MEuro in taxes paid from receiver-company profits
- 7 to 8 MEuro in taxes paid on employees' salaries.

Other benefits

It is a well-established fact that cost savings are achieved by the companies that acquire and adapt space technologies for other uses. These savings encompass product-development costs, manufacturing and production costs, costs for training employees, and costs of protecting and ensuring employee safety.

Financial returns to ESA

Along with the 'softer' returns from the TTP, such as an increased awareness of ESA programmes and an increase in the capabilities and breadth of the space research base, ESA and the TTP also receive measurable economic returns.

Royalties

In cases where the intellectual property of a space technology is owned wholly by ESA, the Agency itself acts as the donor company and usually receives royalty payments. The best example of this type of revenue generation is the transfer of knowhow to industry through the general publication of a set of software standards that were developed by ESA for use by its contractors in large projects. These rules ensure that software being developed by different contractors at different locations have common specifications, design, validity, test and documentation. They were so effective and popular in ensuring that software was compatible and projects were successful that the contractors began using them even for non-space projects.

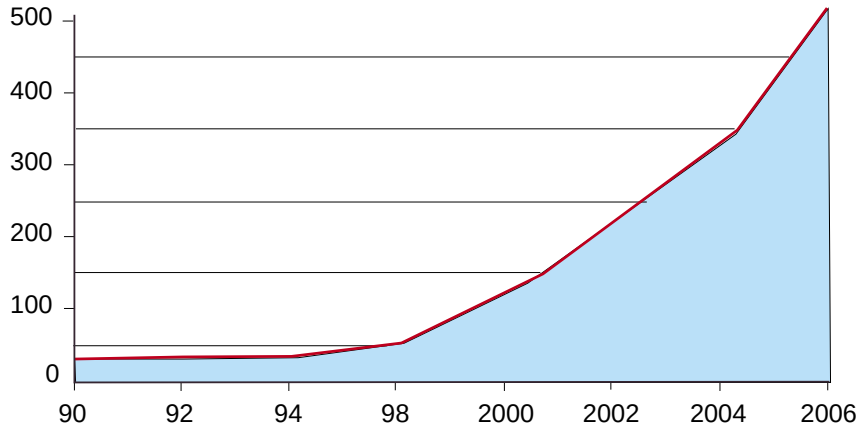


Figure 1. Cumulative turnover generated for receiving companies, in MEuro

Returns on investment

As mentioned earlier, companies have been benefiting from ESA and the TTP filling a gap in the European investment market by providing seed funding for the completion of feasibility studies and other research to validate the implementation potential of a particular technology transfer. Any company that receives seed money is required to reimburse a small percentage of its sales revenue to ESA in the event that the transfer is successful. Payments come in as a fixed percentage of sales until the amount invested has been recovered. Thereafter, a smaller (to be defined) percentage of sales is returned to ESA over the lifetime of the product.

Concrete examples

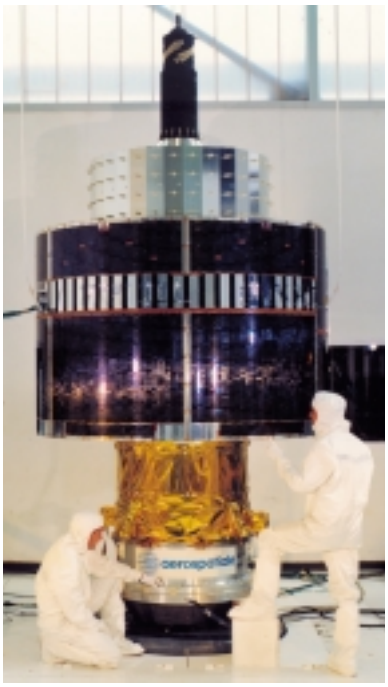
Space telescopes and the early identification of skin melanomas

A mathematical algorithm employed to analyse sets of X-ray data collected by space

telescopes has been adapted for use in the early identification of skin melanomas.The algorithm has the ability to extract information from large and 'noisy' data sets, allowing it to identify previously unknown galaxies and other space objects. Researchers have adapted the algorithm into a tool that scans and magnifies the surface of the skin, and determines if cells and their structures have cancer cell characteristics. Doctors using this tool are more likely to detect and properly diagnose skin cancers at an earlier stage than with current techniques.

Space radiation and heart-disease treatment

The small British company Radiation Experiments and Monitors (REM), based in Oxford, has developed a Radiation-sensitive Field-Effect Transistor (RADFET) for ESA. The device acts as a radiation dosimeter, monitoring the cumulative or integrated dose of radiation for equipment in space. It has been used on unmanned programmes such as the Meteosat-3 meteorological satellite, and the Hubble Space Telescope. The simply designed silicon chip carries a layer of 'thermal oxide', which has been sensitised to ionising radiation (gamma-rays, hard and soft X-rays and high-energy particles). Radiation impinging on the sensor permanently changes the silica layer such that it acts as a record of the radiation received. A key advantage to the RADFET is that, as a micro-electronic device, it can send its 'integrated dose' signal through a cable or radio link and can thus be read out remotely.



When doctors find plaques and accumulations of cholesterol on the interior walls of arteries (arteriosclerosis), they often treat such patients using coronary angioplasty. A balloon catheter is inserted into the artery to open the blood vessels and so prevent coronary events such as heart attacks. In about 45 percent of patients, arterial blockages or closures re-occur during the healing process (restenosis) and the patient must undergo the procedure again.

Recent research has shown that irradiation can prevent the arteries from becoming blocked again. This involves inserting a catheter into the blood vessel, which is then exposed to beta or gamma-ray radiation in a treatment known as 'endovascular brachytherapy'. In order to control the degree of irradiation so as to prevent damaging the surrounding tissues while optimising the treatment, the amount of radiation applied in each layer of the tissue needs to be precisely monitored.

The solution, being developed by REM and IST, is to mount a RADFET sensor in the catheter in order to monitor the locations where radiation doses are to be delivered. The aim is to send the signal giving the accumulated radiation level to instruments that the medical team can monitor during treatment. Because the RADFET is so cheap when produced in bulk – less than 1% of the total cost of treatment – it can be thrown away after each procedure.

Diamond-like coatings for clearer plastics

When two components in a system rub together they create friction, which can wear out the components themselves and heat up the system. A small German company, MAT in Dresden, has developed a special diamond-like coating for treating bearings in the fuel pumps of the Space Shuttle. This coating is a carbon-based material with a molecular structure resembling that of a diamond. The advantages of the coating are its resistance to wear and scratching, its chemical stability, and the fact that it minimises friction in mechanical systems.

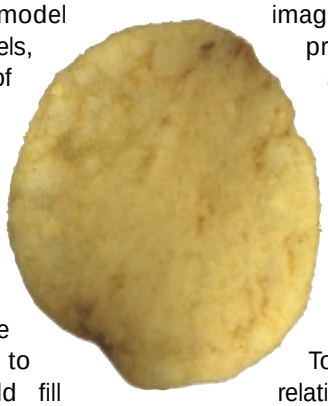
Plastic foils are manufactured using a large rolling mill, called a 'calendar'. The main parts of the calendar include the extruder, which mixes the polymer, and a series of rolls that transform the plastic material into sheets, or foils. Within the extruder, the granules of plastic are heated so that they melt and congeal into a continuous material. A key component of the extruder is a rotating worm, which mixes the material during this process.

Before the coating process was used, the surface roughness of the rotating worm caused the plastic to stick to it during mixing. The plastic stuck to the hot worm would then carbonise and crumble into the plastic mixture, forming black particles in the finished foils. Kalle Pentaplast, the World leader in plastic film and packaging, attempted to reduce sticking by coating the rotating worm with a variety of materials. Subsequent customer complaints about 'dirty' plastic increased Kalle Pentaplast's costs, particularly when orders had to be remade to meet customer specifications. Coating the rotating worm with the diamond film resulted in a significant reduction in residues.

The reduced friction between the coated rotating worm and the plastic material being produced also increases throughput in the extruder, because there is now less drag in the system. Each calendar can therefore produce about 10 to 15% more output than before.

'Landing' a potato crisp

The small German company Hypersonic Technology (HTG), in Grottening, specialises in solving aerodynamic flow problems for space projects. By observing how model spacecraft behave in wind tunnels, HTG can calculate the effects of very fast airflow on the motion, temperature and physical properties of space vehicles.



In 1998, MST – the German Spacelink partner – was challenged by an inquiry from a German packaging-machine manufacturer, Rovema, trying to develop a machine that could fill packets with lightweight food products, such as potato crisps, quickly and without breaking them. As the leader in the packaging-machine sector, Rovema must continually upgrade its wide range of machines in order to stay competitive. The constant search for ways in which to improve the performance of its machines led Rovema to explore space technologies and knowhow.

It was recognised that the scientific problem of dropping a potato crisp into a bag without breaking it is conceptually similar to landing a spacecraft safely. Both must take into account the optimum speed for a safe descent, and also consider how the flow of air affects the temperature, structure, speed and direction of the failing object.

Using the modelling, calculation methods and measurement knowhow developed through its work on ESA projects, HTG was able to develop a bagging system for Rovema which could be integrated into a new machine that can package foods 30 to 50% faster than existing equipment.

Rovema has tested a prototype model and anticipates that its new packaging machine, which received its first public viewing at the major international packaging trade-fair INTERPACK in Dusseldorf (D) in May 1999, will soon be mass-produced.

Conclusions

It has been proved that space-developed technologies can often find a place in non-space industries and products. In order to be transferred, however, these technologies frequently need to be adapted to cope with, or work optimally in, their new environment. Today, more and more support is being gained from industry, academia and government entities. The Agency's Technology Transfer Programme has demonstrated the economic viability of this powerful concept, having already resulted in several new business ventures in Europe. In addition to these concrete results, technology transfer is helping to foster the image of the European space programme. The slogan 'From space-developed technologies down to Earth' is now a reality within the European economic fabric, thanks to the ESA initiative, and European and Canadian SMEs, which are playing such a vital role.

Points of contact

To access and receive publications relating to ESA's Technology Transfer Programme, including the catalogues of transferable technologies and spin-off successes, visit the ESA Publications web site at:

http://www.esa.int/

Alternatively, you can contact the Technology Transfer Programme Manager or the SME Initiative Manager:

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Acknowledgements

Special thanks go to JRA Technology (UK) and also to the partners in the Spacelink Group, particularly MST Aerospace in Germany, for their contributions in supplying data and case-study examples for this article.