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Directorate-General for Research, Industrial technologies
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Raising SME research capacity is vital to Europe's industrial future

A dynamic SME sector is essential to the achievement of Europe's goals for competitiveness and employment. Evolving provisions for collaborative research in successive EU Framework Programmes have provided a powerful stimulus for innovation that transcends the capabilities of individual small businesses.

More than 99 % of Europe's 20 million private manufacturing and services businesses are SMEs, ranging from specialist high-technology companies to traditional craft-based firms. Together, they provide two-thirds of all employment in the EU and continue to generate a high proportion of any new jobs. Although now faced by increasing global competition and a climate of financial uncertainty, the continuing success of such enterprises is crucial to the economic future of the EU and the well-being of its citizens. And in today's fast-moving world, success depends on agility and innovation.

Since most small businesses are constrained by limitations in investment and human resources, the European Commission's Sixth RTD Framework Programme (FP6) aimed to provide more than €2.3 billion from its total €17.5 billion budget specifically to fund SME participation in transnational research collaboration.

New instruments support SMEs

The overall aim of FP6 was to strengthen the European Research Area (ERA) by supporting initiatives assembling the critical mass needed to obtain breakthrough results and create a lasting impact on greater coherence at European level.

In addition to established funding instruments carried over from the preceding FP5, FP6 therefore included larger-scale Integrated Projects (IP), together with Networks of Excellence, aimed to a more lasting integration of research activities.

To counter initial concerns that IPs would be too inflexible and long-term in outlook for SMEs, special provisions were made to meet their needs and facilitate their inclusion. In particular, the rules for participation were framed to allow consortia to modify their membership, permitting additional SME partners to join existing projects after their start-up – for example, to contribute to the assessment, testing and demonstration of technologies. Special budgets could be set aside for the incorporation of new SMEs, and the Commission itself allocated further funding for the organising of calls for participation in new SME-specific work packages, while SME associations were also encouraged to participate.

Under Thematic Priority 3, which covered nanotechnology, materials and production technologies (NMP), separate calls for proposals were organised for Integrated Projects dedicated to SMEs (IP-SMEs). SME-led, and with SMEs making up at least half their consortia, IP-SMEs comprised packages of research, demonstration, training and dissemination activities devoted to rapid transformation of traditional industries from today's labour- and resource-intensive practices towards more knowledge-based, sustainable and globally competitive activities.

Mutual benefits of cooperation

As the examples on the following pages show, cooperation between large companies, SMEs and academia in IP consortia brings a multitude of benefits.

Although SMEs with an in-house research and technological development capacity account for only a small proportion of the total SME community, these were the prime target of the IP-SME concept. Given the inventiveness and entrepreneurialism typically displayed by small businesses, a minority of such enterprises can exert a disproportionate influence on whole market sectors. Conversely, Original Equipment Manufacturers (OEMs) and other large-sized industrial partners profit from a speed of reaction they themselves may not be able to match.

Medium- and low-tech SMEs derive advantage from early exposure to third-party expertise and new technologies they do not have the capacity to develop in-house. Participation widens the horizons of businesses that may not previously have considered international activity. It can also provide them with insights into different business practices employed by their counterparts in other EU countries, some of whom may eventually become lasting business associates.

In addition, sharing a platform with the large national and multinational organisations that are often the actual or potential customers for their products and services promotes synergies and an effective spread of knowledge across whole value chains, bringing more holistic solutions to industries' needs. Furthermore, by affording access to resources and infrastructures that would not otherwise be available, it enables more ambitious results to be achieved – while the commercial drive of SMEs hastens their translation into marketable innovations.

The principal interest of universities and other academic researchers is to make new scientific discoveries. However, in the context of the Framework Programmes, their studies must also have relevance in addressing industrial, economic and societal issues. Pursuing these goals in parallel can greatly enhance the prospects of achieving radical innovation. Project funding supports academia in probing the frontiers of knowledge, to deliver fresh ideas that industry can harness in ground-breaking applications.

Key roles

SMEs have key roles in this process: both by providing input based on their 'front-line' experience and expectations to align the research tasks with industry's practical requirements, and by acting as the developers and testers of emerging technologies, devices and concepts. Their presence close to the markets, coupled with a real need to profit as quickly as possible from their efforts, constitutes a powerful driving force for widespread dissemination of the products of research, which ultimately contributes to the competitiveness and prosperity of the EU as a whole.

Textile SMEs reach new applications through innovative networking

SMEs in the textiles industry can become more sustainable and competitive by targeting the development of high-added-value products and services for non-textile sectors. The AVALON project produced innovative hybrid structures incorporating shape memory alloys, while also creating a strategy for smart networking.

A laboratory drawing machine for ultrathin wires developed by CNR-IENI (Italy).

The twin objectives of AVALON were to develop novel hybrid textile structures integrating multifunctional shape memory alloys (SMA), while at the same time introducing concepts, methods and tools to facilitate SME collaboration as smart organisations in innovative networks.

Alloys such as nickel-titanium (NiTi) are capable of memorising an original shape and returning to it after a deformation ('shape memory effect'). Compared with other metals, binary and ternary NiTi alloys also exhibit 'superelastic' characteristics. These two types of shape recovery, both closely related to a temperature- or stress-triggered transformation between two crystal structures, open a wide field of interesting application possibilities.

In AVALON, a 30-partner consortium including 20 SMEs pursued material and process innovations to determine the potential of textile/SMA hybrids in medical and protective intelligent clothes, as well as the use of reinforced composites for the civil engineering, automotive and aerospace sectors. New production technologies had to be developed for thermomechanical processing of SMA filaments just a few microns in diameter, and their integration with conventional fibres in intelligent yarns, plus provision for on-line quality inspection of the internal microstructures.

In parallel management research explored new holistic concepts for the full product life-cycle, establishing a methodology whereby SMEs become proactive network partners for the co-operative development, manufacturing, marketing and recycling of high-added-value products and integrated services. The resultant 'Smart Network' approach employs interoperable systems allowing concurrent enterprise activities of individual network members to be communicated virtually, with full integration of supply-chain planning and monitoring. As the project outcomes show, this has contributed to a high level of achievement across all of the areas of interest.

Prototypes of various innovative products and services have been developed in AVALON, e.g in the area of medical compression clothing, by Grado Zero Espace srl., an easily wearable elbow sleeve with anti-epicondylitis brace.

At the end of the funded period in May 2009, an array of material samples and prototypes was presented, covering the various targeted application fields. Examples ranged from a high-impact-absorbing motorcycle helmet, high-performance racing skis and a helicopter stabiliser, to a semi-rigid orthopaedic support and an endovascular stentgraft.

In addition, some 18 related services were developed – including SMA specification, product design, testing and measurement.

For further commercialisation of these products and services, the partners will continue their collaboration.

> *"Interdisciplinary collaboration allows us to resolve issues from different points of view; this approach is necessary, but very difficult for SMEs outside projects such as AVALON."*
>
> Dr. Karel Volenec, ELLA-CS, Czech Republic

AVALON • Multifunctional textile structures driving new production and organizational paradigms by textile SME interoperation across high-added-value sectors for knowledge-based product/service creation
Total cost | **€11 855 635**
EC contribution | **€7 423 776**
Project duration | **March 2005-May 2009 (51 months)**
Coordinator | **Prof. Dr Thomas Fischer, DITF-MR, Germany**
More information | **www.avalon-eu.org**

Engineering materials derived from biomass

Initial efforts to make productive use of biomass waste tended to focus on less demanding applications. BIOCOMP has now developed a range of engineering-grade biocomposite materials suitable as direct substitutes for conventional oil-based plastics and wood.

Loudspeaker box made from a lignin matrix composite.

Biopolymers from various sources have already gained a substantial share in markets such as packaging, while natural fibres are extensively used for soundproofing and thermal insulation, as well as for plastics reinforcement. In the Integrated Project BIOCOMP, 24 partners from 11 countries sought to take a step ahead by combining biopolymers and fibres into new composites having the performance to compete with conventional plastics in demanding engineering applications.

In particular, the project targeted the mass consumer goods, automotive, construction, electronics and furniture industries. Its goal was to develop a range of thermoplastic and thermosetting materials that would be resource-and energy-saving, adaptable in properties and functionality, lightweight, inexpensive and eco-efficient over all stages of the product life-cycle. A further criterion was that they should readily be processable using established plastics industry techniques for compounding and moulding.

Industry-ready materials

Composites based on the thermoplastic biopolymers lignin, starch, polylactide and polyhydroxybutyrate were developed with properties comparable to those of polypropylene/talcum, which is widely used for component moulding by various industrial branches. Using only non-halogenated flame retardants, they also met the standard fire-resistance classification applicable to electronic equipment. Impact-modified materials with long fibre reinforcement could even compete with ABS and high-impact polystyrene for electronic equipment housings and automotive interior panels. Demonstrator products ranged from thin-walled boxes and thick-walled housings to large structured plates.

Thermosetting furan resins derived from sugarcane bagasse approached the performance of glass fibre/polyester, and could be processed by most common methods. Excellent properties were achieved using carbon fibre fabrics for reinforcement where high stiffness is required. The inherent temperature stability and fire resistance of these materials without additives opens the door to wide fields of application. More resins extracted from plant oils showed promise as binders for medium- and high-density fibreboards, with the advantage that they are completely free of formaldehyde.

Car footrest of polylactide as matrix, with hemp or flax fibers as reinforcement.

Fast to market

In parallel with the materials development, theoretical modelling provided a broad basis for understanding the behaviour of biocomposites as a guide to optimal part design and the fine-tuning of tools and processes.

The concentration on standard mass production techniques will facilitate adoption of the BIOCOMP materials by SMEs, with short time to market. By using feedstocks readily available in Europe, the project also supports non-food agricultural production within the EU.

"The collaboration including the academic research institutes was excellent and difficulties in languages did not really hinder communication."

Helmut Nägele, Tecnaro, Germany

BIOCOMP • New classes of engineering composite materials from renewable resources
Total cost | **€11 781 697**
EC contribution | **€6 658 485**
Project duration | **April 2005-September 2008 (42 months)**
Coordinator | **Norbert Eisenreich, Fraunhofer ICT, Germany**
More information | **www.biocomp.eu.com**

Rapid manufacture cuts cost of customisation

In many cases, product customisation implies simple cosmetic variations and differing accessory packages. CUSTOM-FIT adopted a more fundamental approach whereby shape and other physical attributes are rapidly tailored to the precise needs of the individual user.

Safer customised motor cycle helmet with an inner lining that has been designed to fit the scanned shaped of the rider's skull.

The 28-member consortium of CUSTOM-FIT combined computer-aided design, materials science and rapid manufacturing techniques in an Integrated Project focussing on medical and consumer products that are customised to the requirements of individual human bodies in terms of shape, biocompatibility safety and comfort.

To date, the cost associated with customisation has been a major barrier to its widespread adoption. The manufacture of medical prostheses, for example is a highly skilled process, often involving several iterative stages of adjustment before a satisfactory fit is achieved. The CUSTOM-FIT concept replaces such time-consuming procedures with a seamless transition from the capture of data on a user, to direct design and one-off manufacture using additive processes that involve no special templates or tooling.

The partners created an open and portable data exchange format allowing 3D body scan measurements to be integrated with non-geometrical user information such as personal details and preferences. These inputs can be employed in systems that either combine scan data with engineering data, enabling product design to be accomplished in one single process, or implement CAD operations directly on stored scan data.

Volumetric modelling techniques then determine multi-material distributions and graded structures, from which files containing a wide range of parameters can be generated, to control various types of rapid manufacturing machine.

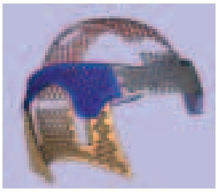
Three manufacturing methods were developed within the project:

- High-viscosity inkjet printing was used to make innovative bone implants, using dedicated print heads to deliver continuous streams of UV-curable resin droplets at high frequency. The technology focused on printing bio-resorbable polymers, with variable porosity to control the speed of bone re-growth;

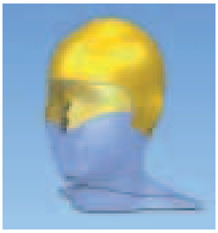
- **Plastic powder printing** depends on the deposition of powder layers in precise patterns by laser fusion. Suitable for a wide range of thermoplastic materials, this process was used to demonstrate fabrication of large products, such as motorcycle seats, helmets and prostheses;
- **Metal printing** again produces 3D objects from powdered material. Parts are a built up and sintered layer-by-layer in order to minimise shrinkage. The CUSTOM-FIT machine is capable of delivering graded metal objects, e.g. in cobalt-chromium, suitable for products such as tibia implants and jet engine components.

The process of customisation takes a standard model and, using Delcam's morphing technology, shapes it to fit the scan.

The design of the customised helmet shape is a single automated process developed during the Custom-Fit project, requiring no technical knowledge of CAD.



The inner liner has a honeycomb structure created to reduce weight and improve comfort for the rider.



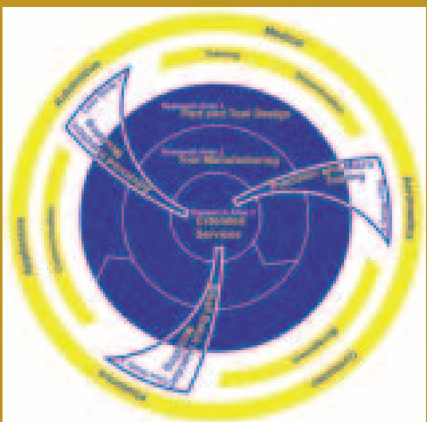
The liner is split in to several pieces in preparation for Rapid Manufacturing at De Monfort University.

> *"The rewards include peer recognition and generating results that are commercially exploitable."*
>
> Chris Lewis Jones, Delcam, United Kingdom

CUSTOM-FIT • A knowledge-based manufacturing system, established by integrating rapid manufacturing, IST and material science to improve the quality of life of European citizens through custom fit products
Total cost | **€15 880 090**
EC contribution | **€9 250 068**
Project duration | **September 2004-February 2009 (54 months)**
Coordinator | **Chris Lewis Jones, Delcam, United Kingdom**
More information | **www.custom-fit.org**

Mould-making advances enhance prospects for SME toolmakers

Moulds and dies are essential manufacturing tools for many major industries. EUROTOOLING 21 enabled new business models based on technology and process innovation that will reposition SME toolmakers as key strategic partners in complex OEM value chains.



EuroTooling21's research area and case study sub-projects and application markets.

Most of the 7 000 European companies involved in the manufacture of moulds and dies for plastics component production are SMEs. Faced with growing price pressure from the low-wage economies, their future competitiveness depends on the ability to harness new methods and business practices in order to increase productivity and deliver products of greater added value.

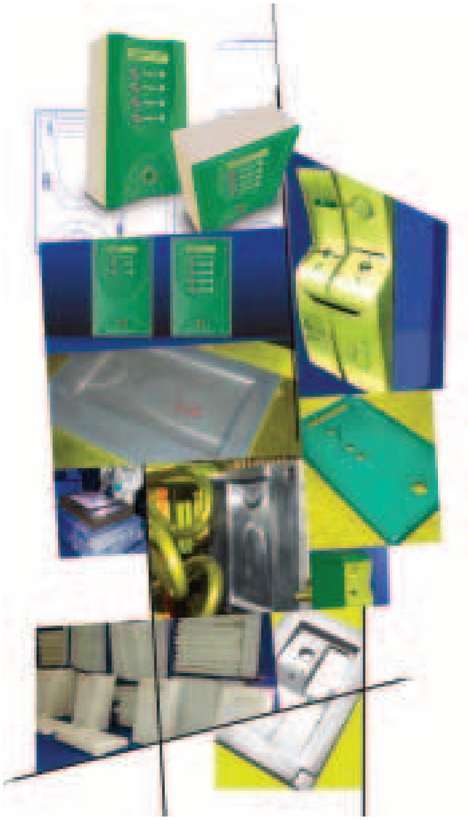
The Integrated Project EUROTOOLING 21 identified technologies necessary to cover the full tool life-cycle, from design to manufacture and extended services such as repair and recycling. With a series of sub-project teams integrating research institutes, OEMs, and SME toolmakers and technology providers, it also ensured effective dissemination of knowledge across the supply chain.

The research explored three areas in case studies seen as representative of the overall tooling sector.

For **high volume injection moulding**, the study group demonstrated a complex multimaterial and multifunctional injection moulded automobile door panel, using a new form of mould architecture that permits automated integration of advanced aesthetical and functional features in the plastic products. In effect, the mould itself acts as a machine, producing parts with many functions and components in a single operation.

Manufacture of micro-tools with very small features and optical surfaces has so far usually required lengthy and labour-intensive procedures. Wider application has also been restricted by a limited choice of technologies and materials for **precision and micro-machining**. In this case, the project partners created a comprehensive database of information on existing and new techniques, assessed a range of candidate methods, and developed specialised CAD/CAM solutions and optimised processing parameters that enabled, as demonstration, the development and production of an innovative optical system. The acquired knowledge points the way to lower-cost automated production of complex parts with improved functionality.

Small batches of large products are typically fabricated in metal, using traditional techniques. To allow the substitution of lighter and more versatile polymeric materials, moulding systems must permit easy changeover with minimal waste. EUROTOOLING 21 presented a concept for moulds and dies based on materials and technologies offering the necessary flexibility, while being cost-effective over a short life-cycle. The demonstrator, a tollbooth machine cover, integrates technologies and know-how that can easily be transferred to other industrial sectors.



Case Study 3: Small Batch Injection Moulding.

> *" Through this project it was possible to collaborate with a wide range of European companies and research institutes, opening new opportunities for partnerships."*
>
> Mr. Pedro Gago, 3D Tech, Portugal

EUROTOOLING 21 • SME-IP to prepare the European tooling industry for the 21st century

Total cost | **€12 033 552**

EC contribution | **€6 800 483**

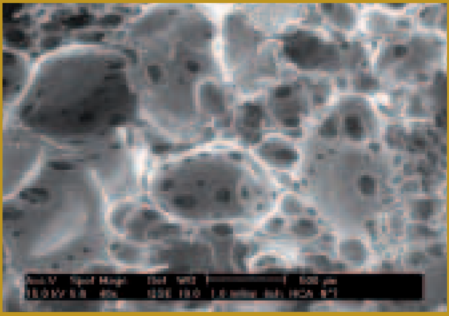
Project duration | **September 2004-September 2008 (49 months)**

Coordinator | **Dr. Rui Gregório Tocha, CENTIMFE, Portugal**

More information | **www.eurotooling21.com**

Renewable multi-barrier composites bring health and safety benefits

Whereas most flexible barrier materials are single-purpose, the FLEXIFUNBAR project developed new multifunctional types based on textiles, leather and paper. Several are already in commercial production, and more are in the pipeline.



Microscopic view of filter.

Flexible barrier structures based on paper, leather or textile are usually optimised for one specific effect – fire retardancy, thermal insulation, dust filtration, electromagnetic shielding, etc. – and are thus unable to provide adequate protection against multiple 'threats'.

The Integrated Project FLEXIFUNBAR brought together 44 partners to develop new composite materials with functionalising micro- and nano-structures providing several barrier properties at the same time: for example, combining thermal and sound insulation; or protection against UV, bacteria and odours. Their versatility opens the door to applications in many industrial sectors, including healthcare, construction and transport.

This four-year initiative involved an entire re-thinking of the production processes, plus the development of predictive toolkits and modelling methods to forecast performance and the life cycle impact. New tools and methods were also devised to characterise the architecture of composites at scales from from 1 mm down to 1 nm in order to establish the relation between structure and barrier efficiency.

Among numerous outcomes were:

- ion exchange filters with macroscopic pores occleded by active polymers functioning as electromechanical actuators to control the barrier effect, making it possible to trap particles of all diameters at concentrations between 1µg/l and 20 mg/l;
- automotive engine air filters combining filtration and flame retardancy;
- anti-microbial textiles for hospital sheets and uniforms, which reduce bacteria counts by at least 80 %, even after multiple industrial washing cycles; and
- shoes that are anti-microbial and anti-odour, as well as being water-resistant.

Manufacturing such materials from natural fibres has the advantage that they are renewable and environment-friendly alternatives to petrochemical-based synthetics.

Filter developed for automotive application (Mecaplast).

Moreover, as part of a bid to reduce chemical additives and pollution by 50 %, sub-projects explored alternatives to end-of-life incineration, such as the production of non-wovens from leather wastes and the by-products of cotton spinning.

By the close of FLEXIFUNBAR, thirteen products had been commercialised, and seven more were expected to be marketable in the medium term. The acquired knowledge will eventually enable the SME members to design new composites with properties tailored to specific customer requirements. A more lasting network has now been etablished, enabling them to continue to share knowledge in building further on the results of the research.

"We created a European expert network, which is enabling us to develop new products with the help of the know-how from our partners."

François Xavier Delatte, Duflot, France

FLEXIFUNBAR • Multifunctional barriers for flexible structures (textile, leather and paper)
Total cost | **€10 872 084**
EC contribution | **€6 438 995**
Project duration | **October 2004-September 2008 (48 months)**
Coordinator | **François Xavier Delatte, Duflot, France**
More information | **www.flexifunbar.org**

Polymer hybrids replace metals for electro-magnetic protection

Electromagnetic shielding and static discharge protection are often provided by metal casings, or using conductively coated or metal-filled plastics. Inherently conductive polymer composites developed in POLYCOND bring superior performance with lighter weight and lower cost.

Medical device for blood pressure monitoring.

To provide new options for the electromagnetic insulation (EMI) and electrostatic discharge (ESD) protection needed for many industrial and consumer products, the Integrated Project POLYCOND developed a range of composites based on the compounding of engineering polymers and inherently conductive polymers (ICP), and on hybrid systems of ICPs incorporating conductive carbon nanotubes (CNT).

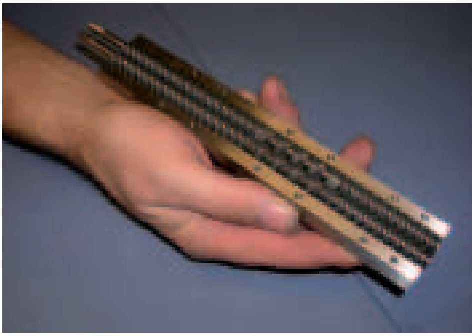
The aim was to improve significantly on the performance of pre-existing solutions, and thus to permit widespread replacement of metals in healthcare, automotive, aerospace, military and other applications. To facilitate adoption by Europe's SME-dominated plastics conversion industry, it was also essential that the materials be processable using conventional moulding techniques.

However, as part of the research, a new elongational flow, or 'chaotic', method for mixing hybrid materials in both batch and continuous processes was developed. This folds and layers two components together, to form a variety of unique structures that result in higher levels of conductivity with lower filler concentrations.

Modification of the CNTs further enhanced the electrical characteristics of dispersions in acrylic thermoplastics blends, polypropylene and polycarbonate. Composites with carbon loadings as low as 0.5wt % were shown to exhibit industrially useful levels of conductivity. CNT-filled polyurethane foam cases and covers could be produced using single-step thermoset reaction injection moulding, improving its surface conductivity that currently minimise the final production time and associated costs.

Thermoplastic formulations for shielding applications achieved signal attenuation rates close to those of solid metal plates, while polycarbonate/CNT/steel hybrids performed similarly and exhibited even more uniform conductivity throughout the bulk and surfaces of mouldings. This is important in cases where both shielding and surface protection from ESD is required.

Developments in polyurethane shielding.



Novel polymer processing techniques.

A series of case studies demonstrated that moulded articles give a better balance of mechanical and electrical properties than the available alternatives. And, while raw material prices remain higher than those of conventional polymers, components with weight reductions of at least 60 % can be produced faster and at much lower overall cost.

"The opportunity to work with leading research institutions such as TNO in Holland and AIMPLAS in Spain brought a new dimension and capability to our company."

Brian Murray, Rondol, United Kingdom

POLYCOND • Creating competitive edge for the European polymer processing industry driving new added-value products with conducting polymers
Total cost | **€8 949 103**
EC contribution | **€4 994 129**
Project duration | **February 2005-January 2009 (48 months)**
Coordinator | **Liliana Chamudis Varan, AIMPLAS, Spain**
More information | **www.polycond.eu**

FP7 widens the net for SME inclusion

New provisions in the current Framework Programme not only target research-oriented SMEs, but also aim to spread innovation across SME-dominated industry sectors.

FP7, the main channel for EU funding of research in 2007-2013, was conceived before the onset of the current economic crisis. It nevertheless includes a range of provisions for the stimulation of SMEs and encouragement of new start-ups, which are more than ever crucial to Europe's continued presence as a strong player on the global stage. Under the Cooperation Programme, which includes the NMP Theme, these measures have already enabled more than 6 000 SMEs to benefit from funding in the first two years of this FP.

The Integrated Projects (IP) and smaller-scale Specific Targeted Research Projects (STREP) of FP6 are replaced by a single funding instrument in FP7: Collaborative Projects (CP). SMEs are able to take part in all calls for proposals – but, as in FP6, NMP has adopted an additional CP-SME category focussing on those SMEs with the capacity to take an active part in the research and development. As well as supporting existing research-oriented enterprises, the aims are to motivate greater numbers of SMEs to become knowledge- and research-intensive, and to help traditional industry sectors to become more active in RTD.

Opportunities for all small and medium-sized enterprises

CP-SMEs provide opportunities for those SMEs that are willing to increase their competitiveness by defining and implementing new industrial approaches, strengthening their networking capabilities, developing and adopting new technologies, modernising their production systems, and developing innovative products and associated services.

The CP-SME projects are required to devote at least one third of the budget (and often spend in fact one half) to activities in SMEs. Such projects are led by research-performing SMEs (although not necessarily in a coordinating capacity), with the participation of universities, research centres and other industry partners, as appropriate. The SME members act as technology providers, as main users of the results and as important vectors for broad dissemination activities. In case of potential multi-sectoral applications, key players from different sectors may be involved to facilitate the wider transfer of technology.

Less advanced SMEs from the targeted industries are also included when their participation has an evident direct added value for the project. Other activities can permit the mobilisation of even larger numbers of SMEs who are not directly included in the consortium, but who are organised in external industrial reference groups – sometimes via industry associations.

Transformation target

In these ways, NMP is striving to maximise the potential of the SME community to transform itself through the introduction of new knowledge-based and high-added-value products, processes and technologies. This will ensure that, when the so-called 'green shoots' of recovery begin to grow, Europe will be ready to reap the harvest.

European Commission

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J.L. Vallés, Head of Unit RTD-G2 'New generation of products'

KI-NA-24-167-EN-C

Small- and Medium-size Enterprises (SMEs) are a driving force for technological innovation and economic growth in Europe. Industrial SMEs with in-house research capacity can push technology to a higher level. In order to use the economic potential of this category of SMEs, a specific funding scheme has been established under the European Framework Programme for Research and Development. The projects funded under this scheme are targeting research issues of interest to individual SMEs and, more in general, to industrial communities in which a high number of SMEs are present. The scheme enables SMEs to conduct research in domains for which they do not have the technological and financial capacity to go it alone. The collaboration with research centres, universities, large companies and other SMEs at a European scale has been a valuable experience for all the participating organisations. This publication presents six examples of European collaborative research projects targeting industrial SMEs with in-house research capacity. The projects have served as flagship examples for the industrial communities they are targeting. The examples highlight not only the technological results, but also the experiences of individual SMEs.

Publications Office