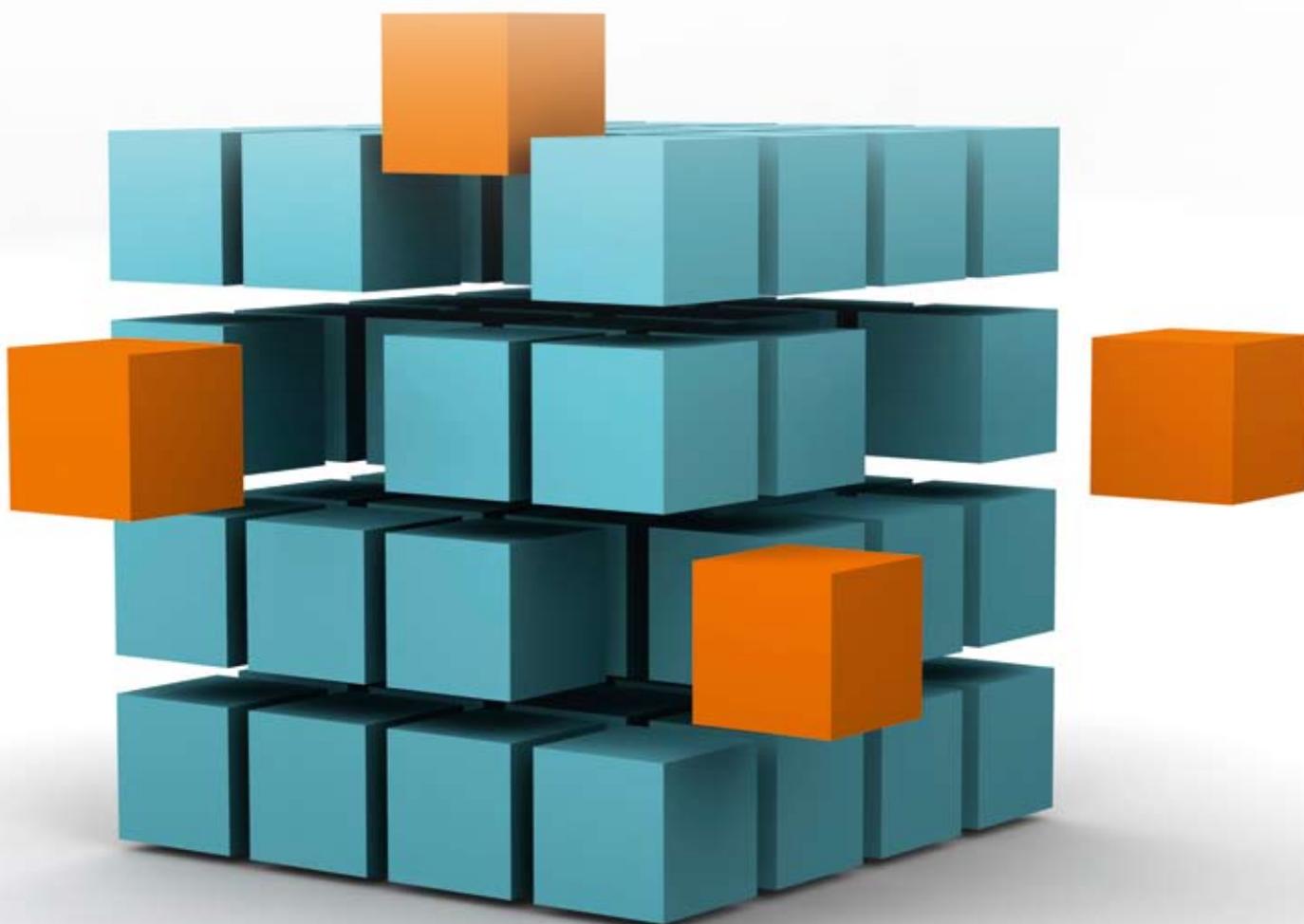


WHITE PAPER

ENGINEERING CONSULTANCY AND INNOVATION



Engineering Consultancy & Innovation

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The original White Book is in French and refers to French institutions and legislation. It has been translated into English by EFCA with the assistance of Syntec-Ingénierie. In order to make the translation more understandable for foreign readers, it has been slightly adapted and completed with footnotes by Jean Félix (Syntec-Ingénierie).

WHITE PAPER

Engineering consultancy and innovation

From the French :

« LIVRE BLANC, l'Ingénierie et l'innovation »,
© Syntec-Ingénierie, May 2008
Translation into English by EFCA,
commented and adapted by Syntec-Ingénierie.

This White Paper is based on the situation in France in 2008, and includes

- an **inventory**, which describes the different aspects of engineering consultancy and the various types of innovation implemented therein;
- a part dedicated to the **leverage for** innovation, that is to say the various factors that are favourable to innovation within engineering consultancy companies;
- a part dedicated to the **obstacles** to innovation that often impede its implementation;
- based on these facts, a list of **recommendations** made by Syntec-Ingénierie to improve the practice of innovation in engineering consultancy.

Each of these parts gives details of the same subjects from a different angle (cultural, financial, administrative, organisational, legal aspects, etc.).

A **summary** of the White Paper lists the major topics tackled and the key recommendations.

November 2008



FOREWORD

In March 2000, the Lisbon European Council adopted a programme of reform aimed at making the EU the most competitive and dynamic knowledge-based economy in the world by 2010, capable of sustainable economic growth with more and better jobs and greater social cohesion, and respect for the environment.

In this context, the release of the European potential for innovation is extremely important for all knowledge-based fields of the economy, notably in engineering consultancy. EFCA, the European Federation of engineering Consultancy Associations, therefore welcomes the 2009 Year of Creativity and Innovation and is proud to support the joint publication of this White Paper on innovation in engineering consultancy developed by Syntec-Ingénierie.

For reasons of compliance with the FIDIC (International Federation of Consulting Engineers) contract terminology, the following concepts have been used throughout this document:

The employer: should be read as “the awarding authority” or “the client”;

The engineer: refers to “the consulting engineer, the engineering consultancy”;

The contractor: refers to the contractor.

EFCA hopes that this publication will contribute to trigger the wider debate on creativity and innovation at EU level.

Dr Panos Panagopoulos
EFCA President
18 February 2009

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INTRODUCTION

The development and implementation of innovation has always been at the heart of the engineering consultancy profession. Yet CEOs realise that today, innovation in the industry **is not sufficient** to face up to the major economic and environmental challenges. The Lisbon Strategy underlined the strategic importance of innovation in a “knowledge-based society” faced with worldwide competition.

The industry is convinced that it can and must play its part in confronting today’s challenges by **contributing its experience** in several fields: anticipation of new requirements and engineering new solutions; ever more widespread dispersal of knowledge; sustainable development; climate and energy changes; control of risk in response to the increasing complexity of projects, etc.

In the post-war period and the following 3 to 4 decades, engineering consultancy innovated for the benefit of its customers and the nation. However, this was followed by a more stringent economic period, in which budgets were squeezed, discouraging long term investment and focussing on the tasks that brought short-term results.

Until recently, the market was flourishing again and engineering consultancy was growing strongly. In this new context which enables it to produce more and widen its range of services, **engineering consultancy has the means for even more innovation.**

An **Innovation Committee** set up by Syntec-Ingénierie in 2005 has been considering these problems with a view to proposing solutions. Its members represent the **various sectors of activity of the industry**: construction engineering and industrial engineering. In their companies, they occupy management and operational positions. The majority of them also take part in the control of organisations or national and European research programmes.

Even though certain engineering companies were already participating in National Research Agency¹ (ANR) programmes, the first action of the Innovation Committee was to **launch cooperative projects enabling engineering companies** to partner in the ANR 2006 call for tenders. This type of action was repeated for the 2007 call. In both cases, an engineering consultancy project was accepted. This

success should greatly encourage engineering companies to work together, and in partnership with research engineers, to develop competitive projects. Participation in such projects enables the whole profession to show its clients that engineering consultancy can provide them with original and innovative solutions.

Syntec-Ingénierie set the Committee a second target of producing a White Paper containing recommendations for **assisting engineering consultancies to increase investment in research and innovation.** For that, it was necessary to take stock of the current situation, release the brakes on innovation and make good use of the internal and external levers. It soon became apparent that the solutions to many problems lay within the engineering companies themselves, but that other challenges were to be found in relations with the State or other public or private partners.

This work was therefore the subject of many very constructive meetings; it also included a round table with stakeholders on 13 June 2007, with the support of the French Public Institutions.

The White Paper, which summarises this work, is intended for CEOs **of engineering companies, their principal economic partners and the relevant state departments in France, but it can also be addressed to these economic players in all European countries.** It is not a simple statement of the past, rather it marks the beginning of a new era to which everyone can contribute in all European countries.

¹ French public institution supporting R & D (see glossary)

EXECUTIVE SUMMARY

Innovation, centre stage today, has in fact always been a daily priority for engineers and technicians within engineering consultancy firms.

Finding solutions to make projects possible is a key issue in both construction and industry. Engineering companies design, study and create works, equipment or industrial products in France and abroad, and for this reason, they are **constantly innovating**.

Thus, to transform a project into reality, from an idea to an execution drawing, then to a completed work, it is not enough to apply purely pre-existing solutions; on the contrary **each project requires new and specific technical, financial, legal and organisational solutions**. It is thus necessary, starting from existing concepts, to invent a new innovating configuration to suit each individual project.

For this reason, the engineering consultancy industry can play an important role in contributing to the “Knowledge Society”, where innovation must play a key part. It is clear today that the **economies of developed countries must reinforce their innovation capacities** to remain competitive in relation to emerging economies, such as China or India.

In addition to this major economic stake must be added an **environmental stake** which is gaining importance: to limit the effects of climate change, to find an alternative to oil as regards energy, to design cities offering pleasant living conditions.

However, against the backdrop of innovation needs, the engineering consultancy industry has established that, due to a number of obstacles, **it is not adequately prepared and does not make optimal use of the innovation capacities that exist**.

The objective of this White Paper is thus clear: **to release the strong potential of innovation at the heart of engineering consultancy**. It presents the levers of, and obstacles to, innovation - within engineering companies, but also in their relations with the State or with public and private partners - and proposes effective actions.

The single most important lever is in-house motivation, as there cannot be innovation if it is not wanted and planned for at board level in the firm. Financial supports for innovation are equally important, in particular government research grants, which are listed in detail in this White Paper. Lastly, it is worth noting that some clauses in the new French public procurement legislation (and in the European public procurement directive) do support innovation, although they are little known and therefore not often used.

In general, **obstacles** to innovation result from divisions which hamper potential synergies between the various actors. The situation is compounded by administrative and financial barriers: insurance, difficulties in the application of the public procurement legislation, or the financial value a company places on innovation. Production constraints often take priority over innovation. Moreover, it would be necessary to improve the effectiveness of the chain between employer/engineering/contractor companies to encourage innovation. Indeed, the current operating model is based on dated concepts (sequential process), which should be re-thought to meet today’s challenges. Relations between clients and suppliers on the one hand, and between the various actors (engineers, architects, contractors, operators) on the other, should be re-organised for sustainable partnerships and improved integration of the roles of the actors (convergent process).

These obstacles can be overcome. The Syntec-Ingénierie Innovation Committee’s recommendations are based on the following major lines:

- To convince top management of the importance of innovation and its promotion in-house.
- To reinforce the relations between the State and engineering companies to encourage joint actions.
- To review the relations between the parties involved in projects.
- To develop technical training programmes, improve the links to research organisations, and valorise training through research within companies.
- To simplify and improve administrative procedures.

Overview of Recommendations		
Key-players	Advice	Recommendations
Four recommendations to managers of engineering companies	Integrate, manage and develop innovation	<ul style="list-style-type: none"> ➤ To dedicate one person to the management of innovation in each company ➤ To promote and recognise internal innovation ➤ To promote innovation in the evaluation of staff
	Benefit from financial levers	<ul style="list-style-type: none"> ➤ To take more advantage of Research Tax Credit² ➤ To take more advantage of financial levers of innovation ➤ To set up co-financed projects ➤ To take more advantage of support from Competitiveness Centres³ ➤ To promote the approval of engineering for Research Tax Credits
	Capitalise knowledge and experience	<ul style="list-style-type: none"> ➤ To organise wide ranging technical awareness ➤ To benefit from experience and guidance
	Innovate on internal methods	<ul style="list-style-type: none"> ➤ To integrate sustainable development in management methods ➤ To include risk management for complex projects
Six recommendations to the State as supervisor and regulator	Strengthen SMEs from a financial point of view	<ul style="list-style-type: none"> ➤ To release profits held in reserve ➤ To allow long-term depreciation of research costs
	Make better use of Research Tax Credits	<ul style="list-style-type: none"> ➤ To review and adapt approval criteria ➤ To improve the definition of eligible engineering services so that they are better understood by engineering and CIR ⁽²⁾ dossier auditors ➤ To make the approval procedure more flexible
	Develop synergies between RST ⁴ and the private sector	<ul style="list-style-type: none"> ➤ To develop synergies between RST and engineering consultancies
	Reorganise the technical corpus	<ul style="list-style-type: none"> ➤ To review the method of producing general technical specifications ➤ To make use of the facilitating role of the state
	Develop more reactive and collegial cross fertilisation between public and private participants	<ul style="list-style-type: none"> ➤ To concentrate the capitalisation of knowledge by field ➤ To develop synergies between different engineering activities: public, private, in-house
	Develop methods for taking account of global strategic choices at national level	<ul style="list-style-type: none"> ➤ To bring in engineering upstream of large projects

2 Specific French tax credit scheme : “Crédit Impôt Recherche” (see glossary). A similar scheme exists in many countries

3 In France : “Pôle de compétitivité”. Partners Associations for R & D implemented in many regions, each having a specific field of competence.

4 Scientific and technical network for R&D, part of the French Ministry MEEDDAT) (see glossary)

six recommendations for decision makers and employers	Improve recognition of engineering knowledge	To sell engineering services as added value services
	Make better use of know-how and quality of engineering services	To assist the employers in the preliminary phases
		In design engineering
		In project management engineering
	Improve the effectiveness of the employer/engineer/contractor chain to encourage innovation	
Provide better protection for innovations produced by engineering consultancy		
Encourage public employers to make use of all contractual possibilities		
Provide responsibility and insurance clauses suitable for innovation		

Two recommendations to research and training partners	Share know-how in innovation and research	<ul style="list-style-type: none"> ➤ To benefit from engineering consultancy/research discussions with professors and post-graduates ➤ To develop relations with public research organisations ➤ To participate in common R&D projects. Develop a dialogue with the AUGC⁵ ➤ To share common themes between research and engineering consultancy ➤ To obtain support from intermediary organisations
	Intensify relations with the French public scientific and technical network	<ul style="list-style-type: none"> ➤ To have the 2007 circular⁶ for the RST orientation implemented ➤ To associate engineering consultancy better with the expression of priority requirements in the sector ➤ To agree a common plan of action with RST and engineering to maintain the long term quality of expertise ➤ To develop alternate professional careers ➤ To invent systems of co- or subcontracting enabling engineering to rely on research subjects conducted by RST ➤ To promote, from an engineering point of view, the AGORA 2020 procedure from the ministry in charge of equipment ➤ To develop a bilateral engineering dialogue with the LCPC, the CSTB and INRETS⁷
One strong collective action	Mutualise actions of common interest	<ul style="list-style-type: none"> ➤ Clearer communication and accessibility to external aid offers ➤ Identify centres of strategic competitiveness for engineering and strengthen its position ➤ Create a 'technical breeding ground' with research partners

5 AUGC : University Association of Civil Engineering (see glossary)

6 A specific French Ministry (MEEDDAAT) circular

7 Different French public institutions dedicated to construction and infrastructure R &D, part of the French ministry network (RST)

ENGINEERING CONSULTANCY AND INNOVATION

This White Paper was produced by **members of the French engineering consultancy industry**, who shared their experience and knowledge within the innovation committee set up by Syntec-Ingénierie, the professional engineering federation in France.

This White Paper concentrates on innovation, **the central concern of the engineering consultancy industry, but also a matter of topicality in the contemporary political and economic debate.**

Innovation has in fact become a **necessity; this will enable us to respond to the major challenges of the present and future.** Climate change, urban population growth, energy and water shortages represent some of the major challenges for “sustainable” development.

The Lisbon Agenda of March 2000 also underlined the importance of innovation in “becoming the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth accompanied by quantitative and qualitative improvement in employment and greater social cohesion”, in accordance with the terms of the objective to be achieved by 2010. One of the major axes of the Lisbon strategy was therefore preparing the transition to a knowledge-based society and economy, in particular through the acceleration of structural reforms to reinforce competitiveness and innovation.

The “European Innovation Scoreboard”, published by the European Commission in February 2008⁸, reviewed the progress of this strategy: it shows that most countries in the EU could improve their performance by transforming their “know-how” inputs into “innovation” outputs. It also underlines that the most efficient countries are Sweden, followed by Switzerland, Denmark, Finland, Japan, Germany, Israel, the United Kingdom and the United States. France lies in 17th place out of the 37 countries studied (EU and non-EU). **An effort is therefore still required to transform innovation capacity into a factor in economic growth in France.**

At the same time, however, it appears that **funds invested in research and development within French companies are tending to decrease.** The breakdown of internal R&D costs of companies by branch of activity from 1992 to 2005 was published on the Ministry of Research and Advanced Training website; these figures also show a **decrease in R&D expenses in the engineering sector.**

R&D expenses in the “engineering, design and technical testing” branch for all sectors:

	2002	2003	2004	2005
R&D Expenses in millions of Euros	328	275	282	242
Engineering R&D as a percentage of the total R&D of all companies and all sectors of activity combined	1.5	1.3	1.3	1.1

Source: French Ministry of Education and Research, France 2007

8 In the meantime, the 2008 “European Innovation Scoreboard” has been published at <http://www.proinno-europe.eu/metrics>

WHAT IS ENGINEERING CONSULTANCY?

Any work, equipment, product or development requires studies and a design.

These can be produced by:

- the internal departments of those ordering them,
- the technical departments of the manufacturers or builders,
- specialized companies: the professional consulting engineering sector.

Engineering companies have acquired considerable importance in modern economies, even extending into technological areas of consultancy. They can serve as a one-stop consultancy offering all of the services necessary for definition/production and thereby assume overall responsibility for these operations.

The task of engineering companies is to respond to a requirement and take it to project level.

Engineering companies design, study and bring about, in whole or in part, works, equipment or industrial products.

They play the part of messenger between the theoretical knowledge developed by scientists and its practical applications: using this new knowledge, they make a client's project feasible, then real.

For example, their mission could consist in designing a motorway, hospital, factory, bridge or dam (design, calculations and detailed drawings), then supervising its construction by contractors. It may also involve designing a product, for example a vehicle lighting system for a car manufacturer, a section of the Airbus A380, or tram equipment.

Engineering consultancy companies design these projects and look after the objectives of their clients during construction and manufacture by specialist companies.

Sometimes the word "engineering" is used for one part only of these services or works.

Designing is similar to the work of the "composer", who creates a musical score. This creation requires all the following:

- perfect mastery of the various elements in play, that is to say mastery of the solutions in terms of techniques, time delays and costs;
- the ability to integrate all the instruments, that is to say the ability to manage the project in its entirety;
- the capacity to innovate, that is to say search for new solutions for each project, in particular integrating its impact on the environment.

Production is similar to the work of the "orchestra conductor". It is a question of managing the project in order to lead it to completion within the restraints of cost, delivery times and quality and therefore manage the risks. This assumes:

- choosing and organising all the numerous musicians, that is to say the various participants in the project;
- ensuring harmony between all the "instruments", that is to say ensuring cohesion between the various participants in building the work;
- directing the "orchestra", that is to say directing the satisfactory progress of the project;
- giving the "rhythm" to this musical ensemble, that is to say ensuring the completion of the project at a sustained rate.

Engineering consultancy on behalf of the client

- What engineering consultancy brings from the customer's point of view:
 - **optimisation** at all stages of the project;
 - a response that is **relevant to a defined requirement**;
 - **upstream integration of multiple constraints.**
- To complete a customer's project, the engineering consultancy must demonstrate its capabilities to adapt to concrete and specific project requirements; innovation necessarily is part of this process, such as research into solutions that will meet the special requirements of the customer.

The place of engineering consultancy in the French economy

A few figures:

- **215,000 jobs**, of which almost half are engineers or managers
- **Turnover: 36 billion Euros in 2006**
- **20,000 recruitments per year.**

Engineering consultancy, the spearhead of French international competitiveness

The skills that will lead to tomorrow's growth in developed countries and give international weight in the face of new economic powers such as China or India are precisely those that characterise engineering consultancy: **the capacity to innovate, find new ideas and concepts, manage ever more complex projects, and value scientific and technical knowledge.** Engineering companies therefore have a major role to play in maintaining the competitiveness of France and Europe at international level.

WHAT IS A PROJECT?

It is worthwhile to clarify the term “project”, since this term can be understood in different ways. In this White Paper, the word “project” is meant in its widest sense, corresponding to all stages of involvement of the engineering consultancy.

A project follows a sequence of actions including three main phases:

- **A preliminary phase from the emergence of the requirement to the “decision to act”.** During this period, a project covers all the actions to be taken in order to justify the response to a requirement which will eventually become something concrete, or a decision to do nothing:
 - The statement of requirement, the justification of this requirement, the scenarios of solutions to meet this requirement, the feasibility study for these solutions, the choice of a solution and a decision to act.

- **A design and construction phase that starts with the decision to act, including:**
 - Definition of the subject (programme), the selection of designers, the design (functional, architectural and technical studies), the cost, the selection of the contractors or manufacturers, the works up to the delivery.

- **An operation and maintenance phase continuing until demolition,** comprising setting up normal maintenance and operation programmes and putting into operation (especially for works that include processes to be optimised).

A **global approach** encompassing all these phases provides an understanding of the challenges of the project in terms of the **overall cost** and **long-term development**.

It should be noted that the true added value of the engineering industry lies in the people: whether they are engineers, architects, technicians or specialists (environment, law, etc.) these are the professionals that make the completion of complex projects possible through their capacity to conceive new ideas.

INNOVATION IN A FEW WORDS

The French Academy dictionary defines innovation as “*introducing something new in application, in practice or in a particular field*”. Innovation is not to be confused with *discovery*, which is “*the act of discovering what had been unknown or passed over*” and which typifies the work of the scientist.

Research is a programmed and voluntary activity, the purpose of which is to discover new facts corresponding to a discovery or an innovation. For universities and also, perhaps, for government research bodies, this word often means “**basic research**”. Engineers consider that they are not doing basic research, but rather innovation, or even “applied research”.

Innovation is quite simply a definition of the activity of engineers, as distinct from that of researchers.

Engineering consultancy and innovation.

In reality the **engineering consultancy industry**, in the activity of design and achievement of a product or work, consists in relying on known concepts and adapting or improving them, **and integrating them in an, often original, configuration to best satisfy the requirements of the subject.** It is therefore “**applied research**”.

Innovation can be:

- either the search for a permanent improvement, perfection in the desire for cost saving, simplicity or efficiency;
- or the development of new products, by a new assembly of existing products or by the transfer of a defined application to a new field;
- or a true leap forward, a breakthrough; this aspect of a breakthrough that relies on “discoverers”, whether explorers or engineers (for example, pre-stressing) is always a result of:
 - the availability of new tools that enable you to progress further at a given moment (for example, the compass);
 - new constraints: adapting to climate change, globalisation, competition, etc.;
 - questioning beliefs (for example, the world is not square).

There are three types of innovation in the engineering consultancy:

- Innovation within operational projects: this consists of creating a new method or a new product or in producing an innovative combination of already existing products or methods.
- Innovation on request, or in anticipation of customers’ requirements: this consists in applied R&D to propose a precise technical solution to a given problem, apart from an operational project.
- Innovation in the management of projects in a consortium: this consists in better designing the methods and organisation of the whole project.

CURRENT CHALLENGES

The problem today is as follows:

- A **certain reluctance within engineering companies to innovate**. There are two reasons for this:
 - Requirements, usually formulated in terms of deadlines, leave little or no time to innovate: when a project must be finished by a final date, the search for innovation appears as an overload of work;
 - the difficulty of imputing the innovation budget into the total project cost often proves a prohibitive obstacle.
- On the other hand, it appears that **innovation is necessary today** for various reasons: the requirements of employers and civil society have an increasing impact on projects: the constraints in terms of long-term development, health and safety are now indisputable. Innovative solutions must be found to meet these requirements;
 - the form of projects is also evolving: they are becoming more complex and encompass an ever wider range of fields (environment, legal, social, etc.) making cross-disciplinary and methodological innovation necessary; internationalisation clearly has direct repercussions on the market and international competition reinforces that. Today, to remain competitive faced with emerging powers such as India or China, it is necessary to innovate by proposing non-standard products;
 - the utilization of new technologies (CAD⁹, virtual models, GPS¹⁰, GED¹¹, etc.) modifies in depth the tools and methods of work. On one hand they permit a massive and extremely quick transfer of technologies and knowledge and, on the other hand they create a new world, combining the real and the virtual, which calls for new working methods;
 - in a much wider sense, innovation is unavoidable today to meet the many challenges of modern society; climate change and its consequences, the energy problem, urban development, the conservation of heritage, management of water resources, etc. These challenges constitute the problem, which from now on is central, of sustainable development.

- finally, it should be noted that it is the younger generation who will have to find adequate responses to these challenges. It is necessary to introduce them to the scope of innovation to be covered in order to continue to attract them into the profession, and begin to train those who will guarantee our future.

Innovation cannot be avoided, but at the same time, obstacles often make its implementation problematic. The White Paper endeavours to draw up an inventory of the situation faced today by the engineering consultancy industry. It lists the **leverages** and **obstacles** encountered when implementing innovation, and moves on to suggest a certain number of **recommendations** that could alleviate this situation and enable companies to exploit their skills fully in terms of innovation.

9 Computer Assistance Design

10 Ground Positioning System

11 Electronic management of documentation

I INNOVATION IN ENGINEERING CONSULTANCY

ENGINEERING CONSULTANCY IN DEFINING REQUIREMENTS AND CONSULTATION

Likening the role of engineering consultancy to a simple role of technical design companies is a false and extremely simplistic view. In reality, engineering companies are recognised for their capacity for **project management, that is to say their ability to design and build the most complex works.** Syntec-Ingénierie groups together the largest of these French companies.

But **reducing the role of engineering consultancy to a project management role still represents a too restrictive view.**

By integrating various skills, combining general designers and specialists (programmers, lawyers, economists, environmental specialists, etc.), many engineering companies have for a long time also demonstrated their ability to **work in the employer's sphere, from the statement of a requirement to the decision to proceed.**

The purpose of this upstream assistance in **defining requirements** consists of making the appropriate responses prior to any commitment, and to optimise the response to the requirements by integrating all the constraints and taking part in discussions.

This upstream assistance cannot be effective without a strong capacity for **innovation** over a range of services.

Depending on the type of project, engineering consultancy can therefore perform:

- definition and feasibility studies,
- pre-programming,
- assistance with discussions,
- institutional and financial deals,
- socio-economic studies,
- environmental and sustainable development studies,
- studies on establishment in the territory and the location of geotechnical studies,
- hydrological studies,
- regulatory studies,

- economic modelling: traffic/revenue/costs,
- plans for urban transportation,
- transport and traffic plans,
- etc.

The 2006 FIDIC¹² -EFCA-AHCEA Congress in Budapest clearly revealed the concept of **“Trusted Adviser”**, which qualifies this very specific role of **upstream** project engineering. Many large employers confirm their requirements for this type of skill.

Apart from this upstream role, engineering can play the role of **adviser in all phases of a project.** In fact, an employer is not expected to possess skills in all of the areas or even have access to all of the necessary resources to perform his tasks correctly. That is why it is sometimes necessary to utilise **“employer's assistants”**, whose role is to clarify and assist in certain projects.

Engineering consultancy provides this assistance, which may be:

➤ **Of a “specialised” nature:**

- Upstream studies (before the decision to proceed), as described above;
- risk studies and management,
- programmers,
- preparation of the programme,
- general planning,
- financial and economic expertise,
- technical, contractual or legal expertise,
- sustainable development expertise,
- HQE (High Environmental Quality),
- contracts and partnership expertise,
- etc.

➤ **Of an “inter-disciplinary” nature:**

inter-disciplinary missions consist of assistance to the employer for all or part of the handling and/or management of the project:

- conducting the operation,

¹² International Federation of Consulting Engineers (see glossary)

- project management,
- payment or delegation (for public projects),
- delegated employership (for private projects),
- international “project management”.

➤ **Dedicated to the operation and maintenance phase:**

The completed work passes to the operator or user. In this new situation, assistance may also be necessary to :

- define the operation and maintenance programme,
- ensure start-up,
- carry out operation and maintenance.

DESIGN ENGINEERING

At the design stage, engineering can play a role in the innovation process in a number of different ways:

a) Internal innovation: optimising production

Engineering consultancy continuously innovates to make progress in its methods and productivity. In these situations, it may be a question of either innovations of the “*bottom-up*” type, by operational teams improving their production process in respect of their daily requirements, or *top-down* improvements in the productivity of the whole company through strategic decisions by the management. These actions are self-financing.

In this way a systematic and in-depth **knowledge management** approach enabled the time required to make a preliminary estimate of the cost of a transport infrastructure project to be reduced by a factor of 40 (with an uncertainty rate equal to that for traditional methods). This improvement benefits firstly employers, who can make an optimum choice from a large number of variants.

Several recent examples of concessions or PPP contracts¹³ with fully integrated design teams also show that large companies have appreciated the engineering consultancy input: general optimisation of the project, introducing design productivity and knowledge of all the upstream constraints.

What is “Knowledge Management”?

Knowledge Management describes the **methods and techniques used to identify, analyse, organise, memorise and share knowledge between members of one or more organisations**, in particular knowledge created by the company itself (e.g. research and development, good practice) or acquired from outside (e.g. monitoring and economic intelligence) in order to improve the performance of the organisation.

For companies, the stakes can be:

- an added value of the company associated with increase in the knowledge capital;
- an improvement in the performance of the company.

To these stakes can be added risk management: risk of loss of skill and risks in general.

The objectives of knowledge management are:

- to develop the productivity and quality of services;
- to preserve know-how;
- to ensure transfer to subsequent generations;
- to develop commercial efficiency;
- to stimulate creativity and innovation.

In the case of an engineering company, it is a matter of:

- **organising the circulation of data, information and documents useful** for the efficient performance of its services and customer contracts from their collection, management and updating (professional reference material, basic regulation monitoring, etc.);
- **ensuring the transmission of knowledge between individuals** by means of the system of formalisation of knowledge (REX - feedback of experience, good practice, books of knowledge, collection of know-how, etc.) and connecting individuals (tutoring, networks, community practice etc.);
- **accompanying transfers of expertise and skills** (retirement, promotion, etc.) to ensure that the level of corporate knowledge is maintained;
- **optimising access to knowledge, its updating and enrichment by means of efficient information systems** (professional websites, collaborative working tool, with a definition of the centres of interest of each and “push” system, research engine, e-learning platform, etc.).

b) Innovations developed on behalf of employers

Employers may be: a local authority, a public or private owner/institution, an industry, a company, another non-specialised engineering consultancy, etc.

> Innovation at the request of the employer

In this case, engineering consultancy develops an innovation **in mutual understanding and agreement with an employer.**

For example, following the storms of 1999 in France it was necessary to reinforce the foundations of

13 PPP contracts : Public Private Partnership contracts

large electric pylons. RTE¹⁴ selected an innovative solution from an engineering company that achieved this at a cost of 20% less than alternative traditional methods.

➤ **Innovation intended for several employers**

In this case, engineering consultancy **anticipates the request from several employers or collaborates with some of them** to develop a general method that will be useful to them; this full or partial self-investment is rewarded by the competitive advantage that the company obtains from it. An example of this is the GERICI¹⁵ project on the reduction of vulnerability of the transport infrastructure to climate change, which developed a Geographical Information System (GIS) for the operators, facilitating forecasting and preventive measures, including immediate action just before or during periods of crisis. In this particular case, the innovation's benefits to society were clear, and justified the self-investment. It should be noted that some European employers, and also the World Bank, consider it to be of great interest; the wide development of the use of this innovation in France would enable useful new references to be acquired for international competitiveness.

➤ **Innovation pre-financed by several employers**

Engineering can also **gather a group of clients at the start of a project** who will be associated with the definition of the specifications of a product and will contribute to financing the initial development of this product.

In this way, the CANOE project developed a modelling system to assist in the design and management of urban drainage systems by associating three large towns, two departments and a customer ministry from project start-up. Other customer groups joined the initial group throughout the project. The CANOE system is now available commercially.

➤ **Innovation in multi-member consortia**

Such innovations can also be developed in multi-member consortia. In this type of project, there is clearly a general interest.

Engineering can be the **catalyst for a decompartmentalising action between the members of the whole chain.**

The PROPICE project on "secret sites" includes a large employer, also an operator, as well as two large world-leading French companies. The project is directed by an engineering company. The purpose of the project is to make certain open recommendations for better preparation of large sites by minimising, for example, the congestion associated with the work. The interest of the local councillors and other European participants in the matter demonstrates the relevance of this innovation.

c) Innovation in daily engineering

It is the basic business of engineering to **collect and evaluate existing innovations that are** already available "on the shelf" in order to satisfy the functional specifications of the employer. This role is normally included in engineering services.

The functioning of this mechanism is more effective when all the incentives are favourable to it.

The Renault Logan¹⁶ is a good example: the idea was to manufacture a vehicle at a price to beat off all competition. The solution was to have it built in countries where the manufacturing costs were very low, but with a lower level of engineering skills: so it was therefore necessary to design a car based on already-existing techniques and concepts that were reliable and industrially proven, while being simple enough to permit decentralisation of manufacture. A new car concept was born. Engineering is thus a **key player in the spreading of innovation, both at home and abroad.** The legislator must create an adequate environment in which this role can be fully performed for the general benefit of all. For example, reinforced soil was a very innovative way of designing and building large embankments, especially in environments where space is very limited. The principle of reinforced soil was invented by Vidal, a French architect and engineer, in 1965: this process gives new mechanical properties to the soil through close association with reinforcing frames. A construction from reinforced soil is a foundation consisting of horizontal layers of rubble between which frame beds are laid. This process is used especially for building supporting walls with facings, generally made from reinforced concrete

14 The company which operates the electricity transport network in France

15 systems developed by the public research network with the assistance of employers, and engineering firms ...

16 Car produced by Renault.

layers connected to frames. This is a French innovation that has practically revolutionised the design of certain types of work and has spread widely on an international level. It brings a very substantial gain in terms of costs of filling works, (it is therefore employers that benefit the most from this innovation) and provides a suitable technical solution when the site constraints are very high.

d) Innovation in consulting engineering and technology

Consulting engineering and technology developed rapidly **in the 80s during the deployment of Computer Assisted Design (CAD)** in the development of industrial products. Previously, this activity concentrated mainly on the subcontracting of design, essentially in the mechanical and electronics sectors. This development took place owing to the **support of large employers** who, having requirements in all sectors, enabled engineers to acquire the skills on industrial development.

This support thus permitted the development, for example, of vehicle instrument panels, exterior and interior equipment such as rear view mirrors and bumpers and also mobile telephones and fax (except for the electronics), train and metro equipment as well as aircraft sections.

Reduction of the life of consumer products also created **an upsurge in new product designs**. Engineering companies were therefore organised to confront this new demand, firstly by intensive staff training in the use of CAD tools in order to support the research and development sectors of large companies. This was followed by the development of trades such as metal working, plastics, quotation and value analysis; essential tools for all designers.

PROJECT MANAGEMENT ENGINEERING

a) What is project management engineering?

Managing a project consists in **ensuring its completion within the constraints of performance, cost, delivery times and quality in a context of sustainable development.**

“Project management” is becoming increasingly linked with the **management of complexity**, due to:

- the multiplication of the parameters that have to be controlled: performance, cost, delivery times, quality, safety, the environment, contractualisation and health of companies, increased regulation, social expectations, communication and politics;
- the multiplication of stakeholders and interfaces;
- the initial immaturity or instability of the project: insufficient definition (programme), modifications requested by the customer or employer;
- multiplication of the uncertainty factors: - the reliability of simulations, methods and estimates based on “hazy” items (physical and programme data, costs, delays);
- random factors inherent in human activities: accidents due to the environment during the completion of the project;
- unexpected changes in the project - environment: regulations, economics, competition, etc.

To cope with this complexity, the manager, who has to manage the project, can use decision making tools, and also:

- common sense
- method and rationality
- evaluation and integration of random factors and safety margins
- his/her knowledge of similar projects
- efficient organisation
- reliable and reactive communication.

b) Innovation is necessary for project management

These resources however are not sufficient in themselves. The manager must also **innovate continuously** for optimum management of complex projects. **Innovating in project management** consists in:

- searching for new methods of working and new tools
- rethinking the organisation and the relationship between key players
- changing the culture of the players: the employer, the engineer, the contractor. In the same way that project management has considerably improved industrial production; it must be used today to rethink the relationships between participants, which are strictly bound by French regulations. For example, it is forbidden for the same team to be both upstream and downstream of projects. New methods of contracting (design-build, partnership contracts) impose a necessary rethinking in this area.

c) Managing Projects

> The tools of project management

Project management comprises all the decisions that must be taken to complete a project satisfactorily. This means relying on a certain number of **indicators which are provided by project management tools**. The tools give a continuous view of any deviation (at a time and forecast at the end of the project) between a reference projection and the true state of progress. These tools have already been in effective use for some forty years, although computers have made them even more efficient. Planning tools can be used to control delivery dates. Budgetary forecasting and monitoring tools are used to control **costs**. Finally, **quality** is checked by means of quality compliance follow-up sheets.

> Risk management tools

In this field, much still remains to be invented, mainly because it is impossible to develop tools of this type without a coherent **risk management method**.

The purpose of these tools is to:

- optimise reliability;
- capitalise on a wide range of experience;
- prioritise risks (consequences of a fault, priorities to be defined);
- simplify actions: what is effective?
- choose between two courses of action.

Note that an ambitious three-year project, supported by the ANR¹⁷, has brought together several engineering companies, construction companies, universities and major colleges in a common objective to draw up an inventory of risk management practices in France and internationally. The GERMA¹⁸ project should therefore produce innovative tools and methods in this field.

What is risk management?

Project management has evolved over the last fifty years and now includes more and more parameters. Technical performance, costs and delivery times were the first factors to be taken into account, then came quality, contract formats, managing change in the course of a project, safety, etc. Recently, two quite new approaches have appeared: **sustainable development and risk management, which are now indispensable in project management methods.**

In fact there are many factors that can cause complex projects to fail: financial, contractual and environmental reasons, problems with delivery, organisation, failure to reach agreement with local residents, etc. That is why there are teams of "risk managers" in large groups whose task is to prevent these risks from arising.

The aim of a **coherent risk management method** is therefore to assess and deal with all potential risks in a project, that is to say to go beyond the strict framework of contractual relations between each of the participants. **Risk management forms an integral part of today's management of complex projects.**

Risk management tools are also useful for supporting the decisions of insurers. **The essential thing for an insurer is in fact knowledge and management of risk.**

This knowledge and management involves firstly the employer, who creates the risk. He must allow all the engineers and contractors engaged in the project the necessary time for study and satisfactory completion of the project. In this context, engineering plays an important role. The tools for design, calculation and simulation, and even prediction, objectivise the risk, in addition to the contributions of inspection and certification

organisations. They are therefore efficient tools in decision making and also provide traceability for projects.

Engineering consultancy, through its skills and "risk measurement" tools, is thus capable of providing positive guidance to insurers in their assessment of innovative projects.

> Collaborative working tools

These are essentially:

- systems for the exchange of information between participants in the project;
- systems for simultaneous engineering and technical analysis;
- project communication systems: intranet and extranet.

In this field, engineering has invented most of the tools currently in use on projects.

Significant progress however remains to be made in the area of numerical modelling (Computer Assisted Design, or CAD).

A virtual, interactive 3D model for infrastructures is currently being prepared by a consortium that won an ANR¹⁹ contract; the various participants required an engineering company to be the driving force for this. This project should represent a very significant French progress towards a standard engineering tool, in particular in the design stages of very large civil engineering projects.

d) The contribution of engineering in consulting and technology

The opportunity to participate in the development of new products enabled engineering firms to gradually acquire knowledge and skills in the various development phases. By combining these resources, they are today able to **propose solutions for the overall development of products and/or industrial projects.**

This has enabled high level jobs to be created in which engineers are involved either in project management, or in trades where technicians and engineers are chosen for their experience.

Engineering consultancies provide real solutions in the development of products and processes in

17 See glossary

18 An ANR project developed with engineering consultancy firms

19 See glossary

industry. They become involved **from the expression of requirements stage, and even prepare specifications** for the consultations they will be required to process.

Today, services can be provided from a statement of requirements up to the industrialisation of products, which means that the personnel of the consultancy must have the same high level of skills as the customer organisations: designers, development engineers, validation engineers (calculation and simulation), project engineers, planners, managers, methods technicians and engineers, specialists, etc. This list is by no means exhaustive.

II THE LEVERAGE FOR INNOVATION

THE INTERNAL MOTIVATIONS OF ENGINEERING FIRMS

The principal motivation for innovation is quite clearly internal. It relies on the motivation of directors, management and all personnel in the company, even very often on the determination of one or more highly motivated persons – determination in its real sense, because it requires a lot of patience and perseverance to overcome the many obstacles preventing implementation of innovation.

Several stimuli can feed this motivation:

- the **search for increased productivity**, necessary to improve profitability and/or competitiveness;
- the necessity of developing new services or products to secure **competitive advantage**, particularly internationally;
- the desire to give a company a certain image and **visibility in the market** (communication strategy).
- the desire to **consolidate links between people within the company** and their attachment to it, the fact of participating in the creation of something new arousing in general a form of intellectual enjoyment in the people concerned.

It should however be emphasised that this motivation can only be transferred to projects if it is promoted by the **will of the managers**.

RESEARCH FINANCING STRUCTURES

Over the last few years in France, the trend has been to **increase financing for upstream and pre-competitive projects combining public research and private partners.**

Special emphasis is placed on SMEs, which are defined differently from one source to another (from 250 staff for the EU and 2000 people for OSEO²⁰). There are many sources of finance for innovation and these are not always clear.

The system, which is complex, **is evolving towards simplification, homogenization and facilitation of SME access.** The merging of sources is still in progress and the scenario described below may still change in the coming months.

Engineering firms are better prepared than SMEs in the administrative mechanics of organising projects and submitting tenders. **They therefore benefit a priori from increased access to research and innovation programmes.** However, even though they may be well represented in the supervision of many programmes, engineering firms do not have a sufficient global presence and do not benefit enough from these leverages.

a) At national level

> National Research Agency programmes

The ANR²¹ is a financing agency for research projects selected on the basis of calls for tender. It is the successor of the former “RRIT” Research and Technical Innovation Networks. **The ANR’s mission is directed at public research organisations and firms:** to produce new knowledge and encourage interaction by developing partnerships between publicly owned laboratories and private operators.

The **ANR budget for 2008** was about € 1 billion. Each programme issues an annual call for projects. **A typical project financed by the ANR lasts for three years, involves about ten partners and receives a subsidy of over €400,000. On average, 20 - 25% of projects submitted are awarded funding.**

Significant changes were introduced into the 2008 planning (www.agence-nationale-recherche.fr). The programmes of most interest to engineering are those run by the Department of Sustainable Energy and Environment, in particular:

- SUSTAINABLE TOWNS, a new programme, successor of the former plans for civil and urban engineering, for mobility, land transport and socio-economy of urban housing;
- HABISOL, Intelligent & Solar housing;
- PRECODD, ecotechnologies and sustainable development;
- RISKNAT, management, reduction and compensation of natural risks.²²

Financing consists of grants which, **for a private company, cover between 30-50% of research costs.** For administrative reasons (the ANR has a fairly small team), management of project evaluation and aid budgets is delegated to other organisations with adequate structures (e.g. ADEME²³ for the PRECODD programme²⁴). Private partners in projects are industrialists and contractors. Engineering consultancy is fairly well represented in some of these programmes, in particular those that are not exclusively technological. **Prior approval of a project proposal by a Competitiveness Centre may be an aid** to releasing ANR financing.

> “Competitiveness Centres”²⁵ and company competitiveness funds

The creation in 2004 of the “Competitiveness Centres” is the result of a new industrial policy aimed at mobilising innovation capacity. A Competitiveness Centre is **the association of**

20 French public establishment supporting SME development (see glossary)

21 See glossary

22 For more information about these programs, see glossary

23 French public agency of environment & energy (see glossary)

24 See glossary

25 See glossary

firms, research centres and training organisations in a given region, engaged in a partnership (common development strategy) intended to release synergies around innovative projects directed at a given market(s). 71 Competitiveness Centres have opened since the establishment of CIIACT²⁶ on 5 July 2007. Seven of them have a worldwide vocation.

The growth of Competitiveness Centres represents an **exceptional opportunity for efficient synergy between MEEDDAT²⁷ and the private sector** in general, including engineering consultancy. The first interesting stage is in progress, its real dynamism at the higher level still remains to be tested. It should also be noted that the synergies between ministries such as the MEIE²⁸ and centres such as Systematics²⁹ have a positive effect on the development of innovation.

The French State allocated **€ 500 million per year over a three year period (2006 – 2008) to the Competitiveness Centres**. Of this amount, about € 60M p.a. was for tax relief, € 170M p.a. to ANR, AII³⁰ and OSEO³¹ grants. The **Unique Inter-Ministry Fund (held in the Company Competitiveness Fund)** has some € 270M for financing projects selected under the two annual calls for tender.

The contributors of these funds are the ministries responsible for Industry, Defence, Equipment, Agriculture, Health and Regional Development. Regionally based authorities contribute to the financing of certain centres.

The projects submitted must involve **at least two firms and a laboratory or research centre**. The average financing for a project is in the order of € 1.5M. Approval by a Centre does not automatically lead to financial support, and a project must often be justified first to the Centre and then to the financiers. Apart from providing financial support for innovation, the Competitiveness Centres provide opportunities for partnership-building.

Engineering firms took part in the reflection and creation of certain Centres, but do not yet have a role in either their development or the R&D matters they deal with. **Engineering firms have experience in complex projects** and, in the light of this experience, are prepared to **make their skills available for the development of the Competitiveness Centres**.

Competitiveness Centres could utilise engineering consultancy skills for various purposes:

- **external experts:** to assess the satisfactory operation of the centres and efficient use of public funding;
- **assistance to the management of centres and R&D projects:** engineering firms are able to bring their skills in the management of complex programmes initiated by the Competitiveness Centres, within the scope of missions such as:
- **control and management of an operation** with the centre managers. This type of mission benefits from good relations between the various partners of a centre (research laboratory, innovative SMEs, industrial firms, etc.). It would also contribute to optimising the management of the centres (choice of priority projects, financing, technology transfer, etc.);
- **technical expert/partner in projects:** participation of engineering firms in applied development projects or as a technological interface between the various technical specialities.

> OSEO

Specialized in supporting French small and medium firms, (up to 2000 employees), OSEO Innovation (e.g. ANVAR – www.oseo.fr) supports innovation projects with a technological component showing real market opportunities.

26 French Interministerial Committee of Development and Territorial Competitiveness (see glossary)

27 French Ministry of Ecology & Sustainable development (see glossary)

28 French Ministry for Economy, Industry & Employment

29 System@tics Paris-Region is a competitiveness Centre dedicated to the development of IT based systems

30 All Agence Innovation industrielle integrated into OSEO in January 2008

31 See glossary

Founded in 2006, the **Industrial Innovation Agency (Aii)**, www.aii.fr, ³²with a budget of some € 1.7 billion, is a financing agency for large industrial innovation programmes undertaken by firms. The Aii was integrated in OSEO in January 2008. This integration has enabled € 800 million to be injected into OSEO activities. It should be noted that € 300 million are to be allocated to **R&D projects by medium sized firms** (250 to 5000 employees) for projects of a declared unitary value of more than € 3 million.

Among the many measures proposed by OSEO, some are especially dedicated to innovation (€ 220 million p.a.):

- **repayable advances** up to a maximum of 50%, as aid for innovative projects. Part of the aid, corresponding to technological know-how, is repayable, even in the event of failure. The remainder of the aid is only paid in the event of success, based on a marketing plan for the end product that is written during the project;
- **recruitment aid for innovation:** OSEO provides a grant to partially cover employee costs for the first year.

➤ **Programmes of the Ministry of Ecology, Energy, Sustainable Development and Territorial Development**

MEEDDAT (the French Ministry of Ecology, Energy, Sustainable Development and Regional Development) controls and finances or co-finances programmes in the field of development, transport and the environment. Within MEEDDAT, **DRAST** (Department of Scientific and Technical Research and Implementation) supports research in the fields of transport, civil engineering, town planning and building. Some of these programmes are also listed on the ANR website (www.recherche-innovation.equipement.gouv.fr). DRAST thus acts as the inter-ministerial secretariat of PREDIT (Programme for Research, Development and Innovation in Land Transport) and RGC&U (“Civil and Urban Engineering” Technological Research Network). It also contributes with the DGUHC (Department of Town Planning, Housing and Construction), to the implementation of research and experimentation policy of the PUCA³³ (Town

Planning, Construction and Architecture Programme) and PREBAT (Building and Energy Programme).

“**National projects**” involving participants in the construction industry, employers and public research are also developing partnership innovations. They target the areas in which the involvement of all participants in the chain can ensure future industrial value. These projects include experimental sites. They are financed jointly by the professions and MEEDDAT (DRAST). The “National projects” scheme is original and is appreciated as much by the sector as by external observers.

DRAST’s Department for Research and Futurology (SRP)³⁴ controls and finances research programmes in support of public policies. Among the subjects that may be of interest to engineering are environmental risks, climate change, water and soil (www.ecologie.gouv.fr).

➤ **Agency programmes**

Agencies such as the ADEME (Agency for the Environment and Energy Control) publish tenders **for projects on matters related to the environment and energy.** The principles of financing are the same as for the ANR.

➤ **Miscellaneous sector-based programmes**

There are many institutions launching sector-based programmes of various sizes. For example, CLAROM, the club for Research Activities at Sea (www.clarom.com) unites several engineering firms active in the petroleum field (more precisely offshore) and support field.

Other **ministries** (the Ministry of Agriculture and Fishing, for example), some **regional and general councils³⁵ and even private institutes** launch programmes, generally sector-based, which sometimes offer engineering firms a small role alongside the academic participants. Aid may be restricted to a contribution to the financing of researchers (thesis grants). The General Council of Isère³⁶ thus finances an annual research

32 See glossary

33 French public plan for research on town planning (see glossary)

34 French Department of Research and the Future (see glossary)

35 French administrative division (The French région is approx. similar to a county)

36 French administrative division in the Alps

programme on natural risks, managed by the Grenoble Centre for Research and Studies on the Prevention of Natural Risks.

➤ **Aid from the National Association for Technical Research (ANRT)³⁷**

This concerns especially **CIFRE³⁸ agreements**, which in 2007 provided **financing of about €17,000 per year** over a three year period to support the research training (doctoral thesis) of a young graduate in a company, in conjunction with a research laboratory.

➤ **Regional financing**

There are **budgetary lines at regional level** to support innovation instead of, or in addition to, some of the above-mentioned financing. The State-Region Plans sometimes have an innovation section and launch calls for projects. However, with the foreseen reform for the period 2007-2013, it is not possible at this stage to give further information on their programme.

In most regions, there are also **associations or networks that facilitate the monitoring and initiation of innovative projects**. For example, in the area of water and the environment; EA-IMaGE (www.ea-image.fr) in the PACA Region (French Riviera area), VERSeau (www.verseaudeveloppement.com) in the Languedoc-Roussillon Region, APESA in the Aquitaine Region and NANCIE in the Lorraine Region (www.nancie.asso.fr).

b) At European level

➤ **The 7th Framework Programme for Research and Technological Development**

The seventh Framework Programme for Research and Technological Development (FP7) ³⁹– <http://cordis.europa.eu/en/home.html>–covering the period 2007 – 2013, is the largest investment programme in the European Union for research and technological development, with a total amount of aid available of **€ 50,5 billion**

FP7 represents a development opportunity for European partnerships and financing of research and innovation for research centres and firms. The purpose of the **Cooperation Programme (€ 32,4 million)** is to stimulate cooperation and reinforce the links between industry and research on an international basis. It comprises 9 themes, independent in their management but complementary in their implementation, of which three may directly interest the consulting industry: energy, the environment (including climate change), and transport.

Financing consists of **subsidies covering 30-50% of costs**. The rate may be lower because different criteria are used to assess eligible costs in calculating the hourly cost price of an engineering company (some expenses are excluded).

Because of the size of the projects, the number of partners and the investment required in producing the proposal, it is nevertheless difficult for an engineering company to control a project proposal. In addition, competition is tough and the chance of success can be less than 10 to 15% in some sectors.

The European Commission has also encouraged the establishment of European Technological Platforms so that the priorities set by FP7⁴⁰ correspond well to the priorities of each sector.

The ECTP (European Construction Technology Platform – www.ectp.org) was thus set up in 2005. It has about 1000 members from all professions, public and private, from the construction industry, urban development, etc.

This platform has already given rise, in the first call for tenders, to a focus on energy in construction. One of the priorities, for example, refers to quality of living in buildings. The more typical subjects, such as tunnels, will not start until 2009. Generally speaking, **all problems that relate to climate change, sustainable development and engineering** are considered a priority by the Committee. Several engineering firms are active within the ECTP, at European level and in the French platform. There are very real opportunities to develop innovations in high-level European consortia.

37 See glossary

38 French financial support for doctoral thesis

39 Framework programme of R & D (see glossary)

40 the 7th Framework Programme

The WSSTP (Water Supply and Sanitation Technology Platform – www.wsstp.org) founded in 2004, groups together participants from the water and urban environment sectors. The large number of participants is giving shape to a common vision and a strategic research plan for the industrial sector concerned.

> The EUREKA PROGRAMME

EUREKA⁴¹ (www.eureka.be) is **the result of a French-German initiative which today includes 36 member countries**. EUREKA is not limited to the boundaries of the European Union. It aims to strengthen European competitiveness by supporting innovative projects “borne” by industry. **The projects come from industry initiatives, not from governments**. A project may therefore be proposed at any time. This *bottom-up* approach induces flexibility, simplicity and rapidity in the procedures implemented by a very light and decentralised structure. On the other hand, it requires vigorous lobbying to convince the financiers of the viability of a project.

EUREKA has a special method of operation: the partners must be multi-national; “EUREKA” labelling at international level is necessary, but the financing of each partner is national, which may lead to unfortunate time lags. In France, the Ministry for Industry and OSEO-ANVAR are the largest contributors – up to now mostly in the form of advances that are repayable in the event of success. The ANR may contribute to the upstream part of the project.

Engineering firms can take part in a EUREKA project, but rarely as *leader*.

> The European Investment Bank

In 2000, the EIB⁴² launched I2I (Innovation 2010 Initiative) to support innovation.

But it is mainly a question of financial or banking instruments (loans, capital investment, etc.) which are of little concern to engineering.

> Other programmes of the European Union

There are many support programmes for innovation in E.U. financing, in particular **in the technical Directorate-Generals**.

c) The Research Tax Credit (RTC)

The Research Tax Credit⁴³ is **an important source of finance for engineering firms**; it requires a great deal of organisation and perfection to show that a project is truly innovative and thus eligible for this credit. The ambiguity of the word “research” in engineering firms should be noted.

Up to now, the mechanism for implementing RTC was a multi-year mechanism: it comprised one part proportional to the eligible base (which corresponds to the value of the services recognised as able to benefit from RTC), at a rate of 10%, and one part associated with the increase in turnover eligible in respect of the previous two years, at a rate of 40%. The dossiers therefore had to provide visibility on activities over a three year period.

This old system has been revised and made more flexible. Since 1 January 2008, **the RTC now represents 30% of the total research effort**. The eligibility criteria have not changed.

The process consists of checks at two levels: one at tax level, carried out by the General Treasury Payer⁴⁴, likened to a check on the form; at the end of this first review, the Ministry of Economy may request the Ministry of Research to carry out a second review (a detailed analysis of the content).

On acceptance by the administration, the company receives **approval** for a Research Tax Credit. Employers and engineering firms develop research subjects. They regularly call on the services of engineering firms to support them in these developments. They can then allocate these costs to the research budget, thereby benefiting from tax allowance on these amounts – on the condition that they make use of engineering firms that have obtained approval for a Research Tax Credit.

The major interest of Research Tax Credit for engineering firms relies on its basic principle: to obtain a tax credit in proportion to the internal and external research and innovation costs of the company. But it is also of value to employees of a company to see their efforts in terms of innovation recognised; the RTC enables enterprising and creative staff to be identified and given recognition from their peers.

41 European Program for technical cooperation (see glossary)

42 See glossary

43 French credit system for tax exoneration (see glossary)

44 A public authority of the French Ministry of Economy

PUBLIC PROCUREMENT

a) The French public procurement legislation

This legislation includes clauses **designed to encourage innovation in public contracts**; however, since the purpose of the CMP⁴⁵ is to promote fair competition, some of its methods of application limit free development. It comes down to correct interpretation by the users.

➤ **Article 75:** Procurement in respect of experimental programmes.

This is certainly the article which, correctly used, provides the greatest opportunities for innovation, by offering **employers the possibility to issue restricted calls for tender for innovative work**

The terms fixed by the law are as follows. The starting point is a national public programme defined by:

- a programme authenticated by a formal act of a national authority possessing the appropriate competence (in France, this is a Ministry);
- a call for tender, correctly published, with equal treatment of bidders;
- submission of proposals by competitors providing solutions to the problems;
- selection of the winners by a jury that is composed in the same manner as if it were a design contest (art. 21 of the CMP), on criteria and selection methods that are fully defined, as for a design contest.

After that, any awarding authority (employer) may launch a call for tender only for winners of the national programme, for the award of design contracts work for building one or more constructions that implement the ideas arising from the tender. A protocol must be signed between the awarding authority, the winner and the manager of the national programme.

Examples of the application of article 75 show that the CMP may be favourable to innovative projects:

- the **CQFD (Cost-Quality-Reliability-Delivery) project of the PUCA⁴⁶** initiated by the Ministry of Housing for the purpose of identifying innovative solutions for the construction of social housing meeting the requirements of cost,

quality, reliability and time. Thirteen winners were retained by a jury for various solutions. HLM⁴⁷ companies can launch construction contracts with those of the winners whose solutions meet the criteria of the national project;

- the DGR (General Department of Highways) 2007 call for tenders for innovation in roadworks for meeting two criteria: reductions in energy consumption and inconveniences caused by roadworks.

Other clauses of the CMP:

➤ **Article 50:** permits, when the awarding authority allows for it, for the formulation of alternatives, of which one component may be **the introduction of an innovation** that satisfies the tender specifications in a different way from that which is pre-defined or expected by the awarding authority.

➤ **Article 53:** this article, which deals with the award of contracts, specifies that the choice must be based on a set of pre-defined criteria, chosen by the awarding authority on the condition that they are justified by the purpose of the contract. One of the criteria mentioned is the “innovative nature”. **It is therefore sufficient that a call for tender highlights the importance of the innovative element for this to become one of the selection criteria.** It is possible to imagine other criteria that leave a free field for innovation, for example, the concept of “total cost”, provided it is accurately defined.

➤ **Article 74:** design contracts prior to carrying out “work under the heading of research, test or experimentation” that is to say innovative work, are exempted from competition, even for operations above the threshold. They can be arranged by a negotiated contract in a restricted call for tenders. For that, **it is sufficient for the employer to explicitly specify that the nature of the contract is innovative.**

➤ **Articles 76-77:** Framework agreements and contracts with order forms. Based on a requirement expressed and explained by an

45 French Public Procurement legislation (see glossary)

46 Plan for Urbanism, Construction and Architecture R & D of the MEDDAAT, see glossary

47 French public organism for social housing

employer, he may select one or more economic operators on the basis of his own criteria. **The satisfaction of a requirement may necessitate an innovative solution. This innovative element may be specified in the criteria.** The employer may then award a contract to the framework agreement holder who best meets the accurate requirement. The framework agreement may not exceed a period of 4 years unless the initial investments require depreciation over a longer period; in which case there is a possibility to take into account investment for innovation.

b) Intellectual and/or industrial property

In carrying out its business, an engineering company naturally produces innovation that can be protected by law. The public authority has judged it useful to clarify matters by means of very precise clauses, **which are contained in the “General Administrative Specifications”** and especially, as concerns engineering, in the CCAG-PI⁴⁸.

These provide three possible options, namely:

- **option A:** all transferable rights (note that the author’s moral rights remain with the engineering company and are respected) are with the public authority which reserves the right to use them;
- **option B** joint rights of use (by default, the most frequent option);
- **option C:** the holder keeps the rights and can exploit them within certain limits.

In all cases, of course, the administration at least acquires the right to use the innovation for its own requirements within the scope of the contract.

In the case of innovations proposed in a call for tender, anti-competitive practices are forbidden by commercial law. The public procurement legislation permits persons responsible for the contracts to provide unsuccessful candidates, upon request, with information on the characteristics and advantages relating to the successful tender – without however divulging all the information about the method proposed, thereby preserving the confidentiality of the offer.

Intellectual property is guaranteed at this level even if there is no contractual bond with the employer at this stage.

c) Competitive dialogue

The purpose of the competitive dialogue⁴⁹ is to **remedy the rigidity of the current procedures**, which require the purchaser to determine his requirements in advance, and candidates to supply an offer that cannot change further during discussions prior to the award of a contract. The public authority can thus resort to discussion: either when it is not able to define the technical means to meet its requirements, or when it is not able to establish the legal or financial set-up of the project (for example, an integrated transport infrastructure, large computer networks or projects whose financing complexity is such that their legal and financial set-up cannot be pre-determined).

The competitive dialogue is **first of all a procedure that enables innovative responses of firms to be used**. The public purchaser defines a functional programme containing levels to be reached or requirements to be met; the firms draw up the particular specifications (CCTP)⁵⁰. If no technical solution is defined by the public purchaser in the specification, the candidates must be interviewed. This enables the candidates to “describe the methods they propose” and makes it possible to “appreciate as precisely as possible the requirements stated” by the administration.

The dialogue, which is in no way a negotiation, can take place in as many successive stages as necessary for the purchaser to define his requirements. The circulation of applications emphasises that, after each stage, the public purchaser can eliminate the proposals of candidates that do not meet his requirements. In any case, this dialogue must above all respect the principle of equal treatment of candidates.

48 In French; « cahiers des clauses administratives générales pour les prestations intellectuelles ». Administrative specifications for intellectual services. In France, they are published by the Ministry of Economy.

49 Procedure described in the Public Procurement Directive and implemented in national legislation

50 Technical clauses specific to a contract. In French : « Cahier des clauses techniques particulières ».

THE ROLE OF THE PROFESSIONAL FEDERATIONS

a) The French Engineering Consultancy Federation (Syntec-Ingénierie)

Syntec-Ingénierie, which includes the largest French engineering firms, felt it important to motivate its members on the subject of innovation in order to improve the competitiveness of the profession by means of its creativity.

The Federation therefore set up an **Innovation Committee** which has reflected on the situation today; its purpose was to propose measures to create an environment that encourages innovation. The White Paper constitutes an important stage in this reflection. The committee also set itself the task to encourage partnerships on subjects of common interest, at a pre-competitive stage, which has enabled projects to be eligible for grants from the ANR.

In addition, Syntec-Ingénierie is responsible, in its relations with the various partners (large employers, construction and industrial firms, research or training organisations, etc.) for **promoting the role of engineering in the process of innovation, as a creative participant, integrator of concepts and/or as organiser.**

b) The European Federation of Engineering Consultancy Associations (EFCA)⁵¹

The European Federation of Engineering Consultancy Associations (EFCA), which represents engineering consultancy and related services to the European institutions, took action to promote and support innovation in local and regional firms.

Within this federation, representatives of the various professional associations are currently working on a **draft code relating to the recognition of the quality of the engineering firms' services.** The innovation aspect forms an integral part of this since it is a factor of competitiveness and added value.

Through its affiliation with ECCREDI (www.eecredi.org), EFCA has participated in the promotion and communication of R&D results.

ECCREDI, for its part, takes regular action towards the European Commission to propose, for example, the establishment of a system of tax and financing measures for innovation in commercial contracts.

In order to mobilise firms at regional level to the challenges of R&D, the European Commission could launch joint actions with various European bodies including EFCA.

c) The International Federation of Consulting Engineers (FIDIC)⁵²

Two major themes were the subject of action programmes by the international engineering federation:

- firstly, the **efficient application of guidelines for sustainable development in project management;**
- secondly, introducing the decisions taken by the international community, in particular OECD, which aims to **spread good ethical practices** in business and fight against **corruption.**

On each of these themes, FIDIC has produced methodological guides that introduce innovative project management processes which should add value to the quality of the services rendered by engineering consultancy firms.

In particular, FIDIC has produced a **“Project Sustainability Management” system.** The essential part of this reference system is a list of objectives associated with sustainable development and indicators associated with them. It forms a **guide to innovative practices, indicating the objectives to be targeted for each project** – knowing that sustainable development assumes continuous progress, since it is an ideal that must be approached as closely as possible; the levels fixed are therefore intended to be surpassed and the results improved through innovative practices.

51 See glossary

52 See glossary

III OBSTACLES TO INNOVATION

CULTURAL OBSTACLES IN ENGINEERING FIRMS

a) The preponderance of production constraints

Engineering contracts almost always contain obligations to deliver a precise, quantifiable and achievable solution. In addition, this response must be produced within a pre-determined time and almost intangible budget. These conditions, inherent in the profession, make it difficult to **embark on a search for solutions based on concepts that are totally unknown at the time of signing the contract.**

At most, it is possible to extrapolate an existing concept a little beyond the known limits and thus progress the technique step-by-step in successive increments.

That is why engineering firms are structured as production units (as in an industrial company), which must each produce a response to the issue at stake, at the lowest cost and in the shortest time. Either the unit deals with the whole problem, which is organisation by project, or the unit produces a part associated with a particular competence, which is organisation by function. It is then sometimes difficult to venture into areas that are too uncertain which risk conflicting with the result (cost, completion date, quality, etc.).

Some engineering firms made the choice, or took the risk, to authorise one of these units not to produce a response to the customer's request directly, but **to produce a response of interest to the company for various reasons (image, niche market leader, etc.)**. These are R&D services. Such cases are **increasingly rare**, since the commonly accepted idea remains that the application is too random for a reasonably short-term return on investment.

Engineers **are trained to design and produce products or works**. Production always involves real and tangible objects that are directly usable. All their training and the culture that flows from it are oriented towards this purpose.

Even if engineers do not balk at intellectual reflection, there is a tendency to consider that, unless it leads to something tangible, it is not within

their domain. In engineering colleges, the study of basic materials concentrates on professional applications. In addition, some general colleges put aside professional technical concerns in order to teach management methods: but there again, the objective is "how to construct it well", and as effectively as possible.

b) The importance of standardisation

The engineering production process is, generally speaking, highly regulated as it is controlled by a number of laws and standards. Yet innovation implies questioning standard processes in order to try something different. In other words, there are **two different intellectual structures**, that of creativity and that of peace of mind. To make these compatible, a strong motivation must be shown.

In spite of that, engineers innovate continuously within their projects: but this motivation is difficult to identify and display. **What is missing is an internally planned innovation.**

Today's executives are usually managers, rather than engineers, which means that they are not the initiators of innovative ideas. And those who do innovate have no direct link with the rewards of their innovation. In addition, engineers do not adequately communicate the value of their innovations to the outside world and therefore lose part of the benefits (a communication problem); secondly, they do not acquire adequate recognition as being the authors of these innovative intellectual products (a problem of intellectual property).

FINANCIAL OBSTACLES IN ENGINEERING FIRMS

a) Internal organisation

Dealing with innovation in a company requires time and money. Yet in this profession, the margins are low, which quells the impulse to innovate. In addition, teams are organised as production units which leaves no time for innovation.

Planned voluntarist innovation rarely exceeds 1%. Ex-post evaluation identifies innovation services at about 5% of turnover (of which 2 to 3% is eligible for a Research Tax Credit).

b) Structure of the operating accounts

French SMEs encounter a special obstacle that drastically limits the financing of research, that of **under capitalisation**. SMEs do not have **sufficient reserves** to invest in innovation.

Resorting to bank loans increases financial costs; at the same time, delays in payments by clients are becoming considerably longer - over the last two years, it has increased from 60 to 100 days and is moving towards 120. All of this increases the need for operating funds, and SMEs cannot operate today **without very large financial resources**. One of the first budgets to be sacrificed is research into innovative solutions.

RELATIONS WITH SCIENTIFIC PARTNERS

a) University research

The relationships between engineering consultancy and university research, where they exist, are inadequate. In many cases, **they are difficult, or even stormy.**

In April 2007, the AUGC (University Association of Civil Engineering) published an in-depth enquiry, conducted with its members, on the synergy between the AUGC and the professional sectors (entitled “Enquiry and Proposals for more effective civil engineering research”). This showed that the relative **mutual lack of knowledge between the two environments had led to a number of misunderstandings**, which must be urgently removed. The stakes, on both sides, are significantly greater than it appears. The gap between the two environments is increasing and it will become more and more difficult to overcome it if there is not a collective leap.

Several parameters explain these divergences.

Firstly, **the timescale of a university and an engineering company are not the same.** Often, for the former, the result will be provided once it has been resolved, without a precise or preset date. In addition, starting up a research project in a university setting is necessarily long, since a professor must be engaged, then student(s) must be found who are interested in the subject and available – since exams always take priority -, etc. In addition, continuity of research is not always guaranteed if it lasts for several years; if that is the case, it requires passing instructions and knowledge from one student to another, which can be difficult to ensure.

Secondly, it is true that sometimes there is, explicitly or implicitly, **reluctance of an ideological nature**: “the university will not provide the private sector with a product that it can use to make money!” The private sector is considered rather as a potential source of finance and often has trouble in gaining acceptance as a partner in innovation, even when its scientific base is solid.

Engineers and research workers

Engineers are trained to think and find solutions in a limited and often very short time. University research workers must take time to think in order to progress the subject of their research. The difference in time scales makes collaboration more difficult.

b) The Scientific and Technical Network

The Scientific and Technical Equipment Network (RST) comprises **about thirty organisations, departments and engineering colleges** within MEEDDAT, or under its authority. In many cases, **very good cooperation** has developed between engineering consultancy and the RST. As an example, from 1970 to 1995, a member company developed many innovations in large motorway sites for motorway concessionaires in close association with the central and regional bodies of the RST (treatment of sub grade soils, laying prefabricated drains with automatic operation, experiments on self-draining coatings for motorways with heavy traffic, etc.).

EXTERNAL FINANCIAL OBSTACLES

In general, **eligible labour costs** borne by subsidising organisations are calculated **below the cost price** of an engineering company, for example in the OSEO system.

In a project financed at a rate of 30% by the ANR (the Business Competitiveness Fund of the CIR), firms have to take on up to 70% of the **finance**, and dedicate a significant amount of **time to prepare the dossier and its follow-up**. By comparison, in research contracts placed by the State, some competitors benefit from 100% financing.

Obtaining finance requires, in addition to the quality of the project proposed, **serious lobbying** which is very costly in time, plus considerable effort and expense. Some Competitiveness Centres remain difficult for engineering firms to access (exorbitant fees, strong influence of large industrial groups, etc.).

It is difficult to understand some sources of finance. Their renewal cycle is short and there is sometimes a lack of continuity between programmes for the same sector. In addition, some budgetary sums are financed from several sources.

The present organisation of financing does not offer sufficient incentives to engineering firms, in particular SMEs. A significant investment in monitoring and understanding of mechanisms is required to master the complexity of sources for aid for innovation, which rules out “small” projects and may discourage SMEs.

ADMINISTRATIVE OBSTACLES

a) Insurance

Insurers generally distinguish between the nature of work associated with “standard techniques” and “non-standard techniques”. A definition of this is given below (*source: Batiweb*):

> Work using standard techniques:

- **in the traditional domain**, work done in accordance with longstanding, proven practices, standards, the DTU⁵³ and professional rules.
- **in the non-traditional domain**, work departing from the standards of the traditional domain, but using ATEC or ATEX⁵⁴ technical instructions (for example, of the CSTB)⁵⁵ or that can be approved by a new technical investigation carried out by a testing organisation.

Insurance contracts provide automatic cover in the case of “standard techniques”, but can reserve the right to inspect in the case of non-traditional techniques.

> Work using non-standard techniques

These are defined as opposed to standard techniques, but are in fact a contractual concept which can vary from one insurer to another. It is necessary to refer to the conditions given in each contract and, in case of doubt, to ask the insurer.

Works incorporating an innovation clearly come in the category associated with non-standard techniques.

This is not the case where the design processes used are innovative, although the work itself does not incorporate innovation, for example, in the materials or manufacturing procedures used.

The insured can be deprived of his rights of guarantee if he does not follow good practice, covered by a regulation, recognised documentation or an agreement. **In general, an innovation is not covered by such a document.** The level of risk is declared when the policy is taken out. An increase in risk can justify the cancellation of a contract. The insurer may, at any time, check the risk he is guaranteeing.

An example of a contractual clause on this subject:

“In the course of the contract, the holder, or by default the insured, must declare, on his own initiative, to the insurer the new circumstances that either increase the risk, or create new risks, thereby making the statement given to the insurer inaccurate or null and void, especially in the form mentioned above (art. L.113-2 of the French public procurement legislation). Under threat of cancellation, the holder must declare the circumstances to the insurer by registered letter within 15 days from the time he became aware of them. Forfeiture due to late declaration can only be imposed on the insured if the insurer can establish that he has suffered damage. Neither can it be imposed in any case in which the delay is due to accident or force majeure”.

In this hypothesis, the insurer can either cancel the contract or propose a new premium. If the increased risk is not declared in good faith, but is detected before any incident, the insurer can cancel the contract or propose a new premium. In the event of an incident, the indemnity for the incident can be proportionally reduced. In the case of bad faith, the contract may be declared void.

In conclusion, if a work contains an innovative aspect, the RC Pro⁵⁶ insurance contract does not automatically guarantee the work.

As a minimum, the insurer reserves the right to check. If the risk increases in relation to the standard conditions of the contract, which the insurer always considers to be the case for non-standard techniques, the insurer can cancel or increase the premium. If the increase in the risk was not declared before the incident, the indemnity may be reduced.

b) Public procurement legislation

> Procedures for awarding public contracts

The method for awarding engineering assignments by traditional public contracts in France normally takes one of the three following forms:

53 French technical specifications

54 technical instructions for experimentation

55 French public organism in charge of standards and certification for the building industry

56 The professional insurance

1. Design contests
2. Definition contracts
3. Open or restricted call for tenders

In the first two cases, the tender is launched on the basis of at least one programme.

Eligible bidders are often encouraged to innovate, but at their own risk, since the intellectual property of the ideas is not protected.

The selection of the winning bid is often linked to a provisional estimate of the investment cost, **based on reliable and proven techniques, and which must also remain within the available budget** (the lowest bidder concept).

If the latter objective is not achieved, the procedure can be declared unsuccessful and the **innovative ideas retained and used to launch a new tender**.

In the third case, **the price almost automatically becomes the determinant criterion**.

Engineering services are remunerated proportionally to the forecasted value of the work.

The remuneration rate takes into account the content of the services to be performed in relation to a complete mission called the reference mission and the specific complexity of the project in relation to projects in the same category.

The engineer is obliged to abide by his undertakings concerning the investment cost. In the event of his non-respect, in a price range depending on the level of precision of the studies used for the estimate (APS, APD, etc.⁵⁷), he is penalised by the application of a reduced rate of remuneration.

In this context, **it is difficult for an engineering company to decide alone, without the prior support of the employer, for innovative arrangements** that lead to:

- additional validation procedures;
- additional studies demonstrating not only the feasibility of these arrangements and their reliability, but also that they will result in medium and long term performance that is equivalent or better than that achieved by application of traditional proven techniques;
- any restrictions in the choice of firms assigned to

achieve them;

- random costs and delays that could potentially impact on the completion of the work;
- insurance problems, etc.

Whatever the state of the economy, engineering firms will have no interest, when submitting tenders, in:

- **increasing the costs of their own remuneration in line with that forecast for the work**, by including the development costs of ideas, processes or **products** in the project;
- **taking risks** on time scales and the successful completion of the operation.

Engineering firms therefore hesitate to embark on innovative projects, since these imply bearing greater risks or seeing the project rejected by the employer.

Only the employers can back an innovative approach, but they do not often do so, in spite of certain proposals of the legislation that encourage innovation.

➤ The role of the Employer/ Engineer / Contractor chain

All members of the decision-making chain of a project notice that, very often, **each feels locked in, or locks himself in a very strict and restrictive application of the various laws that govern the completion of an operation. This collective self-limitation is certainly one of the most significant brakes on innovation.**

➤ **The employer** does not dare to include himself in the establishment of a programme for fear of limiting the possibilities of competition too much. He therefore imposes on the engineering consulting firms a contract by enforcement of the MOP law⁵⁸, fixing very strict limits to the action of his design team for fear of suffering price increases or delays.

➤ **The engineer** imposes limits on himself in order to remain within the framework of the programme, or not to take on a responsibility that he believes should be that of the Employer, or to avoid unforeseen costs that would lead to a price increase in his own contract. In addition, the increasing complexity of the projects leads the engineer to employ a very large number of

⁵⁷ Standardized phases for public procurement in the French regulation (preliminary design, detailed design...)

⁵⁸ Main French legislation which defines the nature and content of the engineering consultancy and architectural services that must be delivered in public procurement

specialised joint contractors or subcontractors in his team, whose management is a burden on the engineer and relations with the Employer.

- **The engineer imposes on the contractor** very restrictive conditions of response to the call for tenders, from fear of seeing his task of assessing the offers and chosen proposal highly complicated and of being led to take a responsibility that he does not wish to bear facing the Employer. In addition, the concept of “change” always leads to the risk of financial discrepancies.
- **The contractors** scrupulously follow the constraints set by the work contract in order not to find themselves in an awkward position with respect to the engineer; they search the contract for procedural faults or techniques that they could use to improve their turnover or margin.

The lack of distribution and valorisation of innovations by employers is hindering the commercialisation of research-based services, even though they meet priority needs of society.

c) Partnership contracts

- **The paradox of partnership contracts (ex-PPP⁵⁹)**

The new procedures (in the French legislation) for partnership contracts (BEH, LOPSI, LOPJI⁶⁰, Partnership Contracts) lead to a new type of relationship and positioning of all the participants in the construction process, by introducing into the practice the concept of “simultaneous engineering” already in use for a long time in the industrial sector.

The contractual novelty of partnership contracts gives rise to two dynamics acting in the reverse direction:

- **On the one hand**, a partnership contract is a long duration global contract, **requiring the implementation of innovative, or at least “state of the art”, solutions in order to limit the risk of rapid obsolescence, which is a source of additional costs in the event of premature renewal.**

The public authority is in fact subjected to a change in paradigm, which leads it to consider its project in regard to its duration and not only from the angle of the initial investment (operation – maintenance – renewal). In MOP type projects ⁶¹, the technology in areas such as hospitals may have evolved in the period between the tender programme and the Detailed Design, requiring changes to the programme. On the other hand, in a Partnership Contract, once the contract is signed, the goals and the price are fixed, and it becomes financially difficult and hazardous to request changes to the programme. **It is therefore tempting to specify the most recent technology which encourages innovation.**

In addition, design in total cost is fully integrated in the procedure and **encourages innovation in optimising the cost of ownership** (cost of investment/cost of use).

Finally, simultaneous engineering between the designer/builder/maintainer will generate new designs by the early integration of downstream constraints (designing for better building and better maintenance).

However, it should be noted that this optimisation will only be truly effective if there is a permanent dialogue between the three parties, **which is not the case often enough today because the procedures have not yet been adapted**; the recurrence of this type of contract will however impose this dialogue.

- **On the other hand**, the financial logic of total cost and transfer of risk to the private partner may **encourage groups to implement well tried solutions in order to reduce the risk of inadequate performance, a source of heavy penalties.**

The pressure on firms to reduce costs does not encourage innovation. This aspect, that firms frequently put forward, in fact quite often concerns

59 In European legislation, “Public Private Partnership contract” and in the French version “ partnership contract” (see Partnership contract)

60 BEH, LOPSI, LOPJI : specific French legislation for PPP contracts for hospitals, justice, and police

61 French legislation on architectural and engineering services

only the optimisation and rationalisation of building methods developed by themselves, but rarely the functionality and quality. Firms consider that a number of unavoidable risks are inherent in projects. They therefore mistrust innovative designs that they liken to additional risks instead of considering them as opportunities.

In the same way, **a good knowledge of the life cycle of equipment is required**; this is based on experience rather than a calculated prediction, which impedes recourse to new techniques of which there is no experience.

In the present situation, the **limited weight of engineering consultancy** in the consortium of firms in charge of “partnership” contracts does not give it sufficient influence to make good use of innovation, and the **risks** associated with design and definition of operating costs (consumption, maintenance) are not sufficiently covered.

> **Innovation in partnership contracts**

Two types of innovation can be identified in the field of partnership contracts: technological innovations, and procedural and contractual innovations. Well specified obstacles make it difficult to implement each of these.

> **In the case of technological innovations:**

- **Total cost:** partnership contracts lead to a change in paradigm, the main purpose of which is optimisation of the total cost. Safety takes precedence over innovation.
- **Remuneration of studies:** the public authorities expect engineering firms to be the driving force for proposals, using multi-disciplinary expertise. However, optimisation studies take place essentially at the tender stage, but the absence or low level of remuneration for studies at this stage does not permit in-depth work to be done.
- **Technological breakthrough solutions:** a technological breakthrough solution can lead to substantial savings in the total cost; the problem is to know who is liable for the risk.

> **In the case of procedural and contractual innovations:**

- **the acceptability of innovative solutions:** partnership contract programmes are often too descriptive and not sufficiently performance

orientated. The acceptability of an innovative solution is not guaranteed. The risk of rejection of candidature is a disincentive to proposing such a solution.

- **design process:** the collaboration within a group is often based on a classic sequential structure, and the expected effect of synergy is insufficient.
- **confidentiality of competitive dialogue:** some innovative solutions are not proposed at the first stage of the competitive dialogue from fear of seeing them “shared” with the other candidates, consciously or not, by public authorities and their advisors.
- **use of article 10 of the enactment of 17 June 2004:** this article provides that a group should make a spontaneous proposal to the public authority in response to a presumed requirement of the latter. This represents a priori a good opportunity for innovation. But the protection of the initial idea does not seem sufficiently assured.
- **insurance:** the “construction” component of a PPP contract is well controlled by insurers (by setting aside the difficulties identified for engineering). The cover for risks associated with the “operating - maintenance” component and division of the respective responsibilities of the various partners are much less well controlled. This lack of visibility blocks innovation.

INADEQUATE PROTECTION OF ENGINEERING INNOVATION

a) Intellectual and/or industrial copyright and innovation

Concerning innovation, intellectual property is based on two considerations:

- **moral:** the creators must receive moral and material recognition of their position as author;
- **financial:** by guaranteeing exclusivity and ensuring loyalty in industrial and commercial relations, the State promotes the commercialisation of inventions.

The protection of copyright, patent, licence or other rights is regulated.

The **problems of innovation and intellectual property (IP) are closely linked**, in that the concept of innovation is implicitly understood by business from the angle of protection of the innovation and the capacity, for the participant in question, to make a future profit from his investment, which could not be envisaged without establishing a right.

Intellectual property law is fairly ambiguous as concerns engineering. The **famous formula according to which “drawings, principles or methods in the exercise of intellectual activities are, in particular, not considered as inventions”** seems to exclude the products of engineering firms in the field of IP.

Looking more closely at this, things are more nuanced and engineering consultancy could without doubt rely on the principal categories of IP rights in its activities:

- patents, when it invents a process;
- drawings and models, when it creates an original design;
- brands, commercial names, etc.;
- author's rights for written and software products.

The unprotected risks associated with innovations are mainly:

- copies and forgeries by competing firms;
- absence of control over end use by competitors and lack of financial compensation;
- unprofitable investment in research and development.

A lack of organisation in the area of industrial and intellectual property not only delays the spreading of innovations, but **sometimes even blocks the**

willingness of management of engineering firms to invest in innovation.

Several past cases, in which employers betrayed the confidentiality of engineering firms which had invested significantly in innovation, have had profound and long lasting consequences on the profession.

b) The risk of “cherry picking” during competitive dialogue

Inspired by a joint desire to find a solution to complex contracts, the competitive dialogue, as embodied in article 29 of the modified European directive, gave rise to questions in the European Parliament – **especially on the subject of confidentiality of exchanges and the possibility of “cherry picking”**: how to ensure confidentiality of information exchanged? Is it possible to change the contract specifications during discussions? To what extent do financial operators receive remuneration for their participation?

Throughout the discussion stage, **the person responsible for the contract cannot alter the specification (by combining items proposed by the various candidates) without notifying all the candidates** – in order to enable them to modify future proposals resulting from the discussions. The specification is frozen after the discussion stage. Tenders are then submitted and the most economically advantageous tender chosen according to the classic methods of the tender procedure. The tender is discontinued if no offer is considered acceptable.

Implementation of this new procedure certainly merits a first assessment. Engineering, which is at the heart of the ideas generated on projects, can only release innovative ideas with **a minimum of guarantees** to protect its skills.

c) Private Law

An obstacle must be pointed out that considerably hinders innovation in private engineering firms: current contracts contain **confidentiality and intellectual property rights clauses** which attribute all the benefits of the innovation discovered solely **to the employer** (since he is financing the necessary research).

Engineering firms working on innovative solutions cannot therefore retain any interest: since they do not own the innovation, nor can they **sell or take any credit for their discovery, or even communicate** their ability to innovate, since the clauses are so restrictive.

In summary, it appears that, looking beyond certain structural factors, the field of IP offers **real opportunities for engineering firms**. The contractual terms must be controlled in order to exploit these opportunities. This can only be achieved through very early discussions with the employers, based on true legitimacy.

IV THE ENGINEERING CONSULTANCY INDUSTRY RECOMMENDATIONS

INTERNAL ACTIONS WITHIN ENGINEERING COMPANIES

The future performance of engineering consultancy in domestic and international markets will depend on its initiative and dynamism in meeting the challenges of innovation.

a) Integrating, managing and exploiting innovation

Innovation is a medium and long term investment, and its financing must be consistent with the stakes and strategy of the company.

All internal actors, including management, are convinced of the principle and necessity of innovation, but they do not know exactly how to produce it. It is essential to remember that **innovation in firms can only come from the willingness of the management.** It is an essential component of the company and it is only possible to have “voluntary” innovation if it is planned.

Innovation can also constitute a method of transmitting knowledge from the senior to the junior staff.

Finally, it is essential to release resources for innovation in an “area of freedom”, away from the restraints of production.

Recommendations

As far as **the internal organisation of firms** is concerned, it is necessary to:

- **Dedicate one person to the management of innovation**, capable of thinking “outside the box”, and with sufficient time, even if he/she has other responsibilities to perform.
- Depending on the size and nature of the activity of firms, this **function** can be undertaken part time or full time, by a person **with experience, but at the same time open to new developments.**

This person, and possibly his team, needs a certain buffer from operational pressures. But on the other hand, the continuity of the “innovation-operational”

chain must be guaranteed by effective co-ordination with operational staff.

The role of the innovation team is to:

- prepare the company for new challenges through new methods and tools to improve productivity;
- explore new products in order to secure a competitive advantage;
- assist in the preparation of innovative offers;
- create centres of competence responsible for developing new services (nurturing new ideas);
- monitoring technological developments in domestic and international markets.

➤ Promoting and recognising internal innovation

Engineers must communicate their innovative ideas more effectively.

It is a good idea for each company to organise **a place (intranet, magazine, seminar, etc.)** where **innovations can be valorised** and distributed, at least internally.

Innovations can also be valorised externally by publication in specialized press and via other channels to be established. This requires allocating time to the people charged with this task. Through its network, Syntec-Ingénierie is also a means of external communication.

➤ Valorising innovation in the evaluation of personnel

A good method of promoting internal innovation is to give credit for a staff member’s ability to innovate. This should be one of the criteria in staff evaluations.

b) Benefiting from financial leverages

Within the company’s innovation strategy, there should be a coherent financing policy. It is therefore important that time spent on innovation is accounted for as such instead of being considered only as a general cost. Without that, there is a risk of non-charged or “hidden” time having a negative and demotivating effect.

Recommendations

It is necessary to:

- **Benefit more from the incentive of the Research Tax Credit.**
- **Benefit more from the financial leverages of innovation.**

For that:

- do not hesitate to consult OSEO, even for intangible innovations;
 - to develop the role of engineering as coordinator of innovation teams and thereby profit from the finance contributed by the other partners.
- **To have the reflex to set up “innovation” co-financing**
 - **To benefit more from the support of the Competitiveness Centres**
 - **To promote the approval of engineering firms for Research Tax Credits**

c) Capitalising on knowledge and experience

The capitalisation of knowledge and innovation takes place by means of an **internal process**, which covers:

- monitoring all technical areas of the profession;
- the **transfer of knowledge**:
 - by technical notes,
 - by coaching (the role of “the old” versus “the young” in the company),
 - by training.
- **Participation in knowledge networks**:
 - Syntec-Ingénierie;
 - research clubs
 - etc.

Recommendations

- **Organising a multi-disciplinary technical watch**

The engineering consultancy industry must go further in its innovative steps to capitalise on knowledge about future subjects, using **knowledge management tools**.

- **Capturing the knowledge from experience and mentoring**

The capitalisation of knowledge and experience is essential (especially because of the “greying” of the

population). Senior staff in firms must transfer **their know-how acquired on different projects and their experience of applying innovation**. That requires work based on the respectful complementing of the specific knowledge of each. Old models must be reconsidered in order to be more effective and reactive.

d) Innovation in internal methods

The change towards a knowledge-based society, the more complex nature of projects and present challenges lead to the valorisation **of methodological innovations**, in which engineering firms play a quite special role. It is important to make the process of valorising and securing the most relevant innovations in relation to current challenges more rapid and effective.

Recommendations

- **Integrating the sustainable development process into management methods**

The profession must work on integrating the sustainable development process into its management methods by linking **European methods for tackling sustainable development with high environmental quality**.

- **Taking risk management into account in complex projects**

This requires:

- making a survey of current methods in France and internationally;
- developing applied methods in our firms (guides, reference material, project risk mapping, analysis matrices, simple networks, dedicated tools, etc.);
- integrating them into the basic project management methods;
- bringing additional tasks to light;
- alerting all actors to the importance of including risk management in operational project definition, design and construction processes;
- producing a Syntec-Ingénierie guide (or in collaboration with the relevant ministries).

THE STATE AS SUPERVISOR AND REGULATOR

The role of supervisor and regulator played by the State is fundamental for the medium and long term development of the engineering consultancy industry – especially to release its innovation capabilities and thus increase the competitiveness of the country.

a) Improving the structure of accounts to encourage innovation

It is possible to take simple measures to enable SMEs to strengthen themselves financially and enable them to innovate.

Recommendations

- **To provide tax relief for profits held in reserve**
- **To allow depreciation of research costs over a long period**

b) Improving the Implementation of Research Tax Credits (RTC)

RTC has changed considerably in France in 2008 and offers increased opportunities for financing research.

Recommendations

- **Changing the criteria for obtaining approval for Research Tax Credit**

It would be advantageous to implement measures aimed at engineering firms that do not have their own research subjects, but with the technical and technological skills to take part in the **development of research topics.**

It would be interesting to put in place criteria of internal project development capacity as well as criteria for internal skills of the “professional expertise” type; presented in the same way as a project, they could receive the backing of auditors and enable approval for a Research Tax Credit to be obtained.

- **Improving the definition of eligible engineering services so that they are better understood by engineers and auditors of the RTC dossier.**

The terminology should be clarified to avoid misinterpretation.

- **Making the approval system more flexible**
It should be possible for engineering firms to submit a dossier for approval for a Research Tax Credit on subjects that they have carried out for customers, that were then paid for; they could then obtain approval without a tax allowance but simply **based on their ability to handle research subjects.**

c) Developing synergies between public research and the private sector

Today, there is unanimity in saying that, in general, the effectiveness of **synergy between engineering and public research is necessary to face current challenges;**

Developing these complementary factors would also strengthen the international competitiveness of engineering consultancies.

Recommendations

- **Developing synergies between public research and engineering firms**

Synergies should be developed between the public research network and the private sector in general. Evolution of the strategic context (for example, in France, the new remit of the Ministry, the focus of the RST, etc.) creates a climate that is currently quite favourable to this type of action.

Concrete action must be taken in the short term, at a general strategic, as well as at a more specific, level.

In the medium-term, a joint reflection is necessary on the possible configurations of a synergy suited to the challenges of tomorrow.

d) Reorganising the technical corps

Reorganising the technical corps would optimise its role, both **in terms of productivity** (for example, standard Technical Specifications that can be linked to a database of experience as an aid to the drafting of project proposals) and **in terms of international competitiveness** (for example: the World Bank’s “Tool-kit” on concessions, developed by a French engineering company).

Recommendations

- **Reviewing the method of producing general Technical Specifications**

General Technical Specifications (CCTG) are one of

the daily working tools of engineering which guarantee the quality of work. Information collected on sites by engineering consultancies is very useful for updating these regulations.

The increasing development of technologies, efficient approaches, European standards and rules such as Eurocodes demands rethinking based on:

- the **priority objectives** of this type of document;
- their **method of design/updating**;
- their **link with the corresponding technical guides**, even the **connections with computer-based training modules**.

➤ **Using the State's role of lever**

In these areas, the growth of the regulating State may constitute an important lever: it plays an essential role of final decision maker. It could therefore encourage more collective work and **play a role of renewed driving force of methods** (for greater productivity/reactivity of traditional working groups). Finally, the State could **promote the use of mature innovations** (Knowledge management, IT, interactive sites, etc.).

e) **Developing more reactive and collegiate cross-pollination between public and private bodies**

In France, the role of the State in the motivation of collective capitalisation of knowledge has been stronger than in countries such as Germany or England. It has become necessary to reconsider this role: some present practices are inherited from a system which has aged a great deal.

Recommendations

➤ **Concentrating capitalisation of knowledge by specific topics**

Capitalisation of knowledge could be **organised by topic, around a range of diverse organisations**, supported by existing public bodies, in which representatives of engineering consultancy, employers and research could participate. The objective is to provide an interface between all public and private participants (in France for example, for the Building sector around the CSTB⁶², for Transport Infrastructure around Setra⁶³, etc.).

These organisations would be responsible for **keeping databanks available and up to date**,

providing a record of knowledge and innovations (with or without quality labelling or validation).

Current subjects could already form a useful capitalisation:

- the various systems found in a building (heating, air conditioning, etc.) in terms of "sustainable development";
- IGH buildings (high skyscrapers), resistant to fire and attack;
- the town of tomorrow and sustainable transport systems (with a comparison of urban design experiences at global level) in association with the Town and Long Term Mobility centre of the ANR;
- development of the railway infrastructure.

➤ **Developing synergies between engineering firms: public, in-house and private**

It would be useful, for example, to create a **think tank** combining professional engineering consultancy, the in-house engineering capacities of large contractors and public engineering capacities on the subject of **the evolution of project management**. The Montreal Club is a good example.

f) **Developing methods for taking global strategic choices into account at national level**

New means of dealing with the challenges are required, so that the strategic choices of a country are made under the best possible conditions.

Recommendations

➤ **To associate engineering upstream of large projects**

From the first discussions on a project, and certainly before major choices are made, national stakes (growth, land management, the environment, socio-economic impact, etc.) must be central to the considerations. **Engineering consultancy must be involved from the start-up of a project**. The services of the State are in charge of this mission of general interest. In France, the interministerial committees (CIADTs) and the projects they propose are a recent illustration of this. But, apart from the fact that these services are not sufficiently confronted with questions that would help to develop the concepts, the means available to the State services are not adequate to fulfil this task alone.

⁶² French public organism for research and certification in buildings construction.

⁶³ French public institution for research on roads construction

THE RELATIONSHIP OF ENGINEERING CONSULTANCY WITH DECISION MAKERS AND EMPLOYERS

Employers are extremely different in their composition, methods and objectives. In addition, they have very mixed resources and technical skills. They can be public (State, local groups) or private (firms, industries, etc.). Engineering consultancy has the ability to adapt itself to different situations in order to optimise projects in terms of cost, time and performance.

a) Make better use of the know-how and quality of service of engineering consultancy

Employers are, or should be, requesting innovations in order to widen the range of solutions so that their projects provide the optimum response to today's societal, political and financial challenges. But they do not always have the skill required to elaborate the various possible solutions or to judge the relevance of the solutions proposed. That is why it is often necessary for them to resort to **assistants whose purpose is to support them in certain projects, or even possibly to direct them towards this or that innovative solution.** Engineering consultants are able to assist employers at all stages of a project, especially upstream.

> Assistance to decision makers, employers at the upstream stage

The success of projects depends on the quality of the upstream stages. In fact, a comparison of the various proposals, at the technical as well as the financial, administrative and legal levels, allows the optimum solution to be identified.

The experience of one single employer is not sufficient to evaluate the effectiveness of an innovation. A specialist must be consulted who is aware of innovative solutions that have not yet been used or who can draw on the experience of other employers.

Engineering firms, by their multi-disciplinary role covering several areas of activity, have close relations with the world of research and provide services on behalf of many employers: that is why they have the means to make a positive and dynamic contribution to the upstream preparation of projects.

Recommendations

> Improve communication on engineering consultancy know-how and its capacity for innovation upstream of a project

To enable customers to profit more from its innovative capacity, engineering consultancy must increase the recognition of its skills in providing specialised or general assistance, in particular concerning the upstream stages:

- strategic studies,
- opportunity studies,
- definition of requirements and optimisation of solutions,
- impact studies,
- risk assessment,
- assistance in mounting operations.

> Encourage employers to make use of assistants from the start of a project

> Encourage employers to dedicate significant study budgets from the preliminary stages in order to achieve total performance

Irreversible decisions, counting for 80% of total project costs, are based on studies that represent less than 1% of the cost of the project, sometimes only one thousandth. It is fundamental to put in place **sufficient study budgets from the preliminary stages** to ensure that the subsequent choices are truly optimal for the general interest, and that all the traditional and new opportunities have been explored.

> Design engineering

In its role as designer and integrator, engineering consultancy assists employers **by suggesting and explaining the most appropriate technical choices.** It is able to propose the choice of the best materials and systems and recommend the best solutions for a given work.

Recommendations

> "Reviewing" the best existing solutions for the total cost

The design phase must be fully rethought with a view to "doing something different", in order to include the total cost, which does not necessarily lead to "doing something new". It is a matter of

“revisiting” the technical solutions proposed from the perspective of reliability, sustainability and maintainability, the optimum possibly being a proven solution or a new one, depending on the case; **innovation then consists in providing the best solution within the total cost.**

➤ **Improving the synergy between the architect and engineer in the building field**

It would be in the general interest to remove the existing barriers between the professionals in order to draw the two complementary approaches together. A basic reflection (that could result in France, for example, in a change in the law) on the status of architects and engineers would appear to be necessary.

Further considerations:

- **set up joint research between architects, engineers, landscape designers, town planners, etc.** (for example, in the field of the environment) by combining architectural, functional and technical aspects;
- **establish or improve links or exchanges** (by developing relations between engineering and architectural colleges).

➤ **In project management**

We know that misunderstanding of operational problems of project management by certain employers (public, but also private) can impede the process of innovation. These are subjects on which some countries are better organised by working in an efficient network with research. Note however that there are attempts at innovative progress in the field of **“management of operational projects”** within firms or groups of firms.

Recommendations

➤ **Developing improved cross-fertilisation between all actors for an overall view**

Emerging areas of innovation such as “the sustainable town and its services”, at the frontiers or town planning, processes, technologies and methods require:

- rethinking our views on the innovation process and the synergy between actors;
- removing barriers between the fields: building, infrastructure, networks, processes, etc.

b) Improve the effectiveness of the Employer/Engineer/Contractor chain to encourage innovation

The present method of operation relies on concepts that are already dated (sequential steps), and which should be re-thought in order to adapt to present challenges. Relations between clients and suppliers on one hand and between the various participants (engineering firms, architects, operating companies) on the other hand must be based on a better partnership and better integration of the roles of each (concurrent steps).

Recommendations

- Encourage close cooperation in a relationship of mutual trust in order to analyse the opportunity for an innovative method and manage its effective implementation
- At employer level, clearly define the objectives and performance of the project and be more audacious in respect of acquired innovative solutions.
 - **Define clear and strong requirements** by a well-founded and drafted programme. In this field, engineering firms can provide strong assistance, separate from engineering/architect contracts, to assist employers in determining their requirements and defining the essential factors and constraints of an operation;
 - **Encourage innovation** by enabling engineers to exercise their capacity for imagination and make use of previous experience. This can also be done by a programme defining the expected outcomes without imposing the means of achieving them.
- **At employer level, manage teams by encouraging innovative solutions, that have been tested and proven, and that are consistent with the objectives of the project.**
 - **Implement innovative solutions in the management of the project management team**, particularly when it is large and multi-disciplinary;
 - Support innovative proposals by a risk analysis, answering the employer’s questions, and that can be invoked against third parties;
 - **In the preparation of work contracts, encourage procedures** that favour innovative solutions, are consistent with the

requirements of the operation and comply with all the terms of the programme.

c) Improve protection of engineering innovations

> By intellectual and/or industrial property clauses

There is unanimity of stakeholders of the engineering consultancy industry in stating that only a real **change of mentality** in the relationship between employers and suppliers can change the situation.

Recommendations

> A change in legislation and contractual protection of innovation

By considering the requirements of engineering customers as well as the legal constraints that bind them, it is considered necessary **to add an “innovation clause” to contracts** covering:

- the remuneration for performance (which exists in Anglo-Saxon contracts);
- the creation of a period of reflection (or a meeting for reflection when a milestone is passed) on the search for performance and innovation;
- automatically obtaining a licence for the use of innovations developed during projects carried out for clients;
- the issue of a bilateral confidentiality agreement at the tender stage;
- compensation for unsuccessful tenderers in the event of use of their innovative solution by a successful candidate.

Concerning legislation, **a review of the regulations on technology transfer should be considered.**

> Better use of innovations

The speed and extent of the **spreading of innovations to projects has become increasingly strategic**, both in the interest of citizens/taxpayers and in the international competition between stakeholders. In order for the applications of upstream research to be diffused rapidly and effectively onto the market, public bodies have developed special structures. For example, in France, CSTB Development⁶⁴ is a

shareholder in small firms introducing practical applications of CSTB research, with an increasingly wide shareholder base of the private engineering firms concerned. In the same way, calls for tender by the LCPC⁶⁵ in the field of materials monitoring must improve the transfer of very good research results into French and international markets.

Recommendations

In order to accelerate the process of valorising innovation in engineering firms, it is necessary to:

> Share the resulting roles and ownership effectively

The experience of Armines⁶⁶, which consists of attributing applied research to companies and generic methodology to research laboratories, is a good example of this; it leads to suggesting that the operational results of applied research are considered as the industrial property of the company directly concerned, so that the company is free to market it. On the other hand, ownership of the generic methodologies used in this context remains with the research laboratory (or the engineering company) which developed them, so that the transfer of the results of this research to other sectors is carried out by those who know best how to do it. In the same way as a laboratory, the engineering company can offer a client in one sector the benefits of experience from several sectors: it is thus often the engineering company that is best placed to maximise the added value of a generic methodology. For that, **it must have the right to use such methodologies.** There is a European guide on improving valorisation in these fields.

> Encourage employers to share and re-exploit existing innovations

Engineering cannot sustainably invest in developing innovations if the group of employers concerned does not play its part in promoting the use of these innovations. The field of **“managing large operational projects”** is a typical example; it is a strategic tool of all engineering firms, both in France and internationally. There are attempts at innovative progress in companies or groups of companies.

It is possible to be inspired by practices in some other countries; the United States, for example, has systematically developed interesting practices,

64 A public organism

65 A public French laboratory for research in construction

66 Association for research linked to Ecole des Mines de Paris, a top French engineer college

combining:

- the **bundling** of separate innovations into a coherent package, providing a concrete answer to a number of operational requirements (e.g.: a package on the rehabilitation of works, in place of dozens of innovations of the patented type on the replacement of support equipment, etc.);
- **the involvement of a group of employers** (for example, the powerful AASHTO⁶⁷) which effectively optimises the innovations that best satisfy the priority requirements (the innovative concept of “lead-state”, the employer communicating to his peers the results of his experimental works). The “Ivor”⁶⁸ documents constitute a first step in this direction.

d) Encourage public employers to make use of all contractual possibilities

➤ By enforcement of the Public Procurement Code

At the present time, the type of contract defined by article 75 of the French public procurement legislation (tenders in the framework of pilot programmes”) remains confidential and is solely an initiative of the French state.

Recommendations

It is necessary to:

➤ **Raise awareness of employers to the real innovation opportunities offered by the public procurement legislation**

For that, positive action must be taken with employers so that they are less hesitant in the implementation of innovative requirements. Misplaced legal action against employers for unfair competition greatly increases the reticence of the former to have an open interpretation of the laws.

Action should be taken:

- firstly **by the State** (supervisor and regulator), to provide explanation and guidance in the application of its laws. Engineering must however act with State departments to push for this action;
- secondly **by the engineering consultancy industry** with its own members, but also with all parties involved in construction.

➤ **To facilitate the development of national public programmes by the State and local groups**

For that, it is necessary to:

- make concrete recommendations to State departments on matters likely to become the subject of **national public programmes**;
- take actions so that regions or other local groups can be initiators of national public programmes on more local subjects (for example, arrangements for fighting or preventing forest fires).

➤ **To follow the legal responses at a European level in the various countries faced with the same European directive on public procurement.**

➤ **By new contracting methods**

Process and contractual innovations, in particular partnership contracts, require special consideration to be given to innovation.

Recommendations

It is necessary to:

➤ **Encourage proposals for innovative solutions**

Make sure that the consultation regulations explicitly authorize and encourage innovative solutions which could break with certain requirements of the programme, apart from those mentioned as intangible. That could lead to prioritizing items of the programme in terms of requirement.

➤ **Ensure that all aspects of the design process are taken into account by all players**

Modes of operation **of the “simultaneous engineering” type** must be established **between the various players**, under the leadership of the engineering consultancy, in order to evaluate the logic within the partnership contract for optimisation of the total cost. For example, the desired saving of time (the consortium only touches its first payment on delivery of the work) must never be obtained by pure and simple suppression or reduction of the contents of certain study phases. **All aspects of the design, controlled by each of the partners** (design, construction methods,

67 American Association of State Highway and Transportation Officials

68 French public label for an innovation implemented in recent works

maintainability, credit worthiness), have to be considered simultaneously.

➤ **Protect all innovative proposals with a confidentiality clause in the competitive dialogue**

The risk of “cherry picking” inherent in this procedure must be minimised by reaffirming the “hermetic” nature of the competitive discussions (**“watertightness” between projects**) and by taking explicit measures to limit the risk of dissemination of information (restricted number of participants, signing an undertaking of confidentiality).

➤ **To remunerate studies fairly to provide the resources to carry out an innovative project**

The public authority and the group must remunerate engineering firms fairly to provide them with the resources to conduct their studies with all the necessary efficiency; all the more so since this remuneration is **not significant for the employer compared to its later returns.**

e) Provide liability clauses and insurance cover consistent with innovation

In this field, everything has yet to be done, especially with the employers and insurance companies.

Recommendations

➤ **Improve risk sharing between all participants in a single contract**

The most fair and effective innovative solution, even the most economical, would be a system based on sharing the **risks between all participants in a single contract.**

Such a measure would doubtless encourage the emergence of innovative solutions for the benefit of all participants.

This solution would no doubt require **a legal proposal that could be put forward by the profession.**

➤ **To make each participant more responsible in a partnership contract and encourage insurers to make an *ad hoc* global offer.**

In the case of extremely innovative solutions that require the payment of an **excess premium**, this should be borne by the employer if he consciously opted for an innovative solution either in his

programme or at the design stage. It is urgent and important that insurers propose a specific global offer for partnership contracts so that each partner is fully aware of their responsibilities and thereby assumes the risk of innovation with full knowledge of the facts.

THE RELATIONSHIP OF ENGINEERING WITH RESEARCH AND TRAINING

a) Sharing know-how on innovation and research

In France, it is necessary to use direct links to reinforce the synergy between engineering firms and research, in particular university research. The sharing of the results of the highest level of research is poor, more so in France than in other countries.

In addition, it must be noted that the professional sector considers that the present training of post-graduates is worth less than three years professional experience in a company; the lecturers of these post-graduates, for their part, regret that this training with scientific rigour through research is not valued, either in terms of starting salaries or job function.

This is a **recurrent problem which will gradually become a real sticking point** if the means are not put in place to overcome it.

Finally, private engineering consultancy, as a profession, is not nowadays close enough to organisations that are “innovation levers” (in France, DRAST, ANR and European organisations, etc.).

Recommendations

➤ **Benefit from discussions between engineering/research with the support of post-graduates**

The basis of resolving the question of post-graduates is wider than engineering and affects the whole professional sector. However, it also concerns engineering firms, since post-graduates entering engineering firms could be effective participants in discussions relating to engineering/research.

➤ **Develop relations with public research organisations**

➤ **Take part in joint R&D projects**

➤ **Develop collaboration with the AUGC**

The AUGC document could be the catalyst for closer collaboration between the AUGC and Syntec-Ingénierie, with the aim of identifying both strategic and operational synergies.

➤ **Share interdisciplinary issues between research and engineering**

CIFRE⁶⁹ theses are an effective and well-tryed system that could be developed relatively easily, taking into account the credits available.

It should be emphasised that some inter-disciplinary subjects could perhaps be treated **in partnership by research laboratories and a professional association such as Syntec-Ingénierie** (for some very inter-disciplinary and precompetitive subjects).

➤ **Rely on intermediate organisations**

The experience of ARMINES⁷⁰ shows that researchers must develop an “appetite” for contractual research; secondly, companies must truly understand what researchers can do for them. Intermediate organisations have been developed (e.g.: Armines, some Competitiveness Centres, etc.). In the same way, the development of **Carnot labels** facilitates access to public research skills and provides an example of the type of opportunities that have to succeed.

b) Strengthen relations with the public research network

In France, the RST has a fundamental role to play in favour of innovation and it is in the general interest, in view of the stakes, for engineering consultancy to build up contacts with this network.

Recommendations

To meet the aims, it is recommended to:

➤ **Enforce the 2007 circular on RST orientation**

Discussions between engineering and the RST must be arranged in order to implement the Circular of February 2007 on the orientation of the RST and possible synergies with the private sector.

➤ **Link engineering more closely to the priority requirements of the sector**

The many engineering contracts on the ground and with employers mean that engineering can be a relevant partner in the identification and

69 agreement with a PhD student

70 Ecole des Mines association (See glossary)

prioritisation of requirements – and therefore subjects for research. Some research organisations, for example the CSTB, have thus made the **“downstream research order”** routine. The LCPC involves professionals in its sector-based committees. Such approaches must now be made more efficient and more general.

➤ **Agree upon a common action plan between RST and engineering to maintain the quality of expertise**

This plan will give rise to follow-up and facilitate capitalisation within the Public Research Network: some specialist experts at national or international level, as well as engineers who have accumulated all the specialist memory (e.g., in France: geotechnics, highways, works, etc. in each LRPC) are **high added-value profiles for all parties**, starting with the employers' group; in addition, engineering consultancy market constraints ensure that these experts tend to hold a position in a public service organisation where they are at the service of all participants.

➤ **Develop alternating career paths**

Reciprocal immersion courses would combine the rigour of research with professional experience. This seems vital for the long-term legitimacy of research organisations and the Public Research Network, all the more for long-term competitiveness of engineering firms owing to high level innovation.

➤ **Invent systems of co- or subcontracting to enable engineering firms to benefit from research subjects conducted by the Public Research Network**

These subjects, aimed ultimately at implementation, would facilitate consultancies to acquire references. In international competition in new domains, French engineering firms are increasingly confronted with competitors from other countries who can refer to studies they have carried out for the Public Authority in their own country. These systems must become much more fluid than in the past: some countries are twenty years ahead of French engineering firms in this respect.

➤ **Valorise programmes for long-term research (such as the AGORA 2020 programme of the Ministry of Equipment in France) in relation to engineering consultancy**

Reflection on this theme could give rise to research subjects, in which engineering firms can play a specific role. The fact that, according to AGORA 2020, about two-thirds of the requirements

identified as priorities have not yet given rise to structured offers, may make this RST/Engineering brain-storming particularly effective for picking up on the societal challenges that were identified.

➤ **Develop a bilateral dialogue between engineering firms and Public Research Institutions like LCPC, CSTB and INRETS in France**

This discussion would develop specific tangible synergies. The fact that these organisations have developed four-year contracts with their supervisors may be a very good opportunity. A strategic step chosen together at the highest level is necessary to make this step effective and sustainable at the detailed level, and sufficiently rapid in its implementation.

The above examples essentially concern MEEDDAT; similar actions may concern technical organisations, depending on other ministries.

POSSIBLE COLLECTIVE ACTIONS

Certain actions can be shared to give companies better visibility of the external aid proposed, but also to open the path to new opportunities.

a) Improve information flow about external funding opportunities

The establishment of a *hotline* or guide to aid, for example, is a good course of action. Proposing a single contact point for information and for requesting access to various sources of aid would contribute to better visibility.

Recommendations

It would be appropriate in France:

- To create a portal, grouping together the principal organisations acting as “leverages for innovation”
- To establish an organisational lever to unify the organisations (in the form of a place for lobbying and seeking sources of finance) and identify the centres relevant for engineering.

On this point, members of EFCA like Syntec-Ingénierie could play a unifying role in sharing these actions.

b) To identify centres of strategic competitiveness for engineering firms and facilitate access to them

To optimise the role of engineering firms in the centres, it is necessary to involve members of EFCA, such as Syntec-Ingénierie, as a partner in their development.

Proposal

- **To secure an active role for EFCA members like Syntec-Ingénierie in the strategic research competitiveness centres**

The professional engineering federation is already a member of the “Sustainable Town and Mobility” centre. It would be advisable to extend its participation to the strategic centres and to take up the role of facilitator between engineering firms and

the centres. This unifying role would thereby encourage access to the SME and micro-enterprise centres.

c) To create a technical breeding ground with research partners

Beyond the knowledge bases of each one, a joint collaboration with research laboratories would provide answers to today’s challenges.

Recommendation

- **To initiate research work on the themes of sustainable development and risk**

V GLOSSARY OF KEY WORDS AND ABBREVIATIONS

ADEME: (www.ademe.fr). A public establishment of an industrial and commercial nature under the joint supervision of the Ministries of Ecology, Energy, Sustainable Development, Regional Development and Ministry of Research. Areas of competence: energy, air and noise, soil and waste, environmental management (sites and products).

AGORA 2020: is a 2020 prospective report from the MEEDDAT studying research priorities in the fields of transportation, town, housing, construction, regional development and natural environment.

AII: Industrial Innovation Agency. This latter has been a part of OSEO since January 2008. This integration should remedy the present weakness in support for medium-sized innovative companies. OSEO will provide a single contact point, offering a wide range of aid suited to all sizes of company and innovative projects.

AMO: Assistance with Employership. AMO is a contract by which an employer engages the services of a public or private authority to carry out the studies necessary to undertake a project. The employer relies first on the engineering consulting capacity. But to carry out his own missions, the employer must implement other skills: definition and control of the programme, times, costs and quality, management of the project, etc. If he does not possess all these skills himself, external assistance is justified, hence the idea of “employer assistance”. See the guide published by Syntec-Ingénierie in October 2005: Assignments of Assistance to the Employer.

ANR: National Research Agency (www.agence-nationale-recherche.fr). A public establishment of an administrative nature created on 1 January 2007. Its purpose is to increase the number of research projects from the scientific community, financed following competition and peer evaluation.

ANRT: National Technical Research Association (www.anrt.asso.fr). A meeting point of research and industry; the ANRT, set up in 1953, groups together the main public and private participants, of R&D: companies, research and training organisations, industrial technical centres, companies for contract

research, engineering and advice. Its purpose is to assist and improve the efficiency of the research and innovation system in France, encourage discussions and develop cooperation, at both national and European level.

ARMINES: Created in 1967 on the initiative of the Paris School of Mines, ARMINES is an association for contractual research, a partner of major Engineering Colleges. (www.armines.net). Its purpose is “industry oriented” research and it provides its joint research centres in colleges with personnel, equipment and operating resources, proportional to its volume of contractual business. With almost 500 employees of its own, working in over 50 laboratories, the participation of research teachers in schools and a contractual business worth 37 million Euros in 2006, it is the largest French structure for contractual research attached to higher education colleges. In this way it strengthens the R&D activity of the “Ecoles des Mines” network under the supervision of the Ministry of Economy, Finance & Employment, the Polytechnic College, ENSTA, ENPC, and the Naval College, focusing on industrial issues.

AUGC: University Association of Civil Engineering. It published in April 2007 an in-depth enquiry, conducted with its members, on the synergy between the AUGC and the professional sectors (entitled “Enquiry and Proposals for more effective civil engineering research”).

BEI: French acronym for the European Investment Bank – EIB (www.eib.org). The EIB is an organ of the European Union. It was created by the Treaty of Rome. Its stakeholders are the Member States, whose Ministers of Finance constitute its Board of Governors. Its task is to contribute to the achievement of the objectives of the European Union by granting long term finance in favour of viable investments.

CIACT: the French Interministerial Committee of Development and Territorial Competitiveness. It is headed by the Prime Minister and includes the ministries concerned in regional development. It was initiated on 14 October 2005 and followed on from the Interministerial Committee for regional development (CIADT).

CIFRE: Specific convention for the employment of a student, for elaborating its thesis (with specific taxes and social incentives).

CIR: Research Tax Credit. Defined in article 244, section B of the general French tax code (CGI), RTC is a system for encouraging companies to carry out research and development work. The expenditure must be incurred in carrying out scientific and technical research and development, whether fundamental research, applied research or experimental development, including building prototypes and pilot installations.

CMP: Public Procurement Code (legislation). In order to harmonise the provisions of the public procurement code with those of the Public Procurement directive no. 2004/17 and 2004/18, which were adopted on 31 March 2004, the public procurement code was modified by a French decree N°. 2006-975 of 1 August 2006. The new rules came into force in France on 1 September 2006.

COMPETITIVENESS CENTRE: "pôle de compétitivité". In an increasingly competitive world, France introduced a new industrial policy in 2004 which mobilises the key factors of competitiveness, especially the capacity for innovation (www.competitivite.gouv.fr). A competitiveness centre is an association of companies, research centres and training organisations in a given region, engaged in a partnership (joint development strategy), aiming to release the synergies resulting from joint innovative projects in one or more given contracts. This policy aims to generate and then support initiatives emanating from financial and academic bodies in a region.

CSTB: "Centre Scientifique et Technique du Bâtiment » French public centre for research and certification in building works. (Part of the MEEDDAT-RST)

DGE: "Direction Générale des Entreprises" Department of the French Ministry of Economy. (www.industrie.gouv.fr/portail/une/dgeso_m/htm). It summarises the preoccupations of industrial policy and regional aspects for which the Regional Departments of Industry, Research and the Environment (DRIRE) are responsible.

ECCREDI: The European Council for Construction Research, Development and Innovation. Its aims are to contribute to the competitiveness, quality, safety

and environmental performance of the construction sector and to the overall sustainability of the built environment, by increasing the extent and effectiveness of construction research, technological and process development and innovation.

ECTP: European Construction Technology Platform (www.ectp.org). The technological platforms were created by the European Commission and are destined to become a key part of European research policy. A technological platform is basically a mechanism for bringing together all parties interested, with a long term view, to face a particular challenge. A move towards partnership contracts is expected in the community of researchers, industrialists, decision makers and representatives of civil society with a view to achieving the objectives set by the European Commission. The ECTP, created in 2005 and dedicated to the construction sector, has the following objectives: 1) to develop research and innovation in the field of roads, railways, ports, bridges, tunnels, cultural heritage, etc.; 2) to develop new and multi-disciplinary approaches in the field of town planning; 3) to support the European construction industry to make it more "knowledge based" and maintain its world leadership; 4) to introduce environmental concerns into the practices of the sector, in particular under conditions of devolution of contracts (*source: CNISF*).

EFCA: European Federation of Engineering Consultancy Associations (www.efcanet.org). EFCA is the sole European federation representing engineering consultancy and related services, in particular to the European Institutions. It represents 29 professional associations from 28 countries, which is a network of over 10,000 firms throughout Europe. EFCA monitors the legislating institutions – in order to ensure that market conditions remain favourable to the engineering consultancy industry, but also plays a strong proactive role (conducting studies on the sector etc.).

EUREKA: created in 1985, the Eureka programme is an intergovernmental initiative which includes 36 member countries and the European Union. The presidency rotates and changes every year. The objective is to provide financial support for technological cooperation projects between European companies and laboratories. The Eureka programme thus enables European businesses to share the risks and costs of innovation which can be very high; it concerns both SMEs and large

organisations.

Besides financial support, Eureka awards a label to the projects supported.

EMPLOYER: the term refers to describe the client or contracting authority and is used for reasons of consistency with the jargon used in FIDIC contracts.

ENGINEER: the term refers to the engineering consultancy(ies)/service provider and is used for reasons of consistency with the jargon used in FIDIC contracts.

FIDIC: International Federation of Consulting Engineers (www.fidic.org). FIDIC represents the engineering sector at international level. As such, the federation defends the interests of the engineering consultancy industry. Its objectives are to develop working methods, promote ethics in business, promote and raise the image of the industry.

HABISOL: an Intelligent Housing and Solar photovoltaic research programme of the French ANR (2008-2010). HABISOL essentially seeks to promote ground-breaking research into the intelligent housing concept and the use of photovoltaic energy as a renewable source for the production of electricity. The programme intends to deal with subjects relating to home domotics, modelling types of construction, insulation components, work on materials for the development and integration of photovoltaic solar cells and innovative concepts involving photovoltaic cells.

HQE: Association (architects, consulting engineers...) for the promotion of high quality environment in construction. Also a label HQE[®] for those works or services which are respecting the methodological criteria defined by this association.

INRETS: French public institute for research in transportation networks and security (part of the MEEDDAT RST).

LCPC: "Laboratoire Central des Ponts et Chaussées", French public laboratory for research on public works. Part of the MEEDDAT RST.

MEEDDAT: Ministry of Ecology, Energy, Sustainable & Regional Development (www.meeddat.gouv.fr). MEEDDAT was created on 1 June 2007; it focuses on ecology, transport, regional development, housing, the sea, etc. Its activities focus on five major areas: Resources, land

and housing; Engineering and climate; Risk prevention; Infrastructure and Transport; and Sustainable development.

MOE. "Maître d'oeuvre" a French concept more or less equivalent to "the engineer". It is in charge of the design of the works and supervision of the construction. The engine is therefore responsible, for designating an individual entity to be responsible for the satisfactory progress of the contract (project management). This is the project leader.

MOU: "Maître d'ouvrage" more or less similar to "the employer". He represents the body supplying the requirement, defining the objective of the project, its schedule and the budget for the project. The expected result of the project is the building of a product, called the work. The employer provides the basic concept of the project and thereby represents the end users for whom the work is intended. The employer is therefore responsible for the functional expression of the requirements but does not necessarily have the skills to build the work.

OSEO: a State establishment, the task of the OSEO is to finance and support SMEs, in partnership with banks and capital/investment organisations, at the most decisive phases of their development (www.oseo.fr). To perform this task successfully, the OSEO has complementary objectives: supporting innovation with financing of investment and the operating cycle in partnership with banking establishments with a guarantee of bank finance and supplying its own funds *with an OSEO guarantee*.

Partnership contract (Public Private Partnership)

A partnership contract allows a public awarding authority to entrust a group of companies with a mission of financing, partial or total design, building, maintaining and managing public works or equipment and services, on a long-term basis paid for by the public authority in instalments. The objective is to optimise the respective performance of the public and private sectors in carrying out urgent or complex projects as quickly as possible: hospitals, schools, information systems and infrastructure.

PCRD: French acronym for the European Commission's Framework Programme for Research and Development. The programme was created in 1984, based on multi-year framework programmes, still remains today the keystone of European policy

for research and technological development: an important source of finance for SMEs. The 7th Framework Programme (FP7) started in 2007 and will run until 2013. It has a budget of 50.5 billion Euros (of which 15% is reserved for SMEs), which is increasing with a view to achieving the goals set in the Lisbon strategy.

PRECODD: The French ANR ecotechnologies and Sustainable Development programme planned for 2008 (4th and final call for projects). This programme (www.precodd.fr) covers environmental technologies centred on the prevention, treatment and measurement of polluting emissions of industrial and urban origin in the widest sense, and aims to strengthen French R&D on methods of “clean production”. PRECODD covers in particular new production and treatment processes, the protection of natural resources and tools and services for the evaluation of environmental performance and integrated environmental management.

PUCA: Town Planning, Construction and Architecture Plan of the MEEDDAT (www.urbanisme.equipement.gouv.fr/puca). Since its creation in 1998, the PUCA has developed incentive research programmes, experimental actions and given its support to innovation and scientific and technical evaluation in the fields of regional development, housing, construction and architectural and urban design.

RISKNAT: The French agency ANR research programme for the Control, Reduction, Compensation and Repair of natural risks (2008-2010). Natural disasters that occur rapidly (sudden and extremely rare disasters with a heavy impact) of lithospheric origin (earthquakes, volcano eruptions, landslides, tsunamis), including some climatic and hydrological factors (mudslides, avalanches, sudden rises in water level, etc.) are not by their nature “controllable” in advance. To reduce their physical, human and social impact, it is not only necessary to control the associated risks (assessment and prevention) but to consider their reduction (what solution to adopt), or even compensation and/or repair (. The programme emphasises the importance of collaboration between the technical, social, financial and legal disciplines.

RST: Public Scientific and Technical Research Network of MEEDDAT. It consists of about thirty design, test, experimentation and teaching organisations, public establishments or State

departments. Their purpose is to produce the scientific knowledge necessary for public action in the traditional spheres of action of the ministry (transport, town planning, development, civil engineering, housing), but also concerning, risk prevention, the environment, land, sea and coastlines, and the elements.. Their staffs are about 15,000 employees.

SRP: French Department of Research and Forecasting, part of MEEDDAT. In association with the knowledge requirements of other departments of the ministry and decentralised departments, SRP is responsible for coordinating research activities, monitoring and scientific forecasting, in the fields of ecology and sustainable development. SRP is also responsible for the distribution and evaluation of research and forecasting, by managing the various public authorities likely to use these results: the “usual” institutional partners of the ministry, regional groups, organisations responsible for open spaces, industries concerned with ecology and sustainable development, associations, etc.

SUSTAINABLE TOWNS: an ANR research programme (2008-2010). The aim of this programme is to integrate research topics into urban systems, from questions of governance to technological aspects. The programme has two major objectives: 1) engineering efficiency on an urban scale with a view to achieving a factor of 4 by 2050; 2) better social and environmental integration in the context of sustainable development. This new programme includes subjects previously dealt with under the PGCU (civil engineering), PREDIT (mobility) and PREBAT (socio-economics of urban housing). It also encompasses the environmental aspects tackled under PRECODD (urban waste management, metrology and air quality, etc.).

WSSTP: Water supply and Sanitation Technology Platform – (www.wsstp.org): created in 2004, the WSSTP includes bodies concerned with water and the urban environment. It is part of the ECTP which brings together stakeholders in construction. The many participants produce a common vision and a strategic research plan for the sector.

"WHITE PAPER: ENGINEERING CONSULTANCY AND INNOVATION"

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- Responsibilities and insurance (French), March 2005.
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