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Advanced Information Systems Project Management

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Monograph: Advanced Information Systems Project Management (published jointly with Novática*)

Guest Editor: *Julián Marcelo-Cocho, Antonio Teti, and José-María Torralba-Martínez*

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CEPIS NEWS

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Presentation

Advanced Information Systems Project Management

Julián Marcelo-Cocho, Antonio Teti, and José-María Torralba-Martínez

Luciano D'Amico places his article "*EUCIP Training for ICT Project Managers and Similar Profiles*" within the framework of the rapid worldwide transformation described by ***Antonio Teti*** in *"Training ICT for the Recovery of European Economies*". The article deals with the knowledge, competencies, and skills required in various key areas. The importance of EUCIP training hinges on the fact that it impacts on a situation to which too little attention is paid and one in which goals are rarely met; it is the normal promotion path for IT professionals; it straddles the promising frontier between organizational and technical issues; and it also converges with the increasingly more common approach whereby production activities are organized as objective-oriented projects.

The widespread recognition of the function of ICT project manager is still such a recent phenomenon that at times it is hard to separate it from the functions of product development and provision of services that make up the bulk of IT training. ***Marta Fernández-Diego*** *and* ***José Onofre Montesa-Andrés*** describe an "*ICT Project Management Methodology*", supported by the chronological reorganization of the PMBoK Project Management Body of Knowledge which is a *de facto* standard for ICT projects (after its adoption by the IEEE as Standard 1490).

As an example of an alternative method, ***Michelangelo Carbone*** contributes his article "*Benefits of a Structured Methodology in Project Management: How to Manage a Project in a Structured Way with PRINCE2*".

José-María Torralba-Martínez, Marta Fernández-Diego, *and* ***José Cuenca-Iniesta,*** tackle the subject of "*Traditional Price Determinants in Software Projects, with Consideration to Non-Corrective Maintenance*". These same authors go on to expand upon this topic in an article that looks into the ever more delicate economic aspects of ICT projects, entitled "*Classification of Software Project Suppliers' Expenses Taking into Consideration that the Software Is Reusable*".

Centring in on the growing uncertainty of the aims of such a dynamic sector, ***Julián Marcelo-Cocho*** *and* ***Marta Fernández-Diego*** introduce the topic of "*Risks and Project Management"* by providing a general overview, before addressing the more specific subject of "*Driving Projects by their Risks"*.

Finally, ***Colin Ash*** looks into the "*Convergence of IT Project Management and Change Management: A Comparative Study*" which would sound like a truism if it were

The Guest Editors

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not so often forgotten that an ICT project is not an end in itself. The ultimate goal of an ICT project is established by the implementing organization in which it is hoped to prompt a change in human behaviour, the success of which is by no means easy to ensure.

The above mentioned articles are basically a selection of the presentations delivered at the EMIS-PM, the first European Meeting on Information Systems Project Management, held in Valencia on June 23 and 24, 2007 as part of the 4th European and Mediterranean Conference on Information Systems EMCIS'2007, and sponsored, among others, by CEPIS and ATI. Thanks are due to EMCIS for granting permission to publish these articles in **UP**GRADE and ***Novática***; especially because these presentations, which are half-way between daily practice and research, are what allow us to entitle this monograph *Advanced Information Systems Project Management*, a concept which is vital if we are to continue to be successful in meeting objectives to a degree that hitherto seem to have been impossible judging by the scant statistics available to the sector.

Translation by ***Steve Turpin***

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The following references, along with those included in the articles this monograph consists of, will help our readers to dig deeper into this field.

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Training ICT for the Recovery of European Economies

Antonio Teti

The offshoring of the European ICT sector and the immigration of IT professionals calls for a drastic review of our professional policy, one which will improve and shape ICT resources to meet the demands of the new global and local scenario.

Keywords: *Globalization, ICT, Offshoring, Professional Certification, Training.*

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1 In a "Glocal" World (Global and Local at the same time)

For a number of years now Information and Communication Technologies (ICT) have taken on the role of main player in all human activities in the world today. Internet and globalization are the glue that integrates information technologies in all organizations, providing services at all levels. ICT can be an enormous help in reducing the cost of products and services which can yield substantial returns, even in the field of employment.

Meanwhile the ICT itself is rapidly changing to accommodate new trends and services (information blogs, e-commerce, e-learning, Internet Protocol TV, etc.). Under the influence of these trends and transformations, the market is being driven by a process of concentration of objectives and strategic alliances between the "players" of an even greater magnitude than in the golden years of the *New Economy*. The record number of acquisitions and of mergers in the last two years both in Europe, and more particularly in the United States, will have a great impact on the years to come, especially on world markets.

This scenario is replete with opportunities and potential. But there are also threats, particularly for southern European countries, if they fail to adopt structural policies to promote sustainable innovation and if their companies do not attempt to innovate, since otherwise they will put their long-term survival at serious risk. The challenge in the coming years for all the players in the market (users and suppliers, and European Governments) will be to read the present situation with eyes toward the future, not to the past, and act accordingly.

It is common knowledge that Southern European economies are based on a large proportion of small and medium-size enterprises which make a consistent contribution to the national economy. This economic and industrial fragmentation does not impact negatively on the development of ICT in companies: in fact it often leads to a great effervescence of the ICT market at its lower levels and may actually be a strong point, given that many ICT solutions tailored to the requirements of the customer (often an SME, Small and Medium Enterprise) originate from the desks and keyboards of local programmers. But at the same time this fragmentation also represents a weakness, because it is not conducive to the provision of complex solutions, undoubtedly in the hands of major international, and especially US, companies.

Southern European markets are strongly dependent on external ICT markets and are highly influenced by external suppliers, whether they be operating systems (Microsoft), anti-malware systems (Symantec, McAfee), databases (Oracle, DB2, SQL Server), ERP systems (SAP, Sage, IBM), servers (Windows, SuSE, Red Hat, Solaris), publishing and multimedia platforms (Dreamweaver, Photoshop), storage solutions (CISCO, Sun), hardware (Dell, HP, IBM), or Internet search (Google, Yahoo, Altavista). Some excellent home-grown and European products may be highly successful, but most find it difficult to break into international markets, partly as a result of weak and poorly interoperable ICT infrastructures. The more the market goes global, the greater this disadvantage becomes. Europe has also been very slow to adopt open technologies and platforms that could provide a great opportunity for innovation and competitive repositioning.

We all know how difficult it is to make accurate forecasts in a sector characterized by constant changes in trends and markets, as amply demonstrated by the "boom" of the *New Economy*, which later turned into a "bust" as a large number of ICT companies launched on the promise of easy pickings went to the wall). But there are also excellent examples of ICT progress in Europe, such as Ireland and Estonia, whose economic growth in recent years rivals that of the "Asian tigers" of the nineties. Dublin is a completely

WiFi wired city, while Estonia may be the most high-tech nation in Europe. But it is not enough to become more organized: the companies and governments of European countries need to make a massive investment in innovation and new technologies to promote the supply of products and, most of all, services which are currently provided under archaic methods and systems.[1]

2 The Drive of "Chindia" (China and India)

Meanwhile globalization has prompted many European companies to offshore their own activity to countries like China and India. India is becoming the low-cost destination for all those service activities that have grown too expensive in the wealthy English-speaking countries (USA, UK, Australia).

The Gross Domestic Product of India is growing at an annual rate of 9% and the real driver of this growth is the ICT sector itself, which in some cases is growing at a rate in excess of 40%. Indians can deliver all intangible services to the English-speaking countries in a perfect English accent (they need only 4 months of language training) with competencies that are often greater than those of their wealthier counterparts, and at a fraction of the cost.

Being quick to realize the potential of the Indian market, the big US ICT companies are spending billions to offshore to India. "ICT villages", such as New Oroville, have sprung up, where a constant stream of technicians (nearly all IT and engineering graduates) live, work, and are trained in state-of.-the art technologies while earning a fraction of what they would be paid in California. Multilingual call centres, accounting systems, multilingual educational aids (exam correction, preparation of tests), telemarketing, legal queries and actions, architectural and engineering projects are just some of the service in the process of offshoring.

Because ICT sector services are already highly offshored: software production; remote customer care for PC users; system interventions for networks, servers, and databases; data migration and integration (documents are physically transferred and restored); security consultancy; document management; statistical analysis of acquired data; multimedia operations (video, audio, and photographic montages), etc. The firms involved are Dell, Oracle, IBM, Microsoft, Sun, Intel, AMD, SAP, HP and a host of others.

China is up there too, and its strength does not only lie in low salaries. The Chinese miracle is also the fruit of high productivity, high quality of education and scientific research, and investment in modern infrastructures. For example, the Zhangjiang High-Tech Park in Pudong is, even today, still largely unknown to most people. Until 1992 it was just a huge field farmed by poor farmers; today it is home to 3,700 companies which have invested nearly 11,000 million dollars to create laboratories and scientific and technological research centres in what has been dubbed China's Silicon Valley. Which companies have invested there? Microsoft, Intel, IBM, Hewlett-Packard and Infosys among others. It is no coincidence that since 2003 Asian markets have even had a specialized profession whose members are referred to as "offshore engineers".

3 Repercussions in Europe

It is not only European companies that are shipping part or all of their manufacturing activity to emerging countries. Queuing up at the borders of Europe are thousands of competent technicians who are hungry for salaries that here we might think ridiculously low. The number of Indian and Chinese engineers is not only growing in English-speaking countries. This is hardly surprising if we consider that on average an Indian IT engineer is happy earning around 17,000 euros in Europe, while his Chinese counterpart (equally well qualified) is willing to accept 13,000 euros. In other, less Anglophone countries we might think that the fragmentation and lack of dissemination of many European languages would act as a deterrent. But in the Balkans and the Baltic states, language schools teaching these languages (German, French, Italian) are springing up like mushrooms to teach the local technicians who want a better income but would prefer to stay in their own country. Such operations are often backed by the big companies that straddle the new European countries and are subsidized by European cohesion funds.[2]

It is not a question of whether this problem of the fierce competition for IT jobs will arise, but rather of exactly what form it will take when it does. The only proactive solution available hinges on the competence and professionalism of all involved. European governments, schools and universities must play a decisive role in a process of cultural renewal involving professional innovation and growth at each and every level. There must be a constant effort to promote cultural and professional growth among Europe's IT professionals at every level, whether institutional or corporate.

Ongoing training means improved skills, greater competitiveness, and therefore a better outlook with regard to the evolution and enhancement of the products/services provided in the context of a worldwide market. For example, in the United States, which has been hugely affected by offshoring, the local technicians are spending money and energy on becoming more specialized, an effort which often pays dividends by allowing them to rejoin the job market with better prospects. They cannot prevent the arrival of job-hungry foreign professionals, so they attempt to lev-

[1] For example, one idea might be the use of digital ID card based on RFID technology (a radiofrequency based ID system) which has been trialled in the United States and is now fast being widely deployed: by means of a very simple, low cost "card" all the cardholder's data plus all case information can be captured speedily. After its trial as an "ID card" it will also be used as a digital passport, without any additional implementation, thereby simplifying procedures and saving time, etc.

[2] The countries that were former colonies of Spain, Portugal, France or Great Britain have fewer language and culture problems; their relative proximity of distance from Europe gives rise to a more stable model of immigration.

erage the cumulative advantage gained in previous years to raise their own skill levels and become competitive again in the job market.

The commitment of European institutions and national governments plays a vital role as a driving force behind the ICT sector. Unfortunately, institutions and governments have for decades been unfairly providing aid to companies without a future (latterly even to football clubs) and have neglected to give proper help to the "jewels" of their economies: companies that were once "centres of technological excellence" and are now mere shadows of their former selves.[3] You do not need to invent the wheel or be a rocket scientist to know which are the best choices to make and which are the best paths to take. Often all that is needed are simple incentives to give a boost to a sector which is already rich with skilled and competent professionals. The simple availability of broadband, for example, may be one of the best "fertilizers" available today, together with the raising of public education standards. But we continue to see incredible examples of wasted financial and human resources.[4]

4 Qualitative and Quantitative Improvement of Professional ICT Skills

The production of IT systems and the consequent distribution of services is the result of a complex organizational machinery involving technology, applications, know-how, and the availability of personnel. Whether we are talking about a company operating in the open market or merely an internal corporate function, these critical success factors do not only rely on the knowledge and mastery of the technologies but, and perhaps more importantly, on the ability to transform technologies into services for external or internal customers.

In the training sector there has also been a major change in direction: professionals and companies need to make a large investment in training, in specialization, and in ensuring that the business activity itself is not only profitable but also as professional as possible. As is said in the English-speaking world "…training to invest in yourself".

There are obvious benefits to be obtained from the use of Internet in companies' business processes, whether in terms of increased efficiency or improved performance of existing processes, or in terms of new strategic opportunities.

But the enormous strategic importance of ICT in companies also introduces new and serious risks arising from the need for new professional categories to be introduced in the ICT sector. Economic and social activities' growing dependency on ICT makes it critical to address the problem of defining or creating specific and up-to-date competency profiles in the sector. To ensure the delivery of the desired performance levels, specialists entrusted with the design, construction, and implementation of a system not only need to have a sound competency in a specific area, but must also have a vast, constantly updated, experience of current technological advances. This leads to the conclusion that, even after completing a specialized university course, a young, recently graduated IT professional needs to maintain an ongoing and sustained level of specialization, and cannot afford to relax and let his or her knowledge slide into obsolescence.

5 EUCIP, Paradigm of European Certifications for ICT Professionals

Ongoing training is the key to the success for all categories of specialists wishing to succeed in business environments subject to continuous changes driven by the evolution of technology and the communication media.

For this reason CEPIS (*Council of European Professional Informatics Societies*) decided to set up a European programme to develop a training course aimed at all IT professionals wishing to receive specific, highly specialized training. The basic idea of the EUCIP programme (*EUropean Certification for Informatics Professionals* – http://www.eucip.org) is to establish a level of certification demonstrating a specific professional competence in accordance with the candidate's career path.

CEPIS had previously been responsible for the ECDL (*European Computer Driving Licence*), its popular and widely recognized certification that indicates a basic level of IT competence at user level. But CEPIS places EUCIP at the tip of the certifications pyramid; EUCIP certificate holders have proven themselves to be highly competent professionals capable of occupying top-level positions requiring a high degree of responsibility and professional competence in a business environment.[5]

EUCIP certification does not only aim to raise the profile of the professionals awarded it. It also aims to offer corporate organizations a guaranteed source of certified professionals with a high level of training and specialization who will help optimize the productivity and profitability of their businesses.

6 EUCIP and the re-Launch of ICT in Europe

EUCIP forms part of the Lisbon strategy re-launch proposed by the European Union. CEPIS President Geoff

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[3] Having worked for a number of years at Olivetti's Research and Development Centre (which at the time was more advanced than its American rival, AT&T), I remember how we used to get researchers coming from all over the world to study the technologies used by Italy in the manufacture of the first PCs of that time.

[4] By way of an example we only have to look at the bizarre portal set up to promote tourism in Italy <www.Italy.it> which was recently officially released to the public at large. It cost something in the region of 50 million euros to produce, but expert opinion around the world claim it is slow, technologically obsolete, and poor in content. To cover their backs after a less than glorious presentation, the Government has said that the portal "*is still under development*". Meanwhile China has overtaken Italy as a destination for international tourism. Developments like this are not the way to meet the global challenges posed by ICT.

[5] CEPIS has also developed the IT Administrator certificate, a professional level with a more limited responsibility for positions in smaller, either independent or decentralized, entities.

McMullen presented EUCIP as part of a project developed by a consortium made up of CEPIS, Manchester University, and Eurochambres, with the sponsorship of the Directorate General Enterprise and Industry [1]. This project analyses an extensive consultation with the ICT industry and its European organizations, both public and private, and a key element of both the current long-term European e-Skills strategy (ICT profiles) and CEPIS's own EUCIP ongoing training strategy to acquire those e-Skills.

The study uses six scenarios to cover the range of possible job markets and works with a robust prediction model to forecast the supply and demand for e-skills while factoring in the impact of offshoring. The study analyses the influence that some 90 factors may have on supply and demand, broken down into three main headings: the rate of ICT innovation, the economic climate, and the pace of offshoring. Each scenario addresses different professional shortcomings and requires an appropriate public policy at a national and a European level.

The study concludes by recommending that we should seek to improve both our understanding of the growth and globalization scenarios of the ICT sector (by improving the quality of data and making comparative studies) and the degree of collaboration between companies and politicians with regard to the impact of changing ICT cycles.

Finally, the study calls for a detailed examination of the qualitative aspects of the current e-skills gap (for example, by taking joint action to create positive publicity for careers in ICT), together with the development of innovative ways to correct the gap between the e-skills that enterprises require and those that universities teach. The study also calls for increasingly more pressing socio-professional agreements, both at a domestic level in each country and at an international and European level [2] [3].

Translation by ***Steve Turpin***

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EUCIP Training for ICT Project Managers and Similar Profiles

Luciano D'Amico

CEPIS's ongoing training and EUCIP certification scheme meets European IT training challenges with courses that are of particular relevance to ICT consultancy and project management, developed in cooperation with Italian and Spanish universities.

Keywords: ICT, Postgraduate Training, Professional Certification, Project Manager.

Author

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1 A Europe without Professional or Academic Frontiers

The essential and increasingly more conscious link between the practice of a profession and the training (both initial and ongoing) required to practise it is bringing about a change in the way the two issues are being addressed in Europe, in a manner that is complementary to the traditional political ideal of a "Borderless Europe", one which tends to omit academic and professional aspects.

In its quest to create a European Higher Education Area (EHEA), the "Bologna Process" is seeking the euroglobalization of things academic and professional, and convergence with the globalizing Europass in order to produce a competency-based, socio-professional curriculum which is transportable between states. In this process, special emphasis is placed on creating common definitions of profiles, competencies, and skills.

Using this dual training and career-oriented approach as a springboard, CEPIS (*Council of European Professional Informatics Societies)* decided to improve the skills of its nearly 300,000 members divided among the 37 national associations that comprise CEPIS. A wide range of 21 ICT profiles (*e-Skills*) have been defined, with each profile backed by its respective European EUCIP certificate to ensure that the IT professionals who receive this certification have objectively and effectively complemented their professional experience with an average of some 1,200 hours of training, assessed by a series of tests, interviews, and practical work.

The intensive nature of the training requires a major effort from the trainers in terms of preparation and monitoring, while trainees need to dedicate at least one year if the training is undertaken on a full-time basis and two if part-time, which places preparation for a EUCIP certificate at the same level as a university master's degree in terms of quantity and quality. The universities of several European countries have recognized this by developing courses leading to academic qualifications running parallel to the training required for the EUCIP exams. For example, in Italy EUCIP has been adopted by the National Interuniversity Consortium for Computer Science (CINI), which is backed by the Conference of Italian University Rectors (CRUI).

2 Ongoing Training for a Continous Evolution

After the first steps taken by CEPIS to analyse the situation and outlook for the profession in all its aspects (see the last section of ***Antonio Teti***'s article in this monograph), a number of national associations of IT professionals, including the Italian AICA (*Associazione Italiana per l'Informatica ed il Calcolo Automatico* – Italian Association for Informatics and Automatic Computation) have tailored that analysis to their own particular local conditions[1]. "*The understanding of the ways in which enterprise models, digital technologies, work organization, and processes evolve and interact to generate new business models, is fundamental to the understanding of how work and the competencies required both by users and by ICT specialists evolve so as to be able to plan, build, install, and manage information systems capable of improving the overall performance of private and public entities…*". "*This complex evolution has had a noticeable impact on the relationship that an enterprise establishes with the market by means of its correlated products/services portfolio, the way it is set up, financed, organized, and operates, and of course, the technological model providing support to the management…*".

On the basis of these considerations, Figure 1, adapted from the above mentioned AICA study, presents three types of situation and requirements regarding ICT competencies:

■ All the staff in ICT user entities use PCs in their work and need a systematic updating of their ICT user skills due

[1] **R. Bellini** (AICA). *Il Cantiere dei Mestieri ICT (misurare le competenze per tornare a competere)*, [The ICT craft workshop (measuring competency to become competitive)] September 2006.

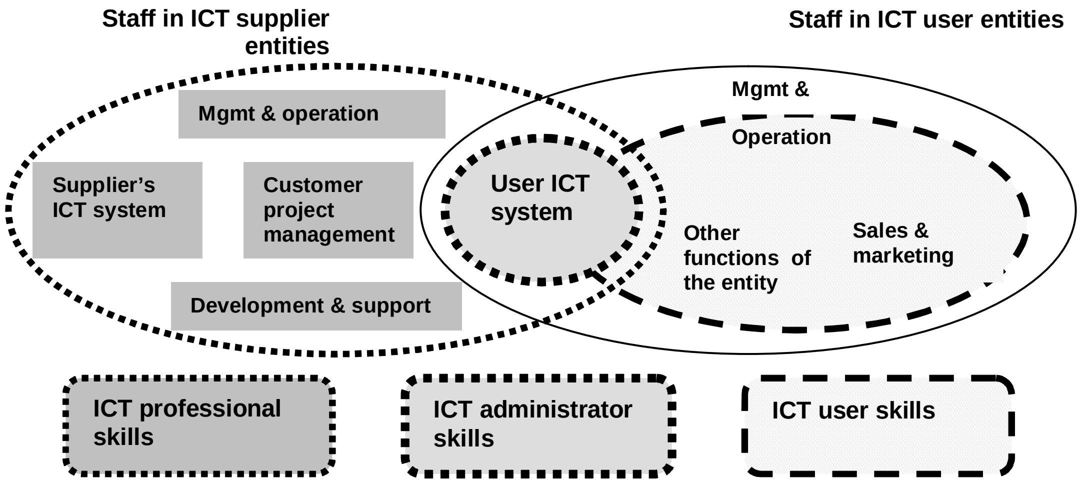

Figure 1: ICT Skills Requirements according to the Different Types of Situation (Source: AICA).

to the complexity of their relations with customers, colleagues, subordinates, suppliers, processes, services, etc. (this updating can be achieved using ECDL (*European Computer Driving Licence)* certification, designed and supervised by CEPIS).

■ User ICT systems jobs are at a level halfway between users (to whom they provide services) and specialists (with whom they share technical skills). For these professionals CEPIS has designed and supervises the EUCIP ICT Administrator certification.

■ Staff in ICT supplier entities are obliged to give their professional guarantee of the suitability and effectiveness of systems supporting the various types of business processes. This calls for the ongoing oversight of their specialized skills with regard to technological trends and developments and the knowhow required to plan, build, and manage "optimal" ICT systems (this guarantee can be achieved using EUCIP certification profiles, designed and supervised by CEPIS).

3 Structure of EUCIP Profiles and Skill Gaps in Certain ICT Professions

EUCIP divides professional ICT competencies into two levels (applying to employees who basically work as ICT suppliers)[2]:

- ***Core level***. This level corresponds to a set of obligatory competencies broken down into the three life cycles of IT: *PLAN (Management of information systems), BUILD (Construction of information systems) and OPERATE (Operation of information systems).*

- ***Elective level***. In this level the candidate's training path subsequent to the three previous cycles is mapped out. This level provides for specialization in particular competencies and allows the candidate to choose the training path that best suits his or her aspirations and abilities. CEPIS has identified 21 profiles covering all the current professional spectrum. These profiles can be grouped into 7 main professional areas (in addition to the 3 cycles of the "Core level"), as shown in Figure 2.

EUCIP has organized the 21 elective profiles into two levels of depth, with over 150 subjects which extend and deepen the 18 subjects making up the common core. These subjects can be credited with knowledge acquired on other courses and certifications from other systems once verified, and full EUCIP certification is only awarded after the candidate has demonstrated experience in the subject appropriate to the target profile.

When comparing the current situation and outlook of Italian IT professionals and their actual needs, the above mentioned AICA study states that *"the ICT profession is incapable of sustaining innovation in products and in a number of critical processes in non-ICT enterprises; in particular there are serious shortfalls in many important profiles"*. In particular:

■ In the PLAN area (management of systems) there is a total, or nearly total, lack of *Enterprise Solutions Consultants, Client Manager,* and *Logistics and Automation Consultants* (needed for organizing Customer Relationship Management [CRM], and Supply Chain Management [SCM] for example). There are also training shortfalls among the manager profiles.

■ In the BUILD area (construction of systems) the profile of *Systems Integration* and *Testing Engineer* is almost completely absent, and even the profile of *IS Analyst* is poorly represented (however there appears to be a surfeit of *Software Developers*).

[2] EUCIP has recently diversified its approach, offering progressive certifications for the *Core* and for the basic EUCIP profile of ICT Administrator aimed at heads of IT working in small entities or decentralized sections of larger entities (and mainly concerned with the operating cycle).

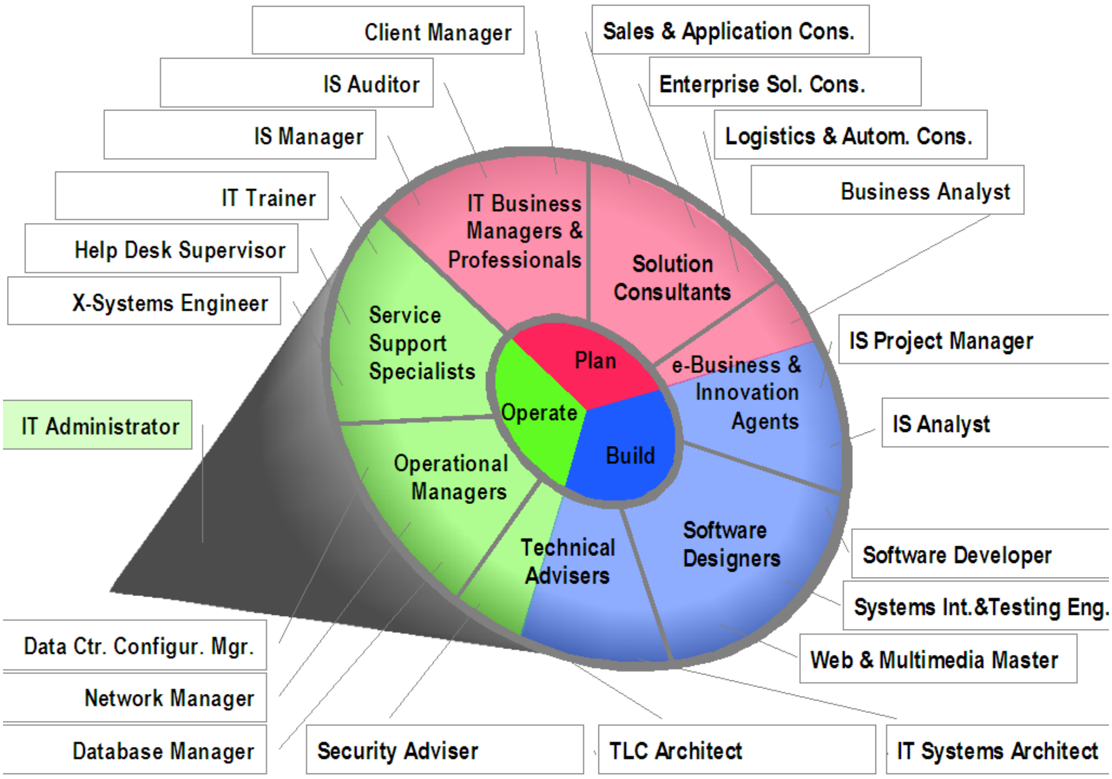

Figure 2: The 21 Professional Profiles of the *"Elective level"* of EUCIP.

■ In the OPERATE area (operation of systems) there are also shortages in the profiles of *Network Manager, Security Adviser,* and *Telecommunications Architect.*

4 Certification for Non-Offshorable Profiles

The hitherto inadequately met need for a range of high-level professional ICT certifications is especially apparent in the PLAN area, which includes the profiles of managers, professionals, and consultants whose functions render them non-offshorable. This need extends to the "border" between system management and construction (the PLAN and BUILD areas) where traditional institutions have also failed to ensure a net supply of suitable professionals.

At this "border", the EUCIP profiles defined by CEPIS corresponding to *Business Analyst* and *IS Project Manager* are therefore not only just as important professionally as all the other profiles, but to date their training needs have been poorly met. Available training tends to be provided by internal training resources with the consequent high cost to the enterprise.

■ The profile of ICT-oriented *Business Analyst* is a little known but crucial link to translate business strategy into information system design and improvement projects. These are acquired on the ICT market or developed internally or externally, either locally or overseas, after the managers have weighed up the risks and benefits of each option and ensured that the various components can be successfully integrated into the current system. The ability to communicate and negotiate with all the players involved, especially with companies that are strongly rooted in their local cultures, makes it difficult to offshore this profile.

■ The profile of *IS Project Manager* lies on the promotional path to practically all the other professional ICT profiles. While at an initial level responsibility is limited to the organizational tasks involved in managing a team (often combined with technical tasks shared with the team), at higher levels the profile is more concerned with the "management of managers", that is to say, the management of programmes and portfolios of projects, with a mindset which is increasingly closer to that of a *Business Analyst* on the one hand that of a *Business Manager* on the other. This profile does not only refer to a member of the ICT supplier team; it is increasingly used to refer to a client manager, one who plans and controls the contracting of external (perhaps offshored) goods and services.

■ For the third "border" profile, the *IS Analyst*, there is a far more robust training market, but which needs to be reoriented much more towards the European side of applications in our glocal world and therefore towards a close collaboration with the professional profiles of *IS Manager* and *IT Project Manager*, the *IS Analyst*'s closest counterparts.

5 The BISA Course at the *Università degli Studi di Teramo* (Italy)

The above considerations were taken into account when the **BISA** combined Master *(Business and Information System Analyst)* was developed to train **ICT experts in business management**. BISA is the first high level university master's degree in Italy based on the EUCIP curriculum for people wishing to work as experts in the organization and management of business IT systems.

A number of entities have collaborated in designing the requirements, goals, and curriculum of the course and defining what jobs it will prepare candidates for. Professional entities are represented by AICA (Association for Informatics and Automatic Computation), and AIP (Association of Professional Informatics), institutional entities by ISCDOS (Higher Institute of Communications and Information Technologies of the Ministry of Communications, Abruzzo Region) and business entities by Telecom Italia and Siemens.

The training towards the Master is aimed at teaching **competencies and behavioural skills**. The former refer to business IT systems and ICT and how they function; the understanding of business and business strategy formulation; business process planning; the identification of the most appropriate ICT solutions to the business in question and its strategies; and inter-enterprise communication.

Behavioural skills develop an attitude towards learning; written and spoken communication skills; attention to the client; ability to collect information; organizational and commercial sensitivity to understand the client's needs quickly and in depth; strategic vision, analytical and synthetic intelligence, imagination and proactivity to formulate and transfer solutions to problems. In short, a persistent goal-driven approach, flexibility, determination, planning and control, team building and leadership.

The success of the first Master programme (2004) led to a second programme being launched (2005). Thus on April 19, 2007 a group of IT professionals became the first people to be awarded EUCIP Professional certification in the *Business Analyst* profile (along with other profiles such as *X-Systems Engineer* and *IS Analyst*).

Prior to their final oral examination, the candidates had submitted a detailed portfolio to the AICA with their work experience, studies, training activities, and accredited modules for their profile. The most objective possible preliminary assessment was made of each candidate's portfolio through a systematic procedure whereby points were allocated to the various aspects under examination. These assessments were then verified and examined in greater detail during an oral exam conducted before a panel made up of three examiners appointed by CEPIS and AICA. In addition to the content of the portfolio, the oral exam also tests the candidate's communication skills with a series of questions relevant to his or her specific professional profile.

6 ConsITIO Specialist and Master Certification in Spain

Like Italy, Spain has also decided to implement EUCIP profile based studies at postgraduate levels leading to either academic diplomas or degrees due to the fact that courses leading to certifications are relatively uncommon in Spain (and especially certifications of such a wide ranging nature).

Thus in September 2007 training for the *Business Analyst* profile begun under the title "ConsITIO". Two semi-classroom-based Specialist and Master university degrees were offered, corresponding to EUCIP's *Core* and *Elective Business Analyst* levels, the curricula of which were adopted in full to qualify for European certification.

Several departments, centres, and Technical Schools of the 3 Polytechnic Universities of Valencia, Madrid and Catalonia, together with the Universities of Cantabria and Murcia, have prepared and personally deliver both the professional refresher courses and the preparation of Enterprise IT Integration Consultants.

From the outset, the Spanish ConsITIO Master has shared organization, experience, and teaching materials with the Italian BISA Master and was present at its launch. ConsITIO in turn has begun to disseminate its programme in Latin America and has signed teaching and recognition agreements as part of the traditional transatlantic university cooperation based on shared cultures and professional needs.

7 EUCIP International University Master Degree in ICT Project Management

The experience gained in these trials opens up the possibility of taking on a new challenge. The Italian and Spanish universities involved in the previous projects are preparing to launch DIPTIC, an International Master in ICT Project Management based on the relevant EUCIP profile and open to the collaboration of other universities and countries. This European Master is organized locally as semi-classroom-based; that is to say, it is basically delivered by specialists in *e-learning* in 6 long weekend classroom sessions at the various participant universities so as to share practical training and experiences.

In total the course consists of some 1,800 hours of study, corresponding to the 60 European credits required (at least in Spain) to qualify as a Master in accordance with the new curricula set out in the European university convergence process.

As in all the EUCIP profiles, DIPTIC is based on the three Common Core level modules which make up some 450 hours of study, to which are added 120 hours corresponding to two classroom training sessions and the preparation of an authorized dissertation leading to a **University qualification at Specialist Level** (which now EUCIP also certificates independently). After its approval (partially transferable), candidates can study for the other four modules forming part of the full Master in ICT Project Management, as shown in Figure 3 below:

- Module 4 - ***Specialization in ICT Projects*** – consists of 13 subjects common to other profiles (in particular to those of *Business Analyst* or ConsITIO, with which it shares 8 topics). This module requires a total of nearly 500 hours of classroom instruction and self-study.

- Module 5 – ***Advanced methods and techniques for***

Mod	Description of competencies to be acquired *Number of =>*	*Subjects*	*Hours*
4	ICT Project Management by standardized management processes	13	500
	Specialization on ICT Projects	***13***	***500***
5	Advanced Project Management methods and techniques	11	370
6	Behavioural skills for Project Management	2	120
7	Classroom sessions (4) and authorized final project		240
	General project management	***13***	***730***
	Total for MASTER *Subjects and Hours of Study =>*	**26**	**1230**

Figure 3: Additional Modules to Gain the Full Master in ICT Project Management.

Project Management – consists of 11 subjects, 10 of which specifically follow standard Project Management texts (and in particular the Project Management Institute's PMBoK). This module requires a total of nearly 370 hours of classroom instruction and self-study.

- Module 6 of ***Behavioural skills for ICT Project Management*** reflects EUCIP requirements for this profile, This module requires a total of nearly 120 hours of classroom instruction and self-study.

- Module 7 includes the other 4 classroom sessions and requires candidates to develop a complete ICT project. This module requires a total of nearly 240 hours of classroom instruction and self-study.

As in all EUCIP Masters, it is possible to transfer subjects from other courses or private certifications, and subjects may be replaced by professional experience provided that it is duly accredited.

Especially in Spain, a number of collaboration agreements with other master degrees in Project Management are being looked into and are very likely to come to fruition. There are a wide range of transferable general subjects being offered to credit, partially or fully, Modules 5, 6 and 7, for which they offer the 500 hours of classroom instruction and self-study of Module 4 of ***Specialization in ICT Projects*** (which, as we have seen, shares many subjects with *Business Analyst* Master) as an intensification of and specialization in ICT Project Management.

The fact that the EUCIP profiles underlying the Italian BISA Master or the Spanish ConsITIO Master exhibit a high degree of convergence with the EUCIP ICT Project Management profile makes it easy to use the former as a springboard for undertaking the latter.

The way the Masters are organized, with the possibility of transferring credits from one to another, ultimately leading to a Master in ICT Project Management, parallels the normal development of professional careers in ICT. Thus candidates begin with the specialized competencies set out in the EUCIP profiles, and work their way up to the kind of

PLAN-type EUCIP profiles	Need	Requ	Spec	Arch	Prod	Inst	Oper	Rev
IS Manager	**A**	B	B	B	-	-	B	B
IS Auditor		B	-	-		-	B	**A**
Client Manager	**A**	B	-			-	-	B
Sales & Applications Consultant	B	**A**	-	-		B	-	-
Enterprise Solutions Consultant	B	B	**A**	-		B	-	-
Logistics & Automation Consult.	-	B	B	-		B	-	-
Business Analyst	**A**							**A**
IS Project Manager		B	-	-	**A**	B		
IS Analyst		-	B	B	B	-		

Need	Needs of the enterprise and ICT skills
Requ	Requirements of the customer and of the proposed system
Spec	Development of specifications of the proposed system
Arch	Design of the architecture of the proposed system
Prod	Production of the proposed system
Inst	Installation & integration of the system
Oper	Operational management & maintenance of the system
Rev	Review of the performance of the system

Meaning of the symbols	
Role played by the profile in the relevant life cycle stage	
A	High
B	Low
-	Negligible
	Nil

Figure 4: Matrix Showing the Relationship between EUCIP Elective Profiles and the 8 Major Stages of an ICT Project Life Cycle.

management positions covered by the profiles of ICT Project Manager or Systems Manager.

8 Towards Specific Basic Training to Sustain ICT Management

Having exploited the natural convergences recognized by EUCIP with the common subjects bordering BISA's "*Business & Information Systems*" Master (equivalent to ConsITIO's "Enterprise IT Integration" Master), attention was then turned to addressing the training shortfalls in EUCIP's PLAN area and its Management profiles.

While the EUCIP profiles falling within the BUILD and OPERATE areas are well catered for by courses at university graduate level or similar, training for profiles in the PLAN area is delivered in a much less systematic manner, if at all, and is often merely embedded within the technical subjects classically considered as being more "scientific" or "engineering-oriented" (as typified by the *Computer Science* or *Software/Hardware Engineering* curricula of the ACM-IEEE).

The traditional training gap in "*Business & Information Systems*", responsible for the creation of most of the ICT jobs in our basically application-based European environment has proved hard to close with models based on US curricula such as MSIS or IS[3].

But the need for specialized intensive training in skills applicable to professional careers in ICT in Europe is driving the construction of a common preparatory knowledge base for the EUCIP "Systems Management" profiles to mitigate this training shortfall.

CEPIS has prepared a matrix which matches EUCIP elective profiles to 8 major stages of the life cycle of an ICT project, indicating the role (high, low, negligible) that each profile plays at the various stages. Figure 4 shows this matrix for the 7 PLAN area profiles and the profiles corresponding to *ICT Project Manager* and *IS Analyst,* the content of which are fairly close to that of *System Analyst Consultant.* As you can see, generally speaking each profile plays a major differentiating role in one of the stages of the project life cycle, with the logical intensification of the training at that stage.

Using this EUCIP matrix as their starting point, in Italy they are designing the first draft of a European graduate curriculum to act as an initial training core for professional careers relating to the planning, management, and operation of Information Systems, to be complemented later by a special postgraduate course in one of the 9 profiles listed in the above matrix.

Translation by ***Steve Turpin***

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[3] "*Guidelines for Graduate & Undergraduate Degrees Programs in Information Systems*" produced by ACM, AIS *Association for Information Systems,* and AITP, *Association of Information Technology Professionals.*

ICT Project Management Methodology

Marta Fernández-Diego and José-Onofre Montesa-Andrés

An Information and Communications Technology (ICT) project manager must have a clear idea of his work, the frontiers of his working area, and any "de jure" and "de facto" criteria that may be useful. This paper describes a chronological project life method using the PMBoK model, which is widely used in many sectors and adopted by the IEEE as standard 1490 for ICT Project Management. The PMBoK Guide is organized into five chronological stages and resembles the post-contractual stages of the better known cycles, models, and methods used in ICT Project Management.

Keywords: ICT, Management, Methods, Projects.

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1 Definitions and Standards

A project, or "a temporary effort to create a result"[1] *, in this case an* Information and Communications System *(ICS), combines a set of documents for communication between the agents involved with a communications package related with the computing hardware. The proportion of both types of communication is variable, just one package of software for simple and obvious solutions, or just a set of documents, for example, in a consultancy project.*

It may be useful if the project structure follows the development life-cycle underlying the project manager's activities execution methods for those activities prior to the contract and for those activities needed in order to fulfil the contract. So a project manager could follow a chronological life-cycle complementing the result construction stage cycle undertaken by the managed team, without confusing the two.

The Project Management Institute (PMI) systematically publishes and updates the Project Management Body of Knowledge guide (PMBoK Guide)[1], a project management method for all types of sectors and services, starting from a contractual agreement reached between the client and supplier[2] . PMBoK is universally known and followed, and as such, it is a *de facto* standard, partially supported by *de jure* national and international standards[3] .

In the ICS specific sector, the IEEE Computer Society[4] has also adopted the PMBoK Guide, and has published *de facto* standard IEEE 1490-2003 which is commonly accepted as the knowledge and practice usually applicable to most projects.

Standard 1490 can be used separately, or jointly, with seven other IEEE standards: 12207 for life-cycle; 610.12 for terminology; 1028 for revisions; 1044 for anomaly classification; 1045 for productivity metrics; 1058 for project management plans; and 1074 for development processes. IEEE 1490 also analyses the correlation in key terminology between the PMBoK Guide and IEEE software engineering standards, and accordingly:

- IEEE 1490 takes from the PMBoK Guide the definition of **project life-cycle** as "*a set of generally sequential stages whose name and number determine the control needs of the organizations involved*", and from standard IEEE 610.12 the definition of **software life-cycle** as "*the period starting when a software project is conceived and ending when the software is unavailable for use*". Although both definitions have a temporal dimension, the PMI definition is limited to a specific project and is centred on its control; while the IEEE definition includes the whole of the life of the software and is centred on the software product and its role.
- IEEE 1490 accepts that the definition of **process** taken from the PMBoK Guide as "*a series of actions that*

[1] The Project Management Institute (PMI, USA) is the author of this general, but compact, definition; it has 200,000 members worldwide interested in project management in every type of sector; including computing, public administration, construction, chemicals, etc.

[2] PMBoK does not include the pre-contractual stage of tendering, which is adequately defined and developed in Euromethod, a European *de facto* standard.

[3] PMBoK is automatically edited as standard ANSI-PMI 99-001 together with the American National Standard Institute (ANSI) and the PMI. Standard ISO 10006, although not mentioning PMBoK, includes the same nine blocks or knowledge areas related to coordination, scope, time, cost, resource, personnel, communications, risk, and project purchase.

[4] The Institute of Electrical and Electronic Engineers (IEEE) is one of the largest *de facto* standardizing organizations in the ICT sector, and has negotiated the adoption of PMBoK with the PMI. It has not edited extensions or interpretations of PMBoK (as has occurred in the public administration and construction sectors) despite the fact that 40 per cent of its members are in the ICT sector.

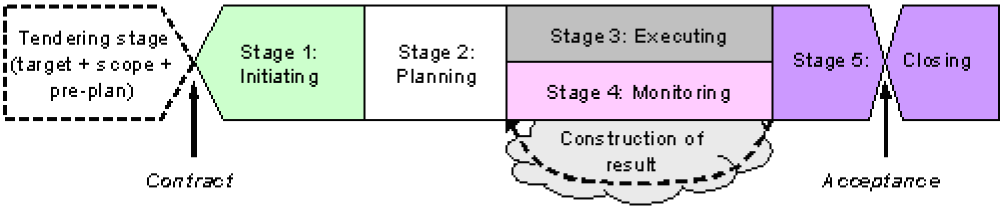

Figure 1: Project Management Life-Cycle Stages according to the PMBoK Guide (own development).

cause a result" is conceptually the same as the definition taken from IEEE 12207.0 as a "*set of activities – resource users – that are interrelated and transform inputs into outputs*".

- IEEE 1490 notes that the definition of a **project** taken from the PMBoK Guide as "*a temporal effort begun to create a product or individualized service*" has semantic similarities at a conceptual level with **software project** taken from IEEE standard 1058 as "*a set of technical and management activities required to satisfy the terms and conditions of a project agreement*"[5]. It can be seen that the PMI definition is centred on the essence of the project, while the IEEE definition includes a description of the characteristics of the project.

The IEEE has also edited version 1 of the Guide to the Software Engineering Body of Knowledge (SWEBoK or "Ironman") [2] in parallel with the current version of PMBoK. The first five areas of knowledge in SWEBoK include the classic software construction cycle (requirements, design, construction, testing, and maintenance); while the other five areas include software project management tasks: configuration (6), engineering (7), software engineering management (8), tools and engineering methods (9), and quality (10). Specifically, the eighth area (software engineering management) in SWEBoK includes a sub-area of measurement, as well as a block in the other five sub-areas which resemble the management cycle stages in PMBoK, as seen below.

2 A Reconstructed Presentation of the PMBoK Guide

PMBoK enables a chronological structuring of the processes following the management task life-cycle; and grouping the processes in five stages, or process groups (see Figure 1).

The staged chronological presentation shown in this paper of the 44 processes involved in project management is more useful for teaching and professional purposes than the structure given in the PMBoK Guide, where processes are grouped into nine knowledge areas:

- The seven processes of **Integration (I)** initiate all the stages to ensure that elements of the project are properly coordinated.
- The five processes of **Scope (S)** identify the scope of work required to complete the project.
- The six processes of **Time (T)** ensure timely completion of the project.
- The three processes of **Cost (K)** ensure that the project is completed within the budget.
- The three processes of **Quality (Q)** ensure that the project satisfies the needs for which it was commissioned.
- The four processes of **Human Resource (H)** ensure the project makes the most effective use of the people involved.
- The four processes of **Communications (C)** ensure timely and appropriate generation, collection, dissemination, storage, and ultimate disposition of project information.
- The six processes of **Risk (R)** enable the identification, analysis, and management of the risks related with the project.
- The six processes of **Procurement (P)** deal with the purchase of goods and services from other organizations.

3 PMBoK Initiating Stage or Process Group

The initiating stage processes require information from a contract or agreement resulting, in this case, from a precontractual stage not envisaged in the PMBoK Guide (see Figure 2).

The first process, **develop project charter (I1)**, supposes that the contract is accepted and the development of the project is authorized refining its assumptions, after the appointment of a project manager. The other process is the **development of a preliminary scope statement (I2)** and reflects the importance of identifying the scope[6] of the work and the deliveries required. This process begins with a **Project Management Plan (PMP)** which integrates the

[5] IEEE standard 1058 states that a software project should have specific start and finish dates, well defined objectives and restrictions, well established responsibilities, budgets, and duration. It may be self-standing or part of a larger project. In some cases, it may include only a part of the software development cycle. In other cases, it may involve many years of work and numerous software subprojects individually well defined and self-standing.

[6] The PMI defines scope as a set of products, services, and results, resulting from a project and the scope of a project as work performed to deliver a product, service, or result, with the specified functions and characteristics. Scope combines the coverage of the system (up to its frontier with the environment) and the depth (detail and granularity).

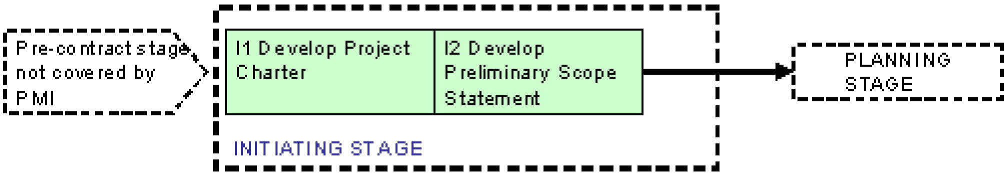

Figure 2: Project Management Cycle Initiating Stage (own development).

various subsidiary plans that will be modified by the successive processes in the planning stage, and which PMBoK considers to be the principal dynamic project document (see Figure 3).

4 Project Management Planning Stage

The planning stage is extensive and can be divided into four blocks of processes: identification-itemization; time-cost; other resources; and risk (see Figure 4):

■ The **identification-itemization planning block** has six processes. Process **I3** for the **development of the project management plan** begins the actions that define and coordinate other PMP subsidiary plans (generated by the processes termed "… planning" and shown in Figure 4). The successive processes reflect the acquisition of a better understanding of client requirements than that obtained in the pre-contractual stage. These include identification of requirements, opportunities, acceptances, restrictions, and risks, together with new interactions between tasks that depend on the nature and progress of the project. The probable changes over the course of the project, brought about as much by the requirements of the client as the resources of the supplier, require a reiteration of the planning processes, thereby updating the PMP with a repeated process of gradual planning until the final plans are identified.

■ The **time and cost planning block** estimates the duration of the activities itemized and defined in the previous block, as well as the costs incurred to achieve these activities. The scheduling of these costs as part of a budget, and the durations as part of a timeline, will give an initial planning approximation. This estimation will be subsequently adjusted by the other processes of resources and risks in the various subsidiary plans of the project management plan for human resource, communications, purchase and acquisitions, quality, and risk management.

■ The processes of time and cost will differ in their objectives when handled from the point of view of supplier or client, the client being primarily interested in predicting the potential financial performance of the product. In any case, for both the supplier and client, the estimation, viability, planning, and monitoring of costs, is one of the most difficult and crucial functions for the project manager, and is the main cause of failure and project abandonment.

■ The **other resources planning block** basically reflects the delicate problems of human resource related to the formation of the working team, the profile of the individuals, and the relationships and abilities that are key to the success of the project. This includes contracting external resources, and overall quality management should monitor the purchased components and their integration in the task of achieving the desired product.

■ The **risk management planning block** implicitly follows the general model of risk analysis and management developed in other sectors, particularly the ICT sector. In this way, the objective of project risk management is to review the possible impact of events that may affect success or the fulfilment of objectives and so minimize adverse events while increasing positive events. Technically, when the critical risk factors in the project (unlike the Critical Success Factors or CSF) are known in advance, they are analysed and placed on the timeline so that responses can be generated that anticipate, or at least mitigate, the effects. However, those unknown risks that appear during the development of the project cannot be proactively managed in advance in an individualized manner. It is therefore worth assigning a reserve of assets and resources to reduce these

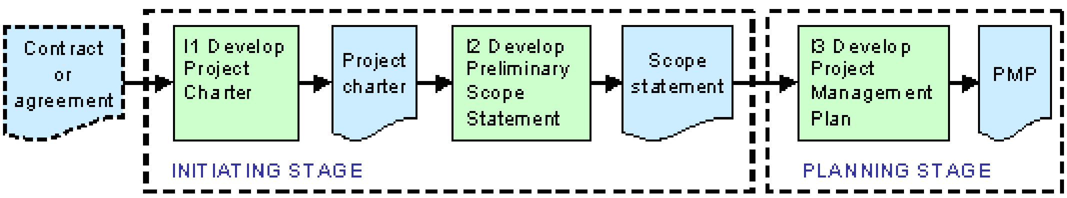

Figure 3: Inputs, Processes, and Outputs in the Initiating Stage (own development).

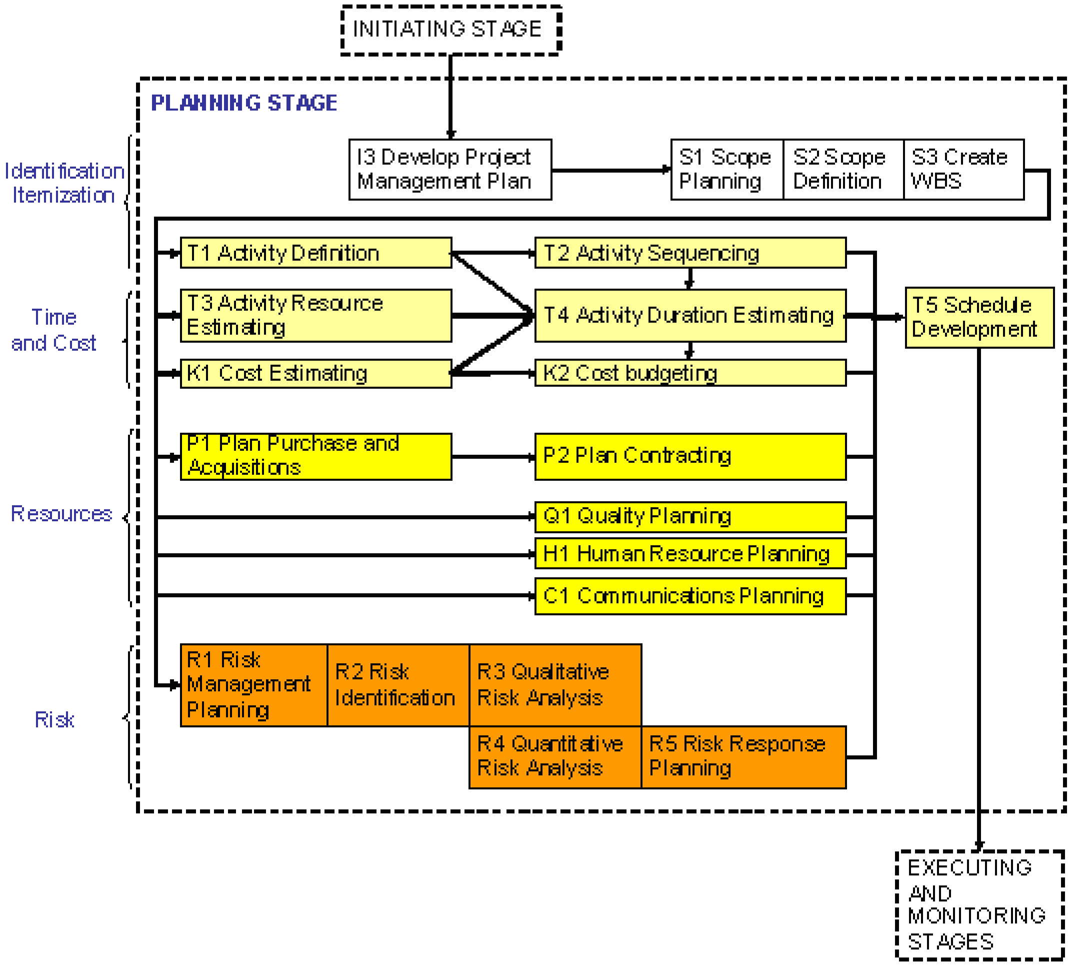

Figure 4: Project Management Cycle Planning Stage (own development).

risks. The PMBoK Guide says that psychologically organizations have attitudes towards risk that determine their exact perception of risk and how they respond. These attitudes should be explicit wherever possible. The responses to risk reflect the equilibrium in an organization between taking and avoiding risk. In any case, the known (however complex) can be anticipated, but the unknown cannot be anticipated. If an element of unknown risk exists, then resources must be reserved for the increasingly important monitoring stage.

5 Project Monitoring and Controlling Stage

This stage is developed in parallel with the execution stage, which is assigned to the project manager, and the result production stage undertaken by the managed team[7]. The project manager observes the development of the project and the construction of results in order to identify and rectify problems. His role has two functions: to regulate any deviations from the project management plan and its performance base, and to include any changes requested and actions recommended to reduce existing deviations and to prevent future occurrences.

This dual activity is achieved in two processes (see Figure 5). On starting the **direct and manage project execution** process (**I4**), the data from construction must be collected and an additional effort of concentration is required. The final process of **monitor and control project work** (**I5**) does not originate in the decisions generated by the project, and this implies a discontinuity in the changes. This discontinuity tends to induce a profound revision of construction[8]. Both processes facilitate feedback for the corrective, or preventive, actions in the following sub-cycles:

[7] Two PMBoK processes have been interchanged between the stages of monitoring and execution to clearly separate both functions, as well as changing their order so as to completely sequence various activities that PMBoK develops in parallel and whose start is irrelevant.

[8] A discontinuity linked to the change would be the most coherent way to deal with the project, but the PMBoK Guide offers a single presentation without discontinuities and this will especially affect the monitoring stage.

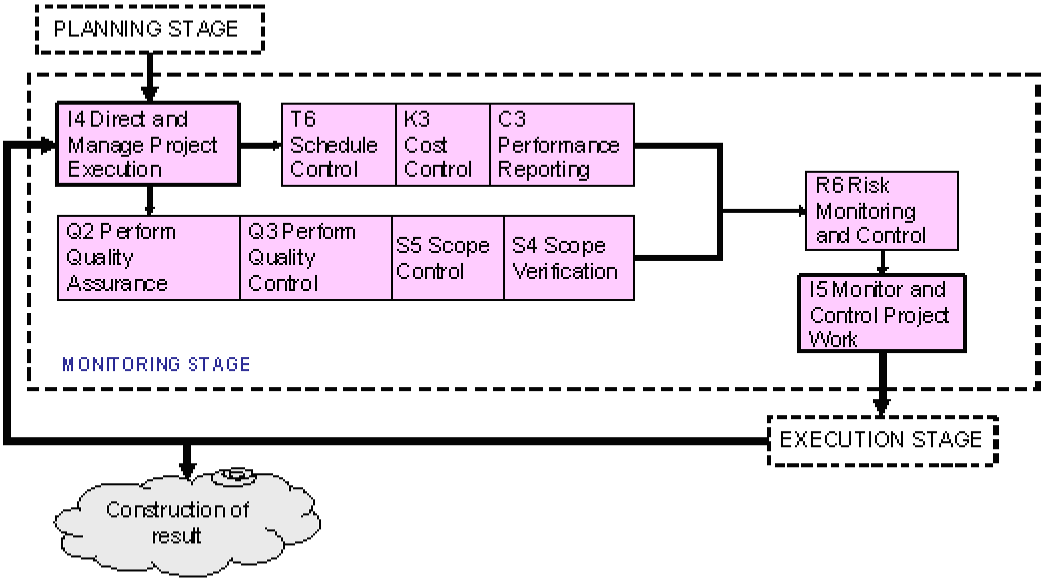

Figure 5: Project Management Cycle Monitoring Stage (own development).

the sub-cycle "do-check-act" progresses according to the project life-cycle; the sub-cycle "do-check-act-plan" is a regression to the planning stage and re-launches the life-cycle as a sub-project of the previous one, or even a new project.

The organization of the monitoring tasks in this chapter follows a dual criteria. All the processes are formally sequenced, following an input/output flow model that postpones changes in order to integrate them into a final process with a structure that enables the computerization of the processes that transform the flow. This homogenizes the contents in two general lines, dealing with time and cost variables (obtained from construction and exploitable with indicators on the progress of the project), and the procedures related to scope and quality. Both these lines end in the process of **risk monitoring and control** (**R6**), prior to preparing actions and integrated changes that respond to these risks. Monitoring is a set of processes repeated when deviation or change is detected. It aims to simplify everything because, as Frame rightly comments, even a minor change in a small task requires 15 or 20 affected agents to be notified.

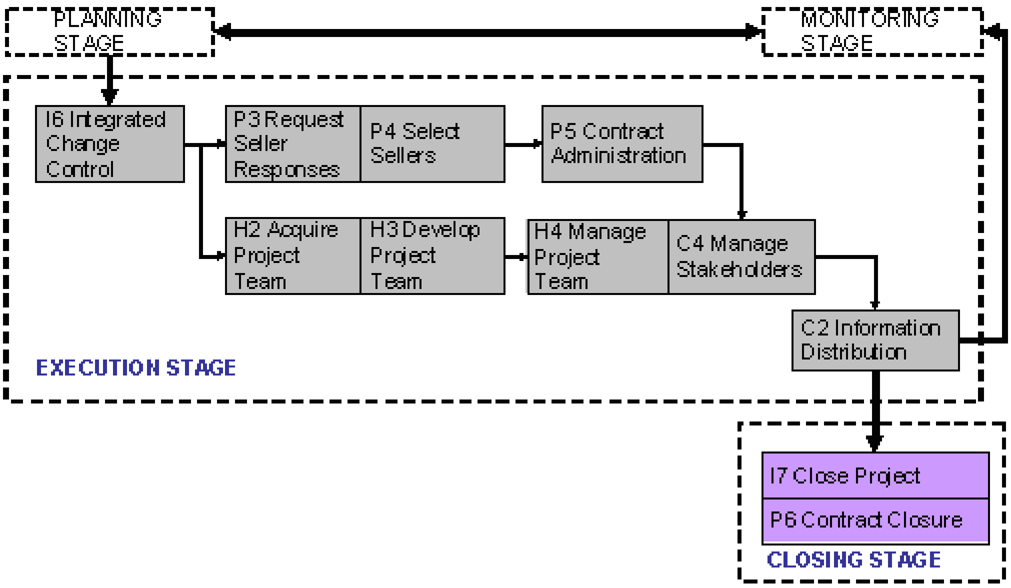

Figure 6: Project Management Cycle Execution and Closing Stages (own development).

6 Project Execution and Closing Stage

During the execution stage, the project manager tackles the delicate processes associated with human resource selection (internal personnel) and contracting (external personnel), with complementary and different functions to those of the managed team.

In the closing stage, after verifying that all processes are completed, the project manager finalizes the activities of the contract and closes the project either through product delivery or cancellation (see Figure 6).

7 The Ease with which Different Projects can be Planned

The methods of project management can be characterized by the relative range given to the planning stage, and increasingly the monitoring stage (compared to the initiating, execution, and closing stages, which every process must also logically include).

It can be seen that the planning stage includes half the PMBoK processes. This range reflects the fact that many projects can be planned; that is, the future can be seen with reasonable accuracy, so it is reasonable to dedicate effort in this stage. Predictable problems can be prevented during the viability studies in projects with well-defined albeit complex objectives. This is achieved by selecting the appropriate technical, economic, and organizational alternatives.

In the times in which we live, when change occurs quickly, it is not always possible to define the objectives of a project precisely. As a result, projects are started with provisional objectives, for an uncertain period of time, and with a dependent and provisional planning; that is to say, a shallow project that does not merit as much effort as in the previous case during the planning stage. The corresponding effort is then transferred to an increased risk management and more careful monitoring stage. This effort is made in the hope (generally confirmed) of being able to react to problems as the project advances. It is often possible to define clearer and more obtainable objectives with the help of decisions that reasonably modify the current plan.

8 Organization of Project Management Processes

Interactions between the processes of project management follow the classic cycle of "plan-do-check-act" attributable to Deming, in order to increase the result quality iteratively. In the central part of the three project stages (excluding the project initiating and closing stages) the planning stage corresponds to "plan"; the execution stage corresponds to "do"; and monitoring and controlling corresponds to "check and act", the processes of which also interact with all the others.

The processes of PMBoK are presented with well defined interfaces, but in practice, they also interact. Project management is an integrated task that connects each process with others, and balances the objectives and requirements of the project. In this way, a large or complex project usually contains processes that must be repeated several times to define and satisfy the requirements of the stakeholders, and this normally affects the process in question and the other related processes. For example, a change in the scope almost always affects the project cost, but such a change may, or may not, affect team motivation and product quality. The application of processes is repetitive, and many processes are reiterated and revised during a project.

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Benefits of a Structured Methodology in Project Management: How to Manage a Project in a Structured Way with PRINCE2™

Michelangelo Carbone

When creating and delivering new products and services, companies are becoming more and more "project-oriented" and are increasingly aware of the benefits which project management can bring. Once companies adopted the discipline of project management, they began to structure their own processes and to standardize them in an internal methodology. The widespread use of PRINCE2, a standard project management methodology recognized worldwide, owes much to the fact that it is an easily tailored and scalable method that can be applied to all kinds of projects. The various roles and responsibilities for managing a project are fully identified and are adaptable to suit the size and complexity of the project, and the skills of the organization.

Keywords: ATO, Benefits, Common Language, PRINCE2 methodology, Project Management, Project Management Certification, Project Manager, Team Manager.

1 Project Approach – Why

When creating and delivering new products and services, companies are becoming more and more "project-oriented" and are increasingly aware of the benefits which project management can bring.

Companies working by projects must manage several activities that are limited in time and not repetitive, and they have to address problems and reasons for failure, the most typical of which are:

- Lack of co-ordination of resources and activities.
- Lack of communication between members of the staff, and between members of staff and the supplier and the customer, leading to products being delivered which are not what the customer wanted.
- Difficulty in the identification of the responsibilities of individual members of the group.
- Poor estimation of duration and costs, leading to projects taking more time and costing more money than expected.
- Inadequate planning of resources, activities, and scheduling.
- Lack of quality control.

The Project Management discipline is not *THE SOLUTION* that completely eliminates all these problems and will allow all risks to be managed, but it is the proper way to reduce the effects of risks and anticipate all these common problems.

Through the discipline of project management, organizations attempt to plan, programme, and control the activities of a project in order to reduce these problems and to meet pre-established targets in terms of costs, timing, and customer expectations.

The way project management is performed in a company will affect the results of a project, since problems will arise in every project. But many of these problems will be solved if processes are well structured, documented and repeated.

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2 From Project Management to Structured Project Management

Once they adopted the discipline of project management, companies began to structure their own processes and to standardize them in an *INTERNAL METHODOLOGY* for internal use only, because they were aware of the benefits derived from a uniform, shared and structured approach to the management of projects. The advantage of a Project Management Methodology is that it makes people work in a structured way.

Many organizations have invented their own methodologies, especially in ICT (information and communication technology), as a result of the need to create a common standard within the organization.

The creation of a method has helped organizations document and monitor processes better and use the results as a benchmark for future projects.

An internal Project Management methodology also helps to improve the identification of specific roles and responsibilities within the organization.

While representing a step forward in the solution of some problems, the use of an internal methodology may cause other problems in the external environment.

An internal methodology that is completely unaligned with the external environment cannot met the new requirements of projects that are growing in complexity and are becoming increasingly internationalized. This calls for a uniform language to be used both internally and externally.

3 From an Internal Structured Project Management to Prince2

Companies are becoming increasingly aware of the benefits which a structured project management methodology can bring. A structured project management methodology must satisfy not only the internal requirements of a company but must also:

- Be flexible and generic.
- Be usable and adaptable to the type and dimension of the project (scalable).
- Be constantly reviewed and updated (the methodology must be modernized regularly with the contributions of its users).
- Use a uniform language (the methodology must create a common language understandable both within the organization and outside it).

In PRINCE2 international organizations seem to have found the methodology that meets these requirements.

4 PRINCE2 – A Brief History

PRINCE stands for *PRojects IN Controlled Environments* and PRINCE and PRINCE2 are owned by the UK government as its standard project management methodology. The method was originally based on PROMPT, a project management method created by Simpact Systems Ltd in 1975. PROMPT was adopted in 1979 by the CCTA, the public Central Computing and Telecommunications Authority, as PRINCE, the standard method to be used for all Government information system projects.

PRINCE2 was launched in 1989 to replace PROMPT for use in Government Projects, and become a generic methodology applicable to any type of project in 1996.

PRINCE2 is owned by the CCTA, now part of the Office of Government Commerce (OGC). The OGC has an ongoing commitment to maintain the currency of the method and the tools that go with it, together with the information, books and manuals used to define the method. OGC continually builds on its popular guidance, working with organizations internationally to develop and share business and practitioner guidance within a world-class best practice framework.

Since 1996 PRINCE2 has been the most widely used project management method throughout the world. More than 250,000 certified Project Managers have passed the Practitioner exam worldwide.

Books on the method are available in English, Dutch, German, French, Spanish, Italian, Danish, Polish, and Chinese.

Key data:

- Used in more than 46 countries worldwide.
- The method has public and private sector users.
- More than 120 accredited training institutes worldwide providing courses in 17 languages.
- An official user group (The Best Practice User Group – BPUG) and other user groups covering more than 10 countries.

5 PRINCE2 Benefits

The widespread use of PRINCE2 owes much to the fact that it is an easily tailored and scalable method that can be applied to all kinds of projects.

Each process is defined with its key inputs and outputs, together with the specific objectives to be achieved and activities to be carried out. The PRINCE2 method describes how a project should be divided into manageable stages enabling efficient control of resources and regular progress monitoring throughout the project. The various roles and responsibilities for managing a project are fully identified and are adaptable to suit the size and complexity of the project and the skills of the organization.

PRINCE2 main benefits:

a) Business Case. Assurance that the project continues to have a business justification. It insists that there should be a viable Business Case for a project before it begins and continues.

b) Common language. Being widely recognized and understood it provides a common language for project participants.

c) Communication. Good communication channels between the project, project management, and the rest of the organization.

d) Control. A controlled and organized start, middle, and end. If you take over a project in the middle, you know what documents to look for and where to find them. Provides control in use of resources and to manage risk

e) Proactivity. It is proactive not reactive (but has to be prepared to be reactive to events - illness, pregnancy, accident, external events).

f) Quality. It focuses on quality throughout the project life cycle.

g) Standard Approach. Structured method providing a standard approach to the management of projects, so the method is repeatable and teachable.

6 PRINCE2 Structure

There are three parts to the structure of the method itself:

- Processes.
- Components.
- Techniques.

6.1 PRINCE2 Processes

The method offers a set of processes that provide a controlled start, controlled progress, and a controlled close to any project (see Figure 1). The processes explain what should happen and when it should be done.

Directing a Project. Steps that Project Board members should take to provide effective support and steerage without excessive time commitment.

Starting Up a Project. How to qualify initial ideas and appoint a Project Board representing User, Supplier and Business interests.

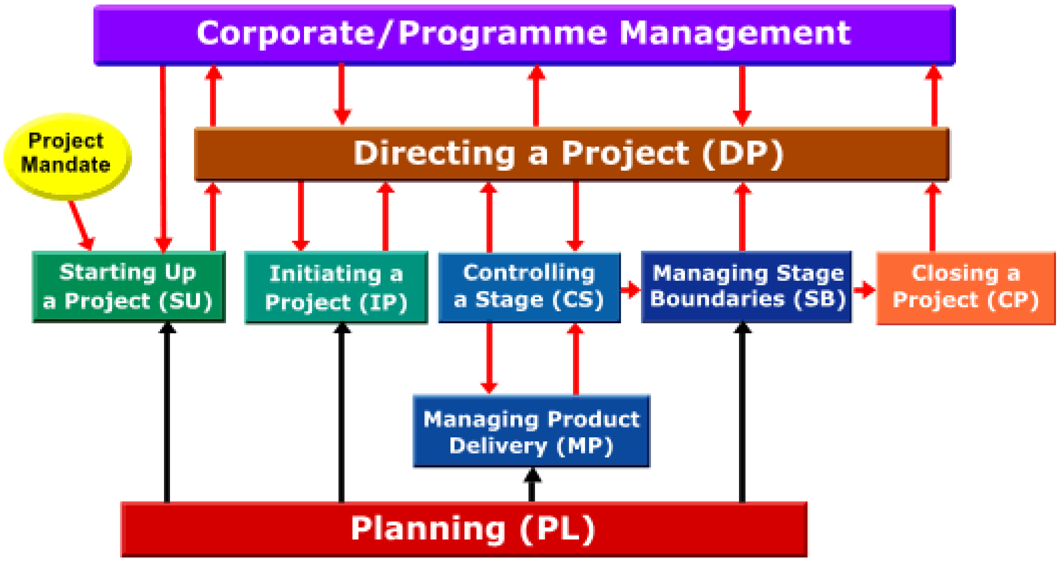

Figure 1: Processes as Defined by PRINCE2.

Initiating a Project. How to fully qualify a project to ensure it is likely to meet its ultimate objectives, ensuring organizational buy in before major commitment of resources.

Controlling a Stage. The day to day steps a project manager should take to manage work, react to events and escalate major issues.

Managing Product Delivery. The steps teams should take to agree work packages, report on their progress, and deliver completed work.

Managing Stage Boundaries. How to prepare for Project Board reviews when progress and future plans are discussed, and out of tolerance conditions handled.

Closing a Project. How to close down a project, how to handle follow on actions, how to handle post project benefit reviews.

Planning. How to plan, irrespective of when the planning is done.

6.2 PRINCE2 Components

PRINCE2 identifies 8 components explaining the philosophy of the methodology with regard to the different aspects of a project:

Business Case. A viable Business Case should drive a project. Its existence should be proved before the project is given the go-ahead and it should be confirmed at all major decision points during the project.

Organization. A structure of the project management team. A definition of the roles, responsibilities and relationships of all staff involved in the project. PRINCE2 describes roles. According to the size and complexity of a project, these roles may be combined, shared or allocated to an individual.

Plans. The method offers a series of plan levels that can be tailored to the size and needs of a project, and an approach to planning based on products rather than activities.

Controls. A set of controls which facilitate the provision of key decision-making information, allowing the organization to pre-empt problems and make decisions on problem resolution. For senior management controls are based on the concept of "management by exception", i.e. if we agree a plan, let the manager get on with it unless something is forecast to go wrong. A project is split into stages as an approach to defining the review and commitment points of a project in order to promote sound management control of risk and investment

Management of Risk. Risk is a major factor to be considered during the life of a project. The method defines the key moments when risks should be reviewed, outlines an approach to the analysis and management of risk, and tracks these through all the processes.

Quality in a Project Environment. The method recognizes the importance of quality and incorporates a quality approach to the management and technical processes. It begins by establishing the customer's quality expectations and follows these up by laying down standards and quality inspection methods to be used, and checking that these are being used.

Configuration Management. Tracking the components of a final product and their versions for release is called configuration management. There are many methods of configuration management available. The Method does not attempt to invent a new one, but defines the essential facilities and information requirements for a configuration management method and how it should link with other PRINCE2 components and techniques.

Change Control. The method emphasizes the need for change control and this is enforced with a change control technique plus identification of the processes that apply the change control.

6.3 Techniques

The method offers only a few techniques. The use of most of them is optional. You may already have a technique that covers that need satisfactorily. The exception is the product-based planning technique. This is a very important part of PRINCE2. Its understanding and use bring major benefits and every effort should be made to use it.

7 PRINCE2 Certification Path

The APMG (*Association for Project Management Group*) has been appointed by OGC to manage the *accreditation of training organizations* (ATO), trainers and training materials, and the certification of candidates.

Candidates can become a Registered Practitioner after sitting the Foundation Examination and then the Practitioner Examination, in that order.

The Foundation is the first of the two PRINCE2 Examinations required to pass to become a PRINCE2 Practitioner.

This level aims to measure whether a candidate would be able to act as an informed member of a project management team using the PRINCE2 method within a project environment supporting PRINCE2. To this end they need to show they understand the principles and terminology of the method. Specifically, candidates must be able to:

- Describe the purpose and major content of all roles, the eight components, the eight processes and the sub-processes, and the techniques.
- State which management products are input to and output from the eight processes.
- State the main purpose, and key contents, of the major management products.
- State the relationships between processes, deliverables, roles and the management dimensions of a project.

The Practitioner Level aims to measure whether a candidate would be able to apply PRINCE2 to the running and managing of a project within an environment supporting PRINCE2. To this end they need to exhibit the competence required for the Foundation qualification, and show that they can apply and tune PRINCE2 to address the needs and problems of a specific project scenario. Specifically, candidates must be able to:

- Produce detailed explanations of all processes, components and techniques, and worked examples of all PRINCE2 products as they might be applied to address the particular circumstances of a given project scenario.
- Show they understand the relationships between processes, components, techniques and PRINCE2 products and can apply this understanding.
- Demonstrate that they understand the reasons behind the processes, components and techniques of PRINCE2, and that they understand the principles underpinning these elements.
- Demonstrate their ability to tune PRINCE2 to different project circumstances.
- Candidates can sit exams at ATO (*Accredited Training Organizations*). In order for any firm to become an ATO and offer training in the method to other organizations, the APM Group has first to accredit it formally. This accreditation has three parts:

- The company has to show that it has the procedures and administrative capacity to provide and support courses.

- The training material and course timetable are checked against the method and the syllabus.

- Each trainer in the method must have passed both Foundation and Practitioner examinations, and scored well in the Practitioner examination.

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Traditional Price Determinants in Software Projects, with Consideration to Non-Corrective Maintenance

José-María Torralba-Martínez, Marta Fernández-Diego, and José Cuenca Iniesta

To determine the price of a project, traditional pricing policy determinants (demand, competition and cost) must all be taken into account, as should other business and marketing policy related factors, all of which make price determination a complicated activity. When software deals are expected to lead to non-corrective maintenance (whether adaptive, preventive, or perfective) in the future, the additional business generated by such maintenance during the useful life of the software may also be taken into account when establishing the price of software.

Keywords: Non-Corrective Maintenance, Pricing Policy, Software Price.

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1 Introduction

Estimating the supply price of a software project requires the use of various scientific and academic disciplines:

a) Software Engineering, since details of how to measure the size and estimate the amount of resources needed are included in texts on this subject [1][2][3].

b) Cost and management accounting: to determine the supplier's cost estimate

c) Marketing, as this subject includes pricing policy [4][5][6][7].

It is, therefore, a multi-disciplinary activity .

In this article, we outline some considerations on the three traditional determinants that affect supply price: demand, competition and costs, as applied to software projects. The fact that software projects may require non-corrective maintenance (either of an adaptive, preventative or perfective nature) could also influence the supply price, given the business expectations created when a project is developed.

When speaking about the difficulty of estimating software project sales prices, an additional point to be borne in mind (in addition to the interdisciplinary nature of pricing already mentioned) is that there are usually large differences between historic cost (i.e. the actual development cost of the project, as determined on its completion) and the final price that is established after sales negotiations are concluded.

These differences depend on at what stage in the life cycle of the project the deal is actually closed; the earlier the price estimation is made, the greater the difference tends to be. Figure 1 shows the estimated sale price at a given moment in the project's life cycle, expressed as a percentage of historical cost. This graph is based on projects carried out by Boehm [8][9][10] in the 90s, which were both innovative and large in scale and complexity.

Given such variability, this limitation (the difficulty of estimating a supply price) must be taken into account, especially when price estimation takes place early on. The price determination process is described briefly below.

2 Supply Price Determination Process

When a customer decides to order a software project from a supplier, and once the supplier calculates the cost that he will have to incur, there is still a long way to go before the *supply price* is determined, as shown in Figure 2.

But before describing all the details and considerations of this process, it should also be noted that price is not the only factor necessary to win over a potential customer.

2.1 Price as one of the Components of the Customer Offering

Before beginning the pricing study, it should be borne in mind that this is only one of the components of the cus-

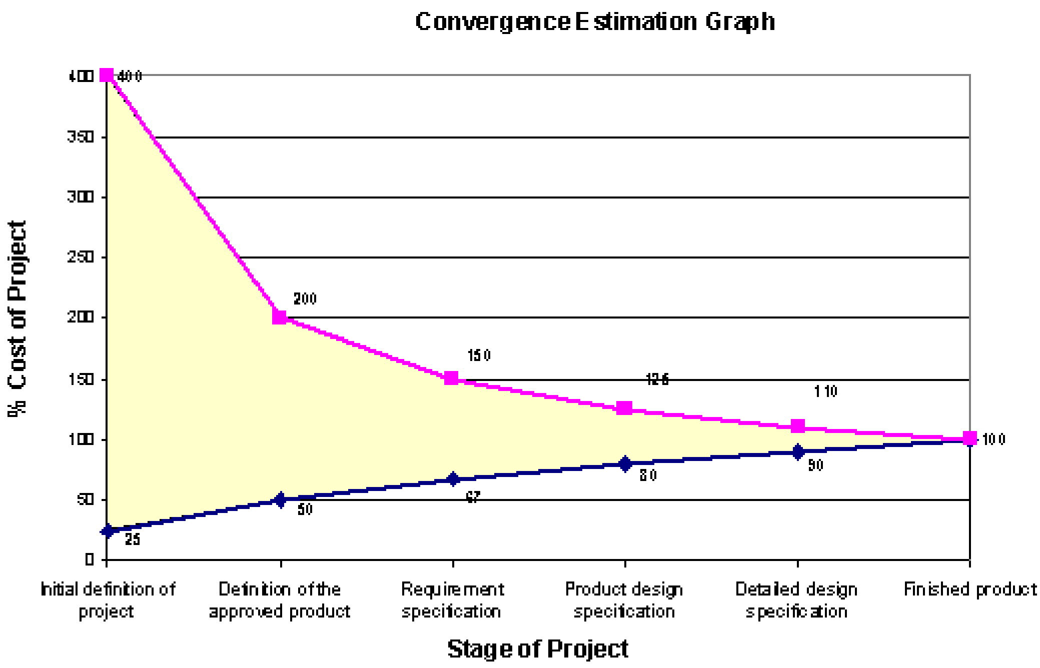

Figure 1: Evolution of Price Variability of a Software Project according to the Moment of Price Determination in a Project's Life Cycle (Source: Reproduced from Boehm et al. [8]).

tomer offering. For any given project, the supplier communicates to the potential customer his willingness to carry out the project, given certain specified conditions:

a) Scope and function of the product.
b) Timing.
c) Supply price.
d) Quality, innovation etc.
e) Training.
f) After-sales service.
g) Assurance in terms of finishing the project.
h) Financial conditions (payment terms etc).
i) Image, brand etc.

All of this forms part of the customer offering. In this article, only one of these components is discussed (that of price). However, it should always be borne in mind that the customer offering is not just about price but includes all the aspects mentioned above and more besides.

3 Traditional Price Determinants

Marketing texts usually refer to the following traditional

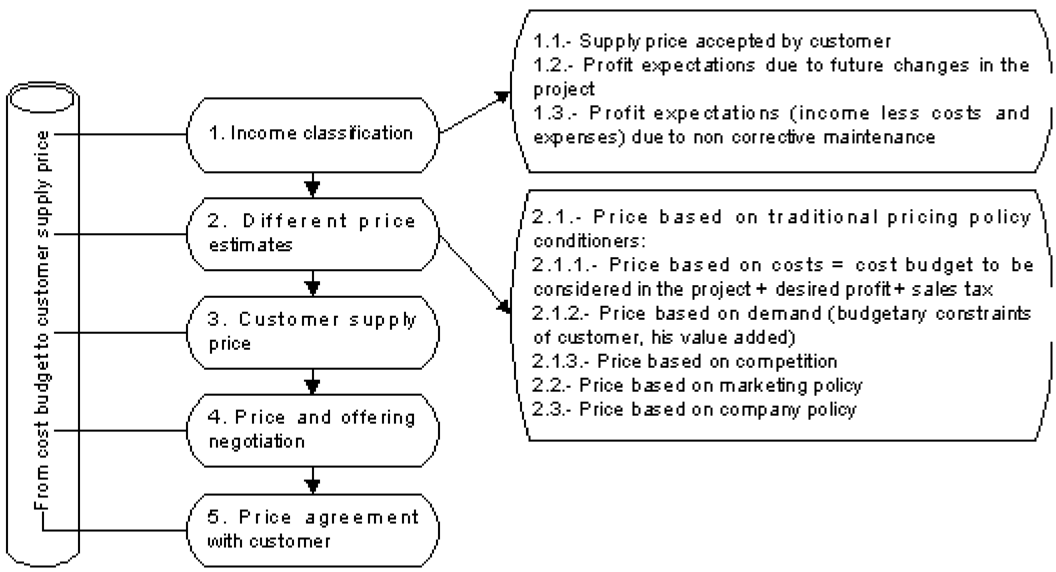

Figure 2: Stages in Supply Price Determination Process for Tailor-made Software, starting from Supplier's Cost Budget. (Source: Torralba [19][20]).

price determinants for any product or service [11]:

- Costs.
- Market (competition, demand, market /industry).
- Characteristics of the company's offering (product, price, distribution, and other marketing variables).
- Circumstances particular to the company.
- Technology.
- Environment.
- Information.

with the three traditional determinants being demand, competition, and costs. We go on to describe how these are applied to the pricing of software projects.

3.1 Demand as a Traditional Price Determinant

Customer Reserve Price refers to the "*maximum monetary amount that the customer is willing to pay for a given project*."[1] [12].

In project terminology, this corresponds to the budget limit established by the customer for the project in question. There is a price limit (the customer's budget limit) above which the potential customer who negotiates with the supplier will not order the tailor-made software project. In general, the customer will attempt to obtain a price as far below this limit as possible, all other conditions remaining constant. Therefore:

a) When the supply price is equal to or less than the budget limit, there may be a demand for the project

b) Above the budget limit (customer reserve price) there will be no demand for the project.

[1] "According to the principle of cost/profit, a customer will acquire the project if the profit hoped for is higher than or equal to the price." ([12], p. 66), (adapted for projects).

Therefore, demand can be represented graphically by two stages of a vertical line (see Figure 3, demand represented by the thick line).

a) a vertical straight line, (in this case there is just one project; i.e. just one unit) which reaches the point equal to the budget limit.

b) another vertical line, on the "open" side of the price axis, which goes beyond the level of the budget limit. This line indicates that demand is nil (the project is not ordered; zero units of the project are ordered from this supplier.).

This budgetary limitation can be either explicit or implicit. It is explicit if the party interested in the given project (a company, organization etc.) has formally established a budget limit for the project. It is implicit when the negotiating party on behalf of the customer has decision-making capacity to determine this price limit. However, in both cases, there is a budget limit above which the project will not be ordered from a given supplier. Therefore, this budget limit (willingness to pay) is what determines the customer supply price and is the main equivalent to what is generally referred to in marketing texts as "demand".

It can be deduced from the above that, when determining a tailor-made software project's supply price, the "demand" determinant can be expressed in the equation on Table 1.

DEMAND DETERMINANT: For certain given supply characteristics, the following must hold: *Supply price by supplier ABC to customer XYZ < = Budget Limit (willingness to pay) of customer XYZ*

Table 1: Equation expressing the Demand Determinant.

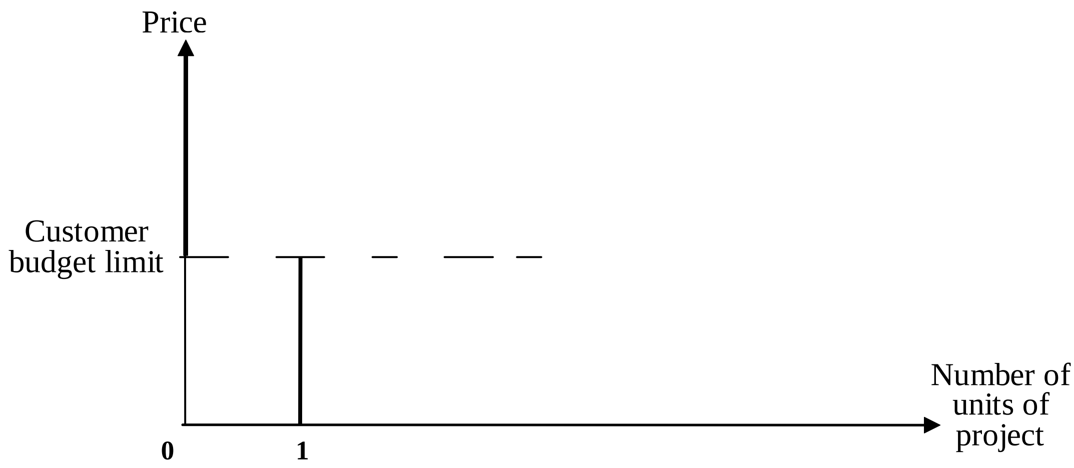

Figure 3: Customer Budget Limit as the Upper Limit of the Supply Price, Plotted against the "Demand" Determinant.

This budget limit is what the customer initially considers when valuing whether the project will be viable from varying perspectives:

- budget-wise, i.e. the total expense must not exceed this limit.
- financially.
- economically or socially etc.

On the other hand, if the rest of conditions are the same, the lower the price, the happier the customer will be.

To conclude, to establish the supply price this demand determinant (budget limit) must be taken into account. We go on to describe other traditional market price determinants.

3.2 Competition as a Traditional Price Determinant

If there is competition in the market, the supplier will decide: 1) not to submit an offer to a specific potential customer if they decide they cannot compete, or 2) to submit an offer, trying to equal or better the bid submitted by competitors.

In the first instance, it is obvious that the circumstances of the competition influences the supplier, as he decides not to submit an offer. The decision not to submit an offer is based on knowledge of the competition as well as the fact that to put in an offer requires some form of work (prior study, pre-project, project itself). This work inevitably has a cost and if the project is not won these explicit costs are not recouped.

If it is decided to submit an offer, success will not be guaranteed unless the competitors' offers are bettered. As has been indicated, price is only one of the elements that the customer values or takes into consideration when deciding what offer to accept.

In short, competitors' offers influence the price that a supplier may offer a customer, as their bids will not be accepted at a price that, taking into account all other considerations, does not improve on the competition's offer.

It can be deduced from the above that, when determining a tailor-made software project's supply price, the "competition" determinant can be expressed in the equation in Table 2.

<u>COMPETITOR DETERMINANT:</u>
For certain given supply characteristics, the following must hold:
Supply price by supplier ABC to customer XYZ < = ABC's Competitors' supply price to customer XYZ

Table 2: Equation expressing the Competitor Determinant.

A particular case is represented by innovative projects in their relevant markets. In the comparison that customers carry out when comparing offers between the supplier and their competition, the amount of innovation in the project should be taken into account. If one supplier's project is innovative in his given relevant market, one could say that there is no competition, in which case the customer would lack a price reference comparison regarding competitors. In this situation, the supplier may adopt one of two different strategies: a) Maximum price (what a customer is willing to pay, i.e. in this case, it is the demand determinant that comes into play, and the maximum price would have to be less than or equal to the customer's budget limit) or b) Non-maximum price, dependent on the criteria established by marketing pricing policy [13].

3.3 Cost as a Traditional Price Determinant

Although this is the last determinant to be described, it is perhaps the best known, as it frequently appears in project texts as the way to determine price. The relevant equation is shown in Table 3.

<u>COST DETERMINANT:</u>
Supply price based on cost =relevant cost + desired profit + sales tax

Table 3: Equation expressing the Cost Determinant.

From this relationship, it can be observed that cost determines price. Given that profits obtained by companies are usually a small percentage of revenues, i.e. of sales volume, it may be said that cost is a key determining element (and is a high percentage of the price calculated in this way, excluding taxes).

In the calculation of the cost to determine the price, the particular feature that the software has, that it *is reusable*, must be considered, in addition to other common aspects, which is why the term *relevant cost* is used.

The three traditional price determinants are shown in Figure 4, which also shows the possible price range, which is limited at the top end by the maximum price acceptable to the customer (or, in this case, consumer) *(the customer's budget limit*), and at the bottom end by the minimum price (*the supplier's relevant cost*), with the situation regarding competitors influencing the last instance. Other aspects also appear in the aforementioned Figure.

3.4 Marketing and Company Policy as Price Determinants

Although not within the scope of this paper, it should be noted that price determination according to the three traditional determinants (*demand, competition and cost*) is not the end of the long road that leads to the setting of a supply price (see Figure 2), as other variables enter the fray, such as pricing and marketing policy (product, positioning, etc.) and yet more variables from the general company policy, which could affect the supply price to a greater or lesser extent.

Neither does the negotiation that takes place between supplier and customer to establish the definitive supply price fall within the scope of this paper, which is itself a key determining factor of the agreed price (see Figure 2.)

Finally, the monitoring and control of measurement, estimation, and costs is a fundamental aspect in terms of managing the project in question, as well as for improving these stages of the budget process in future projects.

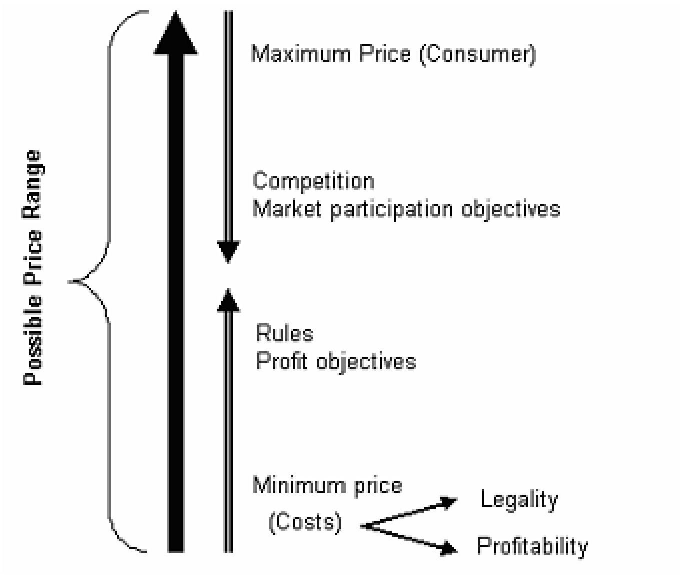

Figure 4: Possible Price Range, Limited by Demand and Cost Determinants.
(Source: Reproduced from Díez de Castro and Rosa [11]).

To conclude, Figure 2 shows breakdown of project revenue which is discussed in the following section.

4 Price and Project Revenue

Revenue derived from a project can be classified as follows (see Figure 2):

- Revenue from carrying out the project (supply price as accepted by the customer).
- Expected profit due to changes carried out during the project.
- Expected profit in case of non-corrective maintenance being carried out (revenue less costs) because the software is susceptible to non-corrective maintenance.

Traditional determinants have already been discussed with regard to the revenue stream that corresponds to the supply price. However, it should also be mentioned that some additional profits can be expected from any changes during the "execution" phase of the project (modifications and redesign), which is very frequent in software projects.

The next revenue stream is *expected profits in the case of non-corrective maintenance*. This refers only to any expected business that might arise in the event of any non-corrective maintenance being necessary during the execution of the project.

A characteristic of software is that it allows for different types of maintenance. As far as this article is concerned, the following classification for made-to-measure software maintenance is interesting [14][15][16], which is based on: a) corrective, b) non-corrective. The first, as is well known, aims to correct any errors that may arise due to their not having been detected in the software testing phase, which takes place before the product is delivered to the customer. The second type, non-corrective maintenance, is normally broken down as follows: a) adaptive, b) perfective or improvement and c) preventive (what other authors occasionally refer to as software reengineering.)

With these three types of non-corrective maintenance in mind, it may be supposed that programs will always be subject to continuous change (Lehman's 1st. Law states constant change in programs [15]).

Software's characteristic of being susceptible to non-corrective maintenance gives rise to a particular situation with regard to revenue. If the potential customer contracts the project from a supplier, revenue streams are: a) the contract price, with the terms and conditions of payment as agreed and b) profits (revenue less expenses) that the project may generate when it is operational, in terms of non-corrective maintenance, although it remains only an expectation when negotiating the supply price.

The supplier should bear this aspect of software in mind, and therefore should consider that if the contract is awarded, a new potential revenue stream is opened up due to future business (and future profits) relating to non-corrective maintenance, always assuming, of course, that the supplier is contracted to carry this maintenance out.

5 Conclusion

In the budgetary process that a software project supplier carries out, once the cost budget is available, (see Figure 2), a study into the supply price needs to be carried out from the perspective of the three traditional determinants: Demand, Competition and Costs, as well as other factors, such as marketing and company policy. Therefore, the suppliers' cost budget is an important step, but not the only one, in the establishment of a supply price.

Software possesses the characteristic of being susceptible to non-corrective maintenance, which creates the possibility of future business, which must be taken into account when setting the price. Other complementary aspects can be seen in the bibliography [17][18][19][20][21][22][23].

Acknowledgements

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Classification of Software Project Suppliers' Expenses Taking into Consideration that the Software is Reusable

José-María Torralba-Martínez, Marta Fernández-Diego, and José Cuenca-Iniesta

The reusability characteristic of software (the capability of using previous developments in order to design and construct new software) raises the question about if it is appropriate to classify software development expenses according to the criterion of "their contribution to the creation of corporate assets for the supplier" in addition to other criteria. Those expenses contributing significantly to the creation of company assets (software elements that can be reused in the future) could be converted to assets and treated as an investment which may be amortised amongst future projects. The software characteristic of reusability which we consider here refers not only to code reuse but also to other software elements, i.e. specifications, design, etc.

Keywords: Cost Accounting, Expenses Classification, Software Cost Budget, Software Reusability.

1 Introduction

In projects management there are five main aspects which constrain the achievement of an objective: a) Scope, b) Delivery times, c) Resources, d) Bid price, and e) customer satisfaction [1]. This article discusses the sub-process of determining the supplier's budget costs , which is a necessary step prior to establishing the bid price for the customer of a software project (Figure 1).

The objective is to present certain considerations regarding the classification of the expenses of a software project, and their treatment in the accounting system, taking into consideration the reusability characteristic of software.

Software Engineering manuals [2][3][4] usually explain the sub-processes of measurement of size and estimation of resources of the estimate process of the software project (Figure 1), and there is a full discussion of these sub-processes in the specialist literature [5][6][7][8][9][10][11][12]. However, with some exceptions [13], they do not usually deal with the sub-process of "Budget cost of the Supplier," which is the subject of this article, the study of which belongs to another scientific discipline: Cost Accounting [14].

The Software Engineering bibliography refers to the significant variations which occur in respect of estimated costs [15] making this a critical area for software development companies.

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2 The Reusability Characteristic of Software

A characteristic which we consider presents itself in a special way in software, which may appreciably affect the supplier's cost estimate procedure, is that of being potentially reusable, which is considered below.

The characteristic of being reusable, i.e. capable of being used to design and construct new software, is dealt with on a general basis in the bibliography referred to. A distinction is drawn between reused code and adapted code.

The reuse is not just of the code, or program codified in a programming language, but also of other outputs or results obtained in the course of the life cycle of the software development, both in its project phase (analysis, …) and in the execution of the project to obtain the product. We do not specifically refer in this work to the development of software based on components, although it is a current topic in research and in the software development production sector [16].

Reusing parts of the software is not only using the experience and learning acquired on developing software, and hence the study and repercussions of its reusable nature are separate from the pure analyses based exclusively on the experience and learning curve [17].

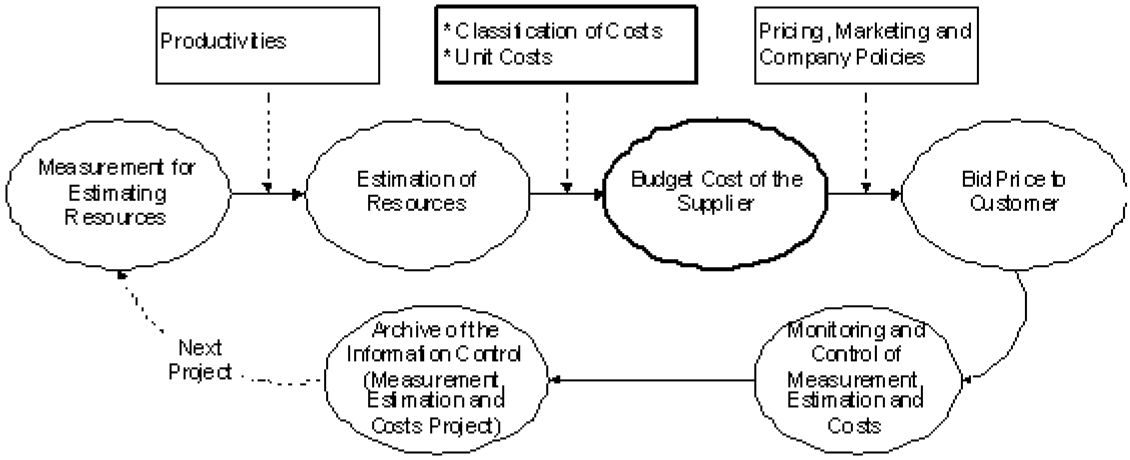

Figure 1: The Estimate Process of the Software Project (Source: Torralba [21]).

2.1 The Possibility of Future Reuse of the Products Obtained in the Life Cycle of the Development of Software

The aspect of reusability which we are considering is in relation to two consequences of the development cycle: a) the code, and b) other outputs of the life cycle prior to execution. Regarding the reusability of these other outputs, the situation cannot be considered specific to software, as some elements of the projects of other technologies also have this property. For example, the plans (which form part of the project) of a secondary school building are reusable in a subsequent project relating to the previous one, and more easily so if they are prepared with a CAD (*Computer Aided Design*) software. The same can be said of the plans of a small bridge over a road, etc., which can be reused with the appropriate adaptation.

2.2 Economic Significance of the Reusability Characteristic of Software

To determine the cost it must be taken into consideration that if an economic resource is not consumed in a single use then its value is distributed among all of its potential uses, which is one of the functions assigned to the *depreciation of fixed assets*. In this situation the part not yet used constitutes an investment. As regards the *economic life* of software, although one of its characteristics is that it is not spent with use, nor, we would add, with reuse, it does however have a limited economic life for a number of reasons: technological change, deterioration due to maintenance updates, etc.

We will consider the characteristic of being reusable from two time perspectives: a) reuse of pre-existing software, and b) possible future re-use; which are commented on below.

a) *Reuse of pre-existing software*. If in a project XYZ we are reusing software obtained in previous projects, then the need for resources (effort) may be less than if it was newly designed and constructed, as we will see in a section below on discussing how this circumstance is treated in some models of estimation of resources. The effect of reuse may be lower expenses, and a lower cost, for the design and execution of the project as against the alternative of no reuse.

b) *Potential future reuse of the software*. If in carrying out project ABC we think that some parts of the software (project and product) may be reused in the future for other projects, then a part of some of the expenses incurred for project ABC could be converted to assets (i.e. included in the assets of the balance sheet of the company, or of any other type of organisation, and not considered a cost at that time) and would constitute an investment.

This investment (not considered a cost of project ABC) would be recovered by being distributed among other projects in the future, a decision which carries the corresponding risk, as is the case with all investments. From an accounting point of view the expenses of project ABC converted to assets could be treated as innovation investments (converted to assets).

This aspect of potential future reuse is what this article is concerned with. Table 1 shows the distribution of the expenses of a project.

Distribution of expenses of project ABC when thinks to reuse some parts	A part is treated as costs of project ABC
	The rest is converted to assets, creating an investment which it is hoped may be recovered in other (future) projects

Table 1: Distribution of the Expenses of the Project between Costs and Investment.

Multiplier of effort	Acronym	Sub-group	Level	Range of values
Requirement of reusability	RUSE	Product	1,31	0,59-1,24
Experience developing similar applications	AEXP	Staff	1,51	1,22-0,81
Experience of the development platform	PEXP	Staff	1,40	1,19-0,85
Experience of the language and the tool	LEXP	Staff	1,43	1,20-0,84

Table 2: Multipliers of Effort Relating to Reusability and Experience in the Post-Architecture Model of COCOMO II.2000 (Source: Boehm et al. [5]).

2.3 The Treatment of the Reusability Characteristic of Software in some Models of Measurement and Estimation of Resources of Software Development

2.3.1 Model COCOMO II.2000, Constructive Cost Model

a) Influence of experience. Boehm et al. [5], in their models for states of *initial design* and *post-architecture*, consider five factors of scale, one of them being "Precedents" (which appears in first place). In the post-architecture model, 17 effort multipliers are considered grouped in four categories or sub-groups: a) Product, b) Platform, c) Staff, and d) Project; three of the multipliers refer to "Experience" and one to "Reusability", as is presented and summarised in Table 2. The *level* expresses a measurement which gives the maximum possible contribution of each multiplier to total personal effort, when their outer values are considered. The reference to experience is explicit, both as a factor of scale (Precedents) and by way of three multipliers of effort {experience of: a) developing similar applications, b) with the development platform, and c) with the language and the tool.

b) Influence of designing software which is reusable in the future. The reference made by Boehm et al [5] to the characteristic of being reusable is classified as required, and it then seeks to measure the extra effort involved in developing software with a view to its being reusable in the current project or in future projects.

They also indicate that the multiplier of effort "Required Software Reliability" can be influenced by the requirement that the software be reusable. And the "Required documentation" could also be considered.

c) Influence of reusing pre-existing software. The reuse of pre-existing code is dealt with in the model by converting it to lines of equivalent new code, to be added to newly created code, to determine the total size of the project.

2.3.2 Method of the IFPUG

IFPUG, *International Function Point Users Group* <http://www.ifpug.org/>, in the calculation of size, provides two focuses: a) Development while thinking of future re-use, and b) Modification of software; which are commented on below.

a) Influence of designing software which is reusable in the future.

In line with what has been seen in the COCOMO II model, it refers to the existence of multiplying factors which adjust the measure of the project in *Unadjusted Function Points* according to certain general characteristics of the system, among which is the foreseeable future reusability of the software to be developed. The general characteristics of the system are involved:

- Expected level of reusability. This is assessed in the following cases: a) part of the software will be reused internally, b) part of the software will be reused for other systems, c) an application is developed with a view to being adapted to other needs, part of the code itself being modified, and d) a parameterised application is developed, to be used by other users modifying some parameters.

It also refers to:

- Installation facilities. This factor relates to the reuse of the work carried out, where the software has to be installed in other places.
- Multiple places. This refers to the software to be developed having to be used in different environments.

b) Reusing pre-existing software.

The second focus referred to, which we may associate with modifications of software, is called increment projects. This type of project contains prior software which will have functionalities added, modified or eliminated. In this case only the size of the project is considered relevant without considering the size of the software obtained. In this way the following functionalities are calculated: a) Unadjusted function points which provide the functionalities to be added (external input, external output, internal logical file, external interface files, external inquiry), b) Unadjusted function points which provide the functionalities to be modified, c) Unadjusted function points which provide the

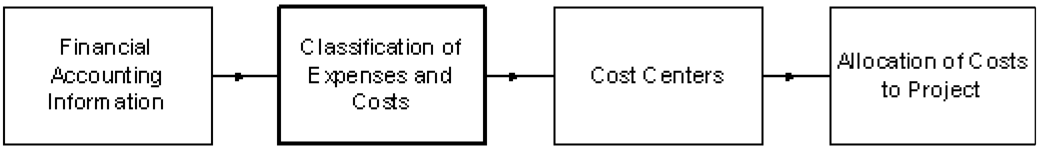

Figure 2: Stages of the Process of Calculation of Costs of Software Projects (Source: Torralba [21]).

functionalities necessary to carry out any data conversion, etc., which might be necessary, and d) Unadjusted function points of the portion of the application to be eliminated. Moreover the general characteristics of the application are considered both before the modification and after and the function points estimated previously are corrected.

All of the function points are added and the size of the project to be carried out is obtained. Note that added functionalities count in the same way as eliminated ones and this is so because eliminating functionalities in software, and doing it correctly may be as laborious as the development of other functionalities.

In view of the above, both COCOMO II.2000 and IFPUG (2001) deal with the reuse of pre-existing software in a project to be carried out, by way of the equivalent size in the unit of measurement of the model (lines of code, or function points); and with design with a view to future reuse, which will require further effort, by way of specific factors (effort multiplier, in the first case, and general characteristics of the system, in the second). Experience is treated in COCOMO.II.2000 in terms of factors of scale and multipliers; and in IFPUG in terms of the productivity used to pass from measurement in function points to effort in personal work.

3 Accounting Treatement of Supplier's Expenses

We will refer to an additional classification of expenses, a consequence of the characteristic of being reusable, and to the accounting treatment given to costs to arrive at the budget cost.

3.1 Classification of Supplier's Expenses Taking into Consideration the Reusability Characteristic and the Experience

Various classifications of costs are used for the purposes of determining the supplier's budget cost, the most common being: 1) that of direct costs and indirect costs, and 2) that of variable costs and fixed costs. Other clasification referred to time perspective.

Classification is the first stage of the costs calculation of projects (see Figure 2).

Another classification should be introduced for the purposes of reflecting the characteristic of being reusable (and also due to the influence of experience). This is classifying expenses according to the criterion of "their contribution, or not, to the creation of corporate assets of the supplier", which means differentiating between two types of expense generated on carrying out a new project:

a) Expenses which *do not contribute* anything significant to the creation of corporate assets which can be used in the future by the project supplier. Some basic examples can be given: the equipment incorporated (hardware, etc.); and also expenses associated with a project for technology which will not be used again in the future, not even for maintenance. The treatment of these expenses is that they are assigned in their entirety as costs of the project in which they appear and of the customer who has ordered it, on determining the estimate, as will be indicated below.

b) Expenses which *do contribute* something significant to the creation of corporate assets of the supplier. A basic example is the carrying out of the analysis and specification of requirements of a software application which it is hoped to reuse (both the experience acquired and the requirements specification products generated) in projects in the future. The assets refer to experience, to reusable elements, etc.

3.2 Accounting Treatment of the Supplier's Expenses Taking into Consideration the Reusability Characteristic and the Experience

The treatment in the accounts depends on the type of expense, according to the classification referred to in the previous section relating to reusability and experience, which is commented on below.

a) Costs generated by expenses which *do not contribute* anything significant to the creation of corporate assets, and which therefore cannot be used in the future by the supplier of the project. These expenses are allocated in their entirety as costs of the project in which they appear, and hence the customer will have to cover all of these costs.

b) Costs generated by expenses which *do contribute* something significant to the creation of corporate assets which can be used in the future by the supplier of the project. These expenses can be divided into two parts:

b.1) Expenses which are converted to costs, which are allocated to the project in which they appear, the customer thus having to cover this part of expenses as costs of the project.

b.2) Expenses which are converted to assets, and which are not converted to costs for the moment, which are not assigned to the project in which they appear, the customer thus not having to cover this part of expenses. These expenses when converted to assets will have created corporate assets which can be used in the future by the project supplier, and will henceforth be treated as cost of future projects.

4 Final Comment

The classification of expenses referred to, (according to the criterion of "their contribution, or not, to the creation of corporate assets for the supplier" -experience, reusable elements, components-), should be added to the estimating process carried out by the software project supplier (see Figure 1), in the re-classification of expenses phase (see Figure 2), to reflect more accurately the expenses which are costs attributable to a particular project and customer. Expenses not attributed create an investment which it is hoped to amortise with future projects. Other supplementary aspects may be seen in [19][20][21][22][23][24][25][26][27][28].

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Abbreviations and Acronyms

AEXP: Experience developing similar applications [see Table 2].
CAD: Computer Aided Design.
COCOMO: Constructive Cost Model.
IFPUG: International Function Point Users Group.
LEXP: Experience of the language and the tool [see Table 2].
PEXP: Experience of the development platform [see Table 2].
RUSE: Requirement of reusability [see Table 2].

Risks and Project Management

Julián Marcelo-Cocho and Marta Fernández-Diego

The management of risk in projects (including failure to reach objective) is always dependent on the complexity of the project and the uncertainty of the objective. These are the two main factors that explain the development of a project, and it is here that adequate countermeasures for risk-reducing preventive countermeasures can be found, as well as palliative countermeasures for use when leading a project in the planning, and increasingly, in the monitoring stage.

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1 Background to Risk Management in Projects

The generic acceptance of the concept of "risk" refers to **business risk**, and the word carries some psychological dualism that is more positive than negative. It is generally hoped that risk will evolve towards **opportunity**; however it should evolve towards the **insecurity** which permeates the concept of **system risk** (including information risks). In a project, risk consists in developing an ***"attained final state"*** (AFS) that differs from the ***"desired final state"*** (DFS) – which is the "objective" (outside the project itself). A project is seen as a dynamic system "adapting" that objective (see Figure 1).

Project Risk Management PRM is a technique that manages the resources available to a project in order to limit the difference between AFS to DFS. If the difference exceeds an established limit, then a risk of not meeting the objective arises. To assure a satisfactory result, decisions are usually required regarding new actions to reduce that difference. The negative aspect of the concept of risk, defined as the "likelihood of loss", underlies current developments in research, science, engineering, economy, society, and everyday life.

Some functional relations underlie the risks of a **computing project** related to an **information sub-system** (and its risks) of some **business system** (and its risks), given that:

- The business system functionality requires information sub-systems built with these type of computing projects
- A software construction project carries "project" type risks that imply the existence of "system" risks in the information sub-system.
- These project risks also imply "business" risks in the business system supporting the information sub-system under construction.

After a **first generation** of **Project Risks Management PRM1** based on questionnaires and expert advice, the **second generation PRM2** began the risks analysis at the launching of a project and plans safeguards or countermeasures to reduce risk, with a wide range of models available such as the Boehm [1], Hall[1] [2], Jones[2] [3] or SERIM [4] models**.** This preventive vision of planning is usually seen

[1] Hall is president of the INCOSE (*International Council on Systems Engineering*) working group on risk management, and leads a project risk management working group at the Software Engineering Institute of Carnegie Mellon University.
[2] Casper Jones is the president of SPR Inc.

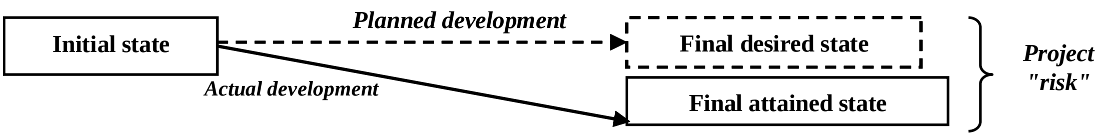


Figure 1: Project Risk seen as a Result deviating from the Objective (source: own development).

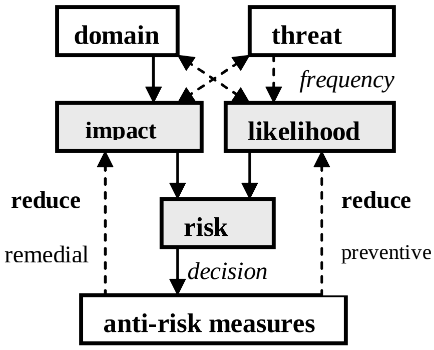


Figure 2: General Model of Risk Management (source: MAGERIT and own development).

as "theoretical" by many project managers, trained in incorporating practical "palliative" countermeasures for offsetting risks as they arise. The "tactical gap" between planners and managers has widened, and this is particularly relevant in the case of software mega-projects which are considered high risk[3]. This introduces a **third generation PRM3** of risks project management that tends to analyse, recover, and incorporate if needed, all other forms of project management – especially the practical type experiences taken from European methodological frameworks such as Euromethod and ISPL [5] or RiskMan-DriveSPI-RiskDriver[4]; as well as guided trajectories such as PMBoK [6]. In PRM3, the quasi-causality given, for example, in Euromethod and ISPL, prepares the way for **project management "by" its risks management**. This is a line that is being researched by various teams such as Moynihan [7][8][9], Barki [10], Schmidt [11][12] or INSEAD [13]. Their empirical work is considered promising, but to date, insufficient.

[3] IEEE Software edited a monograph on Managing Megaprojects (1996) and a monograph on Project Risk Management (1997). Both marked a change of course between the generations PRM2 and PRM3.

[4] Riskman began in 1991 as an EUREKA European project undertaken by a consortium of four participants, for developing an integrated methodology and tool for risk management in all types of projects. The same team launched Drive SPI in 1997 as a risk-driven software process improvement, financed under the fourth European R&D. Drive SPI was prolonged in 1998 under the European RiskDriver initiative, financed by SPIN, as part of an action by the European Commission to promote the dissemination of best practices.

2 A Risk Management Generic Model

Some research teams have separately confirmed that there is just one underlying model in all the studies of project risks in generations PRM2 and PRM3. And the model is also common in studies of risks in computing systems and other sectors. This axiom is receiving a clear verification in the current construction of the forthcoming standard ISO 31000 (previously called ISO 25700) about "*Guidelines on principles and implementation of* ***risk management***", which is common to all sectors and based on a shared process of action on a model that inter-relates some defined conceptual entities and which are then interpreted according to the sector.

This model of project risk management is similar to the management models of system risks, for example MAGERIT [14] or CRAMM. These models relate six entities: assets (of the considered domain), threats, likelihood, impact, risk, and anti-risk countermeasures (see Figure 2).

2.1 Domain, Sub-domains, and Assets

In the case of project risk management PRM, its **domain** includes some assets and it delimits them from its **environment** (considering the influence of environment on the domain). Those assets that play a role in the non-fulfilment of the "objective" can be organised as a set of sub-domains whose lower levels influence the upper levels (see Figure 3).

In this way, the **success** of a project is an **asset** of the upper domain ("other assets") and accumulates the risks of all of them, acting as a generic asset with two sub-assets: efficiency and effectiveness. The "internal" project efficiency has a pre-established reference of "technical" parameters (duration, novelty, structure, coherence, etc) and "organic" parameters (such as its interest level for the actors). Effectiveness requires some "satisfactory result" providing an external reference to the project[5].

[5] **Efficiency** as global success of a project is formed by partial successes (in the sense of Rockart's critical success factors) achieving final and intermediate states for these factors: as foreseen by Rockart. In any case, the final state includes factors of client satisfaction, for example the 50 user satisfaction factors that Jones (Prentice Hall, 1994) defined qualitatively and slightly ambiguously as "quality".

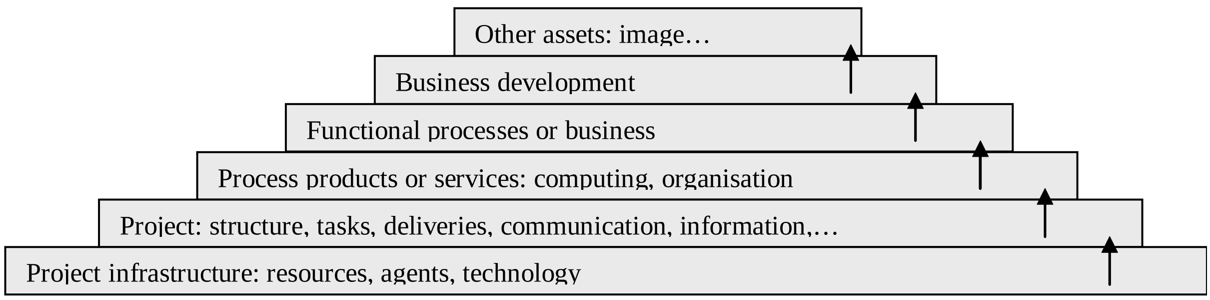


Figure 3: Assets Pyramid in Project Risk Management (source: own development).

Impact	EVALUATED RISK				
Very high	High	Very high	Very high	Very high	Very high
High	Medium	High	Very high	Very high	Very high
Medium	Low	Medium	High	High	Very high
Low	Low	Low	Medium	Medium	High
Very low	Very low	Very low	Low	Low	Medium
Likelihood	***Very low***	***Low***	***Medium***	***High***	***Very high***

Impact	EVALUATED RISK				
0.80	0.08	0.24	0.40	0.56	0.72
0.40	0.04	0.12	0.20	0.28	0.36
0.20	0.02	0.06	0.10	0.14	0.18
0.10	0.01	0.03	0.05	0.07	0.09
0.05	0.01	0.15	0.025	0.035	0.045
Likelihood	***0.1***	***0.3***	***0.5***	***0.7***	***0.9***

Figures 4a and 4b: Risk Evaluation in MAGERIT and in PMBoK (sources: MAGERIT and PMBoK).

43	Factors	*Dimensions*	*17 X-factors*	*26 Y-factors*
23	**Objective domain**	***Business system:***	1	5
		Process:	2	3
		Information:	2	1
		Agents:	3	3
		Technology:	1	2
20	**Service domain**	Process:	2	6
		Information:	2	1
		Agents:	3	3
		Technology:	1	2

Figure 5: Classification of the 43 Situational Factors (sources: ISPL and own development).

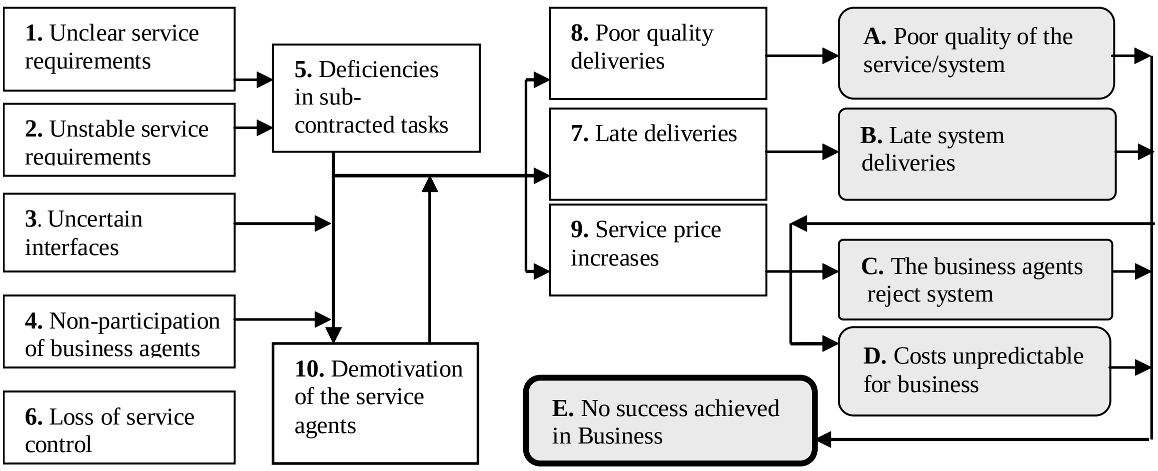


Figure 6: Business and Service Risks (sources: ISPL and own development).

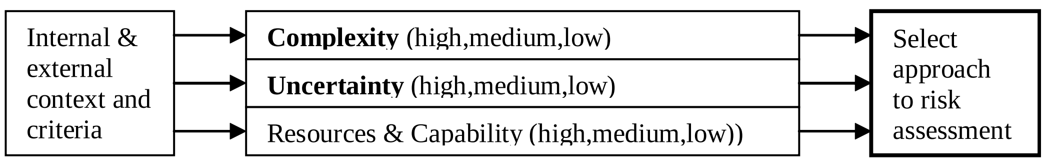
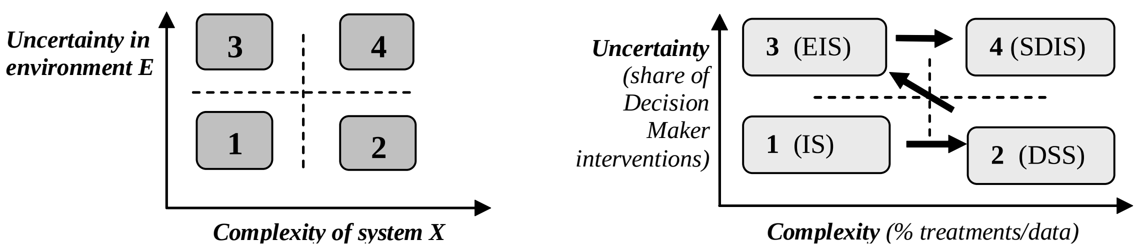


Figure 7: Factors for Selecting a Method of Estimating Risks (source: ISO 31000).



Figures 8 and 9: X and Y Factors in the Selection of Informational and Decisional Systems (source: own development).

Mega-factors		Project Description stage		Construction and Installation stages		
Complexity	**Uncertainty**	**Cooperative**	**Cognitive**	**One shot**	**Incremental**	**Evolutionary**
Low	***Low***	Expert-driven	Analytical	One shot		
High		Participatory			Incremental	
Low	***High***	Expert-driven	Experimental			Evolutionary
High		Participatory				

Figure 10: X and Y in the Organisation of a Computing Project (source: Euromethod own development).

2.2 Threat (or Risk Factor) Likelihood and Impact

Threats to project success (usually called "risk factors" in PRM) are shown in the pyramid of asset sub-domains and relate to: 1) infrastructure and the project itself (size, technological novelty, structure, agents, presence of subcontractors, relation with other projects); 2) characteristics of the products and services desired as the project "object" (complexity, dispersion, implied change, etc); 3) business processes and the business itself where products and services will be introduced (actors, scope, communication between specialists and users, environmental stability); 4) and "other assets" with subtler relationships.

Risk factors can be classified into two large groups depending on the asset group under threat: firstly, the **project** itself, its **infrastructure** and **environments**, constitute the two lower levels of the pyramid; and secondly, the **project's "referred" assets** (the **business** and its **processes**, the **products and services** obtained).

The **likelihood** of presence of each threat on each vulnerable asset is the degree of possible risk of occurrence associated with each "threatening" factor. The **Impact** measures the direct and indirect consequences of the occurrence of each threat (risk factor) that can be measured in the case of projects by the "distance" between AFS and DFS (attained and desired final states) for each analysed asset (success, satisfaction, duration, cost, structure, quality, etc). Impact may be a simple failure to achieve the objective of an asset, or may be the "degradation" of the objective of the project, in accordance with the "tree" or "chain" of aims achievable by completion of the project. The simple dysfunction of an asset does not usually constitute an impact if there is no change of state, or noticeable deterioration, or damage. A micro-deviation of the project, or the automatic re-launch of some task when the project contains mechanisms for auto-recuperation, cannot be considered an impact (although it may imply transitory forms of operation, more or less degraded, provided these are foreseen).

2.3 Risk Evaluation

The evaluation of risk combines likelihood and impact as a qualitative matrix (according to Figure 4a taken from MAGERIT), or as a multiplication in simple cases (according to Figure 4b taken from PMBoK). In any case, the matrix is not symmetrical with respect to the diagonal, as greater weight is given to impact than likelihood: risk will be greater with high impact (and low likelihood) than with low impact (and high likelihood).

2.4 Countermeasures against Risks

The risk factors are the immediate causes of risk and play a central role in the search for effective solutions that may prevent, or reduce, these risks. This may be achieved by means of improving the existing countermeasures in the project domain and/or incorporating new countermeasures. Two types of intentional action are proposed:

- ***Preventive measures*** that act on the ***likelihood before*** the occurrence of a specific threat against an asset using awareness-raising actions, training, information, deterrence, prevention, preventive detection, or a simple accumulation of resources for responding.
- ***Palliative and re-establishing measures*** that act on ***impact and after*** it, reducing its seriousness with corrective actions, recuperation, monitoring, and follow-up.

Preventive or palliative countermeasures for projects are classified according to their period of application. Preventive countermeasures are established during the **planning** period before production; palliative countermeasures are established in the **monitoring** period of production. Few project management experts attempt to systemize these countermeasures during the monitoring period. The risk challenge that faces all

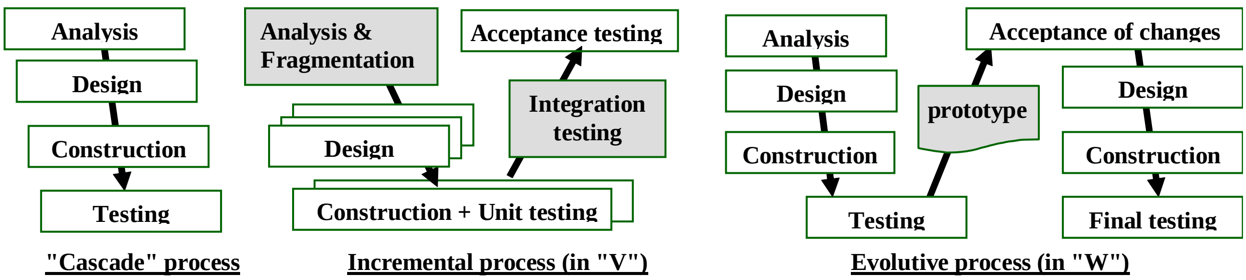


Figure 11: X and Y in the Selection of the Construction and Implementation Method (source: own development).

project management methods is the formal handling of incidences, the choice of countermeasures to resolve them in the monitoring period, and a coherent feedback for risk management in the **re-planning** processes.

3 Complexity and Uncertainty – Sufficient Megafactors

Since 1996 the methodological framework **Euromethod** of the European Union has based project risk analysis and management on two risk mega-factors, **compleXity X** and **uncertaintY Y** (qualified by the limitation of the resource "time" periods). X and Y summarise the other factors causing risk, called **situational factors**. The *Information Services Procurement Library (ISPL)* adds other factors (such as poor quality or imprecision in service/system requirements, non-determination of interfaces, and de-motivation of agents). Some 43 situational factors are classified into two domains (objective and service domains) – their "Dimensions" and both mega-factors of complexity X and uncertainty Y (see Figure 5).

ISPL also uses the value of each situational factor to identify ten "service risks" (from 1 to 10) and five "business risks" (from A to E), related to the situational factors of risk in both domains and the two mega-factors of complexity and uncertainty (see Figure 6).

Euromethod-ISPL only reveals that complexity and uncertainty are mega-factors, characteristics, or ideal dimensions of risk. But it does not show if these are necessary, or even if they are sufficient. However, an increasing number of authors have affirmed their need, and finally, its sufficiency has been theoretically demonstrated. Both mega-factors are enough for dealing with any type of risk[6] [15] .

This demonstration supports a conclusive affirmation of the ISO 31000 standard about "***Guidelines on principles and implementation of risk management*"**, whose Annex B extends complexity and uncertainty to all sectors (completed with the capacity and availability of resources) to select the methodological focus for estimating risk (see Figure 7).

The importance given to complexity X and uncertainty Y does more than just illustrate risk in projects: it becomes a necessary step for a decisive advance in the taxonomy, causality, and prognostic resolution of risk. This opens the possible use of both mega-factors X and Y, as a **necessary condition**, for efficient generalisation of the project concept in many of those sectors that currently study the **theory of complexity**, in the perspective of a **theory of mega-complexity** that is wider and more explicative (in the eco-systematic sense that underlies the combination between the complexity of each system and the uncertainty produced by its environment).

4 Complexity, Uncertainty, Organisation, and Decision

An awareness of the explicative and discriminatory importance of complexity X and uncertainty Y in the theory of management is not new. However, the relation with risk is new. The investigative school led by Mélèse and Le Moigne was already classifying information systems according to the X and Y mega-factors, and relating these to the organisational system S and its environment E[7] as shown in Figure 8.

The application of X and Y enables more advanced correlations between organisational, informational, and decisional systems – and the most appropriate computing systems for dealing with them. The decision aided information systems can be organised according to the two axes X and Y[8]. This qualitative "matrix" (X,Y) establishes four types of organisational systems in its quadrants that, when translated into forms of relation or internal communication between system components, also require four types of specific informational, decisional and computing systems– as shown in Figure 9 [16].

1. X low, Y low. The **Organisation** retains the classic hierarchical pyramidal structure. Its traditional ***Information System (IS)*** (high volumes of operational data batch-handled) implies that the types of data are more numerous than their simple and repetitive treatments.

2. X high, Y low. The growing differentiation offered by a hierarchical **Organisation** requires more levels to control it and forms of communication integrated by a common **informational system –** where the implied volumes of data and the heterogeneity of the treatments are balanced; and including ***Decision Support Systems (DSS)***, i.e. expert systems.

3. X low, Y high. Organisation is fragmented into vertical divisions with little interaction to reduce risks and facilitate re-adaptations; but this implies problems of communication that must be resolved with forms of rapid access to a central informational system, culminating in an ***Executive Information System (EIS).*** This EIS implies that a human decision-maker (DM) frequently intervenes with information search systems to reduce the uncertainty of the organisational system.

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[6] The demonstration is based on an amplification of Shannon's model (which identified types of uncertainty and the entropy related with the system environment) with identification between system complexity and another type of entropy, convergent with the previous one. It concludes that complexity and uncertainty are manifestations of the same entropy that covers the system and environment (or the "universe" of an eco-system). It is therefore sufficient to explain relations between entities inside the same system, and the system with its environment (and even more so, the internal and external relations between the entities of any project, seen as a dynamic system).

[7] "Complexity is a function of the number of elements in the system S, and the number and variety of its relations; every increase in the complexity of the structure and functioning of S gives rise to a more intense exchange of information. The uncertainty of environment E is linked to the acceleration in the evolution of E; the greater is E, greater will be the amount of information to handle". J. Mélèse. *Approches systémiques des organisations, vers l'entreprise à complexité humaine*. *Editions d'Organisation*, 1990.

[8] The horizontal axis captures the X complexity, defined now as "the rate of volume of handling with respect to data....The vertical corresponds to the intervention and role played by the decision-maker... This looks for the resolution to a problem that is a priori unknown*"*. P. Lévine, J. Pomerol. *Systèmes interactifs d'aide à la décision et systèmes experts*, Hermès, 1989)

4. X high, Y high. Organisation adopts a type of matrix structure with horizontal support functions for vertical divisions. To respond in real-time to changes, ***decisions*** are based on a system that enables rapid and specific selection of data (data-mining) from a global information base (data warehouse). This information sub-system combines the search and information treatment systems 2 and 3, in a ***Strategic Decision Information System (SDIS),*** which is formulated with two types of computing programs: the "search motors" such as those that cross the nodes of Internet type networks; and the knowledge motors that access data warehouses through "Intranet" networks and intelligently search for the required information.

Euromethod not only uses X and Y to deduce the anti-risk countermeasures required during the project monitoring stage (e.g. increasing the Production milestones and control frequencies). X and Y help focus the design of organisational, informational, and decisional systems, facilitating the organisation of a computing project in its various stages of Description, Construction, and Installation.

The Description of the result combines *the social or agent cooperative approach* (expert-driven or participatory) and the *cognitive approach* (analytical or experimental) for low or high X and Y (Figure 10). It enables also the selection of the best method and process in the Construction and Installation of the result (see Figures 10 and 11):

- "One shot" method (and the "cascade" process), only if uncertainty Y and complexity X are low
- Incremental method (and the process of fragmentation and reintegration), only if X increases
- Evolutionary method (and the prototype process), if uncertainty Y increases.

In a computing project that supports **strategic decisions**, uncertainty Y tends to prevail over complexity X. It is possible to resolve this with a DSS for routine problems and situations, but its complexity means a choice must be made between an EIS and a SDIS. ***Obtaining*** the necessary strategic information is linked to the structure of the jobs and this represents a problem of complexity, linked to the synthesis of the strategic information from disintegrated basic information.

Its ***treatment*** is not related to the size and characteristics of the primitive database, but with the level of technological maturity relative to implementing an application architecture with standardised interfaces: whether they originate from the user, the communication with other systems, the operational programming, etc.

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Driving Projects by their Risks

Julián Marcelo-Cocho

The extension of the Theory of Project Management for highly uncertain projects leads to a Method of Project Driving that is based on Project Risk Management (risk as deviation from the objective) with Critical Chain Techniques. The MadPRYX method includes these forms of planning and monitoring, but does not yet enable projects to be pro-actively guided "at sight" over the course of the project.

Keywords: Complexity, Effectiveness, Efficiency, Risk, Success, Uncertainty.

1 Is the underlying Theory of Project Management Obsolete?

This classic article on project management caused some anxiety when it was published in 2002 [1], and has since acted as a magnet for heterodoxy in the theories of project management, in contrast to the orthodoxy represented by PMBoK of the PMI [2].

The article applied to project management the "just in time" concepts from "lean" industrial production, as well as the Theory of Constraints (TOC). The article asked if the Theory of Projects should be seen as a flow rather than a transformation, including the time "affected by uncertainty" and the interdependence between tasks. Also included is the generation of value that eliminates unnecessary resources (so as to reduce uncertainty), and maintains the client's requirements as a business aim. The resulting conceptualisation would complete in this manner the transformation view with flow and value views.

The article said Theory of Project Management can be divided into three sub-theories, Planning, Execution and Control. The planning model of management-as-planning is not sustainable, and should be changed to management-as-organizing (including the environment and operation). In execution, unreal launches (with the availability of all needed inputs and resources) should be changed to a system based on a "language/action perspective". Control has outgrown the "thermostatic model" while looking for causes of problems and seeking to improve performance with the use of "on-hand" resources.

The evident anomalies "*or unanticipated results observed in the use of methods based on the theory indicate that the implicit theory of project management is not empirically valid*". The article concludes that "*project management has not achieved the goals set to it: it does not perform in a satisfactorily way. In small, simple and slow projects, the theory-associated problems could be solved informally and without wider penalties. However, in the present big, complex and speedy projects, traditional project management is simply counterproductive; it creates self-inflicted problems that seriously undermine performance*".

Scientific understanding advances by studying anomalies. For example, an explanation of the anomalies in the theory of gravity led to the theory of relativity. With regard to risks management, the Theory of Management represented by PMBoK continues to be useful for many projects, and even projects with a **high complexity X**. However, projects with **high uncertainty Y** require an underlying theory more reactive and supported by TOC.

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2 Uncertainty, Buffers, Critical Chain, and Launch

The practical application of this new theoretical vision shall understand three mechanisms that waste buffer resources (for example, those resources that absorb project delays). These mechanisms are: "*the (bad) student syndrome (starting at the last moment); multi-tasking; and dependencies between tasks causing delays to accumulate and ensuring that advances are lost.*" To neutralise these mechanisms, each step is analysed with "*the maximum priority being given to those tasks that reduce the buffer of a project, either because they are somewhat delayed and form part of a critical path; or because they are so delayed that they might consume the buffer and so affect the critical path even though they are outside the critical path itself … and later the tasks that consume their own feed buffer but do not affect the project buffer"* [3].

In the new model of Critical Chain Project Management (CCPM), an analysis of the causes of delay is based on the prioritised set of tasks. The CCPM method changes the techniques of preparing the stages of planning and monitoring; but not the tasks and processes of project management set out in PMBoK'04.

During the **planning stage under CCPM**, the plan is developed from the objective date backwards, and each task is begun as late as possible, so reducing the duration of each implicit task buffer hidden in the estimation (as the bad student syndrome wastes time and renders useless the protection offered by the buffer for any local incident, or "*murphy*", caused by uncertainty). The durations are regrouped in explicit buffers to absorb the time delays imposed by global murphies that may cause a global delay. These are inserted in the key project milestones, as determined by the critical chain tasks (which deals with dependencies between resources, as well as those dependencies between tasks handled in the critical path). A buffer is so obtained for the whole project, with the feeding buffers at the end of each chain feeding a critical chain. This offers protection from local deviations in the chain (the size of the calculable buffers explicitly takes into account the variations in the implicit buffers in each task.)

In the **monitoring stage of a project with CCPM** the plan is followed to its final objective date and, in a similar way to that of the critical path, the buffers are administered and the final date remains unchanged until the project buffer is consumed.

[1] Two tools are being developed: *MAGERIP* for the planning stage, and *Scoreboard MadPRYX* for monitoring.

[2] In addition to Hall, the brain maps produced by Herrmann (Whole Brain Technology) have influential followers such as Mintzberg (cited in "Mintzberg on Management" The Free Press, 1989) or Webster ("Whole Brain Management for All"); and equally influential sceptics such as Simon. In this article, these maps have only been metaphorically taken, after confirmation of the level of support for the affirmations made by Hall by well known authors such as Carter ("Mapping the Mind". Orion, 1998). The brain is totally interconnected and the quadrants only indicate complimentary functional areas, rather than tendencies or inclinations of any type.

3 Knowledge and Risk

The central importance of complexity X and uncertainty Y in the third generation of Risk Management [4], has led to the design of MadPRYX (*a* ***Model of Adaptation and Driving of Projects by Risk, uncertainty Y, and complexity X***). MadPRYX's first outline was presented in 1999 [5], it was further developed in 2001 [6]**,** and obtained sufficient theoretical support and teaching experience to be considered finished in 2007[1] .

The MadPRYX model starts from the **Hall project management risk model**[2] [7] which links basic organisational and intellectual functions normally localised in specific areas of the brain. The Hall model contains six disciplines PPMMDD and four function and knowledge quadrants (covering dynamic/static and long-term/short-term issues), which correspond to the four gnostic temperamental and organisational "circuits" MMP-PPM-PPD-DDP, related in this case to the general driving of projects (see Figure 1).

- The occipital left region holds the **memory** of the **past** and this has the following influence on the disciplines of MMP (Measure-iMprove-Plan): experience learnt in previous projects offers a long-term perspective to foresee prospects in a practical, consistent, and programmed manner. Experience also helps develop plans and detailed procedures; organise essential data; and maintain their given path. Whoever mostly uses this quadrant is seen as temperamentally organised, sequential, disciplined, and good with detail.
- The frontal left region holds the **logic** of **known** and this has the following influence on the disciplines of PPM

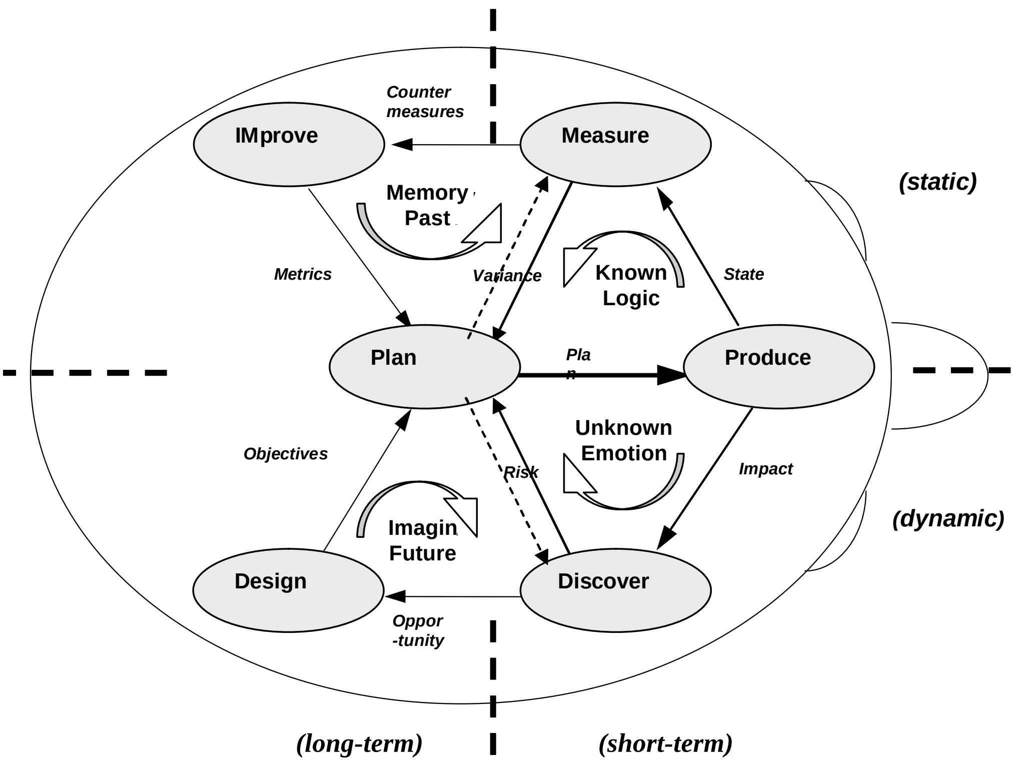

Figure 1: Cerebral Map showing six Disciplines, four Quadrants, and four Circuits (source: Hall and own development).

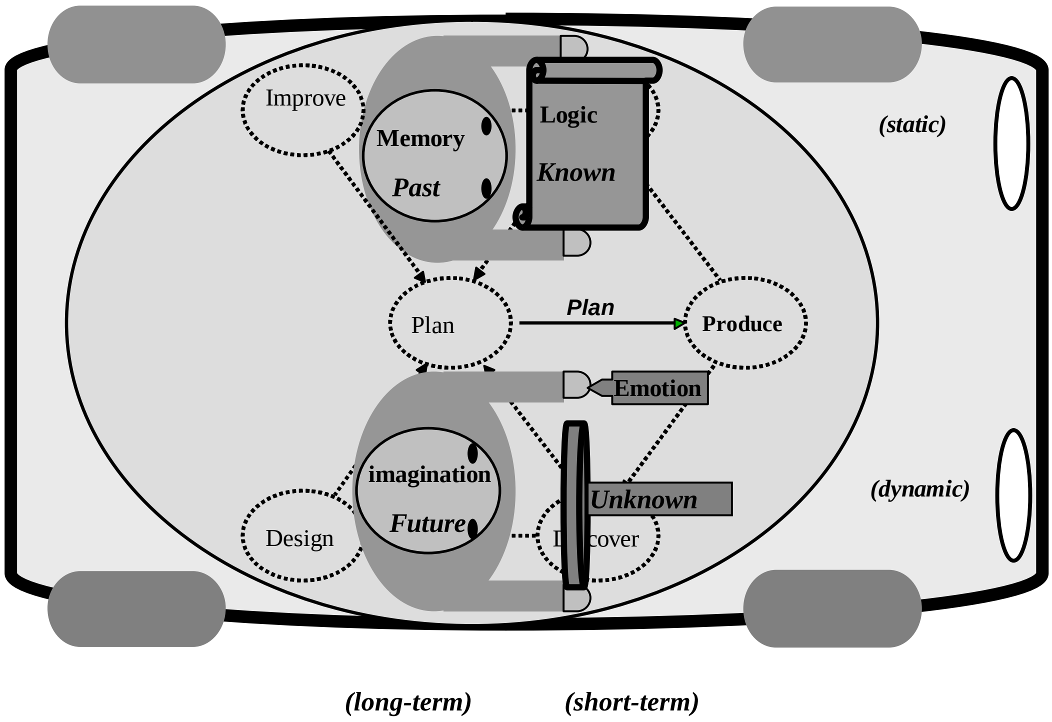

Figure 2: "Rally" Driving using both Brain Hemispheres (source: own development).

(Plan-Produce-Measure): it collects facts, analyses results; resolves problems in the short-term; reasons with the facts; and understands the situation and emphasize the differences with respect to the plan. Whoever mostly uses this quadrant is seen as temperamentally fact-based, logical, rational, and theoretical.

■ The frontal right region holds a sense of **emotion** regarding the **unknown** and this has the following influence on the disciplines of PPD (Plan-Produce-Discover): it provides a short-term perspective regarding parts of the plan and production to be investigated; explores the requirements or technologies and its possible impacts on the plan, resolves problems intuitively; observes signs of imminent change; perceives anxiety about the unknown and redirects that anxiety to new possibilities and panoramas; tolerates ambiguity; integrates ideas; and defies established policy. Whoever mostly uses this quadrant is seen as spiritual, emotional, and empathetic.

■ The occipital right region supports **imagination** of the **future** and this has the following influence on the disciplines of DDP (Discover-Design-Plan): it provides long-term perspective on the circumstances; sees and capitalises on opportunities; develops a prospective vision based on own discovery; conceives new ways to live; considers values and generates enthusiasm. Whoever mostly uses this quadrant is seen as holistic, flexible, imaginative, artistic, and inclined to synthesize.

4 Strategy for Driving Projects by their Risks

The complexity X of an information system (and the complexity of the software to be developed) has received a great deal of intuitive attention; without an in-depth study of its conceptualisation. Uncertainty Y is only beginning to be explored laterally and this hints at the "Project Driving" concept (including Planning and Monitoring during Execution).

The model MadPRYX has gone a step further than the brain metaphor, and uses motor-racing metaphors when discussing the execution of project guidance. Within these metaphors, the Projects are vehicles, their development Environment is a racing circuit, and the Project Managers are drivers.

- In "***formula races***" we use delicate and complex machines with sophisticated features on specially prepared circuits with predictable risks (including perhaps a "killer curve").

- In "***rallies***"we use robust vehicles on approximate and uncertain routes, with circuits no or only slightly prepared (such as the Paris-Dakar), and full of predictable and unpredictable risks.

4.1 "Formula" Strategic Model for Driving Projects

A single driver-manager can handle a highly complex project, providing the circuit only contains ***predictable variations*** (curves more or less risky), and providing that the environment does not contain ***unpredictable uncertainties*** (metaphorically, the circuit must be surrounded by an insurmountable crash barrier).

Although the driver uses all of his mental capabilities, he is basically using short-term frontal functions; whether to remember with the left hemisphere the logic of a "known circuit"; or to anticipate an unknown factor in the curve ahead using the right hemisphere and adapt driving to the circuit (the predictable reference that structures the whole project). In this way, he can centre all his attention on indications of the vehicle behaviour to guarantee the success of the project (with policies and contingency plans to respond to predictable, but updateable events such as breakdowns, punctures, fire, etc.).

4.2 "Rally" Strategic Model for Driving Projects

Rally-style driving takes place on highly uncertain circuits and environments, with predictable and unpredictable risks, and requires two directors, or at least, two functional directives (see Figure 2):

■ The co-driver preventively monitors the circuit and its environment by reading a map. He tells the driver about the known risks on the circuit (predictable uncertainties) having acquired this information before the race as part of the planning process. In this way, he uses the functions of "memory of the past" and "logic of known" found in the left hemisphere of the brain.

■ The driver incorporates as "imagination of the future" the preventive indications of the co-driver (predictable uncertainties); and performs the long-term manoeuvres (gear and speed changes). However, the driver uses the right cerebral hemisphere capabilities to handle the unknown (unpredictable uncertainties) that may arise, and reacting with the brake and steering wheel.

Rally-style driving is best used in projects with great uncertainty, where the correlation of the functions of the driver and co-driver and the functions of both hemispheres are reflected and handled (according to the resources and capabilities available) by a team of specialist managers; or by a single manager with an uncommon ability to realise both functions, and capable of differentiating and combining the roles of driver and co-driver[3].

5 Basic Characteristics of the MadPRYX Model

The MadPRYX model collects the two project guidance strategies of formula and rally, and works by means of some functions included in the canonical development of any project (represented as a sequence of stages, as in PMBoK):

■ ***start function*** includes search and selection of all the possible information about the project and its environment and establishes an external objective for the project; assuring the viability of the objective (in clarity, scope, and resources), and a project development structure that enables the use of MBO (management by objectives).

■ ***planning function*** proactively prepares contingency plans and safeguard policies to prevent predictable risks, and respond to their appearance with the necessary resources (including buffers).

■ ***monitoring (of production) function*** reacts to alerts (established in previous functions) with planned countermeasures (the policies deduced in the contingency plans for predictable uncertainties), and generic resources (buffers and others); and resolves unpredictable uncertainty. This function has the necessary flexibility to respond to unpredictable errors using learning buffers.

■ ***execution function*** includes tasks reserved for the project director handled in parallel with his task of monitoring the production team operations.

■ ***closing function*** gathers experiences and project metrics to prepare for the application of new parameters to successive projects -as learning for predictable risks.

During the stages of execution and monitoring, given the constructive necessities of the content of the project, the previously listed functions can, in the case of a highly complexity X, be reiterated with respect to the itemised **modules**, or the prototypes designed to reduce the high level of uncertainty Y. MadPRYX can be described in teaching terms as an "ABC" model, as below:

■ ***Ample model***, embracing all the phases and functions of a project in an wide sense, from its first mention to its definitive acceptance; including tenders and contract, possible orientation to service and association to all types of evaluation methods.

■ ***Bilateral model,*** gathering the interests of all participants (clients, developers, users...)

■ ***Complete model,*** calculating the project risks (in order to classify threats and critical events) and using the causality threat-countermeasure to develop contingency plans for predictable events, and incident policies for unpredictable events (including the change of milestone dates).

In MadPRYX, as in any risk process, the safeguards are applied in an environment of "persons" with "three I" contexts:

- ***Interested context:*** any change process affects established situations or interests.
- ***Internal context:*** where the main affected interests are found in a reduced area of relationships generated by the project itself.
- ***Intelligent context:*** referring to the contradictions and counter-actions of highly defined actors with unequal powers, requiring sufficient flexibility from the director to adjust to the situation and enough authority to avoid any project ineffectiveness that could compromise its success.

MadPRYX trys to control the situation of each factor that may contribute to the project's global risk with the "three R" focus, that is:

- ***Residual control:*** maintaining the factor values under a defined and revised threshold.
- ***Repeated control:*** reiterating vigilance and intervention if a situation may become out of control.
- ***Registered control:*** conserving the trail of events in order to learn and transmit information to other projects.

6 Proactive Project Driving

Beyond the intuitive image that the "rally" concept facilitates, project driving with help from risks in any incident generated by environmental uncertainty (a "murphy") continues to be reactive and clearly adaptive. That is to say:

[3] Both models of driving also correspond fairly well with the characteristics of the uncertainties and the tasks of the managers that a team from INSEAD (Meyer et al.) have described when proposing a choice between the two major project management strategies: the "proactive" planning strategy; and the "reactive" response strategy (alerts) and learning.

the driver reacts to the incidents as they occur by adopting the adequate measures, thanks to a buffer of resources reserved for these risk situations.

But normal human driving "by sight" supposes not only a reactive step with respect to the project's environment, but a proactive step with respect to the project itself; learning to use a "map" (project plan) when analysing a situation, while resolving small and immediate incidents are resolved mechanically.

The ***planning function*** in a situation of high uncertainty Y, is converted in any sense into a phase of "mapping" that; firstly, shortens the trip to the immediate "journey" ahead with a certain and precise objective (meaning a sub-project or prototype, hereby baptised "***protoject***"); and secondly, virtually achieves the objective and so places the "*protoject*" in the context of the project. The breakdown of the project in tasks changes to becoming a set of iterations, or protojects, that are structured according to the most convenient segments and milestones from the point of view of the resolution of uncertainties (that is, predictable incidents). The "danger map" establishes the most dangerous areas and the most adequate driving measures (for example, speed limits, extra resources to climb "hills", environmental attention frequency, reviews, etc).

The ***monitoring function*** is based on a comparison between what is indicated on the "danger map" (the co-driver or something like an audio GPS system), and what is "at sight" in each planned interval of the protoject. This comparison requires the availability of a set of parameter measurers and measurement activators organised as a Balanced Scorecard; as well as interconnected between them (with measurement and action parameters adjustable as the project advances, in a similar way to automatic transmission or "softness" of the suspension).

The "by sight driver" must maintain a global awareness of the project, as well paying precise attention to the instruments and course, as suggested in the Theory of Constraints underlying Critical Chain Project Management. The progressive exhaustion of the "major resource reserve" (energy in the case of a vehicle) maintains a good level of efficiency in the project; while the "small reserves" (including the activator's space-time margins) enable rapid rectifications required by the relevant contingency.

7 Risk Management and Project Success Factors

A study of the Critical Risk Factors of a project dualizes the study of the Critical Success Factors: taken as a result of fulfilling the objective in a way that is factorizable and measurable with two criteria:

■ ***Effectiveness*** is an "external" criterion of result comparison with the objective established outside of the development of the project; a qualitative criterion (client satisfaction, for example) that implies sub-criteria which are difficult to validate and rarely validated.

■ ***Efficiency*** is an "internal" criterion of result comparison with some reference related to the limitation of resources used in the project, or with the causes of its potential defects. Its measurement is quantitative or qualitative, and more or less subjective; but it can be referenced to the degree of advancement achieved by the project, which can, in turn, be determined by material and immaterial resources used by the participants.

These two criteria are not independent, but rather disynergic or negatively synergic.

■ ***Efficiency*** is more controllable, but impacts on lack of effectiveness when certain resources are unavailable.

■ A strategic ***ineffectiveness*** (abortive shortages) conditions the interest of any tactic efficiency.

■ Even in well organised projects without abortive shortages, a risk of minor non-fulfilment may produce an impact that always requires an increase in resources (meaning a controlled reduction in global ***efficiency***) in order to redirect the project towards the objective.

■ In general, to achieve a certain level of ***effectiveness*** (or a threshold of risk represented by a limited distance between the result and objective), the level of ***efficiency***, or used resource, depends on the levels of uncertainty Y in the development process, until the maximum level of ***inefficiency*** implied in abandoning the project. Before arriving at such an unsatisfactory decision, the lowest possible consumption of resources will minimise waste and reduce inefficiency.

In short, MadPRYX looks for success in the optimal equilibrium of these criteria of *effectiveness-efficiency*: as conditioned by the levels and types of *complexity-uncertainty* in the project process and its environment.

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Convergence of IT Project Management and Change Management: A Comparative Study

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This paper presents the results of a study into the antecedents for IT Project change management success. An established research framework was adapted for gathering evidence to identify the factors for success of an IT project. In order to avoid an original IT-centric position, emphasis was on the success of managing the change of IT projects. Multiple case studies with varying dimensions of IT project scope are described in the context of this model. The results indicate that successful projects were found to have facilitators in all dimensions of the framework, including the change environment, and project management. The least successful project lacked facilitators primarily in the area of cultural readiness and change management.

Keywords: Business Process Change, Change Management, IT Project Management, Organisational Readiness, Project Champion, Stakeholder Satisfaction.

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1 Introduction

This paper discussed the need for recognizing that project management and change management are inseparable, and identifies the major players in the change management regime. Change management is about championing the project and ensuring that the project is understood accepted and embraced by the stakeholder community. Slusarenko [1] argues "*well-managed projects do not involve a separate change management team, or a separate change management activities per se*". Such projects ensure that change management is an integral part of the project management process. Change management then, is not a mere adjunct activity to the project, or a phase within the project. Change management is viewed as a set of activities that starts with the project and ends with the project [2].

Kalakota and Robinson [3, p. 60] state that "*the creation and implementation of an IT project is inextricably linked to the management of change*." This requires systematic attention to learning processes, organisational culture, technology infrastructure, people and systems thinking. IT project change is defined here as an organisational initiative to designed an IT project "*to achieve significant breakthrough improvements in performance*" [4, p. 121]. These performance gains can be achieved through changes in relationships between management, information, technology, organisational structure, and people. Planning and managing such systems requires an integrated multi-dimensional approach across the e-business and the development of new business process models [5][6].

"In trying to bring about IT project change, managers would do well to recognise the complementary nature of technology, business models, and cultural readiness throughout the organisation's value chain" [7, p. 39].

This paper reports on the initial findings from a multi-case study selected from a range organisation's ongoing IT projects. A confirmed model of Project Change Management (PCM) was used to analyse the case content [8]. The findings are to confirm that successful IT projects have facilitators in all components of the PCM framework. Further, there is the implication that stakeholder satisfaction is delivered through project management activities supported by change management.

2 Theoretical Framework

Change management in the context of this paper is the process of setting, managing and meeting the expectations of stakeholders to ensure project success. It is not about scope control and management of changes to scope, schedule, or quality, although these attributes impact the change management process. These latter types of changes are usually known as "change control" or "engineering change control" which is a functional process within project management and is not considered in this paper.

Hence, we discuss change management not as a project in its own right but how that relates to the successful delivery of IT projects. This aspect is distinct and different from "change control" and suggests a new term: Project Change Management (PCM).

2.1 Model of Project Change Management

Norris et al. [9] capture the essence of moving to a new

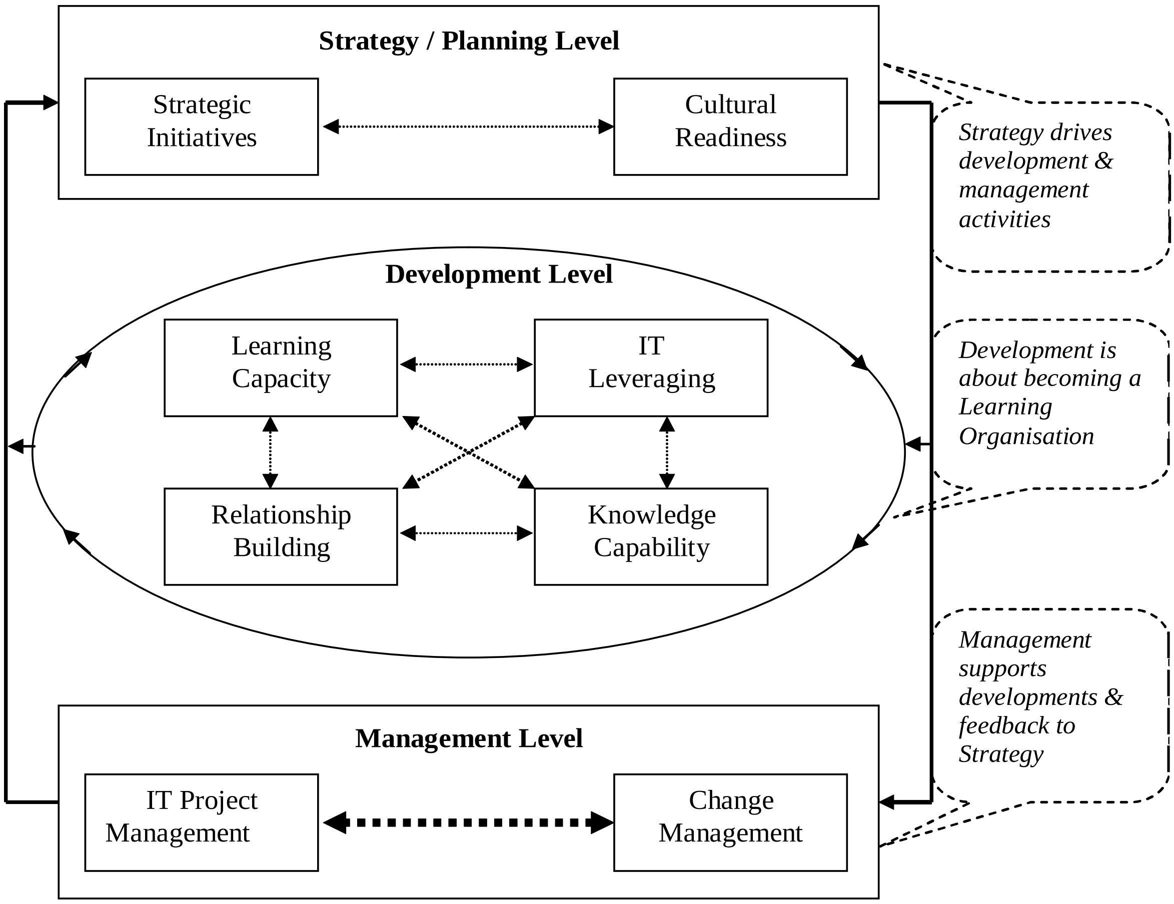

Figure 1: Model of Project Change Management in IT Projects (source Ash & Burn [8]).

IT environment as involving a major organisational change. "*As with ERP major business initiatives, an IT implementation forces change to occur to three corporate domains (technology, process and people) at both a strategic and operational (tactical) level.*". To overcome resistance to change, each component must be aligned, along with the enabling technology, to the strategic initiatives [10]. Barua et al. [7] specifically refer to the success of a company's IT initiatives coming from the readiness of stakeholders to engage in electronic interactions. Figure 1 illustrates a model of PCM, where all components within the three levels are considered antecedents of IT project success. It indicates that strategy drives developmental and managerial activities, where management supports the developments in IT and in turn provides feedback a dynamic strategy. In addition, *project evaluation* (or reporting Level) is considered a sub-level within the Management level.

3 Methodology

The study used an established theoretical framework (see Figure 1) of "e-business change" research [8] which was based on earlier work by Guha et al. [4] on "business process change". It is used for identifying and examining the facilitators and inhibitors of successful IT projects. Figure 1 was adapted from Ash & Burn's model [8] to focus on the unexplored relationship between Project Management and Change Management. The research questions addressed are as follows:

- What components of the PCM model facilitate and/or inhibit success of IT projects?
- Is the PCM model appropriate for identifying patterns of change?
- What are the critical success factors in IT PCM?

Embedded multiple case study analysis was chosen to investigate the research questions concerning the complex phenomenon of change management of projects, in four organisations [11]. Embedded approaches enlist the use of multiple units of analysis: (i) the company (strategy), (ii) the project team, and (iii) the project. This triangulation attempts to validate primary data [12]. The case study selection criterion required a major e-business project, which had organisational implications. Also, as the focus was on studying antecedents to organisational performance, a set of projects having a range of IT initiatives with variance across cases, but with the same performance measures was required: cost reductions, responsiveness, flexibility, shareholder satisfaction and value.

3.1 Data Collection

The study was carried during 2005 and 2006 of eight-

Case Code	Organisation Alias	Location	Employees
1. GFLF	Good Food Ltd - Fiji	Suva, Fiji	~400
2. VBFA	Volunteer Bushfire Fighters Association	Perth, Australia	19600 members
3. LILF	Life Insurance Ltd – Fiji/ Australia	Suva, Fiji, Austarlia	600
4. PSDF	Prisons Services Department. - Fiji	Suva, Fiji	300

Table 1: Case Profiles.

een (18) IT projects out using multiple interviews of senior project staff of a global mining e-marketplace QTX involved in e-business developments of customer within this e-marketplace. Case data were gathered from three sources:

- Primary data; interviews of all open and semi-structured project team meetings.
- Secondary data; telephone interviews and email correspondence to verify the case notes.
- Tertiary data from; company documents and reports sent via emails, student presentations.

3.2 Case Selection

Four IT projects with significant organisational change, were selected for their suitability to represent all cases. These four cases are presented in no particular order of success (stakeholder satisfaction). Table 2 summarises the profiles of the four "representative" case organisations used in the study.

4 Findings

4.1 Case Summaries

Case 1. *Good-Food Ltd of Fiji* (GFLF) based in Fiji with parent company in Australia. Its mission is to create cost effective retail outlets with large and small companies of its frozen and snack food lines. The aim of IT project was to optimise the daily truck routes from its main warehouse to its outlets. The major beneficiary would be sales/ order staff via the automation of the old, paper-bound purchasing and delivery processes. The project was to establish more favourable conditions with the slimmed-down retailer base and build up closer business relationships with each one. Apart from the cost savings from more efficient delivery procedures, the company's sales team have a more strategic role. GFLF sales staff should be relieved of routine paperwork, enabling them to concentrate more on key retail customers will broaden these people's day-to-day task base considerably.

"*We'll have more time to spend on nurturing customer relationships and promoting new product lines from the automation of an optimised set of delivery routes.*".

Case 2. For *Volunteer Bushfire Fighters Association* (VBFA) the primary beneficiaries were the brigade managers who needed email communication to all volunteers with the brigade and gained this through the innovative use of Internet technology. The result was one of considerable time savings and improved reliability of essential *communiqués* and improved volunteer resourcing. The intrinsic motivation by the project champion, and self-management of autonomous knowledge within the development team played an important role in the successful implementation. The emphasis was much more on collective performance rather than individual, but at the same time, development and maintenance of personal and professional reputations was a significant driver. The association's volunteers were initially luke-warm in their support, viewing the proposed system as a threat to a strongly centralised control culture. Once the benefits were understood their initial reluctance subsided.

"*Our project champion assumed responsibility for the success and leadership of the implementation.*".

Case 3. The *Life Insurance Ltd of Fiji* (LILF) case study demonstrates how computer technology division within a large Insurance organisation succeeded in making the sell-side financial products ("new customer accounts") available over the Internet. A new accounts system (extranet) was developed to supersede a paper based sales system by leveraging the power of graphics and Internet technology. This would extend the reach for cross-divisional users. The efficiency gains came from speed, accuracy and security of account transactions. The beneficiaries were other business partners (divisions) and independent partners. The result was considerable cost savings and greatly improved online sales.

"*We are beginning to recognise the potential benefits of leveraging our business processes and functionality through the new Web-based environment.*".

Case 4. The (PSDF) Prisons Management System was the development of the generic web-based application with a SQL backend, to replace the existing spreadsheet and paper based management solution. The PMS is database application that provides an easy to use tool that integrates all prisoner related information via a secure web-based interface. The primary beneficiaries are the Heads of department's and Court judges who demand timely information to make strategic decisions; e.g. Prisoner report cards and profiles. In addition, benefits will be able to be realised when the PMS application is integrated into other applications, such as the Police and other related organisational systems. These benefits will be measured through cost savings in development effort, resources and effective communication.

Components *Constructs*	**Benefits Realisation**	**Most Successful**	**Least Successful**
Strategic Initiatives			
stimuli	pro-active in reacting	pro-active & reacting	reactive
formulation scope	incremental in practice	incremental	revolutionary
decision making	champion leadership	champion emergence	central autocratic
strategy led	IT aligned to strategy	Business a IT driven	IT strategy lead
Cultural Readiness			
change agents & leadership	need for change leader	+	-
risk aversion	welcome change	welcomed	cautious
extent of open communicat.	open communication	+	targeted
Learning Capacity			
adaptation	*learning induced by IT change	learning from others	response to IT change
improve efficiency	learn to be efficient	learning by doing	learning by doing
learning type	learning from feedback	double-loop	single-loop
Knowledge Capability			
external information use	collaboration with partners and competitors	boundary spanners	technology gate keeper
declarative knowledge	*acknowledge knowledge is a corporate asset	focus on core competencies	R&D resources IT development
IT Leveragability	superior IT not required but		
use of Internet technology	* ensure IT is adequate	+ superior	- poor
role of IT	intrinsic to work operations	enabling & socio-technical	dominant factor
Relationship building			
inter-organisational linkages	* Trust and commitment not imperative but needs collaboration for emergence	cooperative	non-cooperative/ competitive
cross-functional cooperation	Data alignment is essential	superior (data alignment)	poor (data alignment)
Change Mgt Practice			
mgt's. readiness to change	* Mgt committed to	committed	resistant
pattern of change	communicate change	+	-
scope of change	at all levels	improvement	radical change
managed change	all aspects in evolutionary change pattern more successful	well managed process for change	alleviation of dissatisfaction,
Project Mgt Practice			
Project measurement	use IT project metrics with feedback	use IT project metrics	No improvement feedback loop
use of tools and techniques	educate about techniques	adequate/superior	poor (tools training)
team-based structure	* reward teaming	+	-

Table 2: Benefits Realisation and Success Factors.

"*We are realising benefits of leveraging our organisation's data through integration.*".

4.2 Evaluation of Project Benefits Realisation and Success

Table 2 summaries the project behaviour across the four cases. Consistent with the research objectives, specific constructs were established concerning each component of the PCM framework. The data gathered on each construct was analysed for its positive or negative influence on project implementation or overall effectiveness of change. This is documented with either a plus (+) or a minus (-) sign. The patterns in Table 2 indicate several important indicators that have implications for both research and practice.

Those constructs identified by (*) were seen as "satisficing" factors, that is, they needed to be present but not necessary to be excellent. These involve components other than strategy and cultural readiness organisational readiness. In some cases, both positive and negative (+ & -) contributions were found from one component variable. For VBFA, leadership was found to exhibit (+ & -) contributions. In some instances, respondents chose multiple values for a specific construct. Table 2 is especially useful in separating those constructs that have variance across the range cases examined and those that have none, e.g. for stimuli all four case were the same, proactive but reacted very differently to stimuli.

While the most successful organisation had positive characteristics, not all characteristics were seen to be equally important or indeed to directly influence success. To be successful, management must support a *proactive* way the organisation *reacts* to the stimuli. Those with significant impact on the project success are in bold type (+) or (-). If we assume these ratings reflect the presence of facilitators and inhibitors, then the initial findings indicate that a successful project should have facilitators in all components, including the planning and management levels, e.g. VBFA.

Interestingly, while the project was rated highly successful there was strong opposition from their city partner operations to implement the same system. This came from the counterpart city firemen who had not been exposed to the participative development process.

Further, there is the implication that least successful projects will have inhibitors in both levels, especially in the area of cultural readiness and change management practice, e.g. LILF.

While the project was rated moderately successful the opposition came from the partner reluctance to implement the same system due to the conflict of the established offline sales channels. The lessons learnt were two fold; (i) the use of a common platform needs the agreement of all functions, (ii) The internal and external marketing of the facility is essential to the acceptance of divisional business network and to foster end-user acceptance of the technological change in business practice.

Once the initial benefits broke down user reluctance, management "assumed" responsibility and leadership for a new global strategy. Further, the lack of a coordinated corporate wide strategy by the parent company was viewed as the main obstacle for uptake of the system by the business partners. It highlights the need to evolve a coordinated corporate strategy and encourages the balancing of conflicting organisational knowledge when contemplating the adoption of e-business solutions.

5 Implications of Findings

5.1 Strategy and Planning Level

Strategic Initiatives. There tend to be strategic "stimuli" ranging from competitive pressures, continued market leaderships, customer expectations, employee dissatisfaction and/or organisation inefficiencies that trigger firms to undertake IT PCM. According to these findings, PCM has to be proactive to be successful, but by the way the organisation is reactive to the stimuli. This is viewed as a satisficing condition for project success. Incremental PCM may work but appears to be appropriate when risk aversion is welcomed. Also, incremental projects were perceived as revolutionary in nature.

Successful IT projects establish a goal/vision and unbiased team/individual champion that continues to push drive the organisation to find new innovative processes. These champions must be empowered to implement the changes within a culture of e-business readiness [13].

Cultural Readiness. To address complexities of change, each component must be aligned, along with the enabling technology, to the strategic initiatives [10]:

An organisation attempting to change performance radically seems to require some "sense of urgency" in their business situation, which translates in turn into a compelling vision that is espoused throughout the organisation. To overcome pockets of reluctance to change, an organisation's vision for change must provide an atmosphere of communication where individual concerns are not seen negatively but rather welcomed.

An important ingredient in the right organisational cultural mix for successful project is leadership from the top and initiatives from employees, together with an atmosphere of open communication, participation, committed cross-functional access to experts, and committed inter-organisational focus.

5.2 Development Level

Learning Capacity. Successful IT change projects are enabled in organisations that; (i) have a propensity to learn from best practice and customer needs, and (ii) exhibit learning whereby employees individually and collectively reflect on their past experiences, modify their course when necessary, and discover new opportunities, a new culture of the learning organisation.

Relationship Building. Successful IT projects require commitment between partner organisations to use common IT platforms and sharing of corporate information.

Knowledge Capability. Successful IT projects are enabled in organisations that leverage external information and experts, and focus on core competencies.

IT Leveragability. Successful IT projects involve the coalescence of IT and organisational change best practice, whereby IT plays a supportive, but not always commanding role that is linked to the business case for IT change. A balanced consideration of the social, technical, and business value elements should be maintained during implementation.

5.3 Management Level

The nature of change was observed to be a "participative" change activity resulting in an evolutionary change tactic. This was also, viewed as a "waterfall" progression of change, starting with an alleviation of dissatisfaction by employees and eventually working towards a well-managed IT implementation from the alleviation of dissatisfaction, with a vision for change by evolutionary change tactics, accompanied by a well-managed process for change.

To achieve this requires continuous articulation and recognition of the value of reporting results, as well as monitoring each individual's contribution and accountability to the overall company's change effort. At the individual employee level, concern should be placed on how IT PCM will improve employee satisfaction and the quality of work life [4].

A well-defined transparent management approach should include; (i) a detailed *change plan*, (ii) the use objective and quantified metrics showing the value of change (MOV), (iii) continuously report (communicate) process metrics to senior management, and possess a well-documented rollout of the new e-business design.

6 Conclusions

An established research framework of project change management (PCM) was used to identify the factors for success of IT projects. The qualitative case methods provided content and discovery of elements that surround each construct to identify those facilitating and inhibiting factors that lead to ultimate project goals (stakeholder satisfaction). The results confirm that successful projects were found to have facilitators in all components of the PCM framework, including the change environment and management practice. There is the implication that the least successful IT projects will have inhibitors in both components, specifically with cultural readiness and change management.

The research framework was chosen as a method for its ability to examine complex relationship of project management and change management. This model is viewed as evolutionary in nature, and was case content driven. It is essentially a diagnostic tool for identifying factors contributing to success of new business models. It specifically explores the areas related to the successful learning organisation where the key issues remain as people oriented organisational issues. In a labour force of inter-divisional virtual teams, management will be more about motivation, and governance may be largely a question of self-regulation rather than control.

While broad generalisations from the four case studies are viewed as premature, various patterns of constructs were developed as indicators that have implications for both project management practice and education. These patterns of variances across the cases presented represent are indicators for success, failure, and a tendency to mediocrity, that is regarded as common practice.

Future studies will need to examine further the interrelationship between project and change management. Change planning and reporting are identified as candidate activities for best practice by today's IT project managers. We observe the convergence of these two fields of management is necessary and sufficient to deliver stakeholder satisfaction.

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The Future of the Internet Protocol

Maurizio Dècina and Paolo Giacomazzi

This paper was first published, in its original Italian version, under the title "*Il futuro del protocollo Internet*", by ***Mondo Digitale*** (issue no. 2, June 2007, pp. 17-29, available at <http://www.mondodigitale.net/>). ***Mondo Digitale***, a founding member of **UP**ENET, is the digital journal of the CEPIS Italian society AICA (*Associazione Italiana per l'Informatica ed il Calcolo Automatico*, <http://www.aicanet.it/>.)

Notwithstanding the extraordinary success of the 4th version of the IP protocol, the scalability of mobile and multicast communications in the Internet is still a difficult challenge and substantial evolution is needed, especially in view of the steadily increasing demand for mobile and multicast communications and the growing penetration of overlay systems. Evolutionary strategies planning the functionalities of future protocols with a strictly technological approach are critical because market requirements need to be taken into account. In fact, the Network has already shown that it changes naturally, according to the needs of users. Development strategies accounting for market requirements are likely to be more successful and the impressive growth of overlay systems such as Skype telephony and multimedia streaming over IP should be taken carefully into account.

Keywords: Internet, Host Identity Protocol, Internet Protocols, Market Requirements.

1 Evolutionary Strategies: The Lessons Learned

The Internet Protocol (IP) was born around 30 years ago and it may be surprising to realize that the basic Best Effort service is still nowadays one of its strongest features and it is the most important Internet transport service. This success of the core functions of the IP protocol is durable, even if the standardization of the new Internet protocol, IPv6, is proceeding apace. Twelve years ago the first IPv6 standard was issued by the Internet Engineering Task Force, but the current market penetration of IPv6 is limited. This suggests that evolving the Internet protocol while keeping its appeal for the market is not a simple task. Figure 1 quantifies the huge effort that has been dedicated to the standardization of IPv6 by plotting the yearly number of IPv6 standards issued from 1995 to

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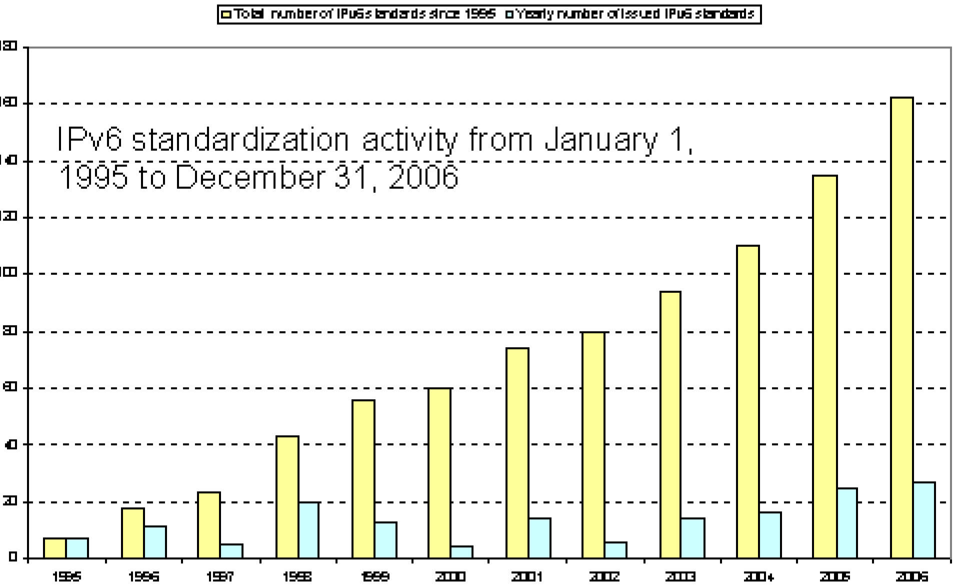

Figure 1: Number of IPv6 Standards Issued from 1995 to 2006.

2006, as well as the total number of standards since 1995. The total number of standards is high (160) and this clearly indicates that IPv6 is a technology approaching maturity. Moreover, standardization activity is accelerating, as indicated by the peak in standards production in 2006.

Since the market diffusion of IPv6 does not seem to match the rather advanced status of its standardization, we need to identify the factors responsible for this mismatch. The factors hindering the penetration of IPv6 may be technological problems, solutions already rolled out that operators are not willing to replace so soon, or a mismatch between market needs and the new features provided by IPv6. Our conclusion is that it is not possible to address all the technological, architectural and service-related issues with a single protocol, however complex that protocol might be.

We begin our analysis by briefly describing a previous effort to design an integrated network that was to be the "Internet of the future": the Asynchronous Transfer Mode (ATM). This technology, born in the mid-eighties, was considered until the early nineties to be the communication technology of the future. This prediction turned out to be mistaken.

ATM: Asynchronous Transfer Mode or *Another Terrible Mistake*? This was the tongue-in-cheek question asked by many people from the world of industry and academia in the early nineties when, after a massive, decade-long effort was spent on the development of ATM technology the final product was of an extremely high quality but had a disappointing impact on the market. Twenty years on, ATM still exists as a niche technology used, for example, by carriers to virtualize transport on the SONET/SDH physical network.

A poor outcome for an effort to which industry and academia worldwide have been committed for many years. Without going into detail, the breakdown of ATM was essentially caused by the purely technological approach adopted in its design. The technical requirements for the "best" communication technology were recognized and a huge effort was made to meet these requirements with a suitable technology. These objectives were achieved, but in the meantime the market had made its choice and the Internet protocol, albeit radically simple compared to ATM, won a very large market share and ATM has been confined to a niche. It is very interesting and instructive to realize that the market has been taken over by a plain vanilla technology, the Internet protocol IPv4.

The critical factor working against ATM's market penetration has been the success of the IP protocol which occurred just as ATM was being developed. Distributed applications started making ever more frequent use of TCP/IP transport for communications and the constantly increasing market success of distributed applications in the Internet market has resulted in the growing strategic importance of IP. Meanwhile, ATM was designed and developed and, when it was ready for deployment in telecommunications networks, ATM encountered a real world where applications were constructed to work over the TCP/IP transport and IP had already been chosen as the real internetworking protocol. ATM offered a high level of quality and reliability, but mere technical quality was not enough to threaten IP's competitive edge.

The lesson learned from the story of ATM is that it is dangerous to establish the requirements of a new Internet protocol from a solely technological point of view. The migration towards the "Internet of the Future" should take in into account market requirements, the current needs of services and distributed applications and, if possible, we should try to forecast the future needs of users and applications. Currently, one of the most important phenomena in the Internet is *overlay* networking.

2 Overlay and Peer-to-peer Systems

Overlay systems are universally known as peer-to-peer, even if the two terms are not exactly equivalent, as peer-to-peer is a special case of overlay networking. Peer-to-peer systems were born as communities for file sharing (Gnutella, Bit Torrent, Kazaa, …): users of these file sharing systems can download from other users' files stored on their computers. The subsequent evolution of peer-to-peer systems has brought about a profound change in the Internet telephony market. For example, Skype is an overlay telephone network over which users can place calls through the Internet from their computers, without using Public Switched Telephone Networks or cellular networks. A third wave of overlay systems is currently coming on to the market in the form of audio/video media streaming systems (Coolstreaming, PPlive, QQlive, Octoshape, and many others). These systems allow users to receive streamed media through their network connections. Real-time or near real-time communications (such as for live events like soccer matches) are possible.

Overlay systems are becoming increasingly more strategically important, as more than 50% of the total traffic transported by a typical European carrier is generated by peer-to-peer applications, and this percentage is growing. However, it is interesting to note that more than 50% of a carrier's revenues are generated by telephony and business data, even if the traffic generated by these two application categories is significantly less than 50% of the total transported traffic. Very frequently peer-to-peer services are exploited by residential users through their ADSL connection, which is often paid for under a flat rate billing method. In this way, computer-to-computer telephony is included in the fixed monthly rate of residential ADSL connections, as opposed to the traditional time-based billing of telephony services. Carriers offering both telephony and Internet services experience a progressive migration of the telephone business towards Internet data, due to the migration of classic telephony towards Skype.

Peer-to-peer systems are a technological innovation that is independent from the current standardization of IPv6 and they have produced a shift in the business of carriers in the order of 10% or even more. Multimedia streaming promises even larger changes in the market of content distribution. Carriers need to plan their business carefully, by taking into account the forthcoming wave of peer-to-peer multimedia streaming systems.

The significant success of peer-to-

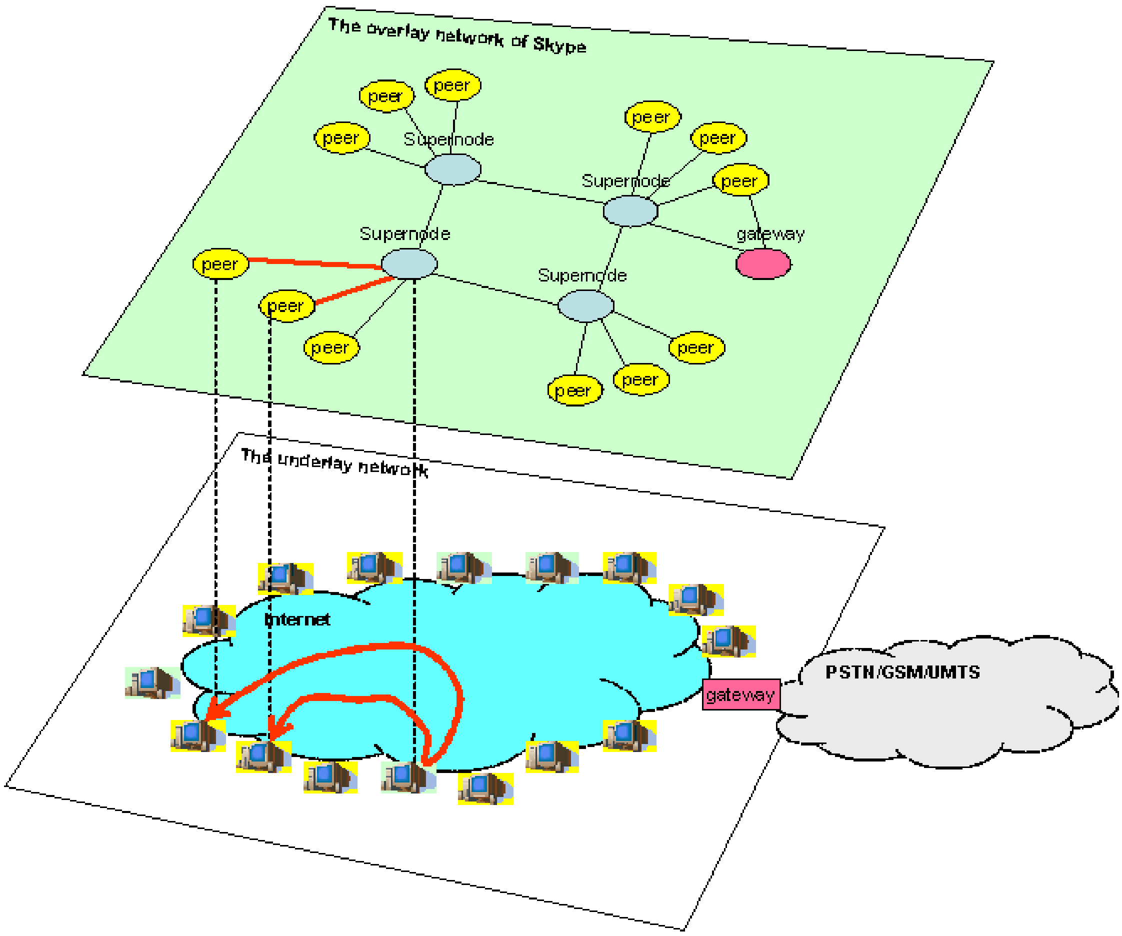

Figure 2: Overlay Systems: The Overlay Network of Skype.

peer systems should be taken into account when devising the best way to evolve the IP protocol towards the next generation. Any new technology produced without considering peer-to-peer networking is likely to be a failure. Therefore, in the following sections we will outline the most important requirements of peer-to-peer systems and we will try to match these requirements against the consequent musts of the next-generation IP protocol.

2.1 Peer-to-peer Telephony

The basic concepts of a peer-to-peer system are illustrated in Figure 2, showing a simplified architecture of the Skype system. The "physical" Internet network, comprising communication links, routers, switches and so on, is the underlay network. The underlay network includes also the hardware user devices (i.e. computers). The overlay system is basically built by the application modules hosted by the users' computers (the *overlay clients*). In the overlay system, the overlay client is a node of the overlay network; that is to say, the overlay client acts as a router of the overlay system. In this way, overlay clients are a logical network, at the application layer, using the underlay network as a facility for the transport of information. Figure 2 shows a network with two layers, but only the underlay network has hardware components, while the overlay network is virtual. This virtual network, in the case of Skype, has two hierarchical levels and for this reason its topology exhibits some similarities with a traditional telephone network. The overlay clients of the highest hierarchical level, called *supernodes* in the Skype terminology, have a role similar to that of the transit exchanges of traditional telephony. Each element of the overlay system corresponds to one device of the underlay network and, very frequently, this device is the computer of a user of the overlay system. In Figure2, the mapping of some overlay functions onto the respective underlay devices is shown with dashed lines.

The overlay client uses computational resources, memory and disk space of the user's computer, as well as the bandwidth of the associated Internet connection. We observe that in overlay systems the upload and download capacity of the Internet connection are equally important, as opposed to classic web-browsing applications where the download capacity is more important than upload capacity. In the Skype system, supernodes must be computers with large computation capacity, memory and bandwidth. The system is able to recognize the computers with adequate CPU and bandwidth and the respective overlay clients will act as supernodes. In Skype, supernodes route telephone calls of other overlay clients.

2.2 Peer-to-peer Streaming Video and Overlay Multicasting

Users of peer-to-peer streaming video systems can receive audio/video media from other users, in the form of a traffic stream. These systems can scale up to very large sizes, in terms of both number of clients and geographic area covered.

This is achieved by exploiting multicasting, performed at the overlay layer. It should be noted that a worldwide multicasting carried out directly at the underlay layer with the functionalities embedded in the IP protocol would not be possible.

In the case of video streaming systems, in the simplest cases the overlay network is a distribution tree. The root node distributes the media to a limited number of overlay clients. These users can watch the media but, at the same time, their overlay client redistributes the media to other users and so on. Each user propagates the media to other users and the limit to this process is the upload bandwidth of the user's Internet connection and the CPU power of her/his computer. In a few passages the number of users reached by the media can become very large as its growth rate is potentially exponential.

System resources are the CPUs, memory and disk space of personal computers, and the bandwidth of the Internet connection. With average computers and Internet connections it is possible to set up a worldwide overlay system, as the available resources increase as the number of users grows; in other words, the system is naturally scalable.

The multicast tree for media distribution is built at the overlay layer and at the underlay layer communications are point-to-point (unicast). The overlay system builds a worldwide multicast communication between peers by exploiting the point-to-point communication capability of IP. This demonstrates the practical impossibility of building large multicast trees for the distribution of media at the underlay layer.

2.3 Technical Problems of Overlay Systems

The internet of the future should be designed in such a way to facilitate the operations of overlay systems in order to foster their development and extend the set of services delivered through this channel. It is interesting to note that current specifications of IPv6 already adopt a significant enabling solution for overlay systems; IPv6 addresses are 128-bit long, while current IPv4 addresses are much shorted (32 bits). The fact that address length can heavily influence the operation of a peer-to-peer system may be surprising, but in the following discussion we will show that this problem is strategically critical.

With reference to Figure 2, in a peer-to-peer system, two clients need to communicate in order to exchange files, media, or telephone calls. This may seem very simple, as the two clients are two networked computers, each with its own IP address, and so they should have no problem communicating. However, very often this is not true, because the Network Address Translation (NAT) may force clients to communicate through a supernode, as shown in Figure 2, instead of communicating directly. This relaying of communications consumes a large amount of resources but, before analyzing this drawback, we will explain why Network Address Translation is necessary and why it can cause the need for tandem communications through supernodes.

2.3.1 The Conflict between Network Address Translation and Overlay Systems

NAT is necessary because the total number of IPv4 addresses is insufficient. When IPv4 was designed, the use of 32 bits to code addresses seemed to more than adequate (2^{32}=4,294,967,296 addresses). However, we have already exhausted the entire set of four billion IPv4 addresses. The IP protocol requires that each network interface (of computers, printers, routers and of any networked device) has a unique address. This is why no more free IPv4 addresses are available and this problem is addressed by Network Address Translation.

Network Address Translation artificially expands the space of IP addresses. A set of addresses that can be reused multiple times (the *natted* addresses) have been reserved. For example, a company can use natted addresses for the computers and, more in general, for all network interfaces inside its private network. Other companies or institutions can use the same addresses for their private networks. In a communication between two computers inside the same private network, natted addresses work properly, even if an arbitrary number of external private networks are using the same addresses for internal communications. The problem arises for communications between a natted computer and another computer outside that natted domain. In this case, conflicts are possible as multiple computers may use the same natted address while, for the proper functioning of IP, such conflicts must be avoided. The collision of natted IP addresses is circumvented by NAT. When an IP packet generated by a computer inside a natted private network needs to travel through the public Internet, a special device called the NAT box, placed at the boundary of the private network, translates the natted address into a proper unique IP address, referred to also as a *public address*, valid worldwide. Many NAT boxes assign the same public address to all packets from the private network to the public Internet. This may appear to be impossible, but the NAT box is able to do it properly with complex mechanisms that we will not go into here. The net result is striking, as with a single public IP address a NAT box is able to manage the communications computers inside a private network with external computers. The number of available IP addressed is thus multiplied without any obvious upper limits.

Unfortunately, natted communications exhibit some limitations, especially with reference to communications in overlay systems. When two natted peers need to communicate, direct communication is often impossible, depending on the type of NAT boxes that the packets need to cross. The basic problem is that the natted address of a computer is not known outside the private network and, in this case, a direct communication cannot be established. Natted peers need to use a supernode to communicate. This is always possible, as a supernode must have a public IP address. Both natted peers can reach a supernode and use that supernode as a relay for their communications. In this way, the communication between the natted peers is broken into two segments, from peer to supernode and from supernode to the other peer, as shown in Figure 3.

The cost of this type of communication is high. When natted peers use a supernode as a relay two underlay end-to-end connections are set up and this roughly doubles the consumed bandwidth. The percentage of natted peers is high and it is continually growing, therefore, a large proportion (difficult to quantify exactly) of peer-to-peer communications use the relaying service of a supernode. This phenomenon is important, as more than 50% of Internet traffic is currently generated by peer-to-peer communications. A rule of thumb estimate of the percentage of overhead Internet traffic due to supernode relaying amounts to 20% (again, an exact estimate is difficult). From this point of view, IPv6 is promising because it uses a larger address space and NAT would not be needed. Certainly, the rollout of IPv6 is extremely difficult, as changing the addressing scheme of the Internet is a huge task and this is slowing down IPv6's penetration into the market. However, peer-to-peer applications would benefit significantly from the adoption of IPv6.

The inefficiency of overlay communications between natted peers has other negative aspects. Peer-to-peer telephony between natted peers use supernodes as if they were telephone exchanges, consuming the supernode's CPU, memory, and connection bandwidth. For example, the average Skype supernode seems to be able to carry at most a few dozen concurrent calls. This limits the scalability of Skype and similar systems: the system can scale up only if enough supernodes are available but, since supernodes are high-profile computers with a fast Internet connection and with a non-natted address, they are relatively rare and they are the real bottleneck for scalability. We conclude that a primary target of the future Internet protocol should be to eliminate the need for NAT in order to alleviate scalability problems and facilitate the operation of overlay systems (the large address space of IPv6 is very likely to be sufficient for this purpose).

3 Separation of Identity and Location, the Host Identity Protocol (HIP)

A serious problem of the Internet is that IP addresses have multiple meanings. Firstly, the IP address is a location information allowing packets to reach their destination. However, a second important meaning is carried by the IP address insofar as it is a fundamental component of the host identity. An application hosted by a computer is identified, among other factors, by the IP address of the computer. The consequences of this double meaning of IP addresses are impressive. With reference to Figure 3A, the logical termination point of application-layer connections is the socket; i.e. a pair of values formed by the IP address of the computer hosting the application and the logical transport port (at the TCP/UDP layer). A communication between two application peers across the Internet is a logical coupling of two remote sockets, one socket for each application-layer party of the communication. However, the IP addresses in the two sockets have two meanings -

location and identity - and they are fixed at connection setup time. What happens if one or both hosts move? Since the IP address carries location information, the IP address must change, but this will also change the identity of the application. Therefore, when a host moves, from the point of view of the application of the remote host, the moving application changes both location and identity. In brief, the two application parties will no longer be able to recognize each other and the connection will be disrupted. This is a serious mobility management problem, a problem that we may consider practically unsolved up to now.

When a host moves continually, it repeatedly changes both location and identity. The simplicity of IPv4 point-to-point communications between distributed applications has been the primary reason for the success of IP. However, this communication paradigm is too rigid to be considered appropriate for modern mobile communications. Many applications and services would benefit from a more flexible approach capable of providing moving applications with a stable identity. For example, an application needing to communicate with a remote peer need not necessarily know the location of that peer, but only its identity. Also multicast communications at the underlay layer would be facilitated. For example, it would be possible to assign the same "group identity" to all hosts participating in the same multicast communication. In conclusion, the mobility and multicast requirements of modern distributed applications are not met by the current Internet protocol, which offers only very basic mobility and multicast services. For example, there is an enormous difference between the rudimentary mobility provided by IpV4 and the extremely advanced mobility enabled by GSM and UMTS cellular networks. These systems implement a distinct separation between names and addresses and they connect three billion moving user devices worldwide. The current mobile IP paradigm does not allow a similar mobility and the situation is similar for multicasting [1][2][3].

Possible solutions to this problem are positioned both at the overlay layer [4] [5][6] and at the underlay layer [7]. As far as the overlay layer is concerned, the proposed solutions are specific to the application in question; for example, in peer-to-peer systems for the distribution of video streaming only the implementation of multicasting is addressed. Also, current solutions specific to multicast are not able to manage mobility, and vice-versa. General overlay solutions capable of completely decoupling location and identity, independently of the specific application, have been theorized. For example, the i^3 (Internet Indirection Infrastructure) is very interesting and elegant [4]; however, this solution is still just a theory.

The only approach supported by an Internet standard is the Host Identity Protocol [7] (HIP), an underlay solution (Figure 3b). The basic principles of HIP refer directly to the most pressing problems to be solved and the objectives to be met in order to facilitate the development of the Internet. These principles are outlined in [7]:

- We need a name space (henceforth, *name* and *identity* will be used synonymously) to be used by communicating applications for mutual identification.
- Identities <u>must</u> be <u>completely</u> independent of Internet addresses, which are to be used only for location purposes.
- Names must replace all occurrences of IP addresses in the application-layer payload of packets.
- Application developers have found it handy to transport the IP address of communicating hosts in the application-layer payload of IP packets. The practical reasons of this choice are obvious and understandable, but this creates a strict bind between location and identity. Replacing IP addresses with names in the packet's payload is a major intervention and will require an adaptation of the Application Programming Interfaces of distributed applications.
- The name length must be short in order to maintain a small overhead in IP packets carrying the identity of the communication partners.
- The probability of collision among names must be very low; i.e.

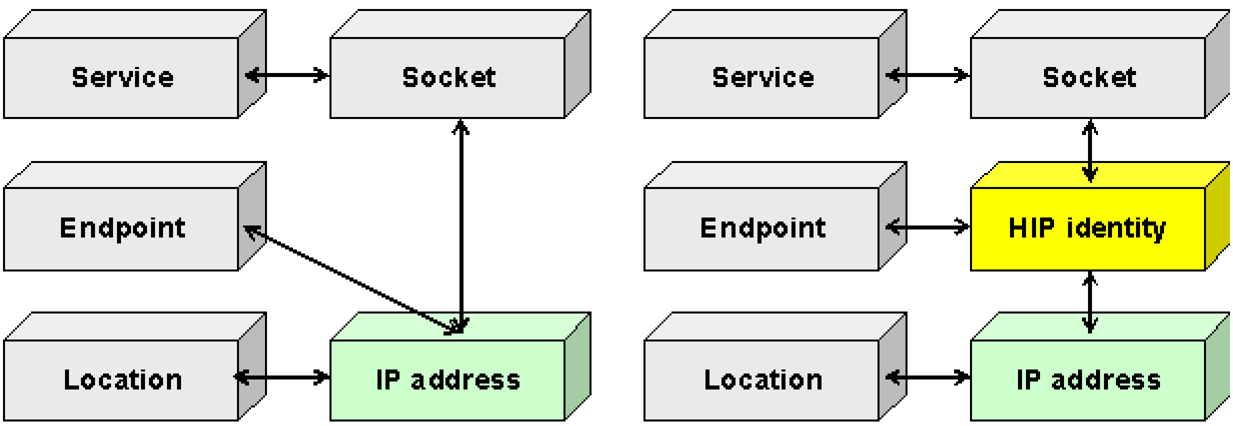

Figure 3: a) Multiple Meanings of IP Addresses; b) HIP Identity.

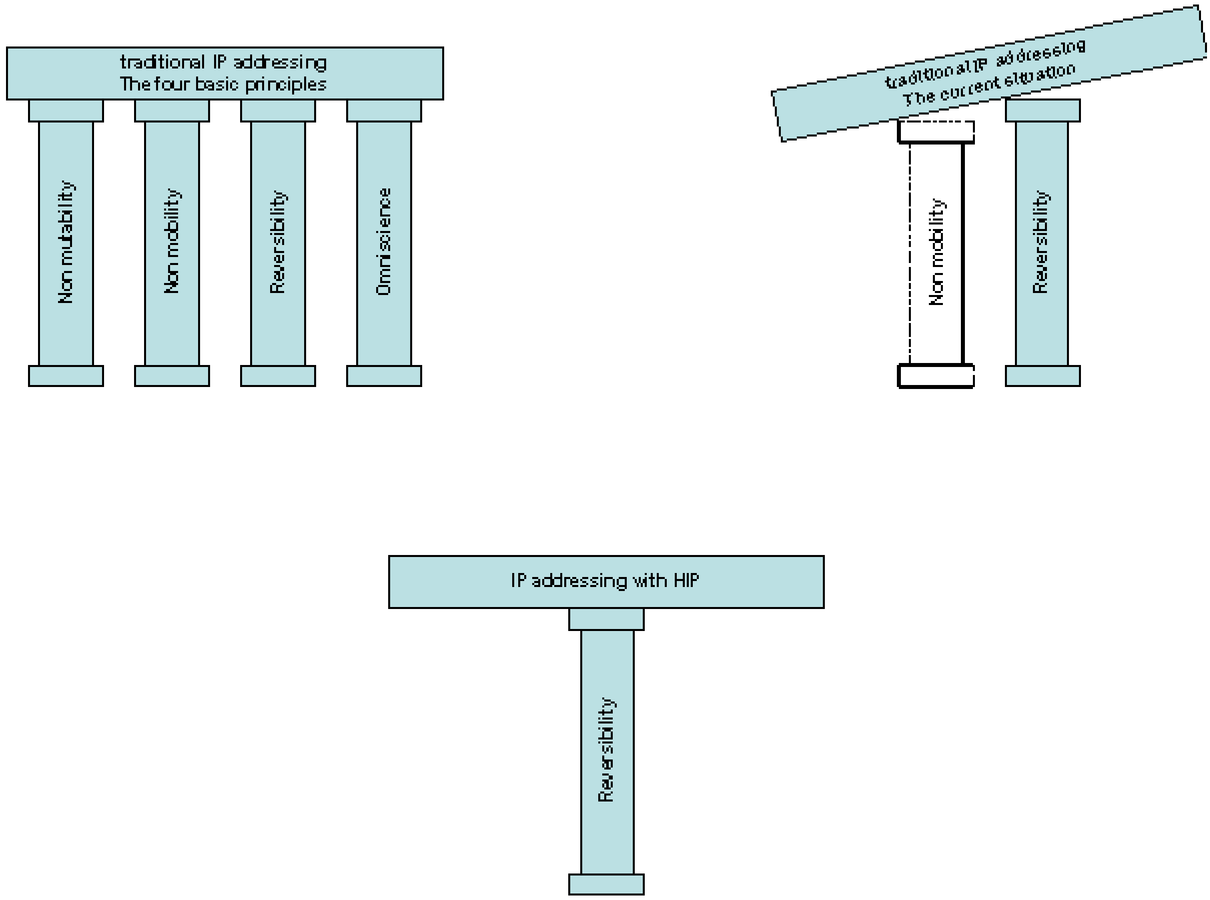

Figure 4: a) Basic Principles of the IP Protocol; b) Current Situation; c) IP Addressing within the Framework of the Host Identity Protocol

two entities must not be assigned the same name. This objective conflicts with the need to keep names short and the probability of collision grows rapidly as the length of name shrinks. The well known birthday paradox can quantify this phenomenon: given a group of just 23 people, the probability that two persons have the same birthday is approximately equal to 50%. In the same way, the probability of collision in the name space of the Internet can be surprisingly and dangerously high. For example, if names are coded with 64 bits, the name collision probability in a population of 640 million users is nearly 1%; in other words, very high. It would seem a better idea to choose at least 160-bit names (Host Identity Tags (HIT)). Moreover, in order to resist cryptographic attacks even longer names could be necessary (for example, 512 bits).

In the framework of HIP, a name identifies one host (it is also referred to as *Host Identity* (HI)). The Host Identity identifies hosts univocally in a statistical sense, as there is a small residual collision probability. A system may have multiple names and in HIP the name is the public key of a pair of asymmetric cryptographic keys. The great advantage of this solution is that the name carried by IP packets can be used as a means to authenticate the sender of the packet and it constitutes a structural defence against several types of attacks.

The HI of a system is public, as it is the public part of a key pair, while the system retains the secret (private) key. By applying standard authentication mechanisms, a system can prove its identity by proving that it holds the secret key corresponding to its public key. A single private key can be shared by a set of mutually trusted systems to build a group identity (this feature could be used for multicasting). Host Identity tags may be stored in the servers of the Domain Name System or in a dedicated infrastructure, similar to the DNS.

3.1Socket, Identity and IP Address

As shown in Figure 4a, the IP address of a system currently identifies the location of the network interface of that system, and the IP address identifies the system. The IP address is a part of the socket, the termination point of a communication at the application layer. In order to decouple these multiple meanings of the IP address, HIP interposes the concept of identity between location (IP address) system (endpoint) and socket. The Host Identity Tag (HIT) identifies the system, instead of the IP address, which is downgraded to a mere location indicator. If a system is moved, its IP address changes but its identity does not vary and this greatly facilitates mobility management.

3.1.1 Rendezvous *Communication*

Initiating a communication with a remote moving host is a challenge both in the current Internet and in the framework of the present standardization of HIP. The host starting the communication needs to know in advance how to reach the remote moving host (its IP address changes while it moves). HIP adopts the *rendezvous* communication paradigm to reach a remote peer. A *rendezvous* server provides the host with a first contact point. If a host has previously registered on a rendezvous server, other hosts will be able to find it, based on its identity and without knowing its IP address. The rendezvous mechanism in HIP is currently under study and an official standard has not yet been issued [8].

Hosts register with a rendezvous server and, in order to be reachable, they must also specify the address of the rendezvous server in their DNS (Domain Name System) record [9], by using a special field (the HIPRVS field). Hosts can reach registered hosts by querying the DNS system. The DNS returns the HIT identity of the searched host, as well as the address of its rendezvous server. In this way a communication can be established using, in the initial phase, the rendezvous server as a relay node.

3.1.2 HIP mobility

The HIP mobility specified in current standards is elementary. When a moving host communicating with a remote host changes its IP address, it notifies the change to its remote partner [10]. This framework for end-to-end mobility is very simple if compared with the full mobility that radio cellular operators provide with carrier-grade quality on a worldwide scale. Currently, the mobility supported by mobile operators is available to several billion user terminals. GSM/UMTS mobility uses two types of names (permanent IMSI, International Mobile Subscriber Identity, and TIMSI, Temporary IMSI) and three types of addresses (permanent, MSISDN, Mobile Station ISDN Number; for roaming between operators, MSRN, Mobile Station Roaming Number; and for handover between radio cells, HON, Hand Over Number) and is based on a complex system for the mobility management, comprising HLRs (Home Location Register) and VLRs (Visitor Location Register). Moving users in the GSM/UMTS network can be traced and rendered reachable by such a system.

The simple end-to-end mobility of HIP is managed through an exchange of messages between the two communicating terminals, without the support of a system for the mobility management. Current HIP mobility is just a preliminary step along the path to carrier-grade mobility in the Internet. In order to reach this objective, it would appear to be necessary to adopt a dedicated system, as ha been done in the case of GSM/UMTS networks.

3.2 The Evolution Supported by HIP

The classic IP protocol was founded on the basis of four principles (Figure 4a):

- *Non-mutability*: The IP address carried in the IP packets must not vary while the packet travels through the Internet (we have shown how NAT limits the validity of this principle).
- *Non-mobility*: from the point of view of a remote communication peer, a moving host should not change its IP address during the communication. The mobile IP protocol tries to meet this target, but its scalability is poor.
- *Reversibility*: a host receiving a packet can always reach the sender of that packet by inverting source and destination addresses.
- *Omniscience*: all hosts know the IP address to be used to reach a specific remote host.

Figure 4b shows that in the current Internet the first, second and fourth principles are not valid any more, basically because of Network Address Translation and the limits to IP mobility. In the sections above we have described some of the problems that the Internet is facing because the four principles are not (completely) valid any more. It is interesting to note that the IPv6 protocol tries to restore the four principles, especially that of non-mutability, by providing a very large address space and in turn obviating the need for Network Address Translation.

The revolutionary aspect of HIP is that it requires only the third principle, reversibility (Figure 4c): if the communication can be inverted by exchanging source and destination addresses, the IP protocol is not strictly required to offer directly non-mutability, non-mobility, and omniscience as they would be indirectly provided by HIP.

4 Conclusions

In this paper we have tried to show that the correct approach for the development of the Internet protocol is evolutionary and it should take into account the needs of emerging peer-to-peer applications, whose rapid growth raises important and difficult scalability problems, especially when mobility and multicasting are needed. The strict coupling of identity and location information carried by the IP address is one of the main limiting factors of the IP protocol and the solution of this problem (i.e. the separation of identity and location) is one of the most important challenges to be faced on the road towards the future Internet protocol. From this point of view, work is in progress and the most interesting solutions, such as the Host Identity Protocol, are at the beginning of their standardization process. An important step in the evolution of the Internet protocol would be combining the large space address and value-added functions provided by IPv6 with a framework for the separation of location and identity.

Translation by the authors

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CEPIS Projects

CEPIS/Harmonise Newsletter

François-Philippe Draguet

Harmonise

As mentioned in the last issue of **UPGRADE**, the contractual period of the Harmonise project is now over. CEPIS would like to thank all project partners for their participation. Their involvement and their permanent availability have been key to achieving the goals set three years ago. It has been a pleasure for CEPIS to work with them on this project.

CEPIS would also like to thank its Member Societies and all individuals who committed to the success of this project. Their input was invaluable in both the collection of information and in reviewing the results. Their support and involvement have been crucial to the project. Thank you all.

The project lasted 36 months and collected a very large amount of information: previous studies were analysed to extract detailed information; employers were interviewed to share their views on certification; job adverts were collected to understand the place of certification in hiring ICT professionals.

Certification companies helped the project consortium gather information on quality assurance and CEPIS Member Societies were asked to contribute to a European survey on the value of certification in national markets. All of these efforts were necessary to be able to provide a large but precise report summarizing the current certification market situation. This document then led to setting up a business case for EUCIP and to proposing a roadmap for the harmonization of ICT certification for professionals.

The report is now in the hands of the European Commission. As soon as the European Commission gives its approval, CEPIS will publish the report on the project website <http://www. cepis-harmonise.org/harmonise/php/index.php>. CEPIS encourages you to read the report, once it is available, to gain a complete picture of the ICT certification market for professionals.

Euro-inf

The Euro-inf consortium continues to improve the "Framework Standards and Accreditation Criteria for Informatics Programmes". The public version is still available on the website <http://www. euro-inf.eu/component/option, com_ docman/task,cat_view/gid,3/Itemid,12/>.

The document will be reviewed a second time by the Euro-inf consortium during our next board meeting in Venice (13-14 December 2007), taking into account the feedback received from two sources:

- Organizations and individuals (Conference of Deans, representatives from the University of Madrid, the University of Joensuu…)
- Visits to Bosnian universities where the applicability of the Framework Standards was tested in the context of a TEMPUS project for Quality Assurance in Higher Education.

A new version of the Framework Standards will be made available after the review. The Euro-inf board also envisages organizing two conferences/workshops. One would address Higher Education Institutions that have agreed to host a Euro-inf trial-accreditation, and provide training for programme managers in preparing the self-evaluation report and/or offer a forum for discussion of the Euro-inf Framework Standards. The second workshop would offer training for educated peers on the application of the Euro-inf Standards and Criteria. The dates and the locations are yet to be decided. CEPIS will keep you informed of these details.

CEPIS News

CEPIS recently organized its 39th. General Assembly on November 24, 2007 at the Jolly Hotel du Grand Sablon, in Brussels. It was a great pleasure to meet the representatives of the Member Societies again.

During the meeting, participants were addressed by Nick Batey, Communications Officer at the e-Inclusion Unit, European Commission. Mr. Batey provided an overview of the e-inclusion situation in Europe, stressing the fact that many people are still excluded from the information society. Mr. Batey underlined that e-inclusion was one the pillars of the e2010 initiative from the European Commission and explained that the recent Communication COM(2007) 694 on e-Inclusion represents a milestone in reinforcing the EC's commitment to this agenda.

The meeting provided the opportunity to show the importance of the "e-Skills Foresight Scenario" project, which was referenced in the European Commission Communication on e-Skills for the 21st. Century: Fostering Competiveness, Growth and Jobs. Other activity reports included updates on CEN/ISSS, the e-Skills Industry Leadership Board, and Harmonise among others. A discussion followed to find out how CEPIS could be more involved in Research, Skills and Professionalism.

The day ended with a social dinner where our Member Societies Delegates had the opportunity to enjoy local food in a convivial atmosphere.

We would like to thank all Council delegates for their commitment and their participation. We are looking forward to seeing them again in Ljubljana.

