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An Innovative Approach to Research and Development: The CEFRIEL Experience

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Abstract

CEFRIEL (Centre for Research and Training in Information Technology) is a non-profit organization that represents a point of contact among University, Technological Companies and Public Government. Since its foundation in 1988 its goal has been related to the education and the research in Information and Communication Technology (ICT). CEFRIEL constitutes itself in seven areas embracing all the aspects of ICT, from hardware design to software engineering. The enormous number of trained specialized technicians represents the most important result of the Centre: more than 500 specialists and about 100 researchers for the ICT sector. In 1998 CEFRIEL created a new area, the Information and communication TEchnology for Medicine area (ITEM), as the result of the previous positive experiences in the healthcare field. In the last two years the results obtained by the ITEM area show that CEFRIEL's approach could be profitable also in the healthcare sector.

Keywords:

Academies and Institutes; Medical Informatics; Non-profit Organization; Telemedicine.

Introduction

CEFRIEL [1], Centre for Research and Training in Information Technology, came into being as an environment for knowledge exchange between the worlds of Industry and the Academia; the competencies of those who work, study and conduct research at the Centre cover the main and most innovative areas of the Information and Communication Technology (ICT).

Since its foundation CEFRIEL has pursued the objective of providing the Milan area with a centre of excellence for the transfer of technologies in the information processing sphere to provide continuous stimuli and act as a high level point of reference for its clientele, both public and private.

CEFRIEL's core activity is the Masters Degree in Information Technology; the educational programme acts in synergy with the research and consulting activities.

These activities represent a natural outlet for the expertise and skills collected and enrich the contents of the training courses through continuous reference to the realities of the Industry and the Service sector.

Over the years CEFRIEL has maintained and developed its initial vocation of acting as a link between the interests and the capacities of local Industry and Academia. This interaction takes concrete form in the co-operative research, which is done on a pre-competitive basis.

Even if other centres are present in Italy with similar missions [2, 3], CEFRIEL has some peculiar characteristics that will be shown in this paper.

Background

History

CEFRIEL is a non-profit organization established in Milan in 1988 following an agreement among three poles: scientific, public and industrial.

The basic objective of enhancing the co-operation and knowledge exchange between the academic world and the realities of the industrial world was strongly backed by the Politecnico and the Università degli Studi di Milano, the Regione Lombardia and the most important companies working in the ICT sector.

Main Areas of Activity

CEFRIEL is organized in seven different operative areas covering the most important topics of the ICT world.

- **Advanced Mobile and Wireline Transmission Systems area.** It deals with mobile radio systems focusing on the UMTS, GPRS and GSM, broadband access networks and Optical.
- **Embedded Systems Design area.** The focus of the area is on the methodologies and technologies to design embedded systems. The core competencies range from

hardware to software, including tools for hw design, analysis of power consumption, Intellectual Property cell and design for reuse, virtual prototyping and hw/sw codesign.

- **Image & Audio Processing area.** It deals with all the technologies related to video and audio processing. In particular, it focuses the activities on Video over IP, VoiceXML, Watermarking and Voice recognition.
- **E-Service Technologies area.** Its mission is the validation of innovative technologies in order to use them to provide services for final users. Security, middleware, web technologies, E-Commerce and Mobile services are the main fields of interest.
- **Network Systems area.** Its mission is to study innovative communication protocols and network architectures to support the deployment of advanced modern distributed applications. Main topics: Quality of Service, Voice over IP, Multicast IP, Network Security, Network Planning, Network Management, Wireless IP/mobile IP.
- **Web & Internet Software Engineering area**. This area applies engineering techniques for the construction of web-based and Internet software systems. Software engineering is the branch of computer science that deals with the building of (complex) software systems.
- **Information and Communication Technology for Medicine area**. The mission is the application of the newest technologies in the field of health-care. Main topics are: HCI and multimedia applications, integrated Health-Care (HC) information support & management, telemedicine, teleconsultation, virtual medical presence, home care.

Education activities

CEFRIEL's training activities are spread over a series of different and complementary initiatives and are attuned to developing a level of professionality or updating it with their highly specialised knowledge of the ICT world.

The Masters Degree in Information Technology gives first-rate knowledge and experience to about 60 young graduates and undergraduates in various scientific disciplines. The Masters Degree requires a time commitment of 40 hours per week (full time) for 10 months with classroom lectures accounting for about one third of the total hours; the other two thirds are spent in the labs, assigned to research groups that work in the development of specific projects. A Tutor (an industrial, university or CEFRIEL researcher) looks after each participant's lab work on a daily basis, and a Mentor (a University teacher) supervises the writing of the Masters thesis.

In the last two years CEFRIEL organized also several masters, related to particular market fields, in partnership with the principal Italian ICT actors.

In addition to the Masters courses, the Centre also gives courses and seminars for continuous training, and in the last year started its activity in Distance Learning through a course of e-Commerce for Small and Medium Enterprises.

Research activities

The medium term research activity represents an essential component of the Centre's training model; it is conducted in an innovative way by mixed work groups, composed of researchers from university, industry and the Centre itself. The basic goal is to minimise the time gap between research and the practical application of its results.

The effective co-operation between industrial delegates and CEFRIEL researchers in an especially stimulating technological environment, enables CEFRIEL to conduct a wide range of research activities and facilitates the transfer of technology, with none of the risks usually caused by the isolation of the academic world from the world of production.

In order to facilitate this critical phase, each research group is made up of researchers from CEFRIEL, Industry and Academia, assisted by new graduates or students pursuing a specialisation. An overall view of the organization and structure of each research area, as well as centralized functions is illustrated in Figure 1.

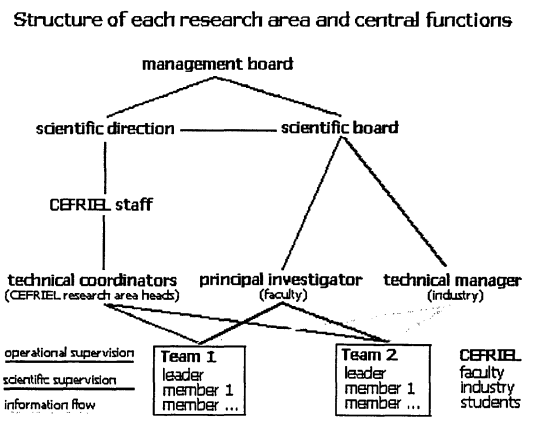

Figure 1. Structure

Research teams are composed of four kind of members: research advisors from CEFRIEL, industry and the faculty (any of them can be the team leader), and junior researchers.

The definition of research subjects and objectives, the evaluation of results and the publication policy are the responsibility of a scientific board composed by the principal investigators and by the technical managers of the sponsoring industries. The Scientific Director manages the overall activity of the Centre and mediates between academic and industrial needs at the scientific board level.

The Centre research activity is at a pre-competitive level; the consortium is entitled to copyright and owns the material (text, software, hardware) developed by Centre's

activity. Proprietary developments for particular contractors can also be established under "ad hoc" research contracts.

There are several EU founded projects in which CEFRIEL is involved: a complete list could be found in [1].

Consulting Activities

CEFRIEL is a well of knowledge and competencies in the ICT field and a generator of innovative technological solutions. In particular, through a network of external projects, CEFRIEL designs and creates prototypes, conducts feasibility studies and tests existing technologies. CEFRIEL's involvement in supporting the computerisation of the public administration processes is particularly strong both at the local and at the national levels.

The development of new ideas is facilitated, creating prototypes, new models, new software architectures and new solutions, which respond to the needs of the public or private clientele. Consulting activities include project management, feasibility studies, the testing of new technologies or new products and comparative testing.

Results

Human resources represent the most important result of CEFRIEL. Since the beginning of its activities, CEFRIEL has trained 500 specialists and about 100 researchers for the ICT sector.

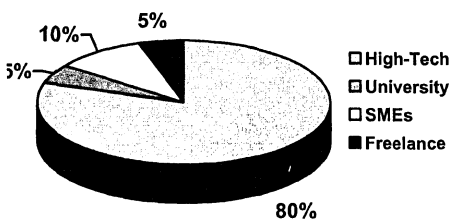

Figure 2. Employment distribution following the Master.

Figure 2 shows the employment distribution of those who graduated at CEFRIEL: the majority is involved in high-tech companies such as Italtel, Siemens, HP, Nokia, Ericsson, Telecom Italia, Lucent, Omnitel, Olivetti, Philips, Cisco, Alcatel, DEC, Bull and IBM. Note that more than 5% of the graduates work abroad (US, France, UK,...).

It is also important to note that the CEFRIEL's approach to education is very appreciated by ICT companies. A demonstration of that is the number of companies' Master that was born in the last three years involving about 80 ICT specialists. In particular:

- **Master in Telemedicine**, in collaboration with the Department of Bioengineering of the Politecnico di Milano and Regione Lombardia.
- **Master in Internet Software Design**, in collaboration with Siemens;
- **Master in Web Portal Design**, in collaboration with CiaoWeb;
- **Master in Wireless & Web**, in collaboration with Omnitel;
- **Master in Telecommunication and Management**, in collaboration with GPLVPartners and SDA Bocconi of Milano;

CEFRIEL approach is profitable also in the healthcare sector. The Information and communication TEchnology for Medicine area (ITEM) represents the concrete result of the Centre efforts in this particular field.

Information and Communication Technology for Medicine Area

The Information and communication TEchnology for Medicine area (ITEM) came into being in 1998, as the result of CEFRIEL's previous positive experiences in the healthcare field [4,5,6]. Specific target of the ITEM area is to be active in promoting CEFRIEL's interests in the health-care sector.

The ICT world is continuously evolving and new technologies come to the fore. Unfortunately not always is clear how these new possibilities could be applied to the HC world and which advantages could be given to its operators; moreover HC technological repercussions are often proposed by actors non-completely aware of the real needs of people working in the sector: physicians, nurses, etc.

As the whole Centre is the bridge between the research and the industry, the ITEM area would be the bridge between the ICT and HC worlds. The main role of the ITEM area could be summed up in clarifying and validating these new technological possibilities, by taking into serious account the real needs of those who will use research products. This mission is carried out with several activities.

- Collect of technological needs and requests from the HC sector. This is particularly made easy by the bridge role the ITEM area plays.
- Study and development of prototypes that use the most promising ICT technologies. This is particularly simplified by the pluriannual technological experience of CEFRIEL.
- Validation of new applications effectiveness with operators, through clinical usage. Again this is exploited through several contacts with the operators.
- Educational forum for technological alphabetisation of sector workers. This is facilitated by CEFRIEL's experience in education.
- Educational centre for technical operators of the HC sector. This is showed forward with CEFRIEL's Master in Telemedicine.

Team Composition

As described above the mission of the area is vertical in the HC sector while at the same time being horizontal in the

number and types of applied technologies. For this main reason on the one hand the team members require a unique sensibility toward the HC world, and on the other hand a widely spread competence in the technological world. For this reason the team is made of several competencies ensuring a large coverage of the ICT world: seven researches with specializations in electronic, bio-medics, informatics, networking and economy.

Being the range of ICT used technologies so large, the collaboration with other CEFRIEL's areas reveals to be a key factor for the effectiveness of proposed solutions. For this reason one of the main ITEM area success factors is the large number of collaborations within the Centre.

Results in the healthcare sector

The following three cases are an excellent example of the ITEM area quality of work and results.

CARMEN and the CARDNET Network

CARMEN [7,8,9] is carried out in the context of the TeleRegions SUN2 European project.

The purpose of the system is to supply either hemodynamics specialists or heart surgeons with innovative information and communication technology tools. The primary aim is to facilitate and streamline remote exchange of clinical information while reproducing the characteristics of a real consultation as closely as possible. The scope of the system is to reduce the number of patients' and doctors' transfers from the Secondary Care Hospital to the Tertiary Care Hospital and to make it possible to hold remote consultations just as if the physicians were sitting around a table in the same room.

The good results in the pilot test led Regional Authorities of Lombardia to extent the experience to other hospitals creating CARDNET, a cardiology network involving about 20 hospitals between Lombardia and Catalunya (Spain).

INCAS

INCAS [10,11] is a modular teleconsultation platform developed as requested by the medical service of an Italian oil company, matching its specific needs and making use of the existing resources: images, biosignals and textual data had to be acquired, viewed and shared over dedicated satellite lines ranging from 64 to 19 kbps.

The system integrates acquiring devices (e.g. film scanners, electrocardiographs, cameras) and transmission channels using standard protocols. The physician working in remote countries, through an innovative and easy to learn user interface, can acquire clinical data, work in stand-alone mode making textual and graphical annotations, and discuss the case with the specialist located in Italy using the collaborative tools integrated in the platform.

After a validation period, the system has been installed in June 1999 in Pointe-Noire, Congo, and in July 2000 in Port Harcourt, Nigeria. The system is going to be installed in other sites in Africa and Asia.

Master in Telemedicine

The aim of the Telemedicine MSc Course is to train highly qualified persons who will be fully acquainted with the latest technology and deeply aware of the needs of the sector. The Course focuses on two fundamental aspects: the first is a solid theoretical training in ICT and in the specific problems of its use in the Medical sector. The second aspect is the direct use of such technology as adopted by Treatment and In-patient Structures and by their supply Companies. High priority is given to the participation in specific research and development projects.

The Course has been jointly designed by the Department of Bioengineering of Politecnico di Milano and CEFRIEL and it has been included in the Poliedra project (a Politecnico di Milano institution of which CEFRIEL is a partner). The organization of the Course is similar to the IT Master previously described. Some example of the result obtained could be found in [11,12,13]. The first edition of the Course was in 1998 and now we are planning a second edition. More information related to the first edition could be found in [14].

Discussion

CEFRIEL proposed in Italy a new form of collaboration between Industrial and Academic worlds becoming, after twelve years since its foundation, one of the main research centres in Italy. Since its foundation CEFRIEL took particular care of the knowledge sharing among industrial and academic experiences, giving a positive impulse to the diffusion of an ICT culture. The large amount of students that received Master's degree, the numerous scientific results and the good overall reputation that CEFRIEL internationally has, are a testimony of the good work done up to now. Besides CEFRIEL's activity in the ICT traditional sectors, the Centre is working to give its experience to one of the most crucial ICT sectors of the next years with the work of the ITEM area. The Health Care sector is presently suffering due to the too high difference between open problems and available technological solutions. For this reason CEFRIEL has a vision made of several points:

- Education through the training of technological roles within the HC with the Telemedicine Masters.
- Diffusion of technological culture through the sensitisation of the clinical world.
- Research through the developing of prototypes and the commitment into European Projects.

Conclusion

The paper presented CEFRIEL's organisation and its two-years experience in the HC sector with the ITEM area. This experience shows that CEFRIEL's approach could also be profitable in the HC sector.

This area is continuing its contribution with research and

developing of new prototypes and solutions (for further information please look at http://www.cefriel.it/ITEM) while evolving at the same time the existing projects: INCAS, whose future is considering different and wider scenarios, and the CARDNET network, whose consolidation –in collaboration with regional authorities- would be a first step toward a real usage of such tele-medical instruments in Hospital's everyday life.

Acknowledgments

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References

[1] http://www.cefriel.it. CEFRIEL home page.

[2] http://www.itc.it/IRST/index.htm. IRST home page.

[3] http://www.crs4.it. CRS4 home page.

[4] Pozzi S, Tancredi, Tisato F, *An Integrated Environment for Distance Learning Education Supporting Multiple Interaction Styles.* Proc. of World Conferences on Educational Multimedia and Hypermedia (ED-MEDIA), Vancouver (Canada), June 1994.

[5] Valetto G, *CAROLIN - Integrated support to medical groupware over wide area networks.* Proc. of 3rd International Conference on Networking Entities (NETIES), University of Ancona (Italy), Oct 1997.

[6] Fogliardi R, Fregonara M, Flaiani R, Frumento E, Valetto G, Dal Degan N, *An operative project of cardiological on-line interactive diagnosis.* Proc. of the 4th European Congress on Telepathology (TELEPATH), Udine (Italy), June 1998.

[7] Frumento E, Fregonara M, Viñas MA, Rincón D, *CARMEN: An International Experience of Telecardiology.* Proc. of the 5th Conference of the European Society for Engineering and Medicine (ESEM), pp. 279-280, Barcelona (Spain), May 1999

[8] Frumento E, Fogliardi R, Rincón D, Viñas MA, *Telecardiology: results and perspectives of an operative experience*, J. of Telemedicine and Telecare, v. 6 (suppl 1), pp. 162-164.

[9] Frumento E, Fregonara M, *On-Field Evaluation of CAROLIN, an Italian Teleconsulting Cardiology Application: Early Results*, Proc. of Computers in Cardiology (CIC), vol. 25, pp. 217-220, Cleveland, Ohio (USA), Sep 1998.

[10]Boccaccio S, Castelli A, Colombo C, Dal Degan N, Lesma A, *INCAS: a telemedicine Network for multi-diagnosis consultation services.* Proc. of Mednet, Bruxelles (Belgium), Nov 2000.

[11]Boccaccio S, Castelli A, Colombo C, Fregonara M, Frumento E, *Guidelines for Human-Computer Interface Design in Telemedicine.* Proc. of 4th International Conference on the Medical Aspects of Telemedicine, Jerusalem (Israel), July 1999.

[12]Castelli A, Colombo C, Frumento E, *Second Opinion through High Level Web Services in Static Pathology.* Proc. of World Conference on Telemedicine, Toulouse (France), March 2000.

[13]Frumento E, Marino P, Fregonara M, *A Web Based System to Share Information and Knowledge Among Pathologists.* Proc. of the 5th Conference of the European Society for Engineering and Medicine (ESEM), pp. 281-282, Barcelona (Spain), May 1999

[14]http://www.cefriel.it/tmed/inglese/index_english.htm, Master in Telemedicine Home Page, 1998

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