Professional and Interpersonal Skills for ICT Specialists

Ariadna Llorens-Garcia, Xavier Llinas-Audet, and Ferran Sabate
Technical University of Catalonia

A study surveying experts and related literature reveals the most- and least-valued generic professional abilities for engineers in the information and communication technology (ICT) sector.

The current business environment is increasingly more complex, dynamic, and turbulent in both the macro and micro scales. This is especially evident when we consider key issues such as globalization, politics, technologies, social and economic matters, suppliers, clients, and product and services competition.[1–3] This effect is particularly noticeable in the information and communication technology (ICT) sector, where escalation in the number and propensity of changes necessarily generates increased uncertainty and makes predicting market behavior more difficult.

Within this new paradigm, we must reconsider the models of competitiveness established to date, especially those that refer to resource and personnel management. Manuel Castells contends that capitalist production has passed from an industrial to an information model.[4] He considers information the new material base of technological activity and social organization, which is manifested in his *network society model*. Furthermore, the European Union (EU) is clearly moving toward a new productive system, a knowledge-based economy, with the objective of becoming the most competitive society in the world by 2010.[5]

Along these lines, Castells claims,

> Faced with the emerging nations, if Western Europe and the US have a knowledge-based economy which generates competitive advantage, it shouldn't be modified by training engineers or developing electronic technology, since research shows that recently industrialised countries are perfectly able to compete; but rather the issue should be treated like other important social fields like anthropology, psychology, sociology, communication, public health, education, architecture, design or management science.[6]

In the same article, he concluded by suggesting that

> our engineers are no better than Chinese engineers—but more expensive, and instead of rediscovering engineering that has been partially replaced locally by computers and robots, or at a distance by Indian and Chinese people, we should build the knowledge-based economy by investing in the social disciplines and linking them to business schools.

Although Castells makes some relevant points, we don't agree with such reasoning in its entirety. The ICT sector faces savage competition, where the threat of new competitors (emerging nations) is added to that of the well-established competition (such as the US and Japan). Recent reports from the European Observatory of Information Technology (EITO; www.eito.com/

1520-9202/09/$26.00 © 2009 IEEE Published by the IEEE Computer Society

start.html) confirm this situation. Thus, it's important to work on the personal characteristics of the telecommunications engineers who must direct a market that in Europe involves approximately €614 billion, 6.1 percent of which belonged to the Spanish market in 2005, according to the EITO.

There is a lovely Spanish proverb that translates as "the swell and storms flatter the best navigators" (www.refranespopulares.com), echoing the English adage "fortune favors the brave." This leads us to ask (with regard to telecommunication engineers, computer scientists, and designers), which ICT graduates' professional abilities will make them the best navigators?

Professional Abilities

To flesh out this question, given the confusion and ambiguity that exists around the subject, we must start by trying to specify exactly which professional abilities we're referring to. We did a related literature review and found plenty of authors and studies that deal with this theme.[7–9] Here's a look at several related studies:

- Debra D. Bragg defined 98 outcome statements that she subsequently grouped into nine clusters by means of factor analysis.[10]
- John Arnolda and his colleagues defined 15 abilities.[11]
- George D. Kuh, based on an analysis of in-depth graduate interviews, employed only five categories of basic abilities that included a total of 13 skills.[12]
- Neville Bennet, Elisabeth Dunne, and Clive Carré only used four clusters that incorporated 42 abilities.[13]
- Michael K. Badawy grouped basic abilities in terms of administrative, technical, and interpersonal skills.[14]

Despite this lack of consensus, we can broadly define the concept of professional abilities as the combination of knowledge, skills, and character that people possess in relation to their professional activity.

In the literature, researchers have paid much attention to identifying and defining the knowledge a telecommunication engineer requires. However, defining the personal abilities required has received relatively little attention. Even though character is intrinsic to a person, difficult to modify, and well defined at an early age, people can work on and successfully improve interpersonal skills, especially in a university environment. It's this gap, this difference or guidance in capacity development, this added value, that Castells refers to in his article.[6]

It's important to clarify that there's much ambiguity in terms, amplified by the subtle yet meaningful variations caused by interpreting vocabulary in different contexts and the absence of exact translations between languages, that sometimes blurs understanding and precision. For this reason, we propose an approach we call *4C* to define, categorize, and clarify the terminology used when we reference the wide-ranging, complex concept of professional abilities. Our 4C approach consists of a principal C (*competence*), which incorporates or unites three others: *knowledge*, *capabilities*, and *character*. (We originally wrote this article in Spanish, where the word for knowledge begins with the letter C.)

Knowledge is the training and experience that professionals accumulate. It incorporates not only explicitly learned knowledge (such as qualifications, postgraduate studies, and various courses and languages), but also all the unspoken, internalized experiential learning that takes place during a person's working life. Thus, knowledge tells us, "What have we learned?"

Capabilities (also known as skills, abilities, or proficiencies) refer to a repertoire of behavior that some people are able to apply better than others, making them more efficient in particular situations. This set of skills tells us, "What are we good at?"

Finally, character indicates the features of our personality and outlook and refers to our way of being, thinking, and feeling, based on our individual experiences. Character traits tell us, "What are we like?"

Objectives and Methodology

The main objective of our work is to define and evaluate the professional abilities of an engineer who works as an IT professional in Spain, primarily telecommunications engineers and computer scientists. Their occupational profiles will provide us with a useful tool for defining and conceptualizing curriculum plans for new qualifications, which the EU Higher Education Area

project will require in 2010. European universities, institutes of higher education, and learning centers are currently drawing up such proposals.

This article presents a first attempt at defining the professional characteristics—in terms of competence and aptitude—that an IT professional should possess. It focuses more on interpersonal skills and abilities than to knowledge and technical expertise.

Such an ambiguous objective is too general and broad, so we've defined a certain type of worker and a more specific geographic framework. In particular, we want to identify which skills an ICT engineer should have, and be capable of developing, in order to find employment in companies in the Spanish ICT sector.

To identify these skills, we must begin by establishing an initially broad set of professional abilities that are necessary for the development of professional competence in computer scientists and telecommunications engineers working as IT professionals. Also, we must establish which types of occupational profiles those specialists can bring to the sector. We analyzed the related literature to identify which skills and profiles are significant. Also, using a panel of experts, we attempted to evaluate and then rank the specified abilities for each profile grouped in Mintzber categories. (Henry Minztber divided one organization into three main parts in his organizational configuration model: top management or strategic apex, middle management or middle line, and operation or operating core.) We focused on an expert panel because we believe they're able to forecast tendencies and provide us with significant conclusions.[15] This approach is useful for the purposes of this article, but it also has limitations, which we'll discussion shortly.

Abilities, Skills, Competence, or Aptitude

The range of skills or personal abilities that a professional can bring to the workplace varies widely. Because putting such a general question to the experts could have led to an infinite number of responses, we felt it necessary to establish an initial list. We first asked the expert panel if they considered a preliminary aptitude filter to be acceptable and then to rank each of the different skills.

To carry out the initial filter, we referred to the Department of Vocational Guidance and Work Placements within the Technical University of Catalonia's Friends Association (www.upc.edu/aaupc), which produces an annual report of the abilities and personal skills demanded by companies.[16] The report is based on information obtained through department surveys and details taken from related job vacancy listings.

The most recently published report (2003–2004) is based on an annual average of 730 job descriptions, which corresponds to approximately 20 percent of the graduates who received their degree from Technical University of Catalonia (www.upc.edu). This figure includes approximately 3,638 students in the 2003–2004 academic year, across all centers and including first- and second-year students, according to the management statement for that academic year (www.upc.edu/dades/2005).

To define the personal skills most valued in ICT engineers in the Spanish ICT sector, we also used the White Book, which is produced by the Higher Education Area project and details qualifications in computer sciences.[17] The White Book specifies generic transversal skills in relation to occupational profiles relative to the management and deployment of computer technologies (www.escet.urjc.es/~eees/docs/g/VersionPreliminarLibroBlancoIngenieriaInformatica.pdf). These conclusions form part of a huge piece of field work conducted with a range of engineers and contributions from specialist colleges, associations, and well-respected professionals from the computing sector.

Finally, we consulted the study of occupational profiles known as the Telecommunication Engineering Project,[18] produced by the National Agency for Evaluation of Quality and Accreditation (ANECA, www.aneca.es/publicaciones/libros-blancos/libro_blanco_teleco.aspx), as well as the White Book for future university degrees in the ICT field.[19] We also looked at other literature on an international level, which endorsed the selection of skills.[20–22]

After analyzing the data we extracted from these sources, we drew up a list of the most important skills and abilities. Specifically, we cross-referenced the source material and noted the number of times each term appeared. The important skills for IT professionals include

- change management,
- commitment to customer service,

PAFET

The Proposal of Activities for Training Electronics, Informatics and Telecommunications Engineers (PAFET) was sponsored by the Official College of Telecommunication Engineers (COIT), the Association of Spanish Electronics and Information Communication Technology Companies (AETIC), and the Spanish Association of Telecommunication Engineers (AEIT) in 2001. The PAFET initiative consists of four studies. PAFET 1 focused on knowledge of the position of information and communication technology (ICT) professionals. The following year, PAFET 2 responded to the necessity of updating and broadening the analysis in Spain in light of new conditions. PAFET 3 analyzed the extensive employment of ICT professionals outside their own specific sector. In 2005, the study was extended with PAFET 4, the objectives of which ranged from identifying new services to distinguishing the skills needed by ICT professionals.

- commitment to excellence,
- communication,
- creativity,
- decisiveness,
- empathy,
- innovation,
- leadership
- knowledge management,
- motivation,
- negotiation,
- objective oriented,
- personal development,
- persuasiveness,
- proactive,
- problem-solving skills,
- strategy and planning, and
- teamwork.

Our next step was to assess each of these skills against each of the different occupational profiles required by the highly profitable ICT sector.

Occupational Profiles

Trying to specify occupational profiles isn't a simple task because the sector is constantly changing, making technical skills obsolete.

The first report from the Proposal of Activities for Training Electronics, Informatics, and Telecommunications Engineers (PAFET) project clearly explained that the profiles aren't static; they have a life cycle, and they emerge, evolve, and disappear according to technological advances.[23] (See the "PAFET" sidebar for details on this project.) Furthermore, companies themselves are unable to agree on a definitive list of profiles: large companies use specialized profiles, whereas medium and small companies have more generalized profiles. In a small company, the same person might take on the roles of several staff members in a larger company.

Furthermore, the White Book has sanctioned the profiles of only a few generic groups, suggesting that it's impossible to find a fixed set of occupational profiles because they're in a state of flux. For this reason, we only defined three general profiles:

- software development,
- systems design, and
- management and deployment of information technologies.

This profile classification system conveniently groups many types of work into three categories that define the whole sphere of information technology: software solutions, hardware solutions, and information management. The fundamental advantage of this classification is that it's highly probable that these profiles will continue to be relevant in the long term and, therefore, are less prone to obsolesce.

That said, the personal abilities for each profile are flexible, due to their generality, and we might discover that all the occupational profiles require a set of similar skills. For this reason, we opted to look for more specific profiles and then group them within the more general profiles, consequently benefiting from the advantages of both approaches.

Revising the epistemology, we found and selected several research papers that helped us refocus our subject. The goal wasn't to conduct a study of existing occupational profiles, but rather to ascertain which skills best fit each profile.

In light of this, we referred to the Sectoral Study of Telecommunications, conducted by the European Social Fund (www.ccoo.es) and the Tripartite Foundation, as well as the three PAFET reports (see the related sidebar), which were endorsed by the Board of National Association of Electronic and Telecommunications Industries (ANIEL), the Official College of Telecommunications Engineers, and the Board of Universities. We also paid particular attention to research by the Career Space consortium (http://mural.uv.es/luisupa/Career-Space.zip).

Table 1. Occupational profiles in the information and communication technology (ICT) field.

Occupational profiles	Mintzberg's categories
Applications design for processing digital signals	C
Design of communication networks	C
Design of ICT products	C
Development and maintenance of software and applications	C
Development of research and technology	B
Digital design	C
ICT consultancy	B
ICT management	A
ICT sales and marketing management	B
Integration and implementation testing engineering	B
Management of ICT projects	B
Network and data communication engineering	C
Programming and multimedia design	C
Radiofrequency engineering	C
Security specialist in telematics	B
Systems software design	C
Systems specialist	C
Technical assistance	C

From all the cited literature, we compiled a list that we believe epitomizes all the possible occupational profiles of the Spanish ICT sector. We specify the resulting 18 categories in the next section, but the objective of the study wasn't to identify occupational profiles in relation to a set of tasks or certain areas of knowledge. Instead, we identified occupational profiles with regard to the personal abilities they call for. To achieve this, we introduced a second filter that let us incorporate the 18 profiles into three homogenous groups or sets of similar jobs, paying attention to the skills and personal abilities required to perform them.

The method of categorization we used corresponds to Mintzberg's classification of business organizations:[24]

- Group A (*strategic apex*) includes senior managers who take overall responsibility for management and formulation of strategy.
- Group B or (*middle line*) includes middle managers with formal authority and responsibility who coordinate and see that strategic policies are implemented throughout the rest of the organization.
- Group C (*operating core*) includes the people who carry out the work directly related to the production of goods and services, or company output.

Table 1 indicates to which group each profession belongs.

Expert Panel

Our expert panel included ICT specialists who had extensive work experience, prestige within the sector, a general overview of the sector, and, at the same time, were knowledgeable of matters regarding engineer instruction and training. We interviewed 10 experts, including general directors of significant companies in the ICT sector, public institutions, and administration managers, along with university professors such as the dean of the Official College of Computer Engineering of Catalonia and the dean of the Faculty of Computer Engineering of Barcelona. (The number of experts we selected fits with similar studies based on expert panels.[15]) Their expertise has been established by their status among their peers, their years of professional experience, their own self-appraisal of relative competence with regard to our questions, and the amount of relevant information to which they have access.

We presented the experts with the list of skills and abilities and the list of occupational profiles for Spanish IT professionals. (Each list underwent a prior analysis to check its validity.) We asked them if the lists were either excessive or if we had omitted any skills or occupational profiles. Finally, we asked the experts to confirm that both lists were valid, needing no amendment.

Table 2. Assessment of abilities by homogeneous group.

Abilities	Homogeneous groups		
	A	B	C
Change management	0	0	–20
Commitment to customer service	–2	16	16
Commitment to excellence	0	2	12
Communication	1	8	10
Creativity	–5	–6	15
Decisiveness	2	2	–2
Empathy	2	1	–5
Innovation	0	5	16
Leadership	5	–6	–28
Knowledge management	–1	4	–4
Motivation	–2	–3	–2
Negotiation	4	–6	–22
Objective oriented	0	5	13
Personal development	0	–12	–16
Persuasiveness	0	–1	–36
Proactive	–2	–3	0
Problem-solving skills	–2	0	28
Strategy and planning	5	0	10
Teamwork	1	2	22
Mean average (m)	0.32	0.42	0.37
Standard deviation (sd)	2.47	5.92	17.45
Most valued (m + sd)	2.79	6.34	17.82
Least valued (m – sd)	–2.16	–5.50	–17.08

Next, we asked them to indicate which three abilities they considered most important to satisfy the tasks and objectives relevant to each occupational profile, and which three they considered least important, or less relevant, for that post. We added a positive point when the expert considered an ability relevant and a negative point if they judged the ability less relevant.

We transferred the sum of the experts' marks for each ability and profile to a 2D plane and analyzed the Euclidean distances to check against the possibility of inconsistent values that could have affected the subsequent conclusions. The result of the analysis established the viability of the opinions of all the experts who participated. (Various studies and scientific articles support this method of analysis.[15,25]) Subsequently, we computed and analyzed each profile's assessments and then categorized the results into the three homogeneous groups. Table 2 presents the results alphabetically.

Finally, we noted the abilities rated as most important for the job, or more highly valued, that exceeded the mean average of each homogeneous group plus the standard deviation, as well as those rated as least important, or less valued, that fell below the mean average minus the standard deviation.

Results

The most and least valued abilities for the three homogeneous groups A, B, and C (strategic apex, middle line, and operating core) were as follows:

- *Group A*. The most valued abilities were strategy and planning, leadership, and negotiation. Creativity was the least valued.
- *Group B*. The most valued abilities were a commitment to customer service and communication. Personal development, creativity, negotiation, and leadership were the least valued.
- *Group C*. The most valued abilities were problem-solving skills and teamwork. Persuasiveness, leadership, negotiation, and change management were the least valued.

These results demonstrate that the most valued abilities differ for each group. Leadership, strategy and planning, and negotiation abilities are most important for the occupational profile

of general directors and managers. Commitment to customer service and knowing how to communicate are highly valued for middle managers. Finally, problem-solving skills and teamwork are the most important for the operating core.

On the other hand, the least valued skills coincide across the groups. In the management Groups A and B, creativity is the least valued ability. Leadership and negotiating ability are less significant for Groups B and C. Furthermore, for Group B, less importance is given to personal development, and for group C, the least critical skills are persuasiveness and change management.

The two main ways to maintain competitive advantage in dynamic markets such as ICT are through innovation and strategic flexibility.[26] Therefore, it seems reasonable to conclude that workers in this sector should possess abilities and skills consistent with flexibility and innovation, especially those with the most management responsibility. Intermediate-level managers must also be responsible for strategy and all operational activity.

Acknowledging that premise and our previous studies,[27] the results we obtained in this study are somewhat surprising. Creativity plays an important role in innovation and strategic flexibility, but it isn't highly valued. In fact, it's considered the least important for the professional groups that have the most responsibility.

Again, it's surprising that abilities related to innovation and strategic flexibility (such as change management, knowledge management, and the capacity to innovate) don't appear among the most valuable skills. Moreover, the notion that change management is least important for the workers in core operations is also unexpected.

We intentionally chose an expert panel for this study because we believed it would help us forecast the tendency of the professional needs, especially considering how changeable the ICT sector is. Therefore, we must acknowledge that our conclusions are based on the knowledge and intuition of the specialists we consulted. There seems to be a clear contradiction between the panel of experts' evaluations, those suggested by strategic theory, and the case that Castells makes in his work. Because our results also seem to clearly contradict what was initially expected according to our literature review, it would be wise for future research to contrast them with data coming from primary sources based on surveys in the ICT sector. Also, due to the limitations related to the number of experts we consulted, our conclusions are preliminary. A quantitative study would help reinforce our conclusions.

If we base European competitive advantage on a knowledge-based economy, so that technological activities and knowledge are a real alternative to the exodus of the mass production industry, perhaps we must more clearly establish what has to be contributed and, consequently, how we should train our future IT professionals. If technical competence is a commodity, and character is defined at an early age, we must establish, between interpersonal skills and competency, what will add value and give a greater return for Spanish IT companies. IT

References

1. C.K. Prahalad and G. Hamel, "The Core Competence of the Corporation," *Harvard Business Rev.*, vol. 68, May/June 1990, pp. 79–91.
2. R.M. Grant, "Prospering in Dynamically-Competitive Environments: Organizational Capability as Knowledge Integration," *Organization Science*, vol. 7, no. 4, 1996, pp. 375–387.
3. D. Leonard-Barton, *Wellsprings of Knowledge: Building and Sustaining the Sources of Innovation*, Harvard Business School Press, 1995, p. 334.
4. M. Castells, End of Millennium, *The Information Age: Economy, Society and Culture*, vol. III, 2nd ed., Blackwell, 2000.
5. Lisbon European Council, "Presidency Conclusions," Mar. 2000; www.europarl.europa.eu/summits/lis1_en.htm.
6. M. Castells, "¿Ingenieros o antropólogos?" [Engineers or Anthropologists?], *La Vanguardia*, 19 Mar. 2005.
7. D.C. Mc Clelland, *Talent and Society: New Perspectives in the Identification of Talent*, Van Nostrand, 1958, p. 275.
8. C. Lévy-Leboyer, "Gestión de las Competencias: Cómo Analizarlas, Cómo Evaluarlas, Cómo Desarrollarlas" [Competences Management: How to Analyze, Evaluate, and Develop Them], *Gestión 2000*, 2003, p. 161.
9. C. McCauley, M. Lombardo, and C. Usher, "Diagnosing Management Development Needs: An Instrument Based on How Managers Develop," *J. Management*, vol. 15, no. 3, 1989, pp. 389–403.

10. D. Bragg, "Educator, Student and Employer Priorities for Tech Prep Student Outcome," Office of Vocational and Adult Education, Univ. Calif., Berkeley, 1997; http://vocserve.berkeley.edu/abstracts/MDS-790/MDS-790.html.
11. J. Arnold et al., "Students' Perceptions of Competence Development in Undergraduate Business-Related Degrees," *Studies in Higher Education*, vol. 24, no. 1, 1999, pp. 43–59.
12. G. Kuh, "The Other Curriculum: Out of Class Experiences Associated with Student Learning and Personal Development," *J. Higher Education*, vol. 66, no. 2, 1995, pp. 123–155.
13. N. Bennet, E. Dunne, and C. Carré, "Patterns of Core and Generic Skill Provision in Higher Education," *Higher Education*, vol. 37, no. 1, 1999, pp. 71–93.
14. M.K. Badawy, *Developing Managerial Skills in Engineers and Scientists, Succeeding as a Technical Manager*, John Wiley & Sons, 1995.
15. C. Cabello et al., "Tipología estratégica de Miles y Snow y factores competitivos: un análisis empírico" [Miles and Snow's Strategic Typology and Competitive Factors: An Empirical Analysis], *Cuadernos de Economía y Dirección de la Empresa*, no. 7, 2001, pp. 365–381.
16. Oficina d'Orientació i Inserció Laboral. Associació d'Amics de la UPC, "Observatori del mercat de treball 2001-2002, observatori de les empreses 2002, memòria AAUPC 2002: rendició de comptes" [Labor Market Report 2001–2002, Labor Market Observatory 2002, AAUPC2002 Annual Report], 2002.
17. J. Casanovas et al., "Libro Blanco sobre las Titulaciones Universitarias de Informática en el nuevo Espacio Europeo de Educación Superior del Proyecto EICE" [Informatics Degrees in the New European Higher Education according to EICE Project], white paper, *ANECA*, 2004, p. 347.
18. Nat'l Agency for Quality Assurance and Accreditation (Spain), "Libro blanco sobre ingeniería de telecomunicación: documento final del Proyecto Ingeniería de Telecomunicación" [Telecommunication Engineering Project, Final Document], white paper, ANECA, 2005, p. 703.
19. Nat'l Agency for Quality Assurance and Accreditation (Spain), "Libro Blanco para los futuros títulos de grado en el ambito de las Tecnologías de la Información y las Comunicaciones" [Future ICT Degrees], white paper, 2004; www.uc3m.es/CG/EEES/azcorr33-4754.pdf.
20. J. Liebowitz, W.W. Agresti, and G.R. Djavanshir, *Communicating as IT Professionals*, Prentice Hall, 2005.
21. R. Cordero, G.F. Farris, and N. Di Tomaso, "Supervisors in R&D Laboratories: Using Technical, People, and Administrative Skills Effectively," *IEEE Trans. Eng. Management*, vol. 51, no. 1, 2004, pp. 19–30.
22. M.A. Soderstrand, "The New Electrical and Computer Engineering Curricula at University California, Davis," *IEEE Trans. Education*, vol. 37, no. 2, 1994, pp. 136–146.
23. J.C. Dueñas, V. Burillo, and J.L. Ruiz, "PAFET 4: Perfiles profesionales TIC para la implantación de servicios y contenidos digitales" [Professional ICT Profiles to Implement Services and Digital Content], 2005; www.coit.es/index.php?op=estudios_215.
24. H. Mintzberg, *The Structuring of Organizations: A Syntesis of the Research*, Prentice-Hall, 1983, p. 561.
25. D. Gregory, G. Davis, and S. Peter, "Porter's (1980) Generic Strategies as Determinants of Strategic Group Membership and Organizational Performance," *Academy of Management J.*, vol. 27, no. 3, 1984, pp. 467–488
26. Z. Shaker and G. Gerard. "Absorptive Capacity: A Review, Reconceptualization, and Extension," *Academy of Management Rev.*, vol. 27, no. 2, 2002, pp. 185–203.
27. A. Llorens, X, Llinàs, and J. Olivella, "Análisis de las competencias profesionales y de las estructuras organizativas en el entorno de las tecnologías de la información y la comunicación" [Analysis of Professional Competences and Organizational Structures in the ICT Sector], *IX Congreso de Ingeniería de Organización*, David de la Fuente García, 2005, pp. 327–328.

Ariadna Llorens-Garcia *is an associate professor of management at the Technical University of Catalonia (UPC). Her research is in innovation methodologies for education in the knowledge society. Llorens has a degree in industrial engineering from UPC. Contact her at ariadna.llorens@upc.edu.*

Xavier Llinas-Audet *is a professor of economics and head of the doctorate program at the Technical University of Catalonia (UPC). His research is on worker profiles in the knowledge society. Llinas has a PhD in informatics from UPC. Contact him at xavier.llinas@upc.edu.*

Ferran Sabate *is an associate professor of negotiation, decision-making, and project management at Technical University of Catalonia (UPC) and is coordinating the Telefonica-UPC team force in the tendencies and evolution of the information society. His research is on e-commerce. Sabate has a PhD in business administration from UPC. Contact him at ferran.sabate@upc.edu.*