Shaping the Digital Future of Europe

European Forum for Information and Communication Science and Technology

Strategy 2013-2015

ACM Europe Council, EAPLS, EASST, EATCS, ECCAI, ERCIM, and Informatics Europe

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The Platform of the European Societies in Information and Communication Sciences and Technologies

http://www.eficst.eu/

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European Forum for
Information and Communication Science and Technology
(EFICST)

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Executive Summary

Advances in information and communication science and technology (ICST) continue to revolutionize our economies and our society. Computational thinking and virtualization are revolutionizing science and technology itself.

Driven by great opportunities and needs for automation, the development of ICST should be accompanied by sound visions of the way we live, work, and do business in the years to come. It requires a permanent dialogue between the many stakeholders, including ICST professionals, to understand where future innovations will take us.

In its strategy for 2013-2015, the *European Forum for ICST*[1] aims to meet the challenges by a choice of actions, impelled by the crucial role of ICST (including ICT and Informatics) for innovation and change. The strategy focuses on:

- Software as a key enabling technology of Europe's digital future,
- Software as the key driver of industrial and societal innovation,
- Experimental informatics research that takes risk on new ideas, and
- Informatics as a scientific discipline in education.

To spearhead new developments, the Forum will regularly install high-level task groups to produce strategic studies on developments in ICST of great expected potential.

1 Society and the digital future

The information age is in full swing, with no end in sight. Innovations in ICST continue to revolutionize the world economy and society. Industrial processes, banking, transportation, commerce, communication, entertainment, medicine all depend on efficient and well-organized information-processing. Computing has become pervasive and inescapable in everyday life.

Information processing and computing have a profound effect on society, transforming the way we do business, access services and communicate in every possible activity. Many simultaneous developments cause this to happen. On the one hand, we become aware of ever more information-driven processes

[1] The platform of leading European societies in ICST including: *ACM Europe*, *EAPLS*, *EASST*, *EATCS*, *ECCAI*, *ERCIM*, and *Informatics Europe*.

that need to be available anytime and everywhere. On the other hand, information and communication technologies increasingly enables us to virtualize, augment or create any process in our daily environment. Everything around us is becoming machine- and network-based.

The deep impact of these developments on all human endeavor is widely anticipated in strategies which aim to guide and stimulate it. The digital economy is growing faster than any other economy, and interactive technologies and social machines are changing our society permanently. The need for supporting measures is aptly recognized in the EC's *Digital Agenda for Europe*.[2]

The challenges for the science and technology of the field are tremendous. The automated systems and services of the future require a re-invention of science from a computational perspective, and software technologies that are simple yet robust enough to enable their creation. It is the domain of *Information and Communication Science and Technology* or ICST for short, encompassing all of Informatics, ICT and their multiple offsprings.[3]

The ideas and methodologies of ICST have a profound impact on all other sciences, from e-sciences to e-humanities, and on all technology development in industrial and societal contexts. This creates a unique challenge for the field, represented by its societies in Europe:

The scientific and professional societies in ICST have a key responsibility in helping to understand and shape Europe's digital future. As Forum members, they aim to collectively identify the visions, needs and priorities, and offer their expertise to the whole discipline and to society.

As a platform of leading professional and scientific societies in ICST, the *European Forum for ICST* aims to contribute viewpoints and strategies for research and innovation in all areas. Its focus areas for 2013-2015 are:

- Software as a key enabling technology for Europe's digital future,
- ICST as the key driver of industrial and societal innovation,
- Experimental informatics research that takes risk on new ideas, and
- Informatics as a scientific discipline in education.

In this strategy paper, we give further background to the Forum's activities aimed at the development of ICST for Europe's *digital future*.

2 Challenges for Europe's ICST societies

The digital future is in the hands of many stakeholders, all driven by different goals and needs. It is important to bring coordinated thinking and action to it,

[2] http://ec.europa.eu/digital-agenda/digital-agenda-europe.

[3] ICST is used throughout as all-encompassing term to refer to IT, ICT, Computing, and all other related fields. Informatics is used to refer to ICST in scientific and educational contexts, and to the many applications in computing and information processing.

so society can benefit in the best possible way and not run the risk of missed opportunities or unwanted effects.

The field of ICST contributes to many challenges of the modern world, for instance:

a. *Society*: creating a sustainable world for the growing populations (e-learning, energy systems, e-health, quality of life, cyber-security, smart environments, language technology, social networks, sustainability, transport, trustworthy ICT).

b. *Economy*: creating and exploiting business models for the networked world (cloud computing, competitiveness through ICST, e-business, entrepreneurship, e-services, global markets, grids, information companies, standardization, web 3.0).

c. *Industry*: designing the ICT-based products and services to facilitate and innovate all societal activity (intelligent objects, interface technology, micro-/nano-electronics, robotics, serious gaming, software and systems engineering).

d. *Science and Technology*: backcasting and understanding the potential of information-based processes and the design of information processes, tackling and eliminating complexity (in e-science, intelligence in systems, modelling and simulation, theoretical exploration, valorization).

Shaping Europe's digital future requires an awareness of the visions and perspectives of the digital society and a preparation for its challenges.[4]. The role of scientists, engineers, professionals and educators in the ICST field is essential.

The *European Forum for ICST* was created in 2011 to meet the challenges put on the joint professional and scientific societies in ICST in shaping the digital future of Europe. The collective membership of the Forum includes the top experts in all sectors of the discipline, from all over the world.

The overall strategy of the Forum is threefold:

- to coordinate strategies so as to enable its member societies to formulate, adopt and implement common views and policies pertaining to ICST (in Europe).

- to instigate collective actions of its member societies in furthering the scientific and technological visions, needs and priorities of the digital future.

- to contribute to the general recognition and visibility of ICST in Europe: in research, in science, in technology, in innovation, in education, and as an economic factor.

[4]See e.g. the challenges of the Horizon 2020 Framework Programme for Research and Innovation, http://ec.europa.eu/research/horizon2020/ The Framework Programme emphasizes three main priority areas: *excellent science*, *competitive industry* (including leadership in enabling and industrial technologies), and *better society*.

Through cooperation, the Forum promotes the coordinated participation of its member societies in the development of relevant international, including EU, policies and actions. We outline the focus areas for the Forum's agenda for 2013-2015 below.

3 Challenges for Europe's digital future: agenda 2013-2015

Since the beginning of the computing industry in the 1950s, the field of ICST has been immensely successful. Almost all aspects of society have been profoundly changed by it, from the most commonplace (such as books, movies, stores, and telephones) to the most innovative (all of the EU's Key Enabling Technologies depend crucially on ICST for their success). This evolution continues today and shows no signs of slowing down.

The crucial question is: *how to build the digital future*? The key criterion is that the interests of human society ('the citizen') must remain central. The challenges for the ICST field are immense. The field is pressed for results, with great pressures on means and manpower. Research projects are increasingly targeted to specific goals, and must encompass the complete chain from fundamental research to technology development and innovation. Note, however, that non-targeted research, often viewed as of purely academic interest, has yielded its fair share of technology as well, with impressive examples: witness the Web, cloud computing, machine learning, or quantum computing.

To address the challenges and risks of this evolution, the *European Forum for ICST* aims its strategy for 2013-2015 at four major challenges for the future of ICST in Europe: *software as key enabling technology*, *software as key driver of industrial and societal innovation*, *experimental informatics research and risk taking*, and *informatics in education*.

We describe each of them in more detail in the following subsections.

3.1 Software as a Key Enabling Technology

Europe's future knowledge-based economy will run on software, to assist and amplify our human powers and to conserve natural resources. Accordingly, software is now one of the major *key enabling technologies* of Europe's digital future.[5] It has been called the 'soul' of European industry.[6] Software permeates everything. Without it, society would grind to a halt.

Software is the key technology for realizing systems. In today's computing artifacts, the complexity of the software has become enormously greater than

[5]The Key Enabling Technologies currently recognized in Horizon 2020 nevertheless only include: micro- and nano-electronics, photonics, nanotechnologies, advanced materials, biotechnology, and advanced manufacturing and processing.

[6]M. Brorsson, Software engineering and development in the multi-core era, SICS, Stockholm, 2009.

the complexity of the material device (the hardware) that makes up the artifact. Despite software's enormous success, its scientific and technological aspects are still poorly understood. Modest successes in software research have simultaneously enabled an acceleration in software use, yet the perceived quality of software has still not improved.

The situation is becoming dangerous as society depends critically on software working correctly. Whereas previously technology could work without software (e.g., telephones, cars, airplanes originally did not use computers at all), for today's technology this is no longer the case. Small glitches can have enormous effects. For example, programming errors in stock exchange software can and have caused stock market runs and crashes. Simplicity as a design objective in software and its use within the complex technological products on which we depend daily in our professions and our lives, is gaining paramount importance for the entire society.

Software is a key technology of Europe's digital future. Designing software is a rigorous endeavour guided by scientific principles. The European Forum for ICST will further the development of technologies for (large) software systems that are simpler and more robust under the challenges of the digital future.

The challenges related to software as a general technology are many.[7] We identify some of the most important ones for the Forum's 2013-2015 agenda:

Software engineering ICST studies the principles of designing complex software systems. This is now enabling the creation of systems with tens of millions of lines of source code, such as modern operating systems (for example, Windows 8 and Mac OS X). No single human being can comprehend systems of this magnitude, yet because of their principled design and extensive use we can be confident that they are essentially correct. The evolution towards larger and more ambitious software systems is ongoing. The complexity of software has now become so great that it cannot be designed directly by human beings anymore, but requires the intervention of automated techniques.

Pervasive computing and utility computing Increasingly human artifacts take advantage of the abilities of computing to improve their functionality. This is happening through two main mechanisms: pervasive computing, in which more and more artifacts contain computers, and utility computing, in which large concentrations of computing resources are put at the disposal of networked artifacts. New network addressing standards, e.g. the recently adopted IPv6, enable both mechanisms since they permit all human artifacts to be connected together through the Internet. This is revolutionizing the ways in which any human artifact can be made more useful through software. Utility leads to 'big data' systems that exploit advances in intelligent data analysis, machine learning, and agent-based technologies to provide new innovative services.

Human-level computing Informatics technology is increasingly capable of interacting with human beings at their level. Virtualizations emulate environments in which users can interact as if they are interacting in real life. To

[7] Software Technologies - The Missing Key Enabling Technology: Towards a Strategic Agenda for Software Technologies in Europe, ISTAG, 2012.

successfully create this quality of human-level computing, advances are needed in artificial intelligence, human-machine interaction and the design of user-interfaces so humans can dialogue with systems in a 'human' way. Accessing the digital world at a human level, is the key to all systems in the digital future.

Dependability Society makes use of many complex systems that totally depend on computing. Essential mechanisms of government and economy, such as transportation, markets, and production, are increasingly computerized. These mechanisms should be resilient to failures and unpredictable behavior which can be caused by both internal and external factors. Neither natural catastrophes nor software errors should cause society to collapse. The dependability of complex systems, which increasingly rely on computer systems and networks, is a crucial issue in social computing. ICST professionals and societal parties must collectively analyse the requirements, research needs, and costs to guarantee that future data and systems are dependable to any needed extent.

The Forum strongly supports the ISTAG 2012 report[7]*, advocating that* Software *is recognized as a Key Enabling technology in Horizon 2020, in the interest of a competitive European software industry.*

The Forum strongly supports the ISTAG 2012 recommendation[7] *that a strategic agenda for software technologies in Europe be developed, in cooperation with industry, academia and the public sector.*

3.2 Software as the key driver of industrial and societal innovation

Software, in fact all of ICST, is a key factor in creating the components of the digital future. Industrial activities and business interactions are all becoming highly automated through ICST. Many organizations thrive due to complex information systems which enable them offer new and competitive services. Communications change radically with advances in mobile technologies, social networking, and cloud computing.

The advances come with many potential benefits, such as increased productivity and facilitating labour-intensive processes. From a business perspective, ICST makes it possible to reach large groups of customers at a low cost. Increasing virtualization, and better and more accessible information enrich everything. Yet, the effects of change by industrial and societal innovations with ICST are not necessarily predictable. Innovations are successful only if they create desired and accepted gradients in society.

Understanding the reasons for acceptance of innovative ICST is an important guide for developing a desirable digital future. The human factor is crucial. If understood, it will be a great source for conceptualizing promising future innovations.

The Forum stresses the strategic importance of industrial and societal innovations with ICST, underlining the key role of the ICST technologies in shaping the digital future.

The challenges are many and vary per stakeholder. We identify some of the most important ones, at the overall level:

Intelligent technologies In the digital future, industrial and business processes will be increasingly automated by new ICST technologies. In all domains of human activity, from industry to medicine, key technologies will be increasingly robot-assisted, knowledge-driven and agent-controlled to reach the highest quality and distribution. Cognitive computing will pervade all systems to enable their evolution. In all industrial and societal domains, the push to discover and design intelligent process technologies poses great challenges for ICST. The key enabling technology will be software (see above).

Sustainability ICST also plays a key role in managing the use of natural resources, in all domains of activity where economic and environmental factors meet. Examples include the sustainable use of energy, modelling and monitoring environmental pollution, and the future of transportation (e-vehicles). In all cases, research is needed on the complex questions of modeling, planning and decision making such that the use of natural resources and waste production are minimized.

Business transformation The ICST-technologies of the future will impact on all activities in organizations, both internally and externally in the interactions with markets and customers. They will require autonomous decision support at all levels, to attain greater productivity and new or better services. The advances in ICST create challenges for all companies in adapting themselves to the virtual economy. In particular, the *smac-technologies*[8] force companies to invent and adopt new digital business models, in order to adjust optimally to the rapidly virtualizing markets over the globe. ICST leads to a new wave of 'digital transformation', as the joint effect of many new information technologies and user centrality coming together.

Information security and trust The technologies of ICST are creating a totally new societal infrastructure, with many great advantages but also many challenges for secure use. Digital security and trust are now crucial areas of research and development in ICST, with a direct bearing on all our interactions over the Internet and in the digital democracy.[9] Many challenges interact, in nontrivial ways. For example, the security and privacy aspects in utility computing are highly intertwined. Trust does not merely follow from online customer reviews. There are complex legal aspects as well, as for information ownership and access rights (including e-identities) in increasingly virtualizing environments.

The advances in ICST deeply impact on every area of human endeavour. Whatever can be imagined, can become a 'reality' in the virtual world. Conversely, it creates great opportunities for companies and businesses to position themselves in the 'attention economy'.

[8] 'Smac' stands for 'social, mobile, analytics, cloud'.

[9] J. Bus *et al.*, Digital Enlightenment Yearbook 2012, IOS Press, 2012.

The Forum promotes anticipating fundamental research on future and emerging, human-centered information processing concepts and technologies. ICST is the key discipline for the virtual economy in Europe's digital future.

Industrial and societal innovations result from consorted actions, inspired by sound strategies. The European Forum for ICST will promote these actions, and stimulate its members to develop a research agenda that inspires and guides long-term ICST research in synergy with the EC's Digital Agenda and other relevant strategic initiatives.

The scientific and professional societies should create and highlight common causes for ICST, that are widely recognized and representative for the digital future and that guide the way to industrial and societal innovations.

3.3 Experimental Informatics Research and the Need for Risk Taking

In informatics, as in all scientific disciplines, serendipity is important. Breakthroughs in ICST cannot all be planned. While the Internet itself was planned (through DARPA support in the US), its growth as a major force for societal change and innovation was not planned. However, unplanned breakthroughs are difficult to achieve in Europe. One reason is that fundamental experimental research in informatics is under-appreciated and almost impossible to fund directly. This is in stark contrast to the US, where major research institutions such as MIT, Harvard, Stanford, Berkeley, and CMU take great pride in their experimental informatics research. These institutions realize that just like in physics, the theoretical and experimental branches of informatics are inseparable: each serves to validate and inspire the other.

It is important that Europe maintains a solid base of fundamental experimental research in ICST, and funds 'blue sky research' to make unplanned breakthroughs and innovations possible. Many successful US companies started up from fundamental experimental research, such as Amazon, Akamai, Facebook, Google, and VMWare. Large US companies are happy to put substantial funding into this kind of research, as demonstrated by Facebook, Microsoft Research, IBM Research, and the Google approach. Successes also exist in Europe, notably Xen, Linux, and the World-Wide Web. Europe wisely funded experimental research in grid computing, but other European success stories are relatively few. The research funded by organizations like the *European Research Council*[10] is giving great opportunities to remedy this, provided they are sustained over a long time.

Breakthroughs in ICST require long-term experimental research. This type of research should be held in high value by society, academia, and funding agencies.

Experimental research is often resource-consuming and labour-intensive, and it may be risky (in the sense that success is not assured beforehand: some

[10] http://erc.europa.eu/

appealing idea may be shown to be impractical). Yet building and measuring are essential to gain experience, to hone knowledge, to test theories, to uncover hidden issues, and to come up with new artifacts. Companies like Google, Amazon, and Facebook are the product of people with detailed technical knowledge who were willing to experiment and quickly fix any incorrect preconceptions.

The software in our digital future is yet to be created, but we already know that it will be more complex than today's. It will contain more opportunities for errors, failures, and security weaknesses. To master this complexity and strive towards simplicity wherever possible, we need to address research challenges in modelling, design, usability, and software economics throughout the software and product lifecycle. In many areas, innovation comes through visionary projects or small start-up companies. Many of them fail, but the occasional success drives the whole industry forward. The acceptance of failure as a possible and useful outcome, is a necessary condition for success.

In part, Europe lags behind in this area because European culture is risk averse. While this is laudable in some areas (e.g. the precautionary principle for protecting citizens against dangerous policies), it is counterproductive for research and technology development in informatics. Most Silicon Valley start-ups fail, and when they do, their employees move on to other companies without any stigma. Founders of start-up companies also move on to found other companies, and studies show that the companies they found after the first have more chance to succeed because of the founder's increased experience.

Experimental research and true risk taking are essential for making progress. Research with risk (i.e., uncertain success) and acceptance of failure must be part of any Research Agenda.

3.4 Informatics as a scientific discipline in education

ICST is a fundamental science for understanding both society and the world around us in terms of information processing and computing. It must be understood and taught as such. Because of its varied and versatile application, ICST skills will be needed in almost all professions. All citizens, and not just technocrats, must understand the basic scientific principles of informatics.[11]

The behaviour of software systems is governed by complex laws which we are only beginning to discover. The fundamental insight that almost all questions about computational systems cannot be found out feasibly or even effectively at all[12], implies that we cannot delegate our understanding of them.

As citizens are exposed daily to the consequences of a society that depends on ICST, they should be educated as active participants and not just passive users of the technology. The visible aspects of ICST such as online systems, social networks, games, Web sites, and applications, only scratch the surface of

[11] This is also recognized in e.g. the activities of the *European e-Skills Association*, http://eskillsassociation.eu/.

[12] C. Moore and S. Mertens, The Nature of Computation, Oxford University Press, 2011.

how society depends on ICST. The true importance of informatics lies deeper, in how it helps understand the basic mechanisms of society.

The digital future will depend on the success to educate and train our current and future generations in the insights and technologies of Informatics. Future professions will all be supported by intelligent technologies, requiring ICST skills that are as important as literacy and numeracy.

The Forum will promote that these skills are taught and trained, and that ICST knowledge is transferred into all levels of vocational and professional education. The challenges are many. Some of the most important ones are:

Informatics education in primary and secondary schools Our children learn the basic principles of science in school as part of becoming adults (i.e. educated citizens). We teach them maths, physics, geology, biology, and so on, to help them understand the world around them and function well in society. In tomorrow's world, informatics will also have to be one of the sciences they are taught. Initiatives by some member societies (ACM Europe, Informatics Europe) have already begun to identify the needed components of digital literacy and future informatics curricula in primary and secondary schools.[13]

Informatics as a profession of the future Society will require more and more people in all areas of the economy who are highly educated in informatics. ICST will remain one of the fastest growing occupational groups, at par with health care; employment in ICST occupations is overall expected to increase by at least 22% towards 2020 (cf. Computerworld, 2012). The challenge is to recruit enough people to fill the need.[14] An even greater challenge is to educate them. It has been shown that early exposure to scientific informatics in school correlates with success in all careers, not only those related to computing. The digital future will require substantial increases in educational capacity at tertiary levels.

Education in the on-life ICST solutions are increasingly encapsulated by virtual worlds, giving highly stylized graphical emulations of real environments in which users are interacting as if they are interacting in real life. This 'blurs the distinction between reality and virtuality', and leads perhaps to the greatest change of all for individuals living in the digital future.[15] It not only impacts on our perception of society, but also on education and on professions in the online world. Digital learning and massively open online courses (MOOCs) will change the way we learn. It will be important to understand the societal effects due to the developing 'digital life' of European citizens, both for optimal benefit and for safeguarding ethics in the digitizing world.

Education is crucial in preparing for the changing society in the digital future. This applies foremost to education in primary and secondary schools.

[13] "Informatics education - Europe cannot afford to miss the boat", ACM Europe/Informatics Europe, Report, February 2013.

[14] The challenge is one of the priorities in the *Digital Agenda for Europe*. On 4-5 March 2013, the EC launched the *Grand Coalition for Digital Jobs* to act on the future need for ICST specialists and entrepreneurs. The Forum actively supports this initiative.

[15] The onlife initiative - Concept reengineering: rethinking public spaces in the digital transition, https://ec.europa.eu/digital-agenda/en/onlife-initiative.

The effects of ICST will be felt in all fields of human activity. Industrial and business opportunities will crucially depend on Europe's ability to adopt ICST deeply in its educational systems.

Understanding the scientific dimensions of informatics is essential to the European citizen's education. Just like schools teach the basics of mathematics, physics, biology or economics, the science of informatics should be taught in primary and secondary school. ICST should be adopted widely in Europe's educational systems, to prepare for the industrial and business opportunities of the digital future and optimal benefits of the future on-life.

4 Summary: action areas for 2013 - 2015

Europe's investments in digital future research are crucial for increasing Europe's competitiveness in ICST. European technology platforms (ETPs), the EIT[16], and the Horizon 2020 Framework Programme for Research and Innovation are vanguards of Europe's advanced technological position.

The scientific and professional ICST societies in Europe need to play a leading role in activating researchers, professionals and educators for the challenges in all dimensions of the digital future. The *European Forum for ICST* aims to develop and promote joint strategies for the major challenges in the field.

The Forum's strategy for 2013-2015 highlights a number of selected areas for action. The following list summarizes these areas and the positions taken by the Forum. The list is not meant to be exclusive, but only represents the current focus of the Forum's concern with scientific policies for ICST in Europe.

A. Recognising Software as a key enabling technology for Europe's digital future

1: *Software is a key technology of Europe's digital future. Designing software is a rigorous endeavour guided by scientific principles. The European Forum for ICST will further the development of technologies for (large) software systems that are simpler and more robust under the challenges of the digital future.*

2: *The Forum supports the recommendation of the ISTAG 2012 report* [17]*, advocating that* Software *is recognized as a Key Enabling technology in Horizon 2020, in the interest of a competitive European software industry.*

3. *The Forum strongly supports the ISTAG 2012 recommendation*[17] *that a strategic agenda for software technologies in Europe be developed, in cooperation with industry, academia and the public sector.*

[16]European Institute of Innovation & Technology, http://eit.europa.eu/.

[17]Software Technologies - The Missing Key Enabling Technology: Towards a Strategic Agenda for Software Technologies in Europe, ISTAG, 2012.

Important policy areas include: software engineering, pervasive computing and utility computing, human-level computing, and dependability.

B. Software as the key driver of industrial and societal innovation

4: *The Forum stresses the strategic importance of industrial and societal innovations with ICST, underlining the key role of the ICST technologies in shaping the digital future.*

5: *The Forum promotes anticipating fundamental research on future and emerging, human-centered information processing concepts and technologies. ICST is the key discipline for the virtual economy in Europe's digital future.*

6: *The scientific and professional societies should create and highlight common causes for ICST, that are widely recognized and representative for the digital future and that guide the way to industrial and societal innovations.*

Important policy areas include: intelligent process technologies, sustainability, business transformation, and information security and trust.

C. Experimental Informatics Research and the Need for Risk Taking

7: *Breakthroughs in ICST require long-term experimental research. This type of research should be held in high value by society, academia, and funding agencies.*

8: *Experimental research and true risk taking are essential for making progress. Research with risk (i.e., uncertain success) and acceptance of failure must be part of any Research Agenda.*

Important policy areas include: funding of fundamental experimental research, true risk taking on new ideas.

D. Informatics as a scientific discipline in education

9: *The digital future will depend on the success to educate and train our current and future generations in the insights and technologies of Informatics. Future professions will all be supported by intelligent technologies, requiring ICST skills that are as important as literacy and numeracy.*

10: *Understanding the principles and facts of informatics is essential to the European citizen's education. Just like schools teach the basics of mathematics, physics, biology or economics, the science of informatics should be taught in primary and secondary school. ICST should be adopted widely in Europe's educational systems, to prepare for the industrial and business opportunities of the digital future and optimal benefits of the future on-life.*

Important policy areas include: informatics education in primary and secondary schools, informatics as a profession of the future, and education in the on-life.

5 Strategy papers

European research and development in ICST must embrace ambitious concrete goals and pursue them until success is achieved. In order to identify, explore and estimate the potential of beginning developments, the Forum will instigate a regular activity of futurecasting in ICST so policies can be set to embrace new developments early. As a side effect, industry may be encouraged to pursue innovations in directions that it would otherwise leave aside as being too risky.

*To spearhead new developments, the Forum will regularly install small but prestigious task groups to produce strategic studies (*white papers*) on developments in ICST of great expected potential. The Forum will promote that these developments are taken up by policy makers and funding agencies, to encourage novel research and technological innovations in ICST in earliest possible stages.*

Strategic studies are needed e.g. on the importance of simplicity as a key informing principle of ICST and on the impact of experimental and risky research.

The development in ICST can be viewed and estimated in many ways, along many different dimensions. The Forum's strategy 2013-2015 gives an starting point, but is not limiting for the views and strategies which the Forum aims at.

To implement its strategic lines, the member societies of the *European Forum for ICST* can call on a large number of prominent ICST scientists and professionals in Europe and abroad. Through the coordinated participation of its member societies, the Forum aims to assist and enrich the development of relevant international policies and actions in ICST, for the benefit of science, industry and society in the digital future.

European Forum for ICST
Utrecht/Louvain-la-Neuve/Paris
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European Forum for Information and Communication Science and Technology

The **European Forum for Information and Communication Science and Technology** (ICST) was established on November 7th, 2011 in Milan (Italy) by a joint action of seven leading organizations and societies in ICST in Europe.

Mission

> *The development of common viewpoints and strategies for ICST in Europe and, whenever appropriate or needed, a common representation of these viewpoints and strategies at the international level.*

Executive board: J. van Leeuwen (president), K. Jeffery (vice-president), P. Spirakis (vice-president).

Coordinating committee: L. Aceto (EATCS), M. Cosnard (ERCIM), P. Doherty (ECCAI), K. Jeffery (ERCIM), F. Gagliardi (ACM Europe Council), C. Ghezzi (Informatics Europe), D. Laforenza (ERCIM), T. Margaria (EASST), M. Shapiro (ACM Europe Council), P. Spirakis (EATCS, ACM Europe Council), M. van den Brand (EAPLS), P. van Roy (EAPLS), J. van Leeuwen (Informatics Europe, EATCS, ACM Europe Council).

Members (2013):

- ACM Europe, *Association for Computing Machinery, Europe Council*
- EAPLS, *European Association for Programming Languages and Systems*
- EASST, *European Association of Software Science and Technology*
- EATCS, *European Association for Theoretical Computer Science*
- ECCAI, *European Coord. Committee for Artificial Intelligence*
- ERCIM, *European Research Consortium for Informatics and Mathematics*
- Informatics Europe, *European Association of Depts of Computer Science and Informatics Research Labs*

Key Issues of the European Forum for ICST include:

- Express common viewpoints for ICST in Europe, when and where needed.
- Join in synchronized, strategic directions for the field.
- Improve the image and recognition of ICST.
- Promote ICST as the key factor for innovating all processes in science and society.
- Emphasize the need for high quality research and education in ICST.
- Develop professional standards and their recognition.
- Make ICST more visible to other disciplines and to each other.
- Aim at a better synchrony with platforms in the ICST industry
- Influence research funding and policies for the field.
- Function as a community that cooperates and interacts across sub-area boundaries.
- Make Europe more prominent in ICST research.
- Represent the (European) excellence of the field.

More information: http://www.eficst.eu/