Strategic directions for ICT research and education in Europe [draft]

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Executive summary

There are many urgent problems for ICT in Europe. We mention in particular the chronic shortage of informatics professionals and the lack of experimental research and risk taking. These problems are partly addressed in the Digital Agenda Initiative and the Grand Coalition for Digital Jobs. To complement the industrial viewpoint which has so far dominated this discussion, the EFICST has included in its analysis all ICT stakeholders, including European authorities, industrial stakeholders, and university and research organisations. We propose eight concrete directions:

1 *Encourage experimental research and risk taking:* Risk taking, in the sense of disruption, should be encouraged and failure should be tolerated.
2 *Keep the smart people:* Smart people should be courted through attractive industrial and research possibilities.
3 *Listen to SMEs:* There should be more effort to incorporate SMEs into the decision-making process.
4 *Support higher and K-12 ICT education:* Higher ICT education is currently underenrolled and underfunded; it cannot produce enough graduates. Adding informatics to K-12 education is part of the solution.
5 *Don't try to get more for less:* Instead of maximising the number of goals with limited funding, ICT funding should focus on research goals and fund them adequately.
6 *Reduce focus on management:* Project evaluation for management should be pass/fail; project success should be based on scientific results and impact alone.
7 *Follow the successes:* European enclaves of success should be studied carefully and emulated.
8 *Prepare for the long term:* Some long-term focus must be put in the system, since solving these problems needs a long-term effort.

Introduction

The Digital Agenda for Europe proposes a pathway to convert Europe into the world's premier innovation society. As ICT researchers, educators, and professionals, we are directly concerned with this initiative and its success. In our view, to make it succeed, certain important properties of how innovation currently works in European society must be recognised openly and addressed frankly. It is clear that there are pressing problems for ICT in Europe, such as the chronic shortage of informatics professionals and the lack of experimental research and risk taking. To complement the industrial viewpoint which has so far dominated the discussion of these initiatives, the EFICST has drawn on the broad

experience of its members to propose a number of additional approaches to meet their challenges. EFICST includes many of the prominent European educational and research organisations in informatics. These organisations have created the EFICST to combine their experience and speak in a single voice to the European authorities.

University departments and research institutes throughout Europe are continuously adapting their curricula and research priorities to meet the rapidly changing goals of informatics. They are educating as many technical and research professionals in computing technology as their budgets allow. They are collaborating intensely with industrial partners of various sizes and with other disciplines (notably in bioinformatics). Most of the professionals they turn out are hired quickly as soon as they finish their education. Despite this, the chronic problems of personnel shortage and lack of risk taking continue to take their toll on informatics development in Europe. We have analysed this situation and we conclude that a more global approach that combines all ICT stakeholders is necessary: European authorities, industrial stakeholders, and university and research organisations. The rest of this document explains eight concrete problems and gives suggestions how to address them.

Technical proposals

Encourage experimental research and risk taking. Unplanned breakthroughs are difficult to achieve in Europe. One reason is that fundamental, risky experimental research is under-appreciated and difficult to fund directly. This is in stark contrast to the US, where major research institutions take great pride in their experimental informatics research, which has led to many of today's most innovative companies. Some of the most significant US advances have been funded by the US Department of Defense, in contrast to European defence industries. European programs such as FET Open (specifically, the FET Flagships) and ERC partially address this problem. They specifically address risk taking, but they form a very small percentage of ICT research funding. In this discussion it is important to distinguish risk in the sense of being disruptive (where success is not assured beforehand) versus risk in the sense of being dangerous (e.g., GMOs in biology). We do not address risk taking in the second sense; it is handled by the precautionary principle. Risk taking in the first sense is quite different; it needs to be encouraged in all ICT research funding, including (and especially) in research that involves industrial partners. This will need changes in how the research objectives are presented, and changes in the evaluation process (for example, a positive score can be given to credible risks in a project). The EU should encourage experimental research and true risk taking in the first sense, since they are essential for making progress. The acceptance of failure is a necessary condition to make this work. It is a fact that entrepreneurs who fail in their first attempt at creating a startup will often succeed in their second attempt.

Keep the smart people. The shortage of qualified ICT people in Europe is especially acute regarding the best and brightest. Many are attracted to American companies (we all know of people who have moved to Google), who spare no effort in courting them. They leave because they want to work on exciting projects and products at the leading edge. Why can European industry not attract them to the same degree? One successful approach in Europe is the "Stanford model" in which the university has the funds and organisational flexibility to help set up and run SMEs, so the academic entrepreneur can take a leave of absence and return to the university should the SME fail. The EU needs to encourage the attractiveness of European ICT industry and research so that the best people do not leave, and work to attract talents from the rest of the world. The EU now has an opportunity with a more liberal

visa regime than the US and with excellent universities and the world's best quality of life. Given the current difficult situation in many member states, the importance of the EU as a driving force has become more critical than in the past.

[Do SMEs have a single voice?]

Listen to SMEs. In practice, the European Commission listens mostly to large companies and not to smaller organisations such as SMEs. But innovation happens primarily in SMEs and university-related research laboratories. More people are employed in SMEs than in large companies and many new SMEs start each year. Startups are created primarily by universities and research laboratories associated with universities. European SMEs such as Rovio (makers of Angry Birds) and Basho (makers of the popular Riak cloud database) are truly innovative. University laboratories such as the Scala Group at EPFL in Switzerland and the startup TypeSafe recently created by them are truly innovative. The Horizon 2020 programme plans for a stronger participation by SMEs; this should be implemented to cover ICT support from end to end, including in the decision-making process.

Support higher and K-12 ICT education. Given the massive shortage of qualified people in ICT (900000 ICT European jobs vacant in 2015 according to the Grand Coalition), there is a continuing suspicion from industry that university programmes are not aligned with industry needs. The reality is quite different: all university graduates in informatics and related disciplines are immediately hired (in fact, many sign contracts before graduation). The shortage is not due to the irrelevance of university programmes in ICT, but it is structural: enrolment in ICT areas is not increasing and universities do not have the resources to produce more graduates. National governments are not investing in ICT education. Some private investors are taking the matter in hand, e.g., Xavier Niel, the founder of Free, France's second-largest ISP, is personally financing the 'École 42' university-level school for educating software developers. But this is a European problem that needs to be addressed at the European level, not at the national level or private level. Both higher education and K-12 must be addressed, since informatics is not a subject that comes into being solely at the university level. Its success at the university level also depends on the right preparation at the K-12 level (including digital literacy and informatics as an independent scientific subject).

Administrative proposals

Don't try to get more for less. European funding agencies try to maximise the number of goals they achieve while minimising the amount of funding used to achieve them. In addition to research, ICT project funding also works towards many other goals such as European integration (three-country rule), promotion of European initiatives, internationalization (partners outside of Europe), collaboration with industry, and reliance on complementary (e.g., national) funding. Unfortunately, this large number of goals is not combined with effective funding support. For example, the Erasmus Mundus doctoral programme funds three-year fellowships to candidates for getting a Ph.D. degree. This time period is insufficient: four years are a bare minimum, and the ideal duration is five or six years. As a result, university researchers must spend significant time and effort searching complementary funding, which is all time lost for doing the research itself. If the right duration is funded, many advantages are gained. Researchers can afford to take risks and make mistakes in order to achieve an excellent result. Researchers can afford to build high-quality software that is close to being marketable, instead of a weak prototype that is barely good enough for use in publications. Research groups can increase overlap between doctoral student generations, thus facilitating knowledge transfer from current students to future students, which ensures

continuity and quality in the long term. The EU must resist the tendency to try to get more for less, which is counterproductive. It should instead concentrate on a smaller number of research-oriented goals and fund them sufficiently to achieve success without needing complementary funding. If they subsequently do achieve success, many of the other goals will follow naturally.

Reduce focus on management. European project funding is well-known for its high administrative load. In ICT research funding, a project proposal is evaluated just as much on Management (one third) as on Scientific and Technological Excellence (one third) and Impact (one third). The focus on management is supposed to (among other things) reduce the risk of project failure and ensure that European money is not wasted. But the avoidance of waste can be done with much less administrative overhead than is done today, and some degree of risk-taking is essential (see above). The focus on management has created a generation of bureaucratic scientists whose main talent is project proposal writing and administration, and not innovative science. We conclude that the EU should reduce the managerial requirements for projects. The main goals should be scientific results and impact. Management should be subservient to these main goals. Management should be judged by an accept/fail criterium: either it is good enough or it is not, and the bar should be set low.

Follow the successes. Enclaves of success exist in Europe, where innovation and risk taking flourish. We have mentioned the FET Flagships and ERC. Other prominent examples are the research and industrial community around Ericsson and KTH in Kista, Sweden, which is often compared to Silicon Valley, and the successful European Institutes of Technology (EIT), in which the researchers and entrepreneurs themselves manage project funding by encouraging innovation and accepting risk. Both the Kista community and the EITs have been highly successful in encouraging risk taking and innovation. The EU should study these examples carefully and incorporate successful ideas into its own programmes.

Prepare for the long term. Many of the most critical problems mentioned in this document cannot be solved by short-term actions alone. They require in addition a change in mindset that can only be obtained through continual effort over many years. Changing a mindset cannot be done in one year or in five years. It requires a generation. Unfortunately, the EU is driven by short-term goals (five-year plans, political election cycles) and it is hard to focus on the long term. Yet, some long-term focus must be engineered into the system.

Related documents

Informatics education: Europe cannot afford to miss the boat. Report of the joint Informatics Europe & ACM Europe Working Group on Informatics Education. Feb. 2013.

Shaping the Digital Future of Europe. Report of the European Forum for Information and Communication Science and Technology (www.eficst.eu). Feb. 2013.

The Missing KET: Toward a Strategic Agenda for Software Technologies in Europe. ISTAG Report on 2020 Key Software Technologies.

A Digital Agenda for Europe. European Commission, Aug. 2010.

Grand Coalition for Digital Jobs. European Commission, March 2013.

Horizon 2020: The EU Framework Programme for Research and Innovation 2014-2020.