IT Education and Business Trends

A proposal for direction in IT education

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Introduction

Over the last decades, the IT professionals have benefited from a relative stability in job employment and career progression. In fact, the information management needs of companies have often been answered by the development of "custom made" specific software solutions. These needs were generally perceived as unique and many companies felt their own IT solution to be superior to that of their competitors[1]. This served as a justification to the ever increasing cost of IT.

However, as the software industry matured and cost concerns increased, the situation changed dramatically. Hence, the IT sector is now facing the challenges of a profound mutation due to three main factors:

1. The increasing pressure on IT costs and IT ROI leading to a redefinition of the role of IT in the enterprise[2]. Nowadays, IT is perceived as a production factor and should therefore provide a measurable added value to the enterprise. This is often summarized by the term "IT alignment with the business". [3]
2. The globalization of IT sourcing for software, infrastructure and services allowing enterprises to look for the best quality/cost ratio. In fact, a large amount of the medium to large size companies is shifting their sourcing strategy to a global model. They seek the best quality/price ratio on a world scale[4]. Then, low wage countries are in direct competition with the western world for the development of software. Moreover the average quality of software from offshore outsourcers is often claimed to be better than what we could get from western developers[5,6].
3. The steady rise of adoption of packaged solutions and component-assembled solutions (often called packaged composite applications[7]) by enterprises.

These challenges should not be considered as an epiphenomenon. It is a solid trend that is a consequence of a maturing IT industry. In fact, as a given sector of the industry moves from the craftsmanship age to the industrialization age, one first sees the emergence of standards, standard components and processes inside factories. These let companies organize mass-production of goods. Then, as the products become more sophisticated, the industry structures itself as a network of subcontractors where some companies specialize in components and semi-finished goods and where others assemble these elements into finished products. But this specialization often leads to higher levels of machine usage. Gradually, the basic steps of production are realized by machines, not by workers anymore.

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[1] Harwick T. – Three Half-Truths About Custom Applications, Forrester Research Inc, 27.11.2002.
[2] Gliedman C. - Business Eyes Are Watching You: Mastering Real Business Metrics. GigaWorld IT Forum Europe, Forrester Research Inc, June 7-9 2004, Barcelona.
[3] Wohlwend F. - Ten management principles to align your IT with the Business. CIO speech, GigaWorld IT Forum Europe, Forrester Research Inc, June 7-9 2004, Barcelona.
[4] "The shift to a global delivery model is fundamentally altering the IT Services industry". Moore S. - Outsourcing Or Dinosourcing: Global Diversity Transforms The IT Services Industry. GigaWorld IT Forum Europe, Forrester Research Inc, June 7-9 2004, Barcelona.
[5] Etwareea R. – Le Sud offre au Nord des millions de cerveaux, Le Temps, Geneva, 25 Feb. 2003.
[6] Moore S. - The Going Global Tool Kit: Advanced Topics In Offshore Outsourcing. GigaWorld IT Forum Europe, Forrester Research Inc, June 7-9 2004, Barcelona.
[7] Kinikin E., Ramos L. - Packaged Composite Applications Emerge - Slowly. January 22, 2004, Forrester Research Inc.

This enables countries with high wages to remain competitive on the market because the wages then only account for a small part of the production cost.

Today, we see the software industry moving to the equivalent of chain production done by highly educated workers. The problem is that the cost of intellectual capital could be an order of magnitude different between developing and developed countries. If software was like the other industrial sectors, we could hope that the next step of industrialization, the machine production of components or goods, will happen to "save" jobs in developed countries. However this is not likely to take place soon. So far the machine production of software has, to a large extent, been a failure[8]. The investment in equipments and machines which is the sign of higher stages of industrial production is then mainly replaced by an investment in intellectual capital, and this is more and more done offshore[9].

Many authors thought, some years ago, that software would follow the same path as other industrial sectors by the provision of fine grained general purpose components to be assembled to build the applications. Some even used the metaphor of Software Integrated Circuits[10] to speak about these forecasted trends. However, as of today, no fine grained component market has really developed. Again, because software development will stay as a people intensive industry, the industrialization movement took another path: the use of low wages and highly educated people in developing countries. Simultaneously, an industry of large grain components (component assembled solution) is emerging to solve standard information management tasks in the enterprise.

Nowadays, it is common to say that an enterprise must be agile and able to adapt quickly to changes in its targeted markets. *Although the time scale is rather different, there is no reason why technical universities should not do the same*. Of course, the academic world should not seek the latest fashion in industry nor follow the short terms training needs of companies. But it has the mission to train people so that they could find a good and rewarding job. It should then be aware of the big trends of the market and react accordingly. But a recent Forrester report noted that the European academic world does not seem to be quick to adapt to the trends, leading to a foreseeable IT skill deficit[11].

Consequences for IT education in the developed countries

Due to the fact that:

1. The intellectual resources will, for a foreseeable future, stay much cheaper in the developing countries[12];
2. The pressure on costs will continue to ask for optimum quality/cost ratio;
3. A substantial part of an enterprise information system can nowadays be built from packages or from the assembly of high level components[13];

one must think about the way the IT people should be educated in developed countries[14].

[8] The closest equivalent in the software industry to machine production is case tools. This approach globally failed in the past. See for example: Barnett L. and Zetie C. - The Return of CASE: Old Wine in New Bottles? - Planning Assumption, Forrester Research Inc, February 13, 2002

[9] For an account of the offshore situation in Europe, see: Mendez M.A. - Europe's Offshore Outsourcing Plans. Forrester Research Inc., June 21, 2004.

[10] Cox B. - Object-oriented programming: An evolutionary approach. Addison-Wesley, 1986.

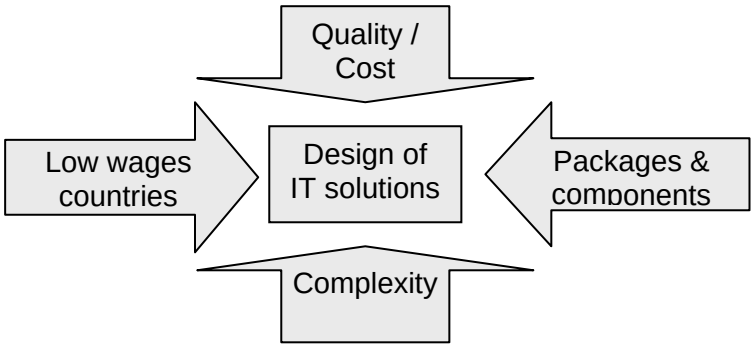
[11] Richard Peynot - Europe's Looming IT Skills Deficit. Forrester Research Inc, July 6, 2005.

[12] There are some signs, however, that wages will increase in some of the traditional outsourcing locations such as India. See for example: Moore S. - IT Trends 2004: Offshore Outsourcing. Forrester Research Inc, December 17, 2003

[13] For an introduction to component-based software engineering, see: Wallnau K.C., Hissan S.A., Seacord R.C. – Building Systems from Commercial Components. Addison-Wesley, 2002.

[14] For an account (in France) of the current needs in IT jobs, see : "Les formations les plus demandées en 2003", 01 Informatique N° 1759, March 5 2004, and for the future change in IT jobs needs see: "35 métiers à la loupe", 01 Informatique N° 1760, March 12 2004.

Moreover, there is another challenge to be faced by IT professionals today which is barely formally addressed in university training programs. It is the ever increasing complexity of the information systems. But this is to be taken seriously when we realize that many IT systems are mission critical for the enterprise. In short, we could graphically represent the forces as:



Then we claim that four elements will shape the responsibility of the next generation IT professionals in the developed countries:

1. Complexity of the information system.
2. Security of information.
3. Quality of information.
4. Alignment of the information systems with the business.

We think that the related functions will stay within the enterprise because they are tied to the very survival of the information-intensive enterprise. Whatever the source for software (standardized components, packages, outsourced development, in-sourced development, internal development) these elements must be kept under control because they are key to the performance and agility of the enterprise. In other industrial sectors where outsourcing is common, the importance of keeping the processes, and especially knowledge, under control has been largely explained[15]. To keep such a control, the IT professional will also need a good understanding of the following other topics:

- System architecting.[16]
- Businesses process and value added processes linked to IT.
- Project management & software development process.
- Contracts and SLA negotiation.

In situations where IT is key to the business, no CEO could afford an information system which does not provide the requested information, which is not under control, which is not secured and faultless and that could not evolve as fast as the business. However, cost control is always present and these qualities must be realized at optimum costs. Therefore, the IT professional will increasingly be required to provide an optimum IT solution in terms of the quality/cost and functionalities/cost ratios rather than actually developing the whole

[15] Becker M.C. – Zirpoli F. - Outsourcing and competence hollowing out: System integrator vs. knowledge integrator? Conf. On Organizing Processes of Building and Leveraging Knowledge, Copenhagen Business School, Nov 1-2, 2002. http://web.cbs.dk/departments/int/link2002/Link_Knowledge1.htm

[16] The term "Architecting" meaning : the action of creating an architecture, is borrowed from the famous book of E. Rechtin: System Architecting - Creating and Building Complex Systems. Prentice Hall 1990.

application[17]. On the other hand, the need for the IT professional to be closer to the business has also recently been highlighted by Gartner[18].

In brief, we are convinced that a large part of the IT professionals will rather soon see a shift in their responsibilities. They will be much less involved with code development but more and more with the "orchestration" and coordination of the building of IT solutions for the enterprise. In short we foresee the emergence of the "*Information System Solution Architect*" whose main responsibility will be to provide the best cost effective solution to an information system need, always keeping in mind the business perspective.

Today the academic world, globally, keeps training IT people as if they were expected to develop all the enterprise software themselves. Although some of the graduates will indeed develop software in software companies, a fair number of them will be employed by non-software companies. We should then think about the kind of training we should provide them to ensure their employability and career development.

A useful analogy: the civil architect

In most of the mature engineering domains, a fair part of the people is not involved with the actual production of the goods but with the design of solutions. Often, a company in such a domain does not produce everything from the smallest parts to the whole, but assembles a set of parts together with its home-built elements to create the finished product. Then, the responsibility of the engineers is to design the product, or architect it, in accordance with its intended properties that are linked to the targeted market segment, hence the business. However the analogy has a limit because such industrial domains often address the mass production of goods, which is often not the case for software[19]. But there is an industrial domain whose production process has a closer analogy to software. It is the industry of building individual houses. There, the architect designs customized solutions from standard components (doors, windows, plumbing …) and specific developments (walls). In this field, the management of complexity and the management of subcontractors and suppliers is key to the success of projects and has given birth to a specific training: the civil architect (CA).

Basically, the CA must ensure that the needs of his customer are well reflected in his design, that the building will have the required qualities and that the costs and planning are under control. Then, the available options for design are explored involving custom-built components, standard industrial ones plus a fair amount of on-site development. It is the responsibility of the CA to design the solution, to "orchestrate" all the involved parties, to establish a contract with them and to provide the optimal quality/functions for the agreed budget. Consequently, the CA must have a deep knowledge of what components are available on the market, what components could be built on demand by a sub-contractor, what could be built "on-site" as well as the techniques, cost and delays involved. Finally he must be able to assess the quality of the components provided by suppliers and subcontractors and the ways to assemble them with other components. This is, of course, a job in itself.

[17] The shift in training needs of the IT professional from pure computer science to a mix of computer science, management and business skills is also emphasized by Linda Cohen from the Gartner Group, cited in : Frauenheim E., Yamamoto M. – Reform, not rhetoric, needed to keep jobs on US soil. CNET Networks Inc, May 4 2004, www.news.com.
[18] "According to the market researcher, businesses will increasingly look to employ "IT versatilists," employees who not only specialize in IT but who demonstrate business smarts by handling multidisciplinary assignments"- news.com , Nov 29, 2005. news.com.com/Gartner+sees+less+demand+for+IT+specialists/2100-1014_3-5974796.html
[19] Here we speak about enterprise-specific software, not office suites, database management systems or operating systems which could be thought to be the equivalent in software of mass produced goods.

Although software seems to bear many similarities with the building industry, it is hard to find such a software solution architect job in enterprises today, even harder to learn it in universities. Although text books on related sub topics begin to be available[20], it is difficult to find a complete curriculum for a Information System Solution Architect who will have both the business perspective and the IT perspective in mind when designing solutions. This is the essence of our proposal.

It must however be noted that, recently, Forrester documented a new function in the enterprise: "Enterprise Architecture (EA)[21]". This could be seen as an answer to control the ever-increasing complexity of the business processes and the associated information systems in the enterprise. In short, the Enterprise Architect is a central function that keeps control of the structure of the business part and the IT part of the enterprise. However, as said in the Forrester articles, there are many definitions of the term "Enterprise Architecture" in the industry. Although our idea of Information System Solution Architect is rather close to some definition of EA, we would like to emphasize that it is dedicated to the actual supply of cost effective solutions to the information needs of the business.

Training the Information System Solution Architect

First of all, it is important to realize that the Information System Solution Architect (ISSA) will need a good understanding of the basic techniques and tools of IT. But the objective of this training will be more to control and assess the quality of supplied components and code than to actually code them. Moreover, this basic training should also include an in-depth presentation of the standards and tools for systems and components interconnection.

Beyond that, we think that the ISSA will need an advanced training in six main topics:

1. Systems architecting.
2. Formal development processes and project management.
3. Security of information and information systems.
4. Quality procedures and quality control.
5. Business analysis and value-adding of information in business.
6. Contract management and vendor/supplier management.

1. System architecting

The key chapters could be:

a. Business processes modeling and design
b. Software modeling and design
c. Data modeling and design
d. Infrastructure modeling and design
e. Architecture assessment and evaluation.

This will let the ISSA create models to let him design and think about the architecture of solutions in the context of the enterprise and its legacy systems. Then, the solutions could be evaluated and the alternatives explored. Moreover, the model of the enterprise will help the architect to keep control over the complexity of the system as a whole. Then the ISSA should be able to design the business process architecture and understand the impact of alternatives on the information system needed to support it. He must also be able to design

[20] One of the first text book on software architecture was published in 1996: Shaw M. Garlan D. - Software Architecture, Perspective on an Emerging Discipline. Addison-Wesley, 1996. Today, one of the classical textbook on software architecture is Bass L., Clements ., Kazman R. – Software Architecture in Practice, 2nd ed.. Addison-Wesley, 2003. A step in component-based solution is given by Wallnau K.C., Hissan S.A., Seacord R.C. – Building Systems from Commercial Components. Addison-Wesley, 2002. However none of these books deal much with the economics of the design of IT solutions for the enterprise.

[21] Heffner R. – The Pillars of enterprise Architecture Terminology. Forrester Research Inc, Nov 11, 2002.

the software architecture with all the needed components whatever the level of detail, to specify/model interfaces between components and to design the data architecture. Finally he should be able to understand the infrastructure and the impact on infrastructure topologies on system performance and reliability.

2. Formal development processes and project management

The chapters could be:

a. Systems and software specification techniques and validation techniques.
b. Formal development process methodology.
c. Project management based on the deliverables and milestones identified by the development process.
d. Project effort evaluation and software development metrics.

This will let the architect negotiate milestones based on deliverables with internal developers as well as suppliers and outsourcers. This will also let the architect follow the work progress of suppliers/outsourcers and be ready to react in case of trouble. In fact, good project management has been identified by Forrester as one of the key success factor for outsourcing[22]. An important aspect is the measurement methodology and project status assessment. This is why a strong emphasis should be put on metrics.

3. Security of information and information systems

The chapters could be:

a. Assessment of business critical information in enterprise.
b. Threats to the security of information.
c. Threats to the security of the information system.
d. Tools and techniques to assess the security of information and information systems.
e. Ways to fight security threats.
f. Security audits.

As information is key to the business success of an enterprise, information quality and access should be carefully controlled. We do not think this function will be subcontracted because information is often a differentiator on the market[23]. Hence a company should keep close control over the security of its information system. This training will allow the ISSA to assess the threats to the information system of the enterprise and to design the optimal security system in accordance with the importance of information to the business.

4. Quality procedures and quality control

The chapters could be:

a. How to define quality in information systems and software.
b. Quality attributes for Information Systems.
c. Quality standards and quality metrics.
d. Ways to assess the quality of software and information systems.
e. Software and system testing strategies.
f. Organizing quality control teams in companies.

The more the system is subcontracted / outsourced, the more control over the delivered products is required. In fact, the quality of a whole system is less that the quality of its lowest quality component. This is why quality control should be put in place whenever some product is bought instead of built in-house. Of course, in-house developed components should also

[22] Moore S. - Critical Success Factors for Offshore Outsourcing, Forrester Research Inc, Dec. 12, 2002
[23] Giera J. - Organizational Design in Outsourcing — Which Functions Should Companies Never Outsource? Forrester Research Inc. Feb. 13, 2002

be checked for quality, but if the developers are in the company, then problems could be solved readily. This is much less the case with products developed abroad. Hence, the ISSA should understand what quality means for software and information systems. Then he should understand the strategies to test software and information systems and to assess their quality. Finally he should know how to organize a testing and quality control team in an enterprise.

5. Business analysis and value-adding of information in business

The chapters could be:

a. Business functions and value of information.
b. Business intelligence and market intelligence.
c. Way to assess the value of IT to the business, relevant metrics.
d. How to increase business value with information.
e. Business risk assessment of IT projects.
f. Information mining and decision support systems.

These topics will actually analyze why and how information could bring value to the business. Then the techniques to add value with information will be explored. First, we should explore how information could actually be gathered from the multiple information sources on the market, primarily, but not only, through Internet. Then we should explore the tools that would help in managing information to add value to the business. This could range from simple information dashboards to more sophisticated data mining and decision support systems using inference engines. Finally we should explore the ways to quantitatively measure the real value brought by IT to the business, after the systems are deployed[24].

6. Contract management and vendor/supplier management

The chapters could be:

a. What is an outsourcing contracts and a SLA
b. Regulation and constraints on such contracts
c. What to put in such a contract
d. How to assess and measure the fulfillment of contracts
e. What to do in case of failure

Obviously, as the ISSA will deal more and more with suppliers and outsourcers, he must have a good understanding of the way to secure the work that should be done and the way to assess the quality of what's provided.

Conclusion

The mission of a university of applied sciences such as ours is to provide the right training to the engineers according to the trends of the job market and industry. We strongly believe that the IT industry is moving quickly to an industrial era lead by standards, functional components and packages and the equivalent of chain production. Although in other industrial sectors the chain production has been replaced by machines giving the developed world a chance to compete this, currently, does not seem to be possible in software. It is therefore necessary for the developed countries' IT professionals to move up the value chain to get closer to the business. The next generation of IT people have been called the Information System Solution Architects. This is to emphasize the idea that they should be closely involved with the business and provide the best cost effective solution to an information system need.

[24] As written by Duncan Ellis from Forrester, if the value adding of information to the business is often used to justify IT investments, only one third of the surveyed decision makers claim to actually measure the real value brought by IT after the systems are deployed. Source: Ellis D. – Maximizing the Business Impact of New IT Investments. Forrester Research Inc., may 2004.

As architects, they should be able to design the structure of the solution based on the available components and suppliers, to assess the relative value of alternatives, and to "orchestrate" the construction of the solution. Our vision is that of the civil architect designing an individual house based on a detailed account of the specification and orchestrating the work of all suppliers and workers to provide the best solution to fit the budget and the schedule.