Creating an Embedded Systems Program from Scratch: Nine years of experience at ALaRI

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Creating an Embedded Systems Program from Scratch: challenges and opportunities

Some history:

- July 1999: Workshop at the University of Lugano* on the challenges of Embedded Systems Education, involving a small number of experts from Academia and Industry.

The core point:

- Industry required a new professional figure, whose profile did not quite fit the ones offered at the time in Engineering or Computer Science schools

* Università della Svizzera Italiana – USI

Creating an Embedded Systems Program from Scratch: the first guidelines

Some characteristics of that profile:

- Education should be strongly cross-disciplinary in the ICT area – not strongly microelectronics-oriented, rather providing competences in hardware and software design, as well as in telecommunications and digital control, finally touching on some relevant application aspects;
- *system-level* aspects rather than specifically technological aspects should be favored;

Creating an Embedded Systems Program from Scratch: the first guidelines

Some characteristics of that profile (cont.):

- A project-oriented approach should be favored, both at individual course level and at Master project level;
- Collaboration between academia and the industry is fundamental (be it through presence in the Faculty or in students' tutoring);
- Soft skills should find space in the teaching schedule – presentation skills ought to be developed;
- Teaching and research activities should be jointly developed…

Creating an Embedded Systems Program from Scratch: the first guidelines

And some “provocative” suggestion:

- Create the program based on the educational profile, not on local expertise or even excellence, and then
- Call lecturers for their “best fit” to the profile and internationally recognized competence, not for their local availability!

At the time, USI did not offer a degree either in Computer Science or in Computer Engineering!

Creating an Embedded Systems Program from Scratch: the start

- No *resident* faculty member: lecturers “commute” from home institutions (some within one hour’s train ride - some from as far as the West Coast of the United States).
- Courses: mostly structured around intensive “lecture modules” lasting about one week, possibly preceded by introductory tutoring and followed by practice and exercise time
- Evaluation often project-based

Schedule may be very demanding on students, but it never led to protest and actually provides good results both from the faculty’s point of view and from the students’ one.

Creating an Embedded Systems Program from Scratch: the experience

A cross-cultural approach starting with people's cultures…

- ***Faculty members*** come from different academic environments; lecturing method, evaluation technique etc. may vary – a fact sometimes disconcerting for students!
- ***Students*** come from a number of countries all over the world – and are asked to collaborate in team work and share housing.
- After some initial adjustment problem, this actually contributes to students' flexibility and to growth in terms of personality as well as from the educational point of view. Employers found that our students' personal flexibility was particularly interesting asset.

Dealing with a “Distributed Faculty”

- The problem of “remotely” advising and mentoring students’ research projects, together with more general aspects concerning tutoring, course follow-up etc., led to conceiving and developing a particular “remote learning” environment.
- Specifications for the remote learning environment emerged from day-to-day experience:
  1. Students need to get in touch with lecturers outside the limited time of the course, possibly to discuss in depth some specific point;

Dealing with a “Distributed Faculty” (2)

2. Project advisors (often remote…) want to keep track of their students’ work, without making public the work in progress; in particular, they need to set milestones and request deliverables, check students’ progress and direct the new activities
3. Students have to make information easily available and to easily receive directions and targets;
4. Access to students’ documents (including projects’ intermediate reports) has to be made easily available to a restricted number of persons; partial visibility should be granted to suitable persons in a well-graduated way (and possibly for limited amounts of time);

Dealing with a “Distributed Faculty” (3)

5. Students need to access documents developed during previous years’ projects; privacy and protection of sensitive information has to be granted;
6. Alumni should be allowed access to their Master project’s documents, at least for a given number of years;
7. Protection of information (in particular, when covered by NDAs) has to be granted
8. Students (and alumni) should have the possibility to access each other’s “public” information easily; alumni should have easy access to ALaRI present life;
9. Finally, a “career space” should allow posting job/PhD openings and accessing selected information on students’ CVs.

Dealing with a “Distributed Faculty” (4)

- When the platform was identified and specification drafted, there were no tools that could grant a satisfactory solution ⇨ a specific infrastructure, the ALaRI Intranet, was created.
- The ALaRI Intranet today: an advanced information system, supporting virtual workspaces, with the aim of enhancing collaborative processes in the management of complex projects among social actors geographically dispersed, but belonging to the same community.(*)
- The platform is a web-based remote application accessible from the ALaRI web site, devised from the beginning to support complex, multi-direction communications.

* The platform was mainly developed within two European projects, ANTITESYS and subsequently Cooper

Project-oriented education: involving students in research

- Students are involved in actual research projects ("internal" projects, consistent with the Institute's research activities, as well as projects proposed and advised by academic and industrial partners)
- PhD students present in ALaRI, besides providing tutoring for courses (a must, given the particular course schedule!), collaborate on Master projects: they provide a sense of "continuity" that could otherwise be lacking.
- For internal projects, students become part of larger teams (mentored by PhD students) and are encouraged to be "creative" rather than simple executors (this has led students to become co-authors of publications or in a few instances of patents filed)

Just Design and Research?

- In 1999, it appeared that large multinationals would be the most probable employers… offering positions in design or R&D division;
- A different world today – SMEs offer the clearest positive hiring trend, start-ups are a growing reality, and even in "traditional" large companies diversified profiles are sought,
- The conclusion: a purely *technical* study track may not be any more the optimal choice - training in basics of economics would often be very well received, or actually requested, both by perspective employers and by student.
- 2004: Faculty of Informatics at USI

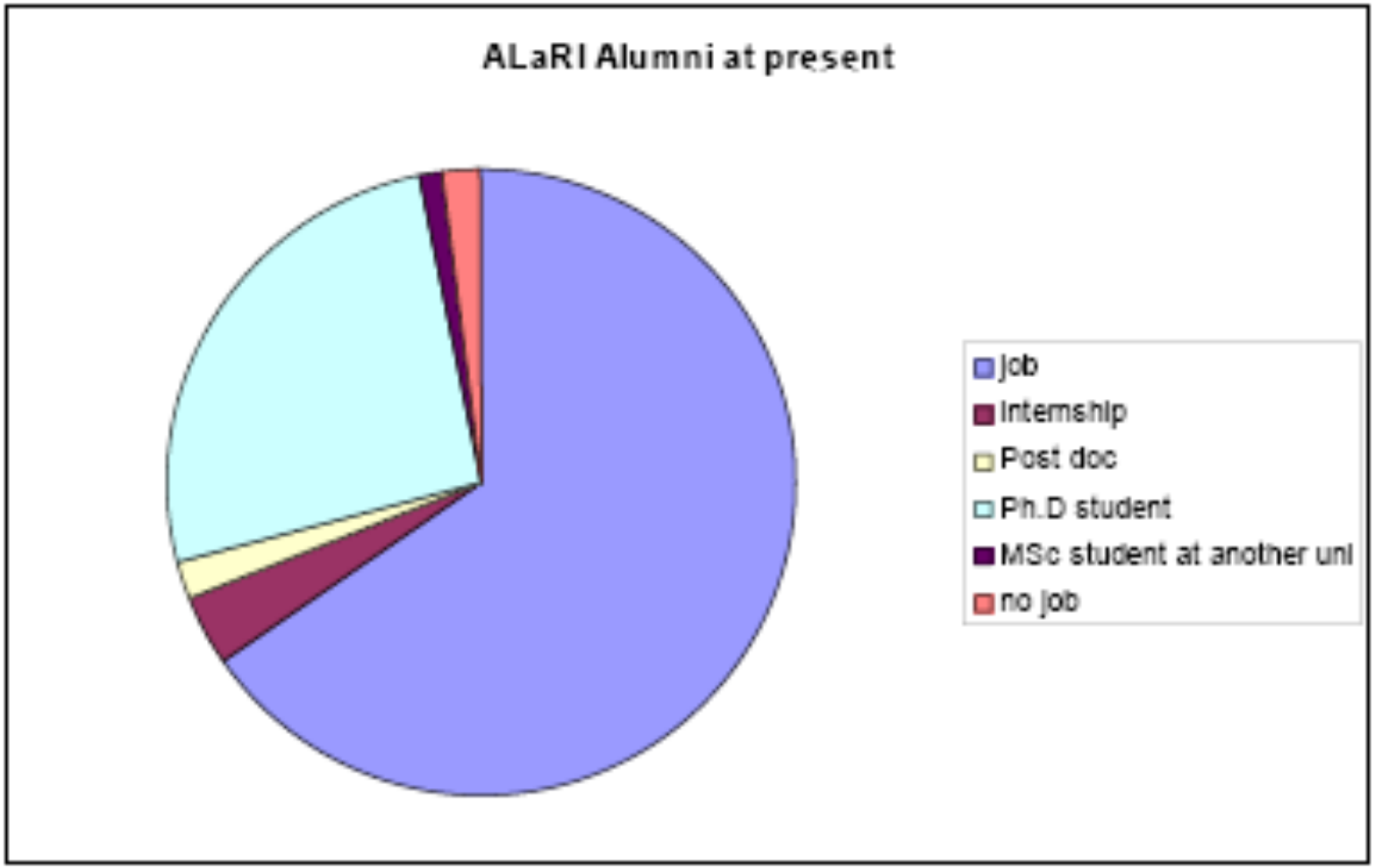
Just Design and Research?

- Second-year MSc students are offered two parallel tracks, differing by about credits (ECTS):
  - A traditional Design and R&D track
  - a “business oriented” track, offering courses such as “Introduction to management”, “Marketing and Purchasing”, “Finance and Managerial accounting”, “Strategy, Organization and General Management”.
- Business track extends to the Master project; students are still requested to develop a *technical* project, whose results must be analyzed from the business point of view, up to outlining the Business Plan for an ideal start-up based on the technical.

LOOKING BACK: HOW DID THE GRADUATES FARE?

- In the first eight years of the ALaRI initiative in Embedded Systems Education (the ninth just closed...) the economic situation was fairly "mixed"…
  - Microelectronics and informatics were peaking in 2000, and the various "bubbles" started exploding ⇨ no excessively favorable bias for our students''
  - Still, our graduates found very good acceptance (most had achieved placement even before getting their degree…)

LOOKING BACK: HOW DID THE GRADUATES FARE?



Where do we go from here?

- Nine years are a long time for an experimental course;
- Main challenge now: keep up with evolution, and grant that the “dynamic education” request discussed during the founding Workshop is taken care of.
- Technological developments in the ICT area are radically changing systems characteristics – e.g., chip multiprocessors are today a reality dealt with in a large number of embedded systems.
- Pervasive systems are really pervading every day’s life, and wireless networking is becoming dominant.
- Individual courses easily follow the dynamics of the respective areas, inter-course relationships are not so immediately reassessed!

Where do we go from here?

- Further, embedded systems applications sre expanding; reality has exceeded forecasts made in the year 1999 –thanks also to the synergy between different technologies and the collaboration between experts in different scientific areas:
  - Health, environment protection, energy management, are emerging with increasing relevance and present new challenges and opportunities.
  - Increasingly, embedded systems will be *networked* possibly in very large, very complex networks.

Nano-Tera: the COMES Doctoral School

- Swiss federal program Nano-Tera (since 2008) funds research for “engineering complex systems for health, security and the environment”.
- Nano-Tera includes Educational project: ALaRI has launched a Doctoral School – COMES, “Complexity Management in Embedded Systems Design”
  - to be held in Lugano on November 16-20;
  - openings for non-Swiss PhD students as well:
  - further information at http://www.alari.ch/comes/index.html

Just design and research?

ACKNOWLEDGMENTS:

Our thanks are due to the whole ALaRI Faculty, which has made the initiative possible and keeps supporting it with great enthusiasm, and to the ALaRI staff, which keeps the whole complex system going!

Questions?

Thank you for your attention

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