A community sharing hands-on centers in engineer's training

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***Abstract*—As teachers in Technical Universities, we must think about the engineer's training. We need good applicants, up to date hardware and software for hand-on. Each university don't have enough money and technical people to cover the new needs. A community sharing remote hand-on centers could be a solution.**

***Index Terms*—engineer's training, client/server, LabVIEW, Java, remote hand-on, shared centers, solution skeletons, TCP/IP**

I. THE SITUATION AT PRESENT

One of the top French engineering universities, INSA Lyon (Institut National des Sciences Appliquées de Lyon), multidisciplinary and international, is at the heart of the European Higher Education Area. Eurinsa is the 2 first years of the studies in INSA for European students, 120 students a year are entering from 20 different European nationalities.

As university professors in charge of the training of engineers we have to ask ourselves what and how we are going to teach in the future world. We must see:

In France, according to a study in 2002, the lack of engineers was around 2000, in the (15-member) European Union it was 25 000.

For training engineers we need applicants highly educated in science and motivated for this job. But for several years now we can see, especially in Europe, a disinterest in engineering studies. Why is it so?

First, finding students who want to become engineers.

In France, in Germany, for example, the number of applicants is decreasing to the point where the number of applicants is less than the number of available places.

We have the choice to continue to fight between us to have the best students in our institution or to find the solution to increase globally the number of applicants from our countries in engineering studies. There are a lot of applicants in the world, but we need also local applicants.

Why don't we have enough good applicants?

The disinterest of young people in science has different reasons:

The social status of an engineer is not prestigious enough, why volunteer for more difficult studies to obtain a social status with a lower image than that of lawyers or managers?

The image of sciences is devalued; the idea of progress is not anymore connected with science. The idea of science is more associated with the atomic bomb than with the knowledge of matter. People do not believe in the capacity of sciences to solve the problems of our world.

We seem to be walking in the blind alley of the life style generated by the discoveries of the last century.

The manner of teaching sciences at elementary and secondary schools should be more attractive.

To increase the number of local applicants we must also open special classes preparing the entrance to our institutions for the interested people at secondary schools especially in the direction of young people with a lower social status (affirmative action).

II. ENGINEER TRAINING

Supposing we have such students, engineering training is different from other types of academic training such as economics or law. An engineer must have the skills and the knowledge in science but he also has to be confronted with the real world. He needs practical experience. Case studies and the simulation of physical behavior are not enough, that is why more than 20% of the students' task is hands-on work and experiment.

In order to be efficient an engineer must know how to handle the latest technology. The training by people who are researchers and teachers is the right way, but we can't know the latest possibilities in all the fields that we are teaching. But we need to have up-to-date technology and equipment at our disposal; too often we use obsolete equipment because our institutions do not have enough money to keep up with the evolution. For obtaining equipment we depend on state funds or taxes paid by firms. More or less obsolete and basic equipment are present in all our institutions used for 2 months a year and then put in storage waiting for the next year. It would be better to concentrate our funds and share up-to-date equipment.

Moreover, the use of the latest equipment requires specialized skills and technicians, however, instructors cannot follow the progress. In these circumstances there is a strong temptation to continue to teach what we know, not what it is necessary. We use teaching practice in the firms to level the skills of our students, as a result our students know mainly obsolete technologies and a few of new technologies depending on what they do at the firms. This is not the good way, we must be able to follow the progress using the skills of our colleagues instead of spending our time reinventing the wheel.

Finally, we have to teach our students to work in team, preferably in an international team. The easy solution is to have students from abroad, as we have in Eurinsa Lyon (20 different European nationalities), but it is more interesting to compose a team of students from other universities in partnership working on the same problem.

The students enjoy that very much (especially if they can travel at the end of the program) but this is difficult to organize, coordination is tiring and demands skills in modern technical communication both for the teachers and students. How many projects can you have with students from different universities working on a subject given by one or two firms? In Eurinsa only one cooperation exists as an example showing that it is possible.

Local institutions, industrialists and higher education have the same issues but in a new context: globalization.

III. POSSIBLE EVOLUTION

Going round finding applicants from all over the world (which is a good way) and at the same time relocating research and development centers outside our countries, for example in India or China, will have a consequence: the de-industrialization of our countries. What will happen when after we have trained these engineers inside, they have the possibility to go back to have a good job in their country of origin where we relocated our research and development centers? At the same time, these countries will have a local market sufficient for covering the cost of innovation. The creation of value will also be transferred to these countries.

It is not my purpose to propose a protectionist system to isolate ourselves. It is wrong to entertain the hope that we can keep a technological gap between us and other countries, what would permit us to continue to propose our own solutions for solving the problems of the world: this is a blind alley. At present the European Union spends half the money than the USA does for R&D and the ratio of engineers per inhabitants is half of that of the USA. It is a suicidal tendency.

IV. CONDITIONS

In the modern world we have plenty of problems (for instance pollution, shortage of energy, water, health, etc.), we may have plenty of applicants, we have good technological solution (even if they must be improved), but what we lack is the capacity of organization and cooperation schemes.

We are in competition but maybe not at all levels and it is obvious that to be competitive, in a first step, firms do cooperate. But there must be rules of competition and the rules must be clear and respected.

Patents and licenses formulate the rules. I was wondering if I am the only one having difficulties teaching my students the idea of respecting licenses. When a group of students produce a solution using software under license, I ask them to provide the certificate of the license. In this case, many students are asking themselves if I am not gaga or senile and when I threat to penalize them by a decreased grade, they think it is time for me to retire. On our campus where there are dormitories with rooms equipped with Internet connection, after 8 p.m. bandwidth in use is multiplied by 3. I have the suspicion that the reason for the strongly increased traffic is not the exchange of solutions for academic problems. It is important to sensibly discipline our students for the respect of license if we want to cooperate with the industrialists.

V. WE MUST RESPOND TO :

Shortage of applicants with a good level and motivated for the sciences

Shortage of engineers in Europe, perhaps not only in Europe

Shortage of means in education (both human and material hardware /software)

I have no miracle solution to propose, but I would like to try to remind the basic points of debate and to propose some prospective.

Is E-learning the final solution ?

Not at all, partly because it is not enough to make only simulation for training engineers, all hands-on cannot be made by remote sensing (when the phenomena are too fast for example); one part of the training needs to be made locally, exams also. In E-learning for engineers, when it is possible, there must be remote hands-on, remote projects and remote supervision of experiment.

VI. SOME TRACKS

If you have some ideas you are welcome to make proposals and thanks in advance.

The educational systems are different in the different countries, each country must specifically change. Except the idea that science must be taught as early as possible using practice at the beginning, at the secondary schools, offering the young the possibility to access interesting experiments. In higher educational institutions up-to-date equipment and technologies must be provided. What needs to be done is far from the possibilities of the researchers and educators alone or from an institution alone but industrialists and teachers, institutions together can engage in an evolution, unfortunately too slow. Knowing that the young people like music, picture, video, game and communication, it could be interesting to offer free web sites in which the gains are obtained by resolving problems in sciences. I can already hear the questions: who is going to pay ? Is it legal ? Our institutions are not meant for entertaining people.

But we can partly open our equipment in remote control to interested people for free.

We need also human and material means.

In this case, maybe the solution is easier in principle. We can create at our institution remote hands-on centers well-equipped with qualified people and pedagogical material in different languages. These centers could be used for teaching our own students and for the rest of the time it could be open for free use by other people.

VII. SHARED CENTERS IN HANDS-ON

These centers localized at our universities equipped partly with the funds of other universities using the center and partly by donation of firms which can focus their help on well-known or famous places where they can promote their solutions.

I hear already some colleagues: “to give away our pedagogical material for free or to use pedagogical material from others ? No way. ”

But this type of organization already exists.

In Lyon different “grandes ècoles” (“big schools”) created a teaching center in automation located in INSA, offering a shared remote hands-on based on National Instruments solution, cameras, …

In each institution, students prepare their solution by using remote possibilities. Obviously, it needs more organization, coordination of the schedules, but the teachers can share pedagogical materials, in this way they build one hands-on and have access to the hands-on built by other colleagues. It is possible also to teach students of other universities (“big school”) exchanging courses, each making twice the same course. In Europe we can do the same in the framework of the Socrates program. I have already taught in data acquisition field in Budapest with my servers in Lyon. In Budapest they have enough material to do the same; it was more comfortable to use

this than building the equivalent hands-on. This is more interesting if the hands-on needs expensive equipment with specialized people to use it. This type of solution exists in CERN for different laboratories and the "Grid" is a good example of sharing calculus power.

VIII. FRAMEWORK FOR COOPERATION

We need at least an institutional framework for our cooperation. Two systems exist with a different meaning. One is the traditional contract between universities and / or firms, the second is the communities based on free software foundation under GPL (General Purpose License). Both are useful, but maybe they are not on the same level. Contrary to some generally accepted ideas, many firms are not against Open Source software. Sun, IBM,… and the scientific community that creates these software. If we, academic people, teachers, researchers and the students have no wish to participate in this community, it would be a pity. With our students we have a lot of labor capacity, we can use the projects made by our students to increase the potential of this community. Sometimes, the results are not very professional, it is normal, but sometimes the results are very good. A student (L. Torwald) made Linux. Later when the products are more specific and professional, they continue to be open source but not free of charge. The professional versions of Linux are not free of charge.

There are already such communities and a good example of sharing solutions is NI-zone in the National Instruments webSite or on our own servers. But we share only software, I think it is time to think also how we can share materials and hands-on as well. What we put on our servers is designated for our students but it is also for inciting and helping some people not specialized who want to participate in the community to use and develop shared solutions.

IX. WHAT HAVE WEDONE IN EURINSA

We have placed Linux and open source software at our students' disposal, so they do not need to crack software needed for carrying out their work. National Instruments also gave students LabVIEW (the full version) for free. Other editors made the same donation of free license. All the materials on the servers are under copyleft (using it, modify it according to your needs but not free for commercial use). If you have interesting materials, we can put it on the server or reference it. When a pedagogical tool is lacking or too expensive, we try to make our own tool under copyleft.

For example, the web server integrated in LabVIEW is not for free; we made a basic applet capable to show the results obtained in graphs. The idea is to help everyone who wants to participate in the activity of a community under construction, but maybe this is the right place and the right time to do it, we put on our server some skeletons for solution in copyleft. I will show you now these skeletons.

No revolution under the sun for this. The principle of solution are client / server architecture under TCP / IP. The skeletons are working on all different platforms (one exception: data acquisition is only under windows, we are waiting for an equivalent of drivers for NI cards under Linux).

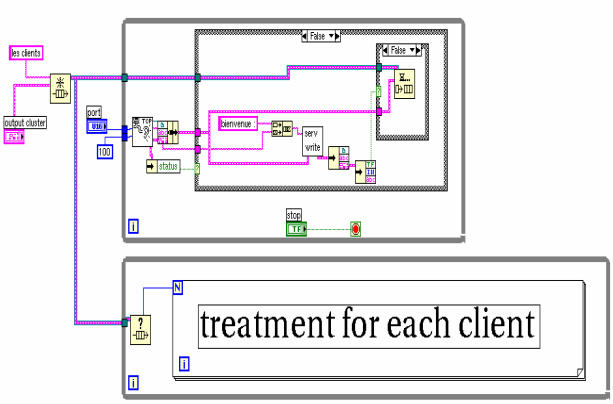
On the Server Side the program manages a queue of clients, decodes the demand, carries out the required task, when it is done, it codes the results and sends it to the client.

On the Client Side the demand is coded, waits for the results from the server, decodes the results and uses the results.

In the skeleton, you have to create the subprograms for coding and decoding information and the specific tasks in the server and client.

An other application which could be interesting is how to put a LabVIEW program under remote survey.

Before seeing the examples, I will show you the principle of managing the queue in the server (using queue vi's). I use LabVIEW because it is the most clearly manner to show it.



You can find these examples :

1-Example of Data Acquisition Server (both in LabVIEW)

2-Example of Chat with server and client (both in LabVIEW)

3-Example of simulation Server (in LabVIEW), client in Java

4-Example of Acquisition Server (in LabVIEW), client in Java

5-Example of a supervision tool using global variables

on http://eurserveur.insa-lyon.fr/ wwwEur/LesCours/tpdistance/skeletons.htm