# The Factory of the Future: A Special Training Program

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***Abstract -*** *The special training program PET (Programa Especial de Treinamento) is a national initiative applying a tutorial active learning method in undergraduate education. A group of selected students, in their second through fifth year, work together to promote and develop abilities to critically discuss and solve problems. For a solid engineering education it is important to study the global challenges toward a consumer-based world economy and its national consequences. Worldwide, the manufacture of new products and processes are rapidly changing and the engineering education process must prepare its students to learn to continually educate themselves and build knowledge within a process of ethical professional interaction. The present work relates and discusses the experience at the Chemical Engineering Department's undergraduate course at the Federal University of São Carlos (UFSCar) in the implementation of the program. The group has been promoting a lecture series about the Brazilian challenge in a world consumer-based economy with the participation of professors and engineers from companies which are promoting these challenges. New paradigm topics which focus on quality production including safety and environmental preservation were discussed. The effects of industrial automation in the chemical and biochemical processing industries has been studied in relation to its effect on employment and discussed. Visits to modern industrial installations were made in order to compare them with those based on Brazilian family owned and structured companies. To learn about Brazilian culture students promoted a video cassette section presenting Brazilian produced movies. The scientific training promoted with the University research groups focused on solving interdisciplinary research problems. At the present, to stimulate partnership between local and international industries and inter-university collaboration at the undergraduate level, a Jr. Company is being structured based in the tutorial method. New companies will serve a society demanding more and more knowledge-based structures. To construct these competencies in the New Engineer and to establish and implement the Factory of the Future it is necessary to answer the question "What is the future of the present factory?". This is not an easy problem to solve, but it permits us to put our creativity to work on the possibilities and try to find the right directions to go in.*

## Introduction

The current changes occurring in the production of goods and services due to the overpowering presence of informatics and microelectronics in all sectors of human activity has created a process of re-evaluation in engineering education. The speed of industrial computerization and automation has signaled the urgency to promote changes in the formation of engineers who will be the ones to implement these changes in the future companies now in formation which will replace the current industrial organization.

The changes in organizational productivity that we are now witnessing had their beginnings in the automobile industry. The Japanese industry created new production paradigms during the decades of the 60's and 70's which spread worldwide through the manufacturing industry. Administrative techniques focused on working in groups and the valorization of human labor to achieve quality production were based on the work of Deming [1]. In the present decade all world-class auto assembly companies have adopted flexible production schedules and decentralization in accordance with these new production paradigms to remain competitive on a worldwide scale.

On the other hand, the industries based on chemical and biochemical processing have gone through a slower process of change because as large production units with automated and continuous production they remain competitive on a worldwide scale and because they are still based on petroleum as their principal energy fuel.

The global changes directed to a socially responsible market economy for the continuity of the quality of human life on the planet and the preservation of the environment are producing the need to create new technical and human skills in young engineers.

This work describes the activities developed by the PET group at Chemical Engineering of UFSCar to characterize the educational needs of the future chemical engineers to be well- prepared to build the future of the Brazilian Chemical Industry. We consider these activities to be an experimental

laboratory for the reformulation of the curriculum and the PET group is regarded as a group whose services are focused on the improvement of the undergraduate opportunities. Currently twelve students in the second through fifth years of Chemical Engineering are participating in the group. The quality of the Chemical Engineering course is nationally recognized and is based on a solid education through establishing fundamental scientific and engineering concepts combined with an initiation in research through a project which is fully developed during the course. *Learning through doing* is PET's basic premise to develop innovation and creativity in students and make them capable problem solvers. The PET group's intention is to provide new opportunities for partnership between the university and processing industries interested in defining problems which will be solved together as a self-teaching process to develop knowledge and competencies.

Activities developed during the first two years of the program's implantation will be presented as well as an organizational proposal for establishing partnerships between the sectors involved, including proposed changes.

## Lunchtime Seminars

A series of seminars on the globalization of the Brazilian economy were presented outside the students scheduled class times. Why changes are occurring in companies in Brazil was focused on by professors from several university departments and engineers linked to various chemical processing companies. Panels on ISO 9000 and ISO 14000, ethics at work, quality control programs ,environmental administration,, interpersonal and inter group relationships in the industrial environment were presented, among others ,by professors from production engineering, social science, philosophy and psychology departments. Panels on quality programs, environmental administration, safety and programs focused on raising the competitiveness of industry were given by engineers from Nestlé, Rhodia/ Rhône-Poulenc, Copersucar, Smar and Sherwin-Williams of Brazil, among others.

The seminars permitted students to maintain contact with professors from other university departments and with engineers, generally former students who are implanting processes of change in their work environment.

## Building Knowledge About The Factory Of The Future

Topics of general interest are studied and discussed in groups. The reading of W. E. Deming's "Quality: A Revolution in Management" [1] served as the basis for concepts on change in industrial management occurring in the Occident. The proposed principles for transformation incorporate administrative attitudes in the management of companies, fundamentals for long term business performance and are therefore of interest for the creation of new production paradigms. " A Study of Competitiveness in Brazilian Industry" [2], a joint research by the Economy Institute at Unicamp and the Institute of Industrial Politics at UFRJ coordinated by L. Coutinho, and J.C. Ferraz, demonstrates the difficulties of competitiveness in the Brazilian society in comparison to societies of industrialized countries. This work shows that competitiveness is a concept which transcends the business environment and involves the actions of governments and the organization of civil society to provide viable conditions for competitiveness for domestic companies or companies operating within the country with companies headquartered in other countries. " The End of Jobs" [3] by J. Rifkin.", a work studied last semester alerts us to the role of the "third sector"-organizations which are neither governmental nor private. The current reduction of job positions, characteristic in almost all economies in the world with the exception of the U.S. economy where a positive production cycle with a low rate of unemployment exists, is developing opportunities for voluntary work in industrialized countries and pointing towards the establishment of new enterprises which are qualitatively different from current service and manufacturing industries throughout the world.

We are living in the center of a hurricane of changes directed towards a new society based on the intensive utilization of telecommunications , microcomputers, automation and robotics. The transformation process of productive units found in the manufacturing sector, as in the automobile industry, is far-advanced in comparison to other sectors. As in every transition, it is not clear how the productive system will reorganize and how current units will be transformed. There is currently room for new experiences based on a sustainable development perspective and the dissemination of a large number of small and medium size production entities incorporating high level knowledge .

The study of sustainable development paradigms will be the next step in the theoretical studies of the group.

## Initiation to Scientific Studies

Incentive has been given to interdisciplinary projects as the initiation to scientific research for students belonging to the group. Current themes in research proposals involve different research areas within the department itself as well as with groups from other University departments. Students begin the initiation work in their fourth year and have autonomy in their choice of topics and advisors.

Meetings between advisors and the group tutor are held to assure that the interdisciplinary project is compatible with the objectives for scientific initiation . Currently areas of highest interest are the

Biochemical and environmental engineering areas , followed by automation and safety research areas. These projects are in the majority restricted to the Department of Chemical Engineering. The participation and involvement of local industry has been unsuccessful. Generally the demands of industry require quick answers and short term solutions which are incompatible with requirements of scientific research currently in development at the University.

In the area of the application of University research and its absorption by the productive sector we have a long road to travel in search of efficient channels to establish effective partnerships.

## Activities to Strengthen Working In Groups

The group has held sessions on group dynamics under the supervision of a professor from the department of psychology and made possible student participation in cultural activities including musical presentations and expositions of internationally recognized painters such as Monet, through the initiative of the PET group. Aside from these activities the group holds meetings to plan activities for the semester and sponsors visits to industrial facilities in the region, comparing more modern production facilities to smaller industrial facilities with greater problems due to their lack of competitiveness. Scholarship students study English to develop their skills for international communication and have microcomputers available for the development of computer skills.

## The Knowledge Factory Proposal

The greatest difficulties in the formation of new engineers are localized in their capacity to develop knowledge to solve real problems for a market of continually changing demands. To prepare for continuing education means being able to intervene and use your initiative and creativity in the construction of a pool of knowledge in a group or company beginning at the undergraduate level. To create then, a tutored Jr. Company. with active participation from course professors. who provide services to build the knowledge the "client" needs to address the preeminent necessities in the current process of change, enables students to have contact with the real problems of companies in transformation and answer the demand of these companies for modernization. Companies interested in partnership in this work could benefit from the University's capacity in technological development and the existing creative environment, by proposing topics for research and projects which search for innovative solutions in areas of immediate and primarily medium and long term interest.

The success of this initiative depends on the establishment of a partnership between companies of large as well as medium and small size and the University group in this and similar initiatives of mutual benefit. This project may not be possible in the short term but it shows us the direction in which we can propose topics and competitive international games between university teams interested in developing the Knowledge Company that may possibly be established in the near future of the market all over the world.

## Conclusions

The PET group works for the Chemical Engineering course like a catalyst works in a chemical reaction, accelerating the necessary changes towards a more adequate approach to a engineering full education. The chemical engineer is primordial for the correct management of the industrial plant in the process sector. It is necessary, then, to educate the students to establish and implement new principles for the construction of the *"Factory of the Future"*. The tutorial methodology applied to promote the necessary changes in the engineering course is having good acceptation by students and professors all over the University. Now, we intend to establish partnerships with companies to promote a special integration experience. For industrial Brazilian culture this is a not an easy decision, but whoever is looking for strategic instruments to stay competitive in the market can become a partner in this long term project.

## References


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