

Informal Incorporation of Environmental Concepts in the Curriculum of the Student

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Abstract. *An old definition of engineering was based on the idea of "modifying nature for the benefit of mankind"....; nevertheless, the most recent history forces us to complement such definition by adding "... in a sustainable way". The sustainability criterion has been extensively added to the traditional objectives in the field of civil engineering activity, such as effectiveness, efficiency, strength, economic benefit ...*

The School of Civil Engineers of Valencia, not only offers to students the Spanish degrees in Civil Engineering (Engineer of Roads, Channels and Ports and Technical Engineer in Public Works, in its three specialties), but it is also possible to study M.Sc. in Environmental Sciences and Geology Engineer, both presented as a second cycle, where a previous university degree is required.

One of the objectives of our School is that our students, future professionals in the field, know the environmental impact of a diversity of techniques and, moreover, become fully aware of the fact that environmental variables are key issues, many times decisive ones, in their future professional tasks.

These ideas, which are really underlying in many good engineering performances in the past, are now being posed in a more explicit way, and should be presented clearly from the first stages at University. In this sense, the School should be exemplary, not only concerning the specific contents of the subjects, but also in its general performance as an Institution, by always trying to introduce in its everyday academic life what should be obvious at the professional level. Nowadays Spain is the country with the highest increase in number of Environmental Management Certificates ISO 14001, and the second in terms of Certified Organizations.

One efficient way of directing our students in efforts toward a correct perception of sustainable development is by means of explicitly introducing the basic related concepts in the daily academic life of the Institution. More precisely, we have established a Normalized Environmental Management System, according to an International Regulation, that they might be using in a near future as professionals.

Our School obtained the Certificate (Environmental Management System – ISO 14001) in December 2002, by means of a Recognized Agency, which guarantees the strict observation of the legal regulations. It is the first Academic Institution in Spain taking this step, and one of the first throughout Europe.

Some relevant aspects concerning the implementation of such a System in the School are presented herein: The implication and tasks of the various groups involved in the process, the difficulties found in adapting to the Regulation and its final Certification, and also the maintenance and operation of the System.

INTRODUCTION

The engineering activity came about from the need to innovate, which in turn comes about from the desires to increase the quality of life, productivity and from the adaptation to the environment. Nowadays, engineering calls for optimization processes for the activity in question, and it incorporates other factors of a social, economic, ecological, human resources, etc. nature to the technological factors, and this situation demands the improvement of the complexity of engineer training.

"Engineering" is defined as an "Activity of building machines and of making them work" or as a "collection of scientific knowledge and of activities determined by such knowledge that are aimed at making a better use of the resources obtained from nature". Also, the "Engineer" is defined as a "person who reflects upon something with ingenuity". We would like to add something to these definitions: "Good Engineering in the 21st century" would be, from our point of view, the activity of building good machines and making them work.....with sustainability. All in all, engineering would be the "most rational" way of creating, and as an extension, of managing and organizing a project or firm of any sort. The goodness or excellence of the activity may be made to become either convenient or necessary for social, ethical reasons, from market pressure, or simply for reasons of survival. In general terms, we can affirm that our concept of engineering is no more than the optimization – rationalization – of the use of resources.

Market competition plays a special role in the exigency of rationality in management issues, since it shall be the competition that shall either award the best engineers or penalize the worst. The market is the means through which society expresses whether it is willing to pay for its services. The market has an influence on technology, and it only allows those who most efficiently respond to social demands to survive. Therefore, most professional activities are seen to be submitted to the pressure of a market that demands raw materials, products and services all at the same time. The production, supply or administration of all of these has to be carried out with "good engineering management" criteria, and its optimum grade, that of "excellence in its quality", is the best guarantee for any project to succeed.

The *professional activity of preparing professionals* cannot remain oblivious to market pressures, but all precautions must be taken. The university is one of the institutions that must be least affected by the economic globalization process and by culture, since at least in theory, even its name is already committed it to universalism since the time its activities started.

Present-day universities, whether they are public or private, are not oblivious to the rationalization demands regarding the use of resources, and excellence is what is immediately demanded; society wants to know as soon as possible the quality of the

university they go to as a student, of the university they send their children to be educated at, or to which they entrust and finance their investigation projects.

THE BACKGROUND OF “ENVIRONMENTAL MANAGEMENT”

The evolution of the paradigms

A virtually similar evolution has been produced within the environmental management policy adopted by most of the administrations of countries with a greater level of development, these being the USA and Europe. Natural environmental organization was concentrated on regulating the directly polluting activities, such as atmospheric pollution, particularly that caused by urban traffic and industry. This was especially the case when such organization started.

It could be said that over recent decades the evolution of the “environmental policies” has almost universally followed the guidelines marked by certain simple models or “paradigms“.

The first environmental protective regulations were of an almost exclusive punitive nature, rather than a correcting nature, and they matched the principle “**Whoever pollutes, shall pay**”. The idea was to attempt to dissuade the possible offender by penalizing the polluting contaminants or spillages. Nonetheless, shortly after this was applied, it was discovered that the effectiveness that this particular form of protection had, that of merely penalizing, was not sufficient. Thus, whoever polluted was perhaps discovered, and in this case, they were reported (but this did not always happen), which gave rise to a process that permitted that whoever polluted would be sentenced (although their acquittal was possible)... etc. In the end, the probability of repairing the damage was possible, but difficult, and worse still, that it proved more difficult to restore the environmental damaged caused.

The second paradigm is based on the saying “**prevention is better than cure**”. A regulation that respected the punitive rules came about that demands of those projects which promote the introduction of those activities that, rather than possibly harming the natural environment, they are only recognized when they are preceded by an *EIA (Environmental Impact Assessment)*. This EIA is a procedure that analyzes the project, as it assesses its effects and also proposes modifications and precautions to be made in order to minimize the damages of its activity or work. Here the effectiveness of the EIA methodology may also be criticized as corrupting the system objectives is also possible when the same firm that is interested in promoting the work is being analyzed, also finances the analysis involved. This argument may continue as there is a possibility that an elimination process may lead to the least damaging solution from among all the possible solutions rather than to the most harmless solution among only those arbitrarily proposed, etc.

The third paradigm is less easily expressed. At the same time it could be expressed as that of having “**sustainability**” (UN 1992) as an objective, and of having to “**distribute responsibilities among all the agents involved**” as a means of action. The regulations that materialize it are diverse. The most significant correspond to: EcoManagement (a rational or sustainable environmental way of administrating firms); EcoLabel (the consumers may pressurize through the choice of products they purchase); and Information, both participation and promotion are the greatest commitments (committed to the Civil Society).

EcoManagement and EcoAuditing (Through Competition to Efficiency)

The V project of action in Environmental matters of the European Union establishes the overall objectives to orientate its policy towards sustainable development. As already mentioned, over the last decade the environmental “paradigms” evolution managed to establish sustainable development as an objective, and also commitments to “increase information and communication” and to “a greater participation of the groups involved”, as well as to resorting to market mechanisms.

The Guideline on the Right to Information on Environmental Matters constitutes a revolutionary instrument that has not been widely used so far. Through the obligation that the Administration has of informing about any issue related to the environment – and almost all the issues contain some environmental aspect- the knowledge is placed into the hands of the citizens, the Non Governmental Organizations (NGOs), or the institutions regarding the subjects that affect them, and consequently the subsequent argument to claim. The transcription of this Guideline to the Spanish Law has been quite restrictive as far as the people subject to the right to information are concerned, and consequently, the Kingdom of Spain has been reported and sentenced before the European Union Court in Luxemburg.

Over recent years in Europe as well as in the USA a series of instruments that constitute the means of differentiating and assessing economic activities in the face of competition has been extended. The “Quality Systems”, the most well known of which is regulated by the International ISO 9000 (series) standards, establish certain standard criteria to recognize how firms apply the best technology available with the final objective of “...providing maximum customer satisfaction”.

The ISO 9000 itself contains environmental specifications to be taken to their final consequences; however, the ISO 14000 standards and their derivatives have established new quality criteria –environmental quality in this case- as they establish which criteria must be the objectives for Environmental Management as far as firms are concerned. The European Regulation (R) 1836/93 is a somewhat more demanding version of the ISO; The Standard and Regulation establish the requirements so that an Environmental Management System (EMS) may be officially verified and certified by recognized Institutions (UNEP/ICC/FIDIC 1977). The European Regulation has been remodelled and the awaited so-called EMAS II is presently in effect, that is the R. 761/2001.

The Regulation establishes that an EMS must fulfil certain very specific requirements. Those firms that wish to be included in the System must perform an *Institutional Declaration*; design a company *policy*, conduct *preliminary environmental assessments* and draw up a *project that marks the objectives and goals to be reached*, create and maintain a series of *registers*, make an express distribution of responsibilities, periodically carry out *EcoAuditings* which allow the proper System functioning to be verified; furthermore an internal and exterior project must be maintained concerning information and training. The introduction of the EMAS may follow a verification performed by a recognized organization, which could certify that this in fact exists and it is being fulfilled. The objective of the EMAS is the continuous, indefinite improvement of environmental management.

WHAT IS THE ROLE THAT THE UNIVERSITY PLAYS?

In relation to previous normative texts, the reference (exigency) to quality guarantee, through assessment, certification and accreditation processes, is introduced as a novelty

to the Organic Law of Universities (LOU) in Spain. These functions correspond to the National Agency of Assessment and Accreditation.

The Quality Management Systems (QMS) in the business world have been imposed as a consequence of the pressures felt by firms, brought about by need to improve efficiency, driven by the competitive market and by globalization. Anything can be purchased anywhere, and only “the most apt” survive to offer the best products and services to an also universal clientele.

Quite the opposite to what would be ideal, universities are not always an ideological driving force for the best innovations –they should be so for good innovations- since there are times when they are pushed by “external forces” that place pressure on structures that occasionally evolve too slowly. Universities are companies that provide services and it seems logical that they ought to be subjected to the same “good management” obligations as the rest of the organizations that society creates to solve its necessities with whatever expressions are required.

Higher Education Institutions attempt to cover the need to train professionals and artists of the highest level. They develop investigation programs and they should favour the development of technology, theoretical thinking and artistic creation. Universities have more or less successfully taken on such responsibilities for centuries, and it is most likely because of this that the university has always had a relatively high social prestige. Generally speaking, this prestige is on a higher level than the payment the university teachers receive for their activity, or higher than Autonomous Administration or State budgets assigned to these Institutions.

It is assumed that the university is socially important, perhaps through the “training effect” consequences it performs on society; both through what the regulated education is made up of –careers- as well as, and what is becoming more important, pre- and post-professional training, masters, business professional training and technological and basic research. Whether there is an employment crisis or not, within ten years companies, administration and services (and all the levels of the government) will have admitted those professionals who are presently in the university lecture rooms: shortly after, these professionals will occupy management posts.

Doubtlessly environmental management is one of the fields where many of the professionals of the future will be committed to in their different disciplines. Over the last few years, certain Spanish universities have started to become concerned about an aspect of their activities that gave rise to potential impacts on the natural environment

These universities began paying attention to the teaching and investigation activity of laboratories and workshops situated in campus for many years, which were producing dangerous waste, that was merely and carefully poured straight into the drains of the sewer system or placed with the urban waste formed in the campus.

In the 90’s many Spanish universities started taking on the responsibilities involved in good solid waste management, and they became “small producers” (less than 10 tons/year). They also started internal awareness campaigns through which the true “waste producers” – teaching staff and researchers – took on the responsibility of correctly controlling, storing, identifying and labelling materials, which until then had been simply thrown away via the most irresponsible, yet handiest way available.

From what we know, the universities which resort to the “authorized waste agents” to manage dangerous waste, the management costs tend to be included in overall budgets for each institution. Success in taking on the performance of good withdrawal

practices has been generally well accepted by the academic staff. However, certain reasonable doubts exist as to whether the struggle against pollution would have been successful if each “waste producer” would have had to pay for the management of the waste that he/she creates himself/herself.

It is reasonably logical, and in accordance with the spirit of the Law of Waste, that the “waste producer” is the person who must take on the responsibility of making the “decontaminating” costs part of the internal teaching or research costs. This is not only to accept the paradigm “whoever pollutes, shall pay”, rather it is because having to pay finally constitutes an element of persuasion on whoever teaches or researches. Therefore, the search into ways of saving money shall stimulate the choice of techniques that minimize or eliminate the pollution in its origin, thus decreasing the need to pollute a posteriori. The present-day situation is that in which it is the university institution, rather than the teacher or the researcher (or their department), who assumes the decontaminating costs, is to a certain extent a “socialization” (externalization) of the decontaminating costs, which does not encourage *good environmental practices* to be adopted by those who draw up teaching programs or who design research projects.

Polluting is not admissible, yet economically speaking, decontaminating is very costly. An example would be the fact that while one kilogram of analytical quality chloroform costs around 8 Euros from a warehouse, once it has been used and converted into waste to be managed, the management invoice shall exceed 10 Euros per kg. Frequently, products are more expensive as waste to be managed than as raw material from a warehouse, and accepting this reality represents a significant change in how to focus on the tasks to be planned and the budgets to be adapted.

Environmental Certification in the University

The European Union Regulations tend to be more advanced than national regulations are in adopting environmentally protective measures. Regulation 761/2001 of both EcoManagement and EcoAuditing is a good instrument through which firms accredit good environmental practices, and they are included in what may be considered to be a “list of excellence for firms”. This is a refined version of the ISO 14001 standards, which appeared shortly after the first version of the Regulation in 1993.

Presently, several European universities are certified according to the guidelines of this particular Regulation, whereas no university in Spain has achieved such certification to date despite the fact that the Valencia Polytechnic University (UPV) was a pioneer in promoting this initiative in Europe years ago (1996). The UPV completed a study, which was financed by the European Commission, to establish the EMAS implantation methodology in university institutions.

Adopting an Environmental Management System would be a way of rationalizing environmental management in general terms (which would include the solving of dangerous waste management problems), and at the same time it would constitute a test for Institutional Quality, which the LOU would attend to.

It is inevitable to once again refer to the non University Quality System (QS) models; in the competitive business world, the priority objectives of any QS are those that *provide maximum customer satisfaction*. The QSs that apply to the Spanish universities started by considering the students to be the “customers”, since they pay the service the university provides them. It cannot be forgotten however that the students in the public,

autonomous and democratic universities of Spain are also, formally, part of their power, since they have a full representation in the electoral bodies.

From the environmental point of view, and justified by what has already been stated, the professional effect on the business world makes it necessary to consider that students are also a kind of raw material when they start university. They shall leave (as a product?) converted into professionals who will develop -or will perhaps not- good environmental practices throughout their working lives, providing services to firms (other clients who contract university graduates?) who take them on as their staff.

What can the Administration do, besides what it is already doing, to take on its responsibilities in this process? Good teaching practices are costly, economically speaking (bad teaching practices are disastrous), as is investigation. Organizing subjects along with their practices is left freely open to the Colleges and Faculties criteria, which have to scrupulously administer their resources. The university Administration within the various autonomous levels of each Spanish autonomous community is free to mark "environmental accounting" criteria to the universities that depend on it. Environmental accounting only makes the segregation in annual accounts of the satisfactory amounts compulsory in order to face environmental responsibilities, waste issues and specific investments. As a last resort, the "ISO 14001 certification or the European Regulation 761/2001" of a university could be the best global assessment method regarding the utilization of good environmental work, as an alternative.

Research on the other hand, is financed differently. It would prove difficult to generalize the demands of environmental accounting for each of the thousands of small technological (technical assistance) research projects that are carried out in universities. However, two very important financing sources currently exist in Spain, and they should be consistent with European and Spanish policy. Those Ministries responsible for Science and Technology should demand environmental accounting in all the projects that are financed through their financial support programs. The part of the sometimes complicated justification of expenditure that accompanies applications, and which also needs to be produced in the writing of final reports, that corresponds to Environmental Management expenditure, should be taken into account. The European Commission itself is presently financing many research projects that are put into practice in Spanish universities, and it seems illogical that while Recommendations are made, that accounting in the same documents of projects that are financed by the Commission itself is not insisted upon.

The European Union and the State should be the first levels at which action is taken in favour of the general interest, by insisting at times on certain efforts by certain people and institutions to protect the common, present and future environment. Acting on the university means obtaining significant mid-term results, and the governments hold a strong regulation power on these institutions for the time being.

Environmental responsibilities are a reference that ought not to be ignored in such an important chance as this is to transform and innovate university legislation. To date the initiatives towards good environmental management in universities have been the result of well intentioned volunteering on behalf of the teaching, staff and student groups. However, if the problem is not faced, it is still possible that departments, workshops and laboratories exist in the university which have not achieved something as simple and categorical as "abiding the law".

PROCEEDINGS TAKEN BY THE VALENCIA POLYTECHNIC UNIVERSITY

As from 1993 the Valencia Polytechnic University (UPV) started to introduce non normalized, Environmental Management System through what it calls its Green Office. This consisted of a first phase in the administration and management of toxic and dangerous waste, of waste assimilable to urban areas through a selective withdrawal system, etc.

In 1996 the UPV was assigned the responsibility of developing an investigation project, financed by the European Commission, for the **“Design and establishment of an Environmental Management System on an experimental scale, based on Regulation 1836/93 regarding EcoManagement and EcoAuditing, that is to apply to European universities”**. The European Commission assigned 16 million former pesetas (approx. 96,000 Euros) to finance this project. This was one of the 5 priority projects (the only Spanish one) financed in the assembly which took place in April, 1996, in relation to the development and extension of the Application of Regulation 1836/93 regarding EcoManagement and EcoAuditing.

The idea of extending the establishment of the EMAS to activities different to the initial activities of the polluting industry embarks upon a second phase, which suggests that it is a secondary policy objective. Importance must not be confused with urgency. Industry, as the main cause of environmental deterioration, constitutes the most urgent objective where action is to be taken, by modifying processes and even interrupting certain activity. In order to efficiently modify any processes, it is necessary to count on the technology that is applied by trained professionals who are willing to apply it.

A methodological guide addressed to universities must only be used for orientation purposes in the elaboration of the systems to be applied, since universities have technical training available to write up their own documents.

As far as environmental impacts are concerned, a university possesses the same instruments that make up a firm (installations and equipment, workers, raw materials, suppliers, contractors, etc), and it may produce certain effects that are qualitatively similar in its surroundings (consuming raw materials and energy, producing spillages and waste, producing emissions, etc). One may believe that it would be enough to simply apply the same regulations and concepts as firms do when it comes to creating and establishing an Environmental Management System.

Nonetheless, the university, as far as its main activity is concerned, that of educating, has certain differential characteristics that demand a complementary analysis to be made on some important concepts, such as raw materials or products. The most significant differences from firms of the industrial sector would have are as follows:

- Raw material subject to the transformation process conducted is represented by students
- Activities and processes are developed as educational curricula rather than as manufacturing processes
- The finished product is represented by the professional or by the university graduate, as are the services and investigation lines conducted
- The university customer, that is, the person the activity is targeted at, are the students themselves, as well as the society in general receiving its services

Therefore the university acts directly on an agent that basically plays the leading role, and which is responsible for environmental contamination: **the environmental management agent of an immediate future**. What is to be expected is that what

students reproduce in their subsequent and productive professional life, needs to be lived as something quite “normal”. Therefore the responsibility that the university has will be to integrate the students themselves into its own Environmental Management System, in which the “Educating Effect” shall become one of the most substantial objectives. Besides which, the university shall act directly on the development of new technology through investigation projects that can reduce the environmental impact of industry and of society in general.

On the one hand, applying an Environmental Management System in the university may produce a considerable number of potential benefits, among which the following stand out:

- Bring order to and facilitate the fulfilment of formal obligations and of materials that environmental legislation demands, as well as adapting to possible changes
- Reduce risks from not fulfilling legal regulations and reduce environmental damage
- Avoid possible lawsuits through formal complaints

ENVIRONMENTAL MANAGEMENT SYSTEMS

Establishment

An environmental Management System is part of the general management system that defines the environmental policy, and it includes organizational structures, responsibilities, practices, procedures, processes and resources to put this policy into practice.

Both the EMS standardized to the ISO 14001 and the European EcoManagement and EcoAuditing Regulation are based on the compromise of continuous improvement, and also on the establishment of a documentation system that regulates all environmental effects, by distributing responsibilities to all the people within the organization. A diagram that is frequently reproduced of what constitutes the EMS is as follows (Fig.1):

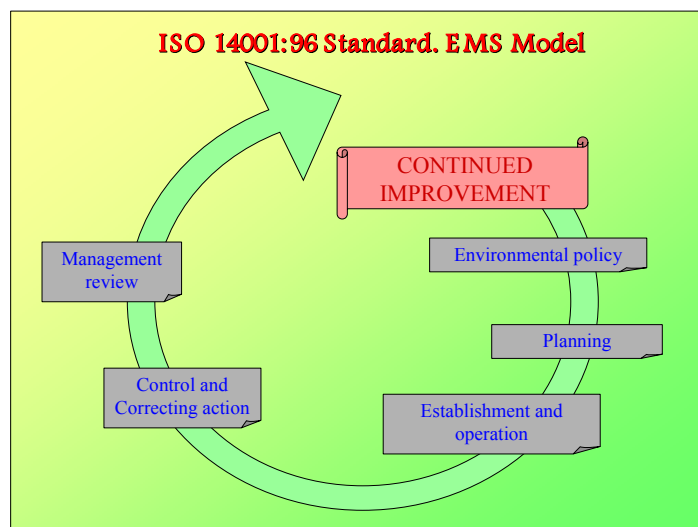


Figure 1 : Management System Model

Establishing an Environmental System in a complex organization, such as the Valencia Polytechnic University, should be conducted in two phases from the start. The Norm permits accreditation by Centres; the Centre concept is the *site in which industrial activities are carried out in a particular place and under company control, including all storage, either connected or associated with raw materials, intermediate sub products, final products and waste material, as are any infrastructure and equipment related to such activities regardless of whether they are permanent or not.*

In the definition of Centre or Unit, a geographical dimension exists, as does a management dimension. In certain cases within our university, both dimensions coincide, yet in others they do not. Within a physical space that depends upon the College, activities are carried out by teachers who depend on Departments, and these also have their own premises and laboratories in which research tasks are performed.

It was decided to commence establishing the EMS in the university by taking the Centres as a unit, and three were taken as a pilot scheme, these being, the Technical College of Civil Engineering, the Faculty of Fine Art and the Polytechnic College in the city of Gandía. In this way, the System achievement is the Centre's activity, by excluding Departments and their laboratories which become known as teaching "suppliers".

The Technical college of Civil Engineering, apart from providing education towards Civil Engineering qualifications (Engineering in Roads and Technical Engineer in Public Works in its three specialities), also gives classes in the second grade of the University Degree of Environmental Sciences and also in the second cycle in Geologist Engineering.

The establishment of the EMS began with the Environmental Policy Declaration, approved by the University Governing Board. A Environmental Committee was set up in the College, chaired by a College Sub director, and it was represented by the various strata involved: teaching staff, administration and services staff, and students.

The Committee's task in the first phase was to produce and approve the System documentation, by counting on the invaluable technical support of the university's Green Office. A first environmental review was completed in order to detect the main environmental problems.

The System documentation consists of:

- A Unit Environmental Management Manual
- A Unit Environmental Plan, to define environmental targets and an action plan, on an annual basis
- Operation procedures and practices
- Continuous staff training plan
- system registers

The College certified its Environmental Management System in accordance with the UNE-EN ISO 14001 Standard through AENOR, in December, 2002. This certification is the result of the commitment the Centre made with regards to the natural environment, and it is also the result of the effort and concern of its entire staff. Thanks to this certification, The College of Civil Engineering is the first university centre in Spain to achieve this certification, and among the first in Europe to do so. Other Centres of the Valencia Polytechnic University have subsequently obtained their Environmental Management System certification.



Figure 2 : Logotypes of Environmental Management Certificates

The most outstanding aspects

The most outstanding aspects of Environmental Management are the following:

- Documentation
- Communication
- Training and awareness
- Waste collection
- Controlling consumption

FUTURE LINES

Just as important as being awarded a normalized Environmental Management System Certification is that of maintaining it. The efforts made to accomplish the certification must not finish once the certification “award” is achieved.

The System, if it is well designed, has to be sustainable. Undoubtedly this involves a political willingness for it to be so, and consequently economic aid is also involved. Nonetheless, the modification of certain habits and the getting used to those things that respect the natural environment the most, is what is most important.

This does not mean having to make huge efforts. Everyone has to be convinced that this is the case, and besides which, no-one has to be a “hero” to achieve this. In all fields there are those who rush forward to bear the flags, but the environmental field is important enough to not allow such actions to fall in the hands of such people.

As for future lines of action, other than that of consolidating the System operation, we foresee that it should be adapted to and certified in accordance with the European EMAS Regulation, which is somewhat more demanding than the ISO 14000 Standard is.

On the other hand, we intend to extend the System to the Departments and their laboratories, with the ultimate idea that the whole university is certified. Until this objective is achieved, we find ourselves facing various dysfunctions, since it is difficult to obtain data or to vary certain behaviors in an isolated fashion in a centralist university, such as ours is.

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