# The Expected Profile of the Next Century Brazilian Electrical Engineer

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**Abstract:** This article discuss the first results obtained from a survey conducted in Rio de Janeiro state (Brazil) among the engineers working in established electrical sector companies, universities and research institutions located in the state of Rio de Janeiro. The survey aims, among others things, to obtain information on the characteristics of their present occupation, as well as their expectations concerning the profile of the next century electrical engineer. This survey is, in fact, an aid tool to help on the ongoing project to stablish the characteristics of the new profile for the electrical engineer professional face the reality of the Brazilian and the world economic trends and the consequent needs of the corresponding market for this category of professionals

**Keywords:** engineering education, curriculum, engineering profile.

## I. Introduction

In this article we present the preliminary results obtained from a survey taking place in Rio de Janeiro state (Brazil), in a sample of electrical engineers holding a full time job in the corresponding market, which includes companies (private and state owned), universities and research institutes. The survey aims characterize the present occupation of the electrical engineers and their opinion concerning the needs and the specific knowledges a modern electrical engineer should have to face the next century challenges. This survey is fully sponsored by ELETROBRAS, the Brazilian state owned electrical company, and is part of a priority preoccupation of ELETROBRAS concerning the formation tools needed to stablish the profile of the next century electrical engineer. Among other things, the outcome of this project will be fundamental in the reform of the undergraduate electrical engineering courses of the Brazilian universities, which has to take place in order to face this turn of the century challenge.

In a sense this project can be viewed as a follow up of previous works already prepared by the authors on technological trends in Electrical Engineering (Power Systems area) concerning changes in the role of the engineer caused by the changes experienced in the world economy with consequences on the Brazilian electrical sector. (See the proceedings of the international conferences ICECE and ICEE) [1], [2], [3], [4], [5]. Two other events were also considered in the discussion of the present paper, namely, the workshop on Electrical Engineering formation, which took place at the Gloria Hotel, in Rio de Janeiro, and the visit of Brazilian university academics to the United Kingdom, sponsored by ELETROBRAS in 1997, to study the changes which took place in electrical engineering courses there as a result of the privatization of the sector [6]. The description of skills and professional attitudes is founded in Ropé and Tangui 87], which was adapted to brazilian reality [8].

A brief review on this topic must be considered, although none of them have resulted in publications besides internal reports organized by the companies. ELETROBRAS organized two small surveys within electrical utilities about the needs of engineering formation, but unfortunately they were not very conclusive. The results observed by spontaneous answer to specific questions in a sense reproduced the past, implying the need of a more elaborated survey which would include both categories of questions, that is, spontaneous and stimulated ones. In 1998 two workshops took place in Rio de Janeiro, Brasília and Recife joining experts from electrical sector entreprises and brazilian and british academies to present and analyse the changes in british electrical industry consequent from privatization, which present similarities to the present changes in brazilian electrical industry [9]. At the end of 1999 some ELETROBRAS experts visited universities and industries in Britain with the same sake [10]. Another study on the subject was requested to COPPE (Coordination of Post Graduate Programs in Engineering of the University of Rio de Janeiro), to develop an arborescent classification of the main important knowledges that is required to the formation of electrical engineers [11]. LIGHT (one of the distribution utilities of the state of Rio de Janeiro) carried out an internal survey on the subject in 1998, via group discussion with their own employees (qualitative kind of

approach) as well as specific survey forms, with the aid of their human resource department [12]. The results were very interesting, but, unfortunately, were not al all published or formally quantified. However, they were thoroughly used in the elaboration of the present survey. It is important to remark that this study conducted by LIGHT was carried out 3 years after its privatization. Finally, a pioneer pilot survey, used to test the survey form developed for the present study, was conducted by UFPE (State University of Pernambuco, northeast Brazil), fully sponsored by ELETROBRAS [13].

## 2. Survey Description

The survey questions were elaborated from the lists containing knowledge, skills and attitudes collected in pre-studies as well as the ABET [14] and ABENGE [15] proposals. The first part of the survey has spontaneous answers (without items indications) while the final part is composed of stimulated kind of questions (where the interviewers were asked to choose or classify items of a pre-given list). The survey was first conducted by direct interview to check on its flexibility and its drawbacks. After this trial period the improved survey form was handed out to respondents in the universe of the study and the answered form returned by mail or even via internet. Statistics mentioned in this article concern the first 229 returned forms.

The basic concept of representativity of the population as a whole does not apply directly in this particular discussion; in fact, it is considered here the estimates corresponding to sub-populations of stratified groups (state employees, private companies and universities; types of formation; etc), to be shown bellow. The complete analysis, with estimates for the populations and sub-populations will be included in the final version of the article, which depends on the conclusion of the fieldwork still going on.

It is the aim of this survey to be applied nationwide, covering different regions of the country. Therefore, the present study can be viewed as a pilot study for the broaden national project of reform of the electrical engineering formation profile which ought to be carried out in the country. The reason why the state of Rio de Janeiro was chosen as a main target of the pilot survey is due to the presence of many electrical utilities covering all aspects of a power system; i.e. generation, distribution and transmission of energy, as well as research centres, universities and coordination bodies (ONS: National Coordinator of the Operation of the Interconnected Brazilian Power System). Also, within the state these electrical utilities fall in both categories; state and private companies.

The data analysis is still on its preliminary stage, and will be presented in this paper in a somehow informal way. We do not produce any sophisticated statistical analysis, as the data collection is still taking place and, although the sample size from which some conclusions are drawn in this article is not big enough to garnet a maximum error margin of 4%, which is our target. To make the presentation more clear, the organization of the survey form is repeated in the subsequent sections of this article.

## 3. Sampling Characteristics

Most of the engineers interviewed are male (90,8%) and hold a Brazilian nationality, more than a half of them are born in Rio de Janeiro (64,6%) and aged between 40 and 50 (48,9%). 72,5% are married, having 1 to 3 children (71,7%). 89,5% have computers in their houses; the majority of them with internet access (71,2%). Their preferences for newspapers are: JB and O GLOBO (86%) and their preferred entertainment activities are: jogging, play football, go to the beach and travelling (each one with around 10% of declared preference). The mainly cultural activities are the Cinema (34,1%) and reading (31,4%), highly above the second, which is going to the theatres (11,4%).

Most of them are graduated in Basic Electrical Engineering, Electronics or Power Systems, being difficult to distinguish between their major, because of the several meanings existing for the same title in the various Engineering Schools of the country. In the sample, there are graduated students from all different kinds of Brazilian Schools, the biggest part located in the Schools of Rio de Janeiro State. Half of them graduated in the seventies (49%), the second biggest group graduated in the eighties (24%). This shows clearly that there has not been a regular policy of hiring young electrical engineers in recent years.

This last observation raises an important issue: most of the engineers did not take any kind of formal computing lectures (only superficially for some of them) during their undergraduate courses. They have taken all of the Calculus courses (compulsory ones) using old fashion methodology (including books written by Granville and Thomas which are out-of-date) and also did not attend any course on Linear Algebra. The reform of the curriculum of the mathematics courses, started in the early seventies was implemented in only a few universities of the country,

and took almost twenty years to spread out the entire country. The systematic use of Linear Algebra and Computer Science is only now being adopted in the professional cluster of subjects in the engineering courses. This was first experienced on the Universities that offered regular post-graduate programs, as these institutions had straight links between both; undergraduate and post-graduate programs.

The Engineering Schools were divided into groups, according to the existence of post-graduate courses with a top classification by CAPES (Brazilian Coordination of University courses) and under-graduate courses highly recommended by the "Provao" (an examination taken at the end of their senior year to test how well the students have learned their major subject) and Abril publisher (first group); existence of post-graduate courses and medium concepts (second group), highly concepted courses without post-graduate programs or faculty members with extensive background (third group), other Schools, mostly private considered as low rated (fourth group) and Technical Schools (fifth group). Actually, the correlations estimated and shown below were calculated by aggregating the first 3 groups into one cluster against the forth and fifth aggregated as the second cluster of Schools.

Considering the above mentioned classification in five groups, it was found that 28,3% of the interviewed professionals graduated in Schools belonging to the first group (from which 16,6% from UFRJ). Only 3,1% professionals were graduated from the Schools of the second group (from which 1,1% from EFEI) and 21,7% belong to the third group (from which 11,8% from UERJ). Finally, 30,9% are included in the fourth group (from which 17,5% from Veiga de Almeida University) and 3,5% fell into the fifth group. The Schools cited above were the most mentioned ones in the corresponding sample. The academic institutions tend to hire graduated professionals from the first group, while the state companies tend hire a little bit more graduated professionals from the first group in comparison with the other groups. The private companies (e.g. LIGHT and CERJ; the other distributing utility of Rio de Janeiro state) tend to hire more graduated professionals from the third and fourth groups, without significant differences between the findings of the companies.

The statistical distribution of hired professionals in the electric sector do not agree with the corresponding distribution of the graduated engineers from Rio de Janeiro State Universities. We believe that this fact is probably due to the fact that in Rio de Janeiro there are well paid job opportunities related to services, particularly the financial market and bankings, which hire a great deal of engineers graduated from the first group of schools. It is worth mentioning that the search for Power System courses in the Universities of the first group has decreased significantly in the last 20 years, mainly due to the lack of job opportunities in this area. As a consequence, the classes in this subject are becoming very small, with only a few students registered. As for the other groups, with Engineering Schools organized in separated Faculties, they tend to keep fixed size classes, and the students have no choice but accept the registration for the available option. In these Schools, the last course to be eliminated, for financial reasons and lack of candidates (current problem in these Schools) has usually been the Electrical Engineering option, because of the facilities of putting up these courses (there exists a great deal of possible lecturers in the city; for instance, state companies employees or those from other universities and research centres)

The great majority revealed that they have chosen their course hoping they would have progress in their career (34,5%) or because they were interested in the subject (30,1%). From the total sample, it was found that 44,9% worked as trainees during one or two semesters of their under-graduate studies, while 39,5% worked during 3 semesters or so. 87,3% studied english as a foreigner language at private english courses and 77,1% took computer science training in isolated private schools. A small group have also attended classes and regular courses in other foreign languages, namely: french, spanish and german.

It is worth saying that 62,9% of the interviewers have considered that their under-graduate courses met the demand of the job market for engineers (against 29,7% who did not agree), contradicting the fact that 62% of them have undertake post-graduate programs, claiming this was important for them to update their specific knowledge. About 5/6 of the interviewers who have concluded post-graduate programmes, considered that they have met present and future market needs. In order to make sense, the sources of professional updating procedures more chosen (the interviewer had to choose one out of 3 options) were: courses (73,4%), congresses (66,4%), reading (56,8%), technical visits (41,5%) and seminaries at the companies (only 32,3%). 67,2% of the interviewers read from 2 to 5 technical publications monthly.

From the total sample, 31% have attended pos-graduate programmes in Electrical Engineering subjects, 8,7% in the Management Science, 6,1% in Computer Systems, 2,6% in Production Engineering and 2,2% in Security. The other subjects were attended by one or two engineers at most. From the total of 89 post-graduate students, 53 have registered for a Master programme, from which 19 without thesis, 65 Extension courses and 26 of were able to get a PhD degree. Also, from this total, 51 have done their post-graduate course at UFRJ, 32 at PUC-RIO and 12 at EFEI.

**4. Job and Current Activities**

So far, in the considered sample (229 engineers), 35,8% of them work in the public sector ( ELETROBRAS and sucursals), 45,9% work in the private sector (LIGHT and CERJ) and 18,4% work at Universities. 47% are still working in the same jobs for more than 4 years, an indication of a great quantity of recent job changes.

43,8% of the engineers interviewed said they hold a technical job, 8,6% have an administrative one and 7,3% work with projects or researches. Contradictively, 27% just claim to have as mainly burden technical duties, 21,8% are involved on supervision, 20,5% on projects or research development, 10,8% in administration, 10% in technical supervision and 5,2% in commercial duties. In other words, the duties not always match with their main activities. On the other hand, about 92,1% answered positively to the question about the compatibility between their post and their functions. Anyway, 86,9% claims that their present occupations require specific technical knowledges, justifying the need of the engineer to hold a degree to execute their duties.

One of the questions of the survey form is concerned with the discussion of their specific activities, where the interviewed had to classify the performance frequency of a list of activities presented. Four different analyses with the information collected on this topic were made. The first one has put together the activities by their frequencies, weighting the answers "very often" and "not very often" with weights 0,75 and 0,25, respectively. Five groups emerged naturally from this aggregation and they are described below. In order to make the presentation easier, the activities are numbered as the description goes. The indicated frequencies (in percentage) correspond to the answer "very often", the order corresponds to the obtained classification. The groups are:

a) (1) making strategic decisions, (2) assistance, assesorate, (approximately 40%).
b) (3) studding or researching new technologies, (4) supervise general constructions or technical services, (5) leading technical teams, (6) management of personal, development (from 33% to 28%).
c) (7) elaborating budgets, (8) technical execution, (9) consultancies, (10) supervising operations performance, (11) public relations/ contact with the public, (12) executing projects in electrical engineering, (13) developing projects on electrical engineering (from 25% to 18%).
d) (14) planning in generation, transmission and distribution of electrical energy, (15) economical and financial planning, (16) commercialization of energy, (17) development of new methods of measurements in power systems, (18) implementing of new meathods of measurements in power systems, (19) creating standard procedures for evaluation of the quality of the energy supplied, (20) measurement procedures of the quality of the supplied energy, (21) controlling the quality of the supplied energy (less then 20%).
e) (22) implementing alternative energy systems (2,2%).

As one can see, the activities related to actual implementation are less frequent than those related to management and decision making.

A factor analysis of the frequencies allows one to organize the list of activities, obtained in previous related surveys, from six explanatory variables ranked in descending order according to the observed frequencies. The groups are:

1) activities 1,2,6,7,9,15 and 16, related to planning and management activities.
2) activities 3,11 and 22, which conjugates new technologies, public relations and alternative energy.
3) activities 4,5 and 8, related to the execution of technical services.
4) activities 10,19,20,21, related to the supervision and quality control.
5) Activities 12,13,14, related to the planning and projects on electrical engineering
6) activities 17 and 18, associated to new measurement methodologies.

The third analysis correlates the listed activities with the type of companies which were mostly mentioned on the survey (minimum of two citations to be included):

- All of them: 9 (consultories);
- Private and state companies: 1,2,3,5,6,17,18,22;
- Private companies: 2,5,7,8,12,13,14,15,16,19,20,21.

Technical services, questions related to equipments, quality of the supplied energy, commercialization, execution and elaboration of projects are more often related to private companies, as one would expected from the distribution utilities recently privatized. The state companies are, somehow, in a similar position to the private ones in all other activities, showing less investment in equipments, and more attempt to management and planning. The Universities only appear on the consultancy activities, because the teaching activities were not at all mentioned.

The fourth analysis correlates the engineers formation and their activities. It was found a significant high correlation of the engineers belonging to the third and fifth group of Schools and the activities associated with technical and execution duties. The correlations of the formations in the other duties are somehow comparable. This result indicates a rapid career progress of the graduated students from the first and second group of Schools in relation to the graduated students from the others Schools, an indication of a better preparation of the students for management duties in these groups of schools.

Concerning the earnings of the interviewed engineers, about 28,4% of them receive salaries in the range of 11 and 20 minimum wage (1 minimum wage is approximately US$ 84), 27,9% between 21 and 30 minimum wage, 22,7% between 31 and 40 minimum wage and 11,18 earning 40 or more minimum wage. These salaries seem to reflect the level of satisfaction of the engineers with their corresponding activities, as 87,4% declared to be satisfied or very satisfied and only 11,8% of them declare insatisfaction with what they are earning today.

## 5. Formation Needs (Expontaneous Questions)

Only 50,7% of the engineers of the sample declared to be aware of the current engineer formation. Therefore the statistical totals of this section will always be inferior to this percentage, as they were the only ones who have answered the questions analyzed in this section.

The opinion about this formation can be considered negative: 10,9% find it up-to-date, 25,3% partially up-to-date and 14% not at all up-to-date. This is a contradiction with the opinion about their own course. One possible explanation to that is the great number of engineers with full time job in companies who has a second one as a lecturer in other universities, particularly those included in the third and fourth groups, considered inferior to the ones they have graduated.

The syllabus of the subjects of a basic electrical engineering course are organized in classes or clusters of subjects as shown below:

- Basic Sciences: Calculus, Linear Algebra, Probability and Statistics, Physics, Chemistry and Computer Science;
- Engineering Sciences: Mechanic, Materials Resistance, Transport Phenomenous, Dynamics Systems Modeling;
- General Professional: Electrical Installations, Electrical Circuits, Electromagnetism, Electronics, Electric Materials, Energy Conversion, Signals and Systems, Control and Servomechanism;
- Power Systems: Generation, Transmission, and Distribution of Energy, Power Systems Analysis;
- Other classes with straightforward descriptions.

The basic point is the inclusion of the Engineering Sciences, of direct interest for the electrical engineer in the "General Professional" class. The subject Computer Science, was sometimes removed from the Basic Sciences class (which will be pointed out) and Electromagnetism was sometimes included into the Basic Sciences.

When they were asked about the subjects they have studied but did not use in their professional lives, 12% to 17,6% of the engineers declared, expontaneously, "none", "Engineering Sciences", "Basic Sciences" (except Computer Science).

## 6. Knowledge Needs (Estimulated Questions)

Jumping now to the main objective of this article, it will be presented and analyzed in this section the classification of knowledges by their importance to the formation of electrical engineers, obtained from the survey data survey. In order to obtain these data, the sample engineers were asked to classify into five levels of importance of subjects organized in a list including the titles defined in the previous section. The list of knowledges was developed by the curriculum of the corresponding habilitation, obtained from the new themes suggested in the already mentioned LIGHT survey and in the other surveys carried out by ELETROBRAS. It was also use the expertise from the universities and the personal managers of some companies and research centres. As before, four statistics analysis were performed.

In the first, the knowledges were classified into groups of importance by adding the frequencies of indications of the two highest levels of importance. The result is shown bellow, with the added frequencies in each group within parenthesis. The themes are indicated in the order of importance.

1. a) Power Systems, b) General Professional, c) Foreign Language (from 86,9% to 89,6%) .
2. d) Basic Sciences, e) Machineries and Electric Equipments, f) New Energy Technologies (79,5% to 75,6%).
3. g) Electric System Operation, h) Writing General Essays and Communication Techniques, i) Alternative Energy Sources, j) Planning Simulation and Optimization of Energy Systems, k) Quantitative Methodology to Prevention and Analysis of Demand, Production and Marketing, l) Automation and Artificial Intelligence, m) Information Technology, n) Commercialization and Marketing of Electrical Energy (71,6% to 54,6%).
4. o) Structure, Integration and System Development, p) Administration of Systems, q) Technical Regulations, r) Strategic Planning, s) Economy, Marketing and Finance, t) Telecommunications, u) Advanced Mathematic Models for Energy System, v) Engineering Science, w) Business and Management of Contracts (52,9% to 43,2%)
5. x) Human Sources Developments, y) Legal and Juridical Aspects, z) Psychology (35,8% to 27,5%)

6. α) Meteorology, Climatology, Hydrology, β) Philosophy and Sociology (16,2% to 13,1%).

The logic behind this classification is clear: the general technological knowledges in the specific Power area comes ahead, followed by scientific technological knowledges which are important to master the former. After these comes the specialized knowledge in Power systems (system operation, optimization, etc), and the innovations on technological and scientific matters. This is followed by the questions related to economy, finance and internal organization of firms. The so called "side technical formation" (engineering sciences) comes behind knowledges already mentioned above, except those related to human resources, juridical knowledges and group 6, that could be considered as superfluous.

The factor analysis (checking only answers that reached high importance levels) generated 6 explanatory variables, showed below using the indices of each subject:

1) a,b,e (technical subjects of general electrical engineering )
2) c,h (oral and written communication)
3) d,v (sciences)
4) f,i,l q,t, α (new and complementary technologies; and technical regulations)
5) g,j,k,m,n,o,p,u (operation and planning – technical and economic – of systems and companies, and associated technologies including also information technology)
6) r,s,w,x,y,z, β (economic management of human sources and general knowledges – indicated above as superfluous)

The correlation of the importance given to the subjects with the background of the engineer was estimated, and the results show a strong relation (twice the frequency) between those graduated from the first group schools with subjects c,d,e,k,n,q,t,x,y,z, α and β; all of them connected to the general culture (scientific or not) and the most "fashionable" advanced methodologies (energy market and telecommunications). This direction of interest reappear if we use weaker definitions of predominance (1,5 times the frequency). We find again the expected profile of a graduated student from a research type of University! This profile, in a sense, meets the relative importance of the subjects.

The correlation of the importance given to the subjects with the company type (private or state) was also studied, and the results revealed a strong relation of the private companies employees with the subjects a, b, c, g, i, j, k, l, m, n, q, r, s, u and w. Here one finds the knowledges needed for planning, operation and development of the equipment' s of power systems, together with the knowledges on economy, business and foreign languages. (LIGHT and CERJ are foreign companies). Once again an expected behavior, associated to the fact that the private companies are mainly related to the distribution of energy and are in the process of changing their equipments (this fact does not occur in the state owned companies; which are still mainly concerned with the generation, transmission of energy and the operation of the power system). On the other hand, the highest presence of graduated students from the first group schools in the state companies, tend to polarize them in the same indicated direction, weakening the explanation that supports this argument. We expect some changes in these findings after the inclusion of more survey forms from FURNAS (a generating utility with headquarters in Rio de Janeiro).

## 7. Skills and Professional Attitudes

The skills required from an electrical engineer were divided into 3 subgroups (c.f. [7]).

The first subgroup, dealing with management and administrative skills, have produced an indication of importance level similar in all of its items (79% to 87,7%), adding the frequencies of the two highest levels: a) mobilization ability, b) autonomy and creativeness, c) strategic vision (inside and outside the company), d) administrative resources, e) speaching ability, f) systemic vision. The order of presentation corresponds to the obtained classification of importance level.

The second subgroup, personal and interpersonal skills, also produced an indication of importance level similar in all of its items (79% to 90%), using the same system which was used in the first group: g) responsibility, h) self-learning capacity, i) face problems, j) sociability and ability of team working, k) oral,written and iconic expression abilities, l) the use of a foreign language, m) leadership

The third subgroup, technical skills, can be divided into 3 distinct subsets, according to the level and the observed importance. They will be represented using the same system that was used above:

- n) reading, interpretation and expression by means of graphics, o) ability to command new technologies, visualizing with creativeness new applications (90,6% and 87,3%, respectively);

- p) ability of obtaining, evaluating and using the available information, q) critical vision of magnitude orders, r) use of theoretical multidisciplinary knowledges to practical questions, s) understanding and modeling real problems, t) coordination, planning, operation and maintenance of electrical systems (82,6% to 76%).
- u) Creation and use of models applied electromagnetic systems (53,7%).

As a matter of curiosity, the technological skills (t,u) are regarded as less important in this skills list, changing the order of the knowledge list. Responsibility and autonomy/initiative seem to be the motu of these indications. They are skills without contents, whose formation depends far more of the general education than the specific training.

It was found some correlation between the fact of the engineer interviewed be a member of staff of a private company and the importance given to the items a, b, c, h, j, m and all the items linked to technical skills except the first one, n. That is, technical and skills related to independence and team work, seems to be a bit more considered in private companies, in comparison with the state ones.

With respect to the correlation between graduate from the first group and the electrical engineers options they are high for the items h, n, p and s (self learning, use of new information, mathematical modeling, use of graphical means) as one could expect of one graduated from a research university.

The list of attitudes can be divided in two groups, according to the degree of importance (adding the observed frequencies of the two highest levels) [7]:

1) a) be responsible by the decisions and possible mistakes, b) social and environmental responsibility, c) accept challenges, d) open minded to dialogues and changes, e) compromise with self-management of their formation, f) promote an environment of participation and security, g) be creative, be entrepreneur, h) be aware and in accordance and in accord with the objectives, politics and the strategic plans of their company, i) compromise with their own future, j) be ready to carry out any task even under a state of uncertainly (90.8% to 83.4%),
2) k) ethic and professional behavior (71.7%).

In all items the majority of the indications came from employees from private companies. It was also found a correlation between the graduate from group 1 and the indication of the items a, b, c, d, e, f, g, h, i, j and k. We could not find reasonable explanation to these correlations.

It is strange the low importance given to the professional ethic behavior, specially when one takes the survey organized by light with their own employees which points strongly to its importance. One could argue that this could have been stimulated by the mediator of the survey and as such its importance was recognized by the interviewed engineers of Light even though it was not expontaneouslly brought up by them. Another observed point worth mentioning was the correlation (in comparison with the others) between items g and h and the fact of the interviewed engineer be a state company employee. In this an indication of negatives consequences of the privatization process which implies in early retirement.

## 8. Preliminary Conclusion

One classification of the importance of the knowledges for the formation profile of the electrical engineer came up quite clearly: the general technical knowledge in the area of Power Systems comes first, followed by the technical and scientific knowledges needed to understand them, from the most particular to the most general. After these, come the specialized knowledges in the area of Power Systems (Operation, Optimization, etc) and the technical scientific formation. Their innovational appears the side technical formation (science of engineering), before the knowledges on human resources, juridical matters and the group 6. The suggestion of suppression of the Engineering Sciences (in the sense considered here) from the curriculum seems, apparently evidenced in this survey.

The technological skills are viewed as less important in the skill list changing the order of the list of knowledges.

Responsibility and autonomy/creativeness seem to be the motu of these indications. They are skills without real contents, whose formation depends far more on a general education than any specific training, and this is a suggestion for the engineering courses.

All the attitudes where equally analyzed, except the professional ethic gesture. The explanatory variables “type of formation” and “nature of the company” were tested against the results and it was obtained a weak correlation between graduated from research universities, working in state companies and the importance to skills and abilities oriented to research and autonomy. It was also obtained a correlation between working in private companies and the importance to technical knowledges about equipments and networks, implementation and execution of projects, and commercialization of energy. Taking into account the present situation in the sector, i.e., private companies (dealing with energy distribution) and the state owned ones (dealing mainly with generation, transmission and system

operation) and the great presence of graduates from research universities in state companies, it is rather difficult to estimate the influence of these explanatory variables.

One possible conclusion is the existence of sub-careers within the electrical sector, all of them requiring technical knowledge. One of them would be closer to management, general planning and innovational project; the curriculum of the research universities being the most appropriated. The other would be more devoted to the project and the execution of technical people with their peculiarities (e.g. teamwork); for them a technical curriculum would be more appropriated.

Another conclusion possible to be drawn is the fact that some skills and knowledges should be acquired only in post-graduate courses, after a good technical background on the undergraduate course and some managerial experience.

A third possible conclusion says that the organization of the contents of the subjects should meet the order suggested for the knowledges; the skills and attitudes being developed by the school using other approaches.

The relationship between the formation in research universities and the professional progress, which polarizes the relation of the former with the activities and managerial knowledges, should be tested in the future, in order to check on the correlation found. The set of conclusions has to be reviewed at the end of the fieldwork, as only a few FURNAS and PUC-Rio employees are included in the sample. As a final word the conclusions presented here should not be seem as the unique source for reforms in the curriculum in the universities. The conclusions should be criticized by those involved in the sector who hold information and history of the electrical sector in Brazil, as well as have a vision of the future – theme of the present survey as mentioned in the introduction.

The present sample expressed conservative opinions, if compared to ones from ABET [14], ABENGE [15] and REENGE and opinions informally collected with directors and human resources responsables in electric sector enterprises and with intelectual (academic or nor academic) studying the subject. The self-image reflected by the consulted engineers in the present sample adress their own formation, which a few influence from present professional changes. Specially, they do not give the indispensable significance (if we consider the other group opinion) to subjects as energy comercialization, energy market and business planning. Also, they relate technical formation only to curricular contents, whithout seeing the relevance of skills and attitudes to this formation (see [7] for a general analysis of this problem). We remember that the classical engineering course structure in the country is completely based in curricular contents, do not considering skills and attitudes, hurting thedefinition of engineering as a profession.

Therefore, we think it is necessary to separate, in the sample, leaders and intelectuals considering the problem from the other ones, to test the correctness of our fellings, i.e., verify the links about the opinions of the ones that have the future of the electric industry in their hands and the ideas exposed in the nowadays litterature.

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