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► **To cite this version:**

Luisa Fernanda Rodríguez Valbuena. Industrial Engineering Education Field in Colombia. International Conference on Industrial Engineering and Operations Management, Jul 2018, Paris, France. hal-02966732

**HAL Id: hal-02966732**

**<https://univ-tlse2.hal.science/hal-02966732>**

Submitted on 19 Oct 2020

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# **Industrial Engineering Education Field in Colombia**

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## **Abstract**

This paper analyzes the professors' narratives of different industrial engineering programs in Colombia, seeking to answer research questions about the characteristics of configuration processes and transformation of industrial engineering education in the country. The methodology used was Bourdieu's fields, from the habitus concept of professors while they are the education's field agents. The study was approached from the analysis of social practices, in which more than mass events of a structural nature, it seeks to strengthen the collective memory of those who have been excluded from official history and serve as an educational space from study of processes and events that led to formation of social subjects, investigating the interaction and conflicts, in such a way that the past can be questioned according to current emancipatory projects. The configuration and transformation processes of industrial engineering as a knowledge discipline in Colombia between 1950 and 2000 were studied through the tensions and ruptures, the conflicts and new interactions generated from the developed world discourses. Critical analysis was considered as the best alternative in information treatment, because it facilitated the professors' narratives analysis. For processing information it was utilized QDA (qualitative data analysis) y GEPHI (graph visualisation and cartography in data mining).

## **Keywords**

Industrial engineering education, Bourdieu field's methodology, social structures and practices.

## **1. Introduction**

The accession of capitalism and the industrial strengthening that gave beginning to the production in mass and determined the need to adopt new forms of rationalization of the work, from the implantation of the development model, about 1950; an untimely managerial summit took place in Colombia that shot the demand for education in these areas, and motivated a new social division of the work.

In 1958, birth the first Industrial Engineering Program in Universidad Industrial de Santander (UIS) the teachers were coming from the careers of Chemistry and Chemical Engineering of the same university. In the same year, with the accomplishment of the first seminar of Scientific Administration, there is created the Instituto Colombiano de Administración - INCOLDA - that gave like proved the creation of the Career of Industrial Administration of the Faculty of Mines, now it annexes to the Universidad Nacional sectional of Medellín. In 1960 believe itself in Medellín the Escuela de Administración, Finanzas y Tecnología - EAFIT - and there is established the career of Industrial Engineering in Universidad de Los Andes. Hereby, the university device of the country was adjusting to industry requirements, which was coming applying the principles of work rationalization: the trades description, times and movements of the work, the cost measure is necessary of every operation and establishment of work standards and production incentives.

During the 70s years as a result of the United Nations for the Development PNUD technical cooperation project, that which sought to direct top education to the occupational and technical thing as base of the economic growth, the increase arises from the demand of careers that are relatives with the administration of the industrial technology (specialized engineering), since it was the case of the industrial engineering, with the administration and 'rationalization' of the State's economy and of the private company (economy and relatives disciplines) searching of answers to the social demand for education and for solution of the social problems derived from the new form of economic growth.

The processes of rationalization that gave origin to the industrial engineering in Colombia and then those of

diversification that have marked his transformation, allow to demonstrate the difficulties in the configuration of a knowledge field, clearly differentiated from other engineering and still of other disciplines as management administration or the economy, and justify asking if it is possible to think in the consolidation process of industrial engineering as a field of knowing in Colombia?

Current events like the Reform to the Law 30 of Higher Education and the incursion in the Free Trade Agreement, make think about the type of formation that we want for our industrial engineers, from the reproduction of the models obtained from the industrialized world, or from alternate speeches, result of reflection and knowledge the structures that are behind the configuration processes of discipline and that they will carry his consolidation, or perpetuating his dependence.

## **2. Methodology**

### **2.1. Industrial Engineering as a Field of Knowledge**

Bourdieu's field theory contributed theoretical substratum from which there are analyzed the diverse tensions that gave origin to the discipline, likewise, the notions on subjectivity of Foucault, while, with the restoration of the development speech, the educational expansion, the urbanism and the industrialization during the consolidation of the modernization, in the second half of the 20th century in the country, were imposed and appropriate new speeches and fields of knowing, as that industrial engineering.

The conformation of the social specific fields of every discipline of knowing or profession, as that of the industrial engineering they serve to realize of the degree of inculcation or permanence of a specific habitus, produced in the disciplinary processes of reproduction, carried out in the social university space. Or saying of another form, the conditions and characteristics that favor the emergence of the processes of reproduction, for the speeches that it creates, turn also into the possibility conditions of the discipliner social field.

One of the decisive events in the structure of these new discursive objects, constituted it the appearance of the modernity notion in the moment itself of capitalism consolidation and the appearance of technology notion in the economic field, Weber for example, who emphasizes the value of technology in exaltation of the capitalist spirit in Europe at ends of 19th century, whereas Marx defines the process of simple accumulation as condition of existence the capitalism that characterized the modern world. And Touraine for whom the instrumental rationality bases of the capitalism, which defined the industrial companies, is sustained in the technology, which began to the fret with the objective rationality of the sciences.

Other studies like (Vásquez, 2007) make a Foucault's analysis of the archaeology offer that on having delimited the margins, the edges, the excluded from the speech, which the history has not used, allows to see the fissures and the problems in the constitution of the human sciences and reveling his instrumental rationality as offer of illustration and as practice of slavery. This rationality carries Foucault to placing the conformation of the subjects in the power / know dispositive, in the technologies of domination and in a detailed consideration of the modern individual as product of a multiplicity of dividing and individualizer technologies, of subordination - subjectivity, questions traditionally ignored by the macrotheoretical perspective of the social critical science.

This study raises also that the Foucault's analysis, it allows to contrast like in the study of Habermas's communicative action, there exists a devaluation of decisive elements for the analysis of the modern relations of power, that surely Habermas, in reason of his loyalties to the theories of Austin and Searle's "speech-act", attributes to them a character idealistic and neutral in excess, disregarding the effect of the bodies administration in the relations power of modern society, when this might constitute an enrichment of perspective to the communication theories.

Industrial engineering as a discipline responsible for the management, planning and control of resources in an organization, that being based on the principles of economic rationalization, would have its origins in the implementation of industrial capitalism in our context and would be associated with the installation time of development speech during the period of modernization in the second half of the twentieth century. This paper is an invitation to make a different reading of the events that brought about the development and the idea of progress that was inserted immediately in the minds of those who were recognized as underdeveloped at that time, especially in technical and management areas like industrial engineering.

## **2.2. Configuration of Industrial Engineering Education Field**

All configuration process starts from the analysis of the facts that characterize and give shape to a notion or concept that prior to said facts did not exist, that is, it is the study of the processes that favor the appearance of a concept, in our case it was split of the historiographic analysis of the processes that gave rise to the education in industrial engineering to focus on this aside in making the logical construction of the field concept of industrial engineering education from the notions of *habitus* and *field* contributed by Pierre Bourdieu, eventually will be made use of power and discipline notions from Foucault, as guides in the analysis and understanding of process.

Thinking in terms of *fields* is to think relationally: they are structured spaces of positions, to which a number of properties are linked, that can be analyzed independently of the characteristics of those who occupy them. A *field* is defined, among other things, by what is at stake and its specific interests, which are irreducible to the commitments and interests of other fields. Each field engenders the interest that is its own, which is the condition of its operation and is composed of people who share the game and is willing and able to play it.

Thus, thinking about the social field of industrial engineering education is to be located in the university social space, in the daily work of its agents, professors, deans, directors and students of an industrial engineering program, structured by the interests that these agents put into play, by the strategies they use to position themselves in the same and by the relations of force generated within them, generating inequalities and ruptures in the exercise of power, blurring and hiding it. This field, which is structured by the force relations engendered by its agents by making use of their accumulated *capital* as differentiating and stratifying strategies that blur and create different forms in the exercise of power, is in turn the structuring of these same agents because it establishes the emergency conditions of their *habitus* and durable dispositions.

*Social capital* is the differentiating principle of social fields, Bourdieu liberates a concept from the economic connotation itself and extends it to any type of good susceptible to accumulation, around which it can constitute a process of production, distribution and consumption, and for so much, a market. In this sense, social fields can be considered as specific capital markets. That is, not everything you need is necessarily a field, it has to be a valued, sought after, that, being scarce, products for its accumulation, that achieves a certain division of labor between those who produce it and those who consume it, between who distribute it and who legitimize it. In other words, it has to constitute a market around that good so that a specific field emerges.

Cultural capital is linked to knowledge, science, art, and is imposed as an indispensable hypothesis to account for inequalities in school performance. Cultural capital, as (Gutiérrez, 2006, p.37) describes it, can exist under three forms: in an incorporated state, that is, in the form of durable dispositions (*habitus*), with a type of knowledge, ideas, values, abilities, etc.; in objectified state, in the form of cultural goods, paintings, books, dictionaries, instruments, etc.; and in an institutionalized state, which is a form of objectification, as is the existence of different school titles, this leads to the existence of social institutions that are recognized as having the legitimate capacity to administer that good. These are institutions of consecration and legitimation specific to the field, stories such as the University, and their appearance and permanence are closely related to the same field activity and their relative autonomy.

In Colombia, knowledge-power field in industrial engineering is based on the diversification and stratification processes characteristic in second middle of twentieth century –the capitalism consolidation period in our societies–. The establishment of the modernization model that involved the removal of all the infrastructure required to carry out the extraction of our natural resources; urbanism: that forced the displacement of large numbers of people from vast rural regions and their concentration in small urban centers; industrialization: which, accompanied by large infrastructure projects, employed large quantities of labor, with clearly differentiated and hierarchical levels and with imported technology, which led to the hiring of foreign professionals specialized in its installation and operation, a phenomenon that increased even more the stratification between the different levels within the newly created industries and; schooling: from which, educational institutions were created and diversified with the new demands for education of the different levels of labor employed. All these processes gave rise to the social division of labor in different layers and social nuances.

The imposition of the development model in our societies obeyed the need to increase and improve the production of the "developed world", in such a way that it made necessary the social division of work around these new functions created and / or specialized from the model, university was reformed to meet this requirement.

In this sense, as explained by (Vasconi, 1975, p.15) the demand for technical training for work is something "objective" within the development of the productive forces, does not depend on the dominant mode of production and therefore does not fall within the division social of work. Contrary to what happened in our education, in which

our society being governed by the private and extractive interests of the developed world, this "objective demand" depended on the social division of labor and the organization of production and not on the technical division of work, as it should have been.

Culture then has a nature of exchange value through the transmission of school knowledge, which operates thanks to the selection in the system of diplomas. Education is produced by its exchange value and not by its use value. Thus the school system is supported by the legitimacy of an unequal's hierarchy. The merchandise of instruction is inextricably linked to the system and is presented as the fundamental instrument of its reproduction. In this logic, the level of educational achievement is defined by the academic credential that is acquired.

All of above allows identifying a field of industrial engineering education marked by the strategies of both diversification and hierarchy resulting from the social division of labor characteristic of all modernization processes carried out in Colombia since the mid-twentieth century, where main but was the production of academic credentials of different value and the reproduction of unequal subjects. In this way knowledge is produced only in terms of its exchange value and not its use value, therefore, we find an industrial field lacking its own technological developments that nurture innovation and learning processes in the educational field.

Some authors like (Escobar, 1996, p.113) emphasize the emergence of the development concept after the second postwar period; it was initially formulated in the United States and enthusiastically accepted and improved by the elites and rulers of the Third World, from then on. According to Escobar, total of the cultures and social formations of three continents were transformed according to the dictates of the so-called First World through a process known as "modernization".

Both Martinez and Escobar agree that the nascent order of capitalism and modernization, inserted in our societies after the discourse of development, depended on a policy of struggle against poverty rather than industrial and technological power, whose intention was not only to create consumers, but to transform society, converting the poor into objects of knowledge and administration. Poverty was associated with traits such as mobility, vagrancy, independence, frugality, promiscuity, ignorance, and the refusal to accept social duties, to work and to submit to the logic of expanding needs. Therefore, the administration of poverty demanded intervention in education, health, hygiene, morality, employment, teaching good habits of association, saving, raising children, and so on. Economic growth presupposed the reproduction in poor countries of the conditions that characterized the advanced capitalist countries (including industrialization, urbanization, agricultural modernization, and infrastructure, the growing supply of social services and high levels of literacy).

With imposition of development model the modernization process seized by the United States in the mid-twentieth century in Latin America were introduced into our societies notions such as mass production and consumption and the consequent appearance of the disciplines responsible for carrying them out such as industrial engineering, later, with the decline of socialism in the world, the model of modernization assumes new forms and is transformed into that of globalization and the discourse of development is nourished by new content such as self-management and self-sustainability. The speeches for the education in industrial engineering are also filled with new concepts and begin to favor highly productive production processes that respect the environment and the training of independent liberal professionals or entrepreneurs.

## **2.2. Habitus of industrial engineering professors**

By *habitus*, Bourdieu understands the set of generative schemes from which the subjects perceive the world and act on it. These generative schemes are generally defined as structured structuring structures, they are socially structured because they have been shaped throughout the history of each agent and involve the incorporation of the social structure, of the concrete field of social relations in which the social agent has been conformed as such. But at the same time they are structuring because they are the structures from which the agent's thoughts, perceptions and actions are produced. This structuring function is based on the processes of differentiation in terms of the conditions and needs of each class.

Modernizing forces such as urbanism, industrialization and schooling that made available to the agents and institutions that were creating or affecting their passage, new discourses and forms of subjectivity, that motivated different social practices in the subjects involved and new forms of knowledge circulation, in the creation of new habitus that according to Bourdieu account for the degree of inculcation achieved once the pedagogical action ceases, by the internalization (subjectivation) reached such as to guarantee its application in practice.

Industrial engineering becomes one of those new forms of disposition or habitus that "it was necessary" to assume the agents responsible for industrialization, to "become necessary" the application of Taylor's principles of economic rationality in the newly created factories, which very soon they were constituted in organizations that produced a wide spectrum of goods and services and then they were denoted with the distinction of companies, becoming an object of schooling knowledge and therefore a new discipline.

The principles of efficiency and productivity on which the economic rationality of the industrialization process is based, became the main capital and constituent element of the habitus or action domain of the industrial engineer.

The social space of the post-war university in the new developed society assumes the responsibility of integrating knowledge into the productive world to guarantee the scientific and technological progress that would allow the long-awaited progress and economic growth in the country and the industrial engineering education field, then arises at the heart of this structure to be configured at the intersection of capital, work and knowledge represented by universities and all instances of it.

To know the constitutive elements of habitus, the social capitals that configure them, know about their processes of conceptual construction around the purposes of training, the characteristics of the curricula and the scope of the regulatory frameworks in their institutions, it was considered fundamental to analyze the distinctions that professors make in their academic practice, from the direct observation of the institutional contexts of industrial engineering programs and their experience as educators. For this, three universities were chosen.

In the study of the concept of habitus as structuring and structured from social practices, the starting point of this theory is the abandonment of the classical distinction -developed strongly in behavioral approaches- between subject and object. In effect, from the notion of habitus it could be affirmed that there is no distinction between the external and internal universes of the individual (or the group), in the process of discursive construction. The subject and the discursive object are not fundamentally different. This object is inscribed in an active context, partially conceived by at least the person or group, as a prolongation of their behavior, their attitudes and the standards to which they refer. In other words: the stimulus and the response are inseparable. They are formed together. Strictly an answer is not a reaction to a stimulus. It is to some extent at the origin of it. That is to say, that this is largely determined by the response.

In the social sphere, the habitus has a functional aspect by giving meaning to the behaviors of individuals or groups in a way that allows them to understand reality from their frames of reference, and adapt and define a place for themselves; that is, an identity. In addition, it constitutes a guide for action, guides social dispositions and, at the same time, makes it possible to determine anticipations and expectations about it.

If, for example, an individual (or a group) expresses an opinion (that is, a response) about an object or a situation, that opinion is in some way constitutive of the object, determines it. The object is then reconstructed from the opinion, in such a way that it is consistent with the evaluation system used by the individual. That is, by itself an object does not exist. It is and exists for an individual or a group and in relation to them. Thus, the subject-object relationship determines the object itself.

Social practices are collectively constructed, oriented and generate behaviors. In this sense, the study of the social practices of the professors of industrial engineering would express the changes produced by the processes of modernization and the labor flexibilization experienced in the space of the universities from the middle of the last century.

The analysis and interpretation in the social practice, during the academic work allow understanding the interaction and connections between the individual and the social conditions in which the university professors change; At the same time, understand the processes given in the socio-cognitive adaptation of university professors to everyday realities and their social and normative environment.

Reflection on questioning: What are the constitutive elements of the habitus university professors trained in the field of industrial engineering or in the field of industry in Colombia, from its beginnings to the present, about the realization of academic work in the universities? It was carried out from the content analysis of interview texts as hermeneutic units from Bourdieu's habitus perspective, for whom distinctions elaborated or induced in situations of interaction, such as interviews, play a frequently more important role than adopted by the subjects in the groups.

The study of relationships in practices leads to the double problem of articulation and interaction between the different constitutive fields of social reality. In other words: if it is found and admits that the habitus determines behavior, what role do they play in the elaboration of effective social practices, that is, in complex systems of action socially invested and subject to social and historically determined challenges? The analysis of the content of the interviews carried out with the professors intended to orient a panorama from which to read what they think, how they think and how they are represented in the field of industrial engineering in Colombia.

For the study of the dispositions of the professors of industrial engineering, the notion of habitus as a socio-cognitive set, organized in a specific way and governed by own operating rules.

### **3. Resultants**

From the critical-hermeneutic (deconstructive) historical research methodology used in this paper work (Foucault, Deleuze and Escobar's work on the deconstruction of development), history is conceived not as a linear set of succession of events ordered in time, history is read as a social process, from its ruptures, from the traces, from the edges that reveal its existence and discourse, in which the concepts emerge from the practicality or the conditions of possibility that donate to the process.

Deconstruction-interpretative (historical-hermeneutic), assumed from the theoretical construction made from the structuralism school (Bourdieu, Durkheim, Weber and Foucault) distinctions or notions emerge from the search from the edges, from the unspoken, from the footprints that the process leaves in the minds and discourses of the subjects, that to not be explicit, makes that the method seeks to explain them and to achieve it makes use of the constructed theory, in a process that is not ordered, nor linear, in the concomitant dialogue between it and what was said to make explicit what was not said.

In the present study, a program was used for the graphic and statistical analysis of complex systems (data mapping) called Ghephi, the mapping of the data in a graphical network, it is a procedure that allows to disaggregate and measure in a statistics the levels of interaction of the elements in a situation or phenomenon, in any field (social, natural, technological, productive, market, etc.).

From the information obtained in the data cartography it is easy to make the interpretation of the phenomenon and make decisions about it. The statistical principle on which the data cartography is based is the clustering analysis, based on the study of the modularity or topology of the network or structure of the database, that is, the concentration in groups and interactions, clearly differentiable. From the concepts expressed by the professors of industrial engineering during the interviews through the use of the Ghephi program, the analysis network was built.

Modularity is a statistical measure of the structure of networks or graphs. It was designed to measure the strength of the division of a network into modules (also called groups, groupings or communities), through the analysis of clustering. Networks with high modularity have solid connections between the nodes (in our case it is about the concepts or words used by teachers during the interview) within the modules or groups. Modularity is often used in optimization methods for the detection of the community structure of networks. The three groups of words or modules with modularity of 0.652, which were identified within the structure with the help of Ghephi program and in the light of field's theory, from the notion of habitus, allowed for validate the categories of analysis:

**First group** it presents the notions from which the professors understand the processes of configuration and transformation of industrial engineering as a field of knowledge in Colombia. (Category: "Configuration of industrial engineering as a field of knowledge")

**Second group** seeks to account for the constitutive elements of the habitus of industrial engineering professors and serve to characterize these professors. It is analyzed from the notions that according to them constitute the task of the professor of industrial engineering (Category: "Professors of industrial engineering education field ")

**Third group**, interspersed with the first, but that arises from some unusual concepts such as this one of "deindustrialization" analyzed in the theoretical corpus as an answer for possible other discourses from which to read for the discipline. (Category: "Others speeches for industrial engineering education in Colombia")

It is easy to observe from Figure 1, how the frequencies greater than 100, correspond to **First group** related to the configuration processes of the discipline, the **Second group** between 100 and 10, they constitute notions would allow to characterize the industrial engineering professor's habitus and there would be **Third group** of some unusual terms with frequencies less than 10 such as "deindustrialization", which would arise in response to the question about possible speeches or other speeches for industrial engineering based on its beginnings the development discourse in mondialization model. The three groups of concepts are also coincident with the three research categories.

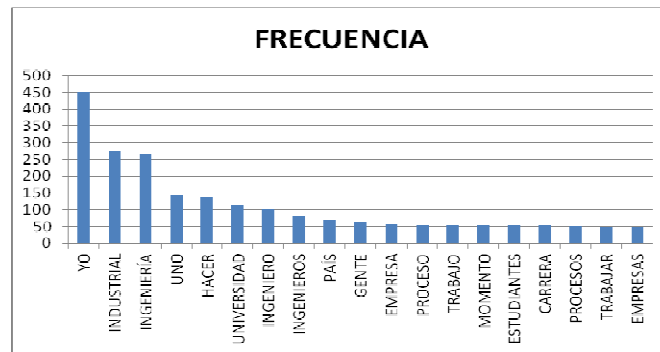


Figure 1. The most frequent notions

After entering the table of frequencies and their relative relationships developed from the QDA (Qualitative Data Analysis) Miner program, presented in Figure 1, we proceeded to define the central core of the interviews conducted content, which is presented in the Figure 2, identified by the Gephi program, this scheme allows visualizing the three groups mentioned, corresponding to the three categories of analysis and the peripheral elements that constitute them. These elements also hint at the themes identified within each category.

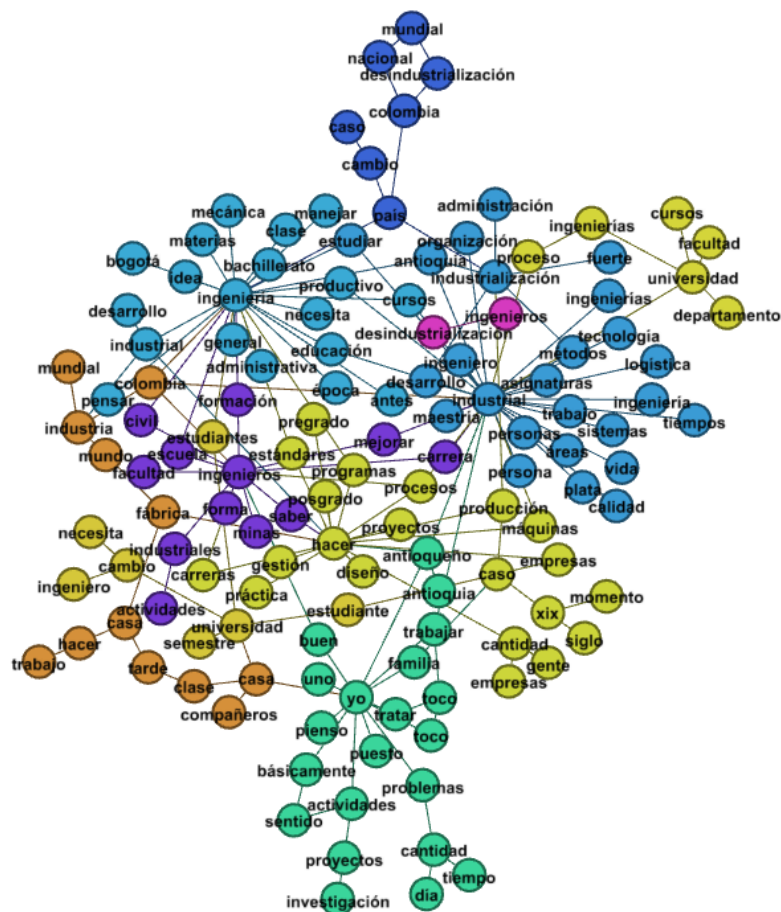


Figure 2. Central nucleus of interviews content





that plays in the structure of the habitus of teachers, is characterized by the integration of other peripheral elements such as <factory>, <management>, <projects>, <processes>, <programs>, <machines>, exercising the function of concretion of nucleus. (Figure 5)



Figure 6. Notion of <make>

Making a revision of the conceptions that are held about action domain of industrial engineering, to understand the scope of the professor's work as a former or deformer agent of the qualities and knowledge that an industrial engineer is supposed to have. It is based on the definition made by the American Institute of Industrial Engineering in 1961 about what is meant by industrial engineering: "Industrial engineering refers to the design, improvement, and implementation of integrated systems of men, materials, equipment and energy. It is based on specialized knowledge and skills in the mathematical, physical and social sciences, together with the principles and methods of analysis and design engineering to specify, predict and evaluate the results obtained from such systems. "

This definition makes clear that the industrial engineer intervenes on production systems (integrated by men, machines and other resources) and that it uses scientific and social knowledge to operate in said systems. But nevertheless, as announced in the introduction, it directs all the content towards the achievement of the ends, underestimating the means, in this case the fact that the industrial engineer intervenes in social systems, leaving aside the study of the actors, their interests and knowledge and the ideologies or policies that frame any intervention in the social.

The document on the specifications for the (ECAES test, ICFES-ACOFI) industrial engineering sufficiency test in Colombia establishes the minimum contents that any industrial engineering program should have, reducing the field of action of the professor in this discipline, to three specific areas:

1. Basic Sciences: Mathematics, Physics and Chemistry
2. Professional: Production and operations research.
3. Complementary areas: Organizations, Economy, Markets, Finance and Humanities

The humanities are considered as complementary areas of support to the central nucleus of the formation, which, since they are not directly linked to it, are reduced to a decontextualized course without major impact. That is why teachers' accounts focus on practical notions from the <make> and their concepts associated with practice, such as machines, processes, factory, company and production, management or design; the reason for being industrial engineering professors and their work (habitus) reduces it to that context.

### 3.2 Habitus of Professors

For analytical approach of academic work of professors were used habitus and dispositions notions from Pierre Bourdieu. "The habitus is the substratum of the everyday, in which men and women "say" and "speaks" their existence; being the everyday for the individual his most private space, but simultaneously the most public". This notion guided the analysis of the teachers' stories because it allows them to be located within their work from their own histories and life trajectories.

This **Second group** or cluster of relationships as central element of professors' habitus, is functional in nature, refers its daily life, social, cultural and symbolic capitals and your aspirations. It is expected to observe how one of the most repeated words in the teachers' discourse is <I> and <myself> (Figure 7), habitus is structured from the

experiences lived by each one, from their lived histories converted in practices, they are the social class made body and to that extent, denote the high degree of self-esteem that has these teachers and the conviction they have that the work they perform is very important, characteristic equally observable in most teachers regardless of the discipline in which they move, in general it could be said that teachers, especially university teachers have a very good image of themselves, which would be a fundamental part of their habitus.

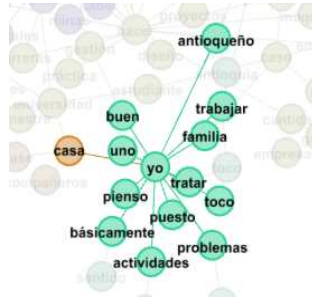


Figure 7. Notion of < I >

The notions that surround the word < I > make the role of peripheral elements, they exert the defense function of the central core of professors habitus, because it is through themselves exemplification and of their lived experiences that they support and defend their postulates. In the teachers' explanations, each one from his family trajectory and his personal experience, his values, skills and knowledge exposes how and why he chose to be an industrial engineer and later become a teacher, letting us see how they shape their habitus and what they become accumulated social capital to be able to play inside the field.

Within professor's discourses arises also the regional origin thematic, that according to Everett Hagen, it depends largely on the social groups and cites characteristics. In the case of Antioqueño's entrepreneurship, determined by Moorish migrations influence and geography of region, these regional characteristics professors convert into accumulated social capital in durable dispositions form from the values and skills incorporated into the habitus.

The subjectivation processes carried out by professors in their habitus conformation, these processes are reproduced so that students have the same effect. Instrumental rationality present in useful sciences, such as mathematics or statistics, bases of industrial engineering, it works as a normalization device preventing critical reflection and paralyzing the collective capacity and solidary action of subjects, keeping them isolated, immersed in productivism/consumerism desire to increase their profits. Reflection of this is the almost absolute absence of questions or criticisms made by the professors regarding the way of doing industrial engineering.

Contrary to happens with human and social areas in public institutions characterized by maintaining an spirit of criticism against notions such as development, progress, growth, competition, and internationalization; engineering areas in the same institutions are characterized for being less critical and complacent with government policies that promote the interests of foreign exploitation companies, in many cases. Most professors interviewed give meaning to industrial engineering practice from these processes, there were some who tried to criticize the discourse on productivism, however, they fail to be forceful in their position to present as favorable the whole process of industrialization and extraction of natural resources, without further questioning,

About internal dynamics in academic work, most of the professors practice self-care, practice exercise, except for retired professors, who for their advanced age do not, for the majority of non-retired professors, their work schedules are quite tight because they must fulfill diverse academic responsibilities distributed between administrative, teaching and investigative functions. Mostly of them describe the ways in which they assume their work and the procedures they use during the same, from practical case studies methodology, of that, students themselves construct and solve based on an existing literature, teacher' work is displaced by the facilitator' one, giving authority for knowledge construction of to the authors' texts, which are generally translations of English manuals based on rationality principles of development that governs the discipline. They reveal the degree of dependence on the knowledge imparted during the academic practice, denoting the absence of the teacher's voice within it, to the point that the same teacher complains about his absence and rewards the self-taught student, who builds his objects of study from the literature available, denoting another mondialisation model characteristics, that operates from normalization and standardization of products, including education, which is delivered as standard packages ready to consume.

A constant in the problems revealed by teachers during the exercise of their work was the economic problem, from the difficulties of not having sufficient resources, which prevents access to information, such as subscription to journals or databases to meet the academic production standards that each teacher must cover. From the need to provide income to their institution from different activities related to research, extension and management of various resources, including the boost to enrollment, however, some express satisfaction with this way of academic production, incorporating all this doing to their habitus and converting it into social capital.

Regarding the difficulties in student motivation, professors highlight the difficulty in mathematics area and make it look like a challenge to overcome in order to be recognized as engineers, as a hard test that they as students must have approved and that their students must also approve. Recall that education in useful sciences (mathematics and its derived disciplines such as engineering) is one of the most effective strategies for disciplining and normalizing the population because it legitimizes the difference in capacity, hierarchy and stratification.

### **3.3 Others speeches for industrial engineering education in Colombia**

The questioning by rationality principles that have ruled industrial engineering until nowadays, the search of other principles and the vision of future for the discipline, in this **Third group** of peripheral elements is evidenced from the notion proposed by one of the professors, of <deindustrialization> (Figure 8). Which presents from its relationship with the socialization processes, both technology and knowledge itself, questioning Calvinist production processes, in which according to him, only interested is surplus value generation, ignoring the human being behind the machine, with creativity and with ability to transform technology, based on a very good knowledge of it, otherwise it ends up being enslaved by it, which is what is currently happening.



Figure 8. Notion of <deindustrialization>

In recent times, when the promotion of critical thinking in engineering education has taken on importance, from the understanding that engineering, —moving at the intersection between the social and the technical—, should adapt technical knowledge to the economic, political and cultural contexts in which those are applied, that is, education in engineering should contemplate the study of the ideological conceptions that are behind the forms of power that motivate any implementation of engineering designs, the study of the actors involved, their interests and purposes and of the ways in which knowledge has been used to legitimize or delegitimize those interests or purposes. For which an analysis was advanced from various aspects of contemporary critical thinking, from the notions of technology and its transformation into power technology, in Foucault and other structuralism tendencies.

The proposition in this part of paper is deconstruction of industrialization notion or <deindustrialization>. For example, an industrial engineer who participates in the design and start-up of a plastic packaging manufacturing plant, since he does not have the tools for critical analysis of his work, he goes directly to execute what they demand without questioning the environmental effects and social causes of his work. The study plans, as shown by the (ECAES test, ICFES-ACOFI) mentioned above, do not provide the student with criteria to propose alternative models of production and consumption based on closed cycle processes or use value of goods.

As the currents of critical thinking in engineering education point out, ignoring whole series of both affective and cultural plots within the discourse, by completely, —processes clearly observed in most interviews, especially in the younger agents interviewed—, entails to reduce the professor' work in industrial engineering to the simple reproduction of economic linear precepts —typical of the field—, being able to conclude that field's agents

persist and above all they insist on continuing reproducing and with new technologies, such as computer and informatics science, from cold and rigid principles of instrumental rationality that characterize the field since its emergence, and, in that sense, speaking of other discourses for the discipline is increasingly difficult.

The serious danger involved in this problem of pretending to ignore the affective and social components present in all human activity within the discourse of industrial engineering professors, is nothing less than to underestimate the whole educational process, taking away its power of social identity construction and transformation—characteristic in every educational process—, it means, reducing it to a simple production of robots.

#### **4. Conclusions**

With the configuration of the socialist bloc in world, after the second post-war period and the danger that for United States, as the nearest world power country, represented that this ideology was spread in Latin American countries, several studies and projects of cooperation and promotion to the industry were promoted. Education in technical and technological areas such as the Currie Study in 1951 "Bases of a promotion program for Colombia" and Atcon's basic plan on the Latin American university in 1961, favouring the emergence and demand of careers such as industrial engineering in the country. The emergence moment of education field in industrial engineering was marked by the influence of these reports.

With communism fall in the world in 1989, the interests of United States to contain its proliferation in the underdeveloped countries through the policies of protection to imports and boost local industry (Mission Currie and Alliance for Progress), were untimely changed by the (Washington Consensus) promulgated now by the total opening of these economies, towards a completely globalized international market, devastating almost completely the local industry and forcing the education sector to further diversify and self-manage; so that, industrial engineers who were previously trained to run large companies or act as employees in them, now, they become trained to act as small entrepreneurs or independent consultants in the new neoliberal paradigm of globalization. The teachers' speeches are also updated in the same way.

The central nucleus of industrial engineering professor's habitus is composed mainly of a high symbolic and abstract reality content, in what could be called a capacity for mathematical modelling, predictive and prescriptive, which is used to build their stories and which converts in social capital to perform in the field. This capacity for modelling leads him to perceive the world only from its commensurable dimension, always susceptible to being improved and standardized, reducing its possibilities for analysis and critical reflection.

Based on the interviews carried out, it is easily discernible how the teachers of the most recent generations give themselves more and more and without any reflection to the demands imposed on them by the university system to be able to stay in it, without opposing any resistance preventing it from arising a guild conscience and overshadowing any attempt at cohesion, each one works individually to meet academic standards, only meets with colleagues for the same purpose, is not interested in appropriating spaces for construction or deconstruction of the knowledge taught.

Older and retired teachers are those who have greater capacity for reflection about their work, however, there are no institutional mechanisms to be heard and taken into account their assessments and recommendations within the universities. There are stories that show, that it would be better in this moment of global crisis, to speak of deindustrialization, and to speak rather of a humanization of the processes.

The deindustrialization notion of productive processes and the return to more traditional modes of production, presented by one of the professors, where manual labour prevails and not mass production, is an interesting alternative for the deconstruction of developmental and globalization paradigms that characterize the current economic sector, which among others has relegated our economies to stop being producers to be outsourcing (our economy is concentrated in a precarious tertiary sector and in a high degree of informality of trade and services, because there is not industry). It is constituted in another fissure or point of break that could motivate new speeches for the professors of industrial engineering education field.

Present work becomes a call to the professors of industrial engineering, to abandon the comfortable position of experts, prescriptive and modeller of reality that keeps them safe in their pedestal of teachers, to stop hiding behind the institutions of higher education, that, —they have not been anything else than the great nurseries of people, containing their actions—, to motivate their students to work in the deconstruction of the consumer and inequitable reality imposed with the development and globalization model, to think in new forms of production, to return to countryside, to get in touch with the peasant ancestors, to recover the knowledge lost during all the processes of violence and exile that we have suffered and to mobilize among all the recovery of the lost territory.

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