Urban Engineering: A different proposal of teaching undergraduate Civil Engineering at Federal University of Sao Carlos - Brazil

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Abstract

A different proposal of teaching undergraduate Civil Engineering that has been offered by the Department of Civil Engineering at Federal University of Sao Carlos is discussed in this paper. Alternatively to the traditional teaching of Civil Engineering in Brazil, since 1978 another teaching line has been offered. This new line is named Urban Engineering and interrelates traditional areas of Civil Engineering (transport, soil mechanics, sanitation and environment) with sustainable urbanism. This new proposal considers the technological advance when incorporating new techniques and procedures that search for the effectiveness of the infrastructure of the cities and the minimum deconstruction. This approach is of basic importance because 80% of the Brazilian population lives in urban areas, coexisting with severe ambient and social problems that only can be solved according to integrated visions of several areas of knowledge. To give continuity to the knowledge of specialized professionals, in 1994 the graduate course in Urban Engineering was created with its focus in the medium and the small-sized cities. This course attends the demand of a market more and more opened to absorb professionals with integrated knowledge and, in addition, recover the social paper of the engineer and other professionals, with a formation worried about the sustainability of the man made interventions.

Key words: Civil Engineering, Urban Engineering, minimum deconstruction, sustainability.

Resumo

Proposta diferente de ensino de Engenharia Civil oferecida pelo Departamento de Engenharia Civil da Universidade Federal de São Carlos é discutida. Em alternativa à linha denominada de Sistemas Construtivos, admitida como tradicional no Brasil, desde 1980 tem sido oferecida outra linha denominada de Engenharia Urbana, que inter-relaciona áreas tradicionais da Engenharia Civil (transporte, geotecnia, saneamento e meio ambiente) com o urbanismo sustentável. Esta proposta inovadora considera o avanço tecnológico ao incorporar novas técnicas e procedimentos que buscam a eficácia da infra-estrutura das cidades e a desconstrução mínima. Esta abordagem é de fundamental importância porque 80% da população brasileira está concentrada em áreas urbanas, convivendo com problemas ambientais e sociais severos que somente podem ser resolvidos segundo uma visão integradora de diversas áreas de conhecimento. Para dar continuidade à formação de profissionais mais especializados, em 1994 foi criado o curso de Pós-graduação em Engenharia Urbana que tem seu foco nas cidades pequenas e médias. Este curso atende à demanda de um mercado de trabalho cada vez mais aberto a absorver profissionais com conhecimentos integrados e resgata o papel social do engenheiro e outros profissionais, com uma formação voltada para a sustentabilidade das intervenções antrópicas.

Palavras chave: Engenharia Civil, Engenharia Urbana, desconstrução mínima, sustentabilidade.

1 - Introduction

The Undergraduate Course of Civil Engineering of the Federal University of Sao Carlos (UFSCar) was created in 1978 with a innovative proposal for the time of its conception. In addition to the disciplines of the traditional basic formation, the students can decide between two lines of work: Constructive Systems and Urban Engineering.

The line of Constructive Systems (CS) deals with aspects of modernization and integration of the phases of production of an enterprise, with intention to get products with more quality. To reach this objective, diverse unusual subjects in many other courses of graduation, such as ambient comfort and rationalization of the construction are offered.

The line of Urban Engineering (UE) is pioneering in the country and interrelates traditional areas of Civil Engineering (transport, geotechnic, sanitation and environment) with urbanism. Thus, the Urban Engineering seeks to follow the technological advance and to incorporate new techniques and procedures, aiming at the effectiveness of the infrastructure of the cities. This innovative proposal considers the technological advance when incorporating new techniques and procedures searching for the effectiveness of the infrastructure of the cities and the minimum deconstruction.

To give continuity to the formation of more specialized professionals, in 1994 the graduate course in Urban Engineering was created with its focus in the medium and the small cities. This course targets the demand of a market more and more opened to absorb professionals with integrated knowledge and, in addition, recover the social paper of the engineer and other professionals, with a formation worried about the sustainability of the man made interventions.

The line of Urban Engineering and the Program of Graduation in Urban Engineering of Federal University of Sao Carlos (PPGEU - UFSCar) consider that the intense urbanization that is changing the profile of the Brazilian cities, more evidently in the States of the South and Southeastern regions, bring, in addition to challenges, many problems for the society. Currently, in Brazil about 80% of the population is grouped in urban area and, such fact causes, not only environmental problems, but also increases difficulties of planning, implantation and management of the urban systems. So, in addition to social difficulties generated by the disordered growth, mainly in the peripheries of the cities, there is a series of questions related to the Civil Engineering and the Urbanism that can and must be reconsidered, such as: pollution of waters, ground and air; scarcity of hydrical resources;

floods; deficiencies of collective transport and problems of traffic; lacks of urban infrastructure, habitations; and inadequate ground usage.

Problems like these have been traditionally seen of sectorial way and, this approach for being shut in itself, generates conflicts and wasteful of resources. Moreover, it shows to be inefficient face to the complexity and to the interdependence of the great majority of the problems and demands verified in the cities. Therefore, an alternative to this traditional approach is the Urban Engineering, that deals with the cities in a holistic way, emphasizing the importance of create sustainable urban environments (PPGEU - UFSCar, 2005).

In Brazil there are other groups of educators who have the same vision on Civil Engineering and Urban Engineering. For example, the Program of Graduation in Urban Engineering of the Federal University of the Paraíba (PPGEU - UFP, 2005) admits that it is necessary a change of policies and methodology that develop an integrated knowledge of the urban problems, as well as the employ of processes of planning, effective and efficient intervention and management for an improvement of the quality of life in the urban centers, having as parameters the question of the environment preservation and the rationality in the solution of the urban problems.

In Portugal also there are educators that are worried about this theme. According to University of Coimbra (2005), Urban Engineering can be identified as an area eminently multidisciplinar that is related, nominated, with urbanism and the environment, the planning of the collective usage of the ground, equipment and the urban services, nets and flows. The Urban Engineering congregates areas so diverse as the Engineering of Traffic, Road Engineering, the Territorial Planning, the Urban Drawing, the Urban Hydraulics, etc. It estimates the application of so vast scientific knowledge of base as the ones that enclose the Analysis of Systems, the Statistics, the Ecology, the Systems of Information, etc. All this set of knowledge, related with the sustainable development of the urban areas and with the welfare of the populations, corresponds to a sector in which high progresses has been registered in the last years. In the truth, the notion of urban appears associated to the organization of space elements, and the scale is each time vaster, nominated, to the development of the new ways of transport, of telecommunications and of technologies of the information, what demands adequate approach of study to this reality.

This is the modern trend of the approaching of the urban question: integrated analyses of complex and wide-ranging problems, whose causes and consequences are interdependent. The

attempt to look for solutions for these problems using only few fragmented areas of knowledge, has found failures that reflect the impotence of this practical.

2 – Urban Engineering

Urban Engineering is a multidisciplinar area of knowledge that studies the urban occupations of a holistic way, to generate sustainable urban environments with the minimum deconstruction of the original environment.

3 - Urban Engineering in Brazil

In Brazil only the Department of Civil Engineering of the Federal University of Sao Carlos offers course of under graduation with emphasis in Urban Engineering. However, there are four courses of graduation that approach the subject Urban Engineering, as described in Table 1.

Analyzing the descriptions listed in Table 1, it is observed that the proposal of the University of Sao Paulo is the oldest. However, this program of graduation privileges the technological approach of the urban question.

The three other programs of graduation offered at Federal Universities have a common objective: to deal with the cities in an integrated way, considering technical, environmental and social aspects.

Specifically, the Undergraduation Course of Civil Engineering of the Federal University of Sao Carlos with emphasis in Urban Engineering and the Program of Graduation in Urban Engineering of the Federal University of Sao Carlos contemplate medium and small cities, and their main focus are the sustainability and the minimum deconstruction of the original environment. These aspects make them originals and pioneers in the proposals of urban studies.

4 – The teaching of Urban Engineering at the Federal University of Sao Carlos

The teaching of Urban Engineering at the Federal University of Sao Carlos was initiated in 1978 to offer an alternative to the traditional study of the Civil Engineering, which has analyzed the urban occupations throughout decades under a broken up way, disrespecting the complexity and interdependence of the demands and consequences of the human actions.

TABLE 1 – Undergraduation and graduation courses that approach Urban Engineering.

Year	Level	Comments
1970	Graduation in Civil Engineering and Urban Construction of the University of Sao Paulo	This Program of Graduation in Civil Engineering and Urban Construction develops its work privileging the technological approach of the urban question through three lines of research: i) Habitational management; ii) Urban management; and iii) Infrastructure and organization of the urban spaces . http://pos.pcc.usp.br/pg_stricto.htm
1978	Undergraduation in Civil Engineering with emphasis in Urban Engineering of the University Federal of Sao Carlos	The line of Urban Engineering is pioneering in the Brazil and interrelates traditional areas of Civil Engineering (transport, geotechnical, sanitation and environment) with urbanism. Thus, it looks for to follow the technological advance and to incorporate new techniques and procedures, aiming at the effectiveness of the infrastructure of medium and small cities. http://www2.ufscar.br/graduacao/engenhariacivil.php
1994	Graduation in Urban Engineering of the University Federal of Sao Carlos	This Program of Graduation in Urban Engineering deals with the cities in a holistic way, emphasizing the importance of if to create sustainable urban environments and with minimum deconstruction of the original environment, is the first one of the country with this approach. The lines of research of this program are: i) Studies of urban and regional processes and phenomena; ii) Planning and management of the urban and regional environment; and iii) Urban infrastructure technology. http://www.ufscar.br/~ppgeu/
2000	Graduation in Urban Engineering of the University Federal of Paraiba	The objective of this Program of Graduation in Urban Engineering is the formation of professionals, researchers or teaches with vision deepened and integrated about the diverse systems of the urban dynamics with five lines of research: i) Urbanism and Transport; ii) Management of the Water for the Urban Environment; iii) Management and reuse of Residues; iv) Technological, material and energetic efficiency in the construction of the urban space; and v) Urban equipments. http://www.ct.ufpb.br/pos/engurbana/index.htm
2002	Graduation in Urban Engineering of the University Federal of Uberlandia	This program of Graduation in Urban Engineering acts in two lines of research: i) Planning of transports; and ii) Evaluation and Planning. http://www.feciv.ufu.br/posgraduacao/estruturacurricular.php#EngUrb

4.1 Team of researchers

The team of researchers that works with Urban Engineering is of pluridisciplinar formation (Geology, Civil Engineering, Engineering Mechanics, Electric Engineering, Architecture and Urbanism) and acts in the following areas:

Collective Transport
Engineering of Traffic
Environmental Geology
Geographic Information Systems
Geological Urban Risks
Geology Applied to Urban Engineering
Geotechnical and Environmental Mapping
Habitation of Social Interest
History of Urbanism
Hydraulic Urban
Hydric Resources
Hydrology
Infrastructure of Sanitation
Infrastructure of Transports
Management of Risks of Municipal Accidents
Operation of Systems of Transport
Planning and Environmental Protection
Planning and Project of the Urban Space
Planning of the Transports
Residuary Water Treatment
Soil Sciences
Sustainability and Quality of Life Indicators
Treatment of Supplying Waters
Urban Drawing
Urban Management
Urban Sanitation Systems

4.2 – Undergraduation requirements

The attainment of the degree of Civil Engineer with Emphasis in Urban Engineering must take care of four requirements:

a) selection process;
b) minimum load of hours;
c) approval of project of the Conclusion of Course Work for board of examiners; and
d) approval of the Conclusion of Course Work by board of examiners.

The selection of the candidates to the Civil Engineering Undergraduate Course of the Federal University of Sao Carlos is carried out by a classification examination.

The course is offered in ten semesters. During the first four semesters the students of the Civil Engineering Undergraduate Course receive a Basic Formation of 1590 hours, common to all Engineering Undergraduate Courses.

In the three following semesters the students attend to more 1620 hours of disciplines of General Professional Formation common to all Civil Engineers.

The three last semesters are dedicated to the Specific Professional Formation (840 hours), when the students opt between the two offered alternatives, which reflect the increasing necessities in Brazil:

a) Emphasis in Urban Engineering and

b) Emphasis in Constructive Systems

Thus, these Civil Engineers fulfill the minimum requirement established by the Ministry of the Education of Brazil, that assures the right to them to the full exercise of the profession, still receive the contents from the Emphasis of its choice.

In addition to getting approval in all disciplines of the Basic Formation, of the General Professional Formation and of the Specific Professional Formation, each student must defend a Conclusion of Course Work, in which is discussed a real case according to the integrated concepts of Urban Engineering. This conclusion work has been developed in two semesters under the direct orientation of a professor.

The defense of the Conclusion of Course Work is carried through in two stages ahead of a board composed by three examiners of different areas of knowledge. The first one, to the end of the first semester, evaluates the plan of work proposed for the candidate to reach its objectives. The second one judges the results reached for the candidate.

4.3 - Graduation requirements

The attainment of the degree of Master in Urban Engineering must take care of the six requirements:

a) selection process;
b) minimum load of hours;
c) approval of project of research by board of examiners;
d) approval in examination of proficiency in English;
e) approval in examination of qualification by means of board of examiners; e,
f) approval of defense of master degree dissertation by means of board of examiners.

A commission composed of three professors carries through the selection of the candidates to the Program of Graduation in Urban Engineering of the Federal University of Sao Carlos. The candidates are evaluated through a written examination about Urban Engineering themes, analysis of *curriculum vitae*, and analysis of the proposed project of research. There are no candidates formation restrictions. Thus, professionals of accurate, biological, of the health, agricultural, social, human, linguistics, and arts sciences are accepted.

The Program of Graduation in Urban Engineering of the Federal University of Sao Carlos offers 22 disciplines, listed in Table 2, which can be attended in one of the three academic trimesters.

This quarterly model allows that the students conclude the obligatory and optional disciplines in only one year, what is very favorable to master degree dissertation development.

The minimum load demanded of each student is of 750 hours (360 hours of obligatory discipline and 390 hours of optional discipline).

Table 2– Obligatory and optional disciplines.

Discipline	Hours	Type
Urban sanitation systems	90	obligatory
Urban transport engineering	90	obligatory
Geotechnical prospection of urban areas	90	obligatory
Urban planning	90	obligatory
Geographic information system	90	optional
Special topics in urban engineering	90	optional
Scientific research delimitation processes	90	optional
Supervised stage for qualification of training of teaching in urban engineering	90	optional
Management and Control of Sanitation Systems	90	optional
Management of urban residues	90	optional
Pluvial water impact control on the environment	90	optional
Planning and management of the environment	90	optional
Environmental geology applied the urban areas	90	optional
Urban Thematic Cartographic Project	90	optional
Planning of the Urban Transport	90	optional
Project of Urban roads	90	optional
Urban traffic	90	optional
Economic pavements and Conservation of Urban roads	90	optional
Management, Quality and Productivity in Transports	90	optional
Urban Drawing	90	optional
Urban Engineering seminar	30	optional

The proficiency examination evaluates if the student has enough capacity to understand and to assimilate technician knowledge written in English.

The proposed project of research, developed with the supervision of a professor, is submitted to a board of examiners.

The examination of qualification is applied after one year of the admission of the student in the Program of Graduation and has as objective to evaluate the capacity of student to the continuity of the works development with sights to the attainment of the master degree.

The defense of Master Degree Dissertation has happened after two years of the admission of the student in the Program of Graduation and has as objective to evaluate the domain of the concepts and methods in the area of research chosen for the candidate to the master heading.

More than 130 Master Degree Dissertations in the Program of Graduation in Urban Engineering of the Federal University of Sao Carlos since 1994 were defended.

The subjects of the Master Degree Dissertation have been extremely varied, as it is observed in Figure 1. The classification of the master degree dissertation for subject considered the predominant approach of the work.

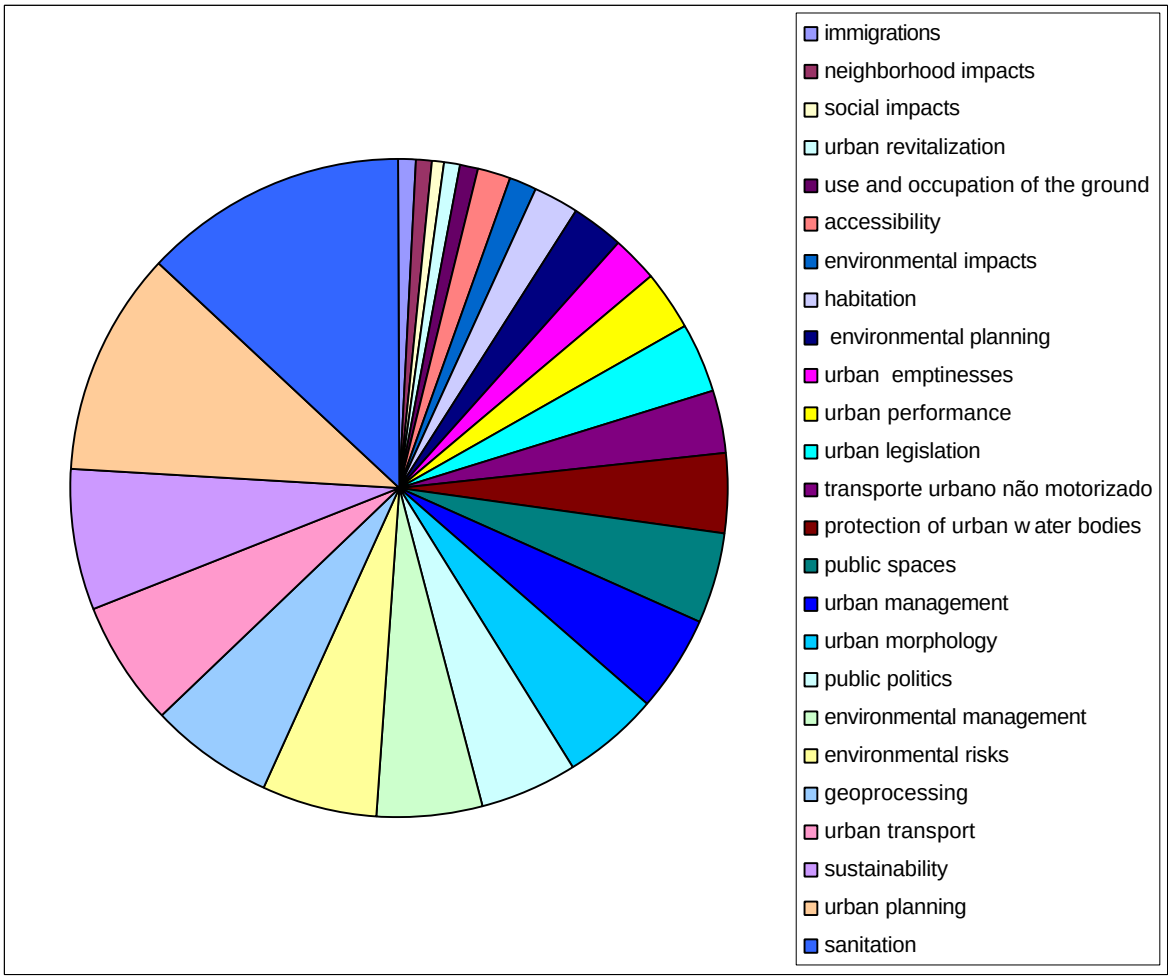

Figure 1 – Distribution of subjects of the Master Degree Dissertations in the period of 1994 to 2005.

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The more explored subjects had been: sanitation, urban planning, sustainability, urban transport, geoprocessing, environmental risks, environmental management, and public politics. It could be admitted that these subjects are classics and more known of the students at this time.

The Figure 1 shows, moreover, that new subjects have been analyzed: urban morphology, urban legislation, public spaces, neighborhood impacts, social impacts, protection of urban water bodies, urban emptinesses, and urban revitalization.

4.4 – Undergraduate and graduate interactions

The teams of researchers of both courses (undergraduate and graduate) are the same, what has allowed the integration on the development of activities of education, researches and extension with the effective participation of all students.

Many Conclusion of Course Works and Scientific Initiation Researches developed in the Undergraduate Course of Civil Engineering at the Federal University of Sao Carlos have been transformed into Master Degree Dissertations in Program of Graduation in Urban Engineering, what it has shown the harmony between both courses. Of general way, the Scientific Initiation Researches are linked to Master degree research, what consolidates the nexus and the integration between both of them.

5- Conclusions

The Undergraduate Course of Civil Engineering with Emphasis in Urban Engineering and the Program of Graduation in Urban Engineering of the Federal University of Sao Carlos can be considered recent, face the traditional teach of Civil Engineering in Brazil. It can be considered that this proposal has fulfilled the requirements of multidisciplinar formation of professionals that wish to treat the urban occupations in a holistic way.

Public and Private Organizations of Urban Management, Education and Research has absorbed the professionals undergraduated and/or graduated by the Federal University of Sao Carlos.

The teaching of Urban Engineering at the Federal University of Sao Carlos approaches to urban considering that the human interventions must happen in harmony with the original environment, looking for the minimum possible deconstruction, in order to prevent that the nature rejects the new configuration intended. The necessities of the human interventions and its effect must be evaluated in a integrated way and balanced with the conditions of contour imposed by the nature, which were defined in accordance with the ambient characteristics that if occur through the times.

Part of the studies are attempts to understand and to solve rejections to the human interventions, that come disrespecting the main element imposed in the process: the original environment offered by the nature; which are deconstructions that had taken the human intervention as the main and imposed element, ignoring the characteristics of the environment and its fragile balance. The rejection processes have hysterics characteristics. When a certain limit is exceeded due to the new conditions induced for the human actions, the environment searches for a new equilibrium, but in a irreversible history of events that cannot be interrupted when the cause that started the process is removed.

Other studies analyze the legislation, understanding it and criticizing it, of such way to guarantee that its fulfillments prevents the beginning of processes of search of new balances. With this same

purpose, several Master Degree Dissertations has produced documents that establish policies for the adequate usage and occupation of regions with high demand of human interventions.

The integration between the students of the Course of Undergraduation in Civil Engineering and of the Program of Graduation in Urban Engineering of the Federal University of Sao Carlos has been stimulate by the interaction of activities of education, research and extension of both groups of students.

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