



2019 10 al 13 de septiembre - Cartagena de Indias, Colombia

RETOS EN LA FORMACIÓN DE INGENIEROS EN LA ERA DIGITAL

A PROPOSAL FOR A FORENSIC ENGINEERING COURSE IN COLOMBIA. VERSION 2

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Abstract

This article presents a proposal for a course of forensic engineering in general format. This proposal can be used for Universities in Colombia or other countries. The communicative and pedagogical model are presented with their interactions in your second version. All the actors are justified and a thematic content is proposed. A schematic proposal is suggested with different levels of complexity. With the contributions of international experts, the topics have been complemented. The proposal presented is product of analysis and reflections done in different academic spaces where the research has been exposed.

The proposal is Constructivist and it is based in the knowledge theory of Aristoteles, the reflexive thinking of John Dewey, the strategic thinking of Peter Drucker and the Problem Based Learning.

Keywords: forensic engineering; Colombian universities; expert in structural failures; structural engineer; forensic engineering course; pedagogical model; communicative model; constructivism; ITC; lifelong learning; online courses for forensic engineering

Resumen

Se presenta la propuesta para un curso de ingeniería forense en formato general. Esta propuesta puede ser implementada por universidades en Colombia u otros países. Se presentan la segunda versión de los modelos comunicativos y pedagógicos con sus interacciones. Todos los actores están justificados y se plantea el contenido temático para el curso. Se recomiendan diferentes niveles de complejidad.

Este trabajo es la segunda versión de la propuesta de acuerdo con aportes de expertos

internacionales recibidos en diferentes escenarios donde se ha presentada la investigación, siendo producto de reflexiones y análisis académicos.

La propuesta es constructivista y se basa en la teoría del conocimiento de Aristóteles, el pensamiento reflexivo de John Dewey, El pensamiento estratégico de Peter Drucker y el aprendizaje basado en problemas.

Palabras clave: *ingeniería forense; universidades colombianas; experto en fallas estructurales; ingeniero estructural, curso de ingeniería forense; modelo pedagógico; modelo comunicativo; TIC; educación continua; cursos virtuales de ingeniería forense*

1. Antecedents

The recent events in Colombia of some structural failures shows the need of believe a new course for undergraduate civil engineers.

In 1995 and 1996, some vehicular and pedestrian bridges failed in Colombia for different causes. The maintenance, wrong calculations and natural events generated the failures.

In this moment in the National University of Colombia, headquarter Bogotá, formed a group of bridges, where experts and apprentices analyzed each case and they presented an inform to the governmental entities that would require this service, of this way apprentices were trained in forensic engineering. For many years, the collapses occurred, being some investigated and others not. The results were not public.

Later, in Colombia, when a collapse occurred isolated investigations were done but these were not public. The new generations of engineers have not learned of this failures for this reason. The importance to do publics the results of these investigations is fundamental for that a new engineer not make the same mistakes.

In October 2013, the Space Building collapses in Medellin (UniAndes 2014). This structure was an important residential building, the municipal hall of Medellin contracted the evaluation of the collapse with the Los Andes University, in Bogotá, this inform was public and all the engineers could know the causes of the failure. (UniAndes), this case had wrong calculations and constructive processes inadequate.

In February 2015, a pedestrian bridge in Bogotá failed (Tiempo 2015). This bridge has for name "Cantón Norte". Isolated investigations were done; the results were not publics. In the photo 1, it is presented this collapse.

In April 2017, a residential building in construction failed in Cartagena de Indias (Semana 2019). The event occurred for bad practice of engineering. The responsible constructor built 16 buildings with the same problems. The Cartagena's mayor contracted the National University of Colombia for the investigation in 2018, preliminarily 5 buildings were evacuated for constructive problems (CVSC-010-2018 2018). The investigation is in process yet.

In January 2018, The Chirajara Bridge collapsed, a vehicular bridge in the highway Bogota-Villavicencio, near to Bogotá.

For the investigations of the collapse causes, Colombia had few engineers with specific experience to evaluate this failure. For this reasons, some foreigner experts evaluated this collapse. Some results are publics how (MEXPRESA 2018), this is an independent evaluation. Some results of the builder evaluation are publics how (COVIANDES s.f.). Officialy, the academy presented not a version about this collapse.

In November 2018, a La Pala bridge shoring structure, in the highway Bogotá-Villavicencio, failed (Tiempo 2018). The results of this investigation are unknown.

The author has participated in some cases of them, but the confidentiality clauses of contracts prevent the divulgation of her results.



Photo 1. Failure of Cantón Norte Bridge. Source: Photo by Zulma S. Pardo V.

Between 2014 and 2017, the author evaluated some collapses of racks in different industries, the results are not publics. But mainly, the origin of these failures was the bad interpretation of standards and the application inadequate of the formulations. The photo 2 presents one case analyzed for the author.



Photo 2. Failure a rack structure. Source: Photo by Zulma S. Pardo V.

These events and the need of to train a beginner engineers about collapses in engineering motivated to Gran Colombia University (=UGC), to impart two courses about forensic engineering. The courses were realized between June to August 2018. In these courses, the author did some interviews about the development of them. She compared her academic program with the evolution in the knowledge of students, the first proposal for a course of forensic engineering of undergraduated engineers was presented in (Pardo 2018). In this article is presented a new proposal, where new aspects collected are incorporated.

2. The proposal

2.1. Educational philosophy

According (Pardo 2013), the author proposes the use of constructivist theory, the theory of the knowledge of Aristóteles (of the part to the all) and problem based learning (=PBL)

In the first stage, the proposal intents that across basic individual cases analysis the student can to obtain a basic knowledge about the structural behavior. This stage applies the theory of the knowledge of Aristóteles.

In the second stage, across Business cases, the reflexive thinking is developed, without to analyze collapses. Each student controls your cognitive processes, he plans how will learn, controls the learning and at the end he evaluate your new knowledges, in this part it es applied the metacognition.

In the third stage, the student begins to solve a short cases of structural failures across (=PBL), in groups minimum of three participants. In this part the reflexive thinking is applied considering the proposal of (Dewey). The teacher has to select aspects of the experience of students that permit the development of the ability to solve a new problem on the part of them.

In the fourth stage, more complex problems of collapses are proposed to the students. The solution of them, have a limited time and it is solved step by step and between groups are compared the different solutions. In this phase is apply the problem bases learning (=PBL)

In the Figure 1, it is presented the communicative model for the proposed course, there are relations between all actors during the preparation of the course.

The Figure 2, presents the student how center of all educative action and your relations with the teacher during the course proposed.

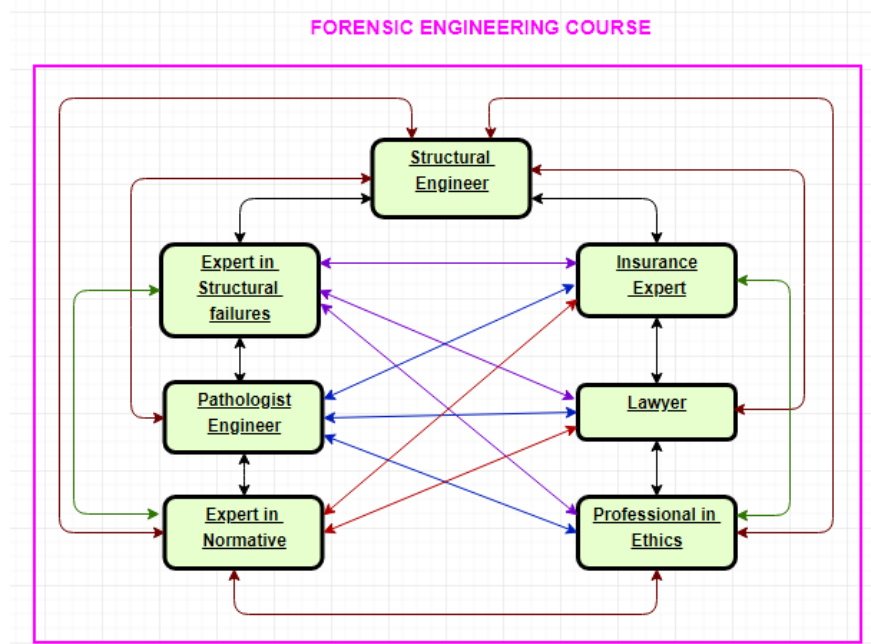


Figure 1. Communicative model proposed for forensic engineering course. (Teachers)
Source: Elaborated by Zulma S. Pardo V.

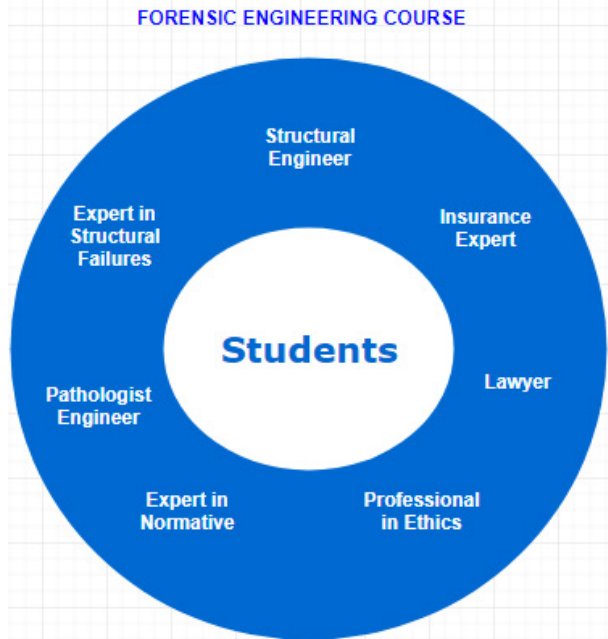


Figure 2. Communicative model proposed for forensic engineering course (Students – Teachers)
Source: Elaborated by Zulma S. Pardo V.

The Figure 3, presents the pedagogical model for the course proposed. The model presents the different stages and the evolution in the knowledge of student with your autoreflexive stages.

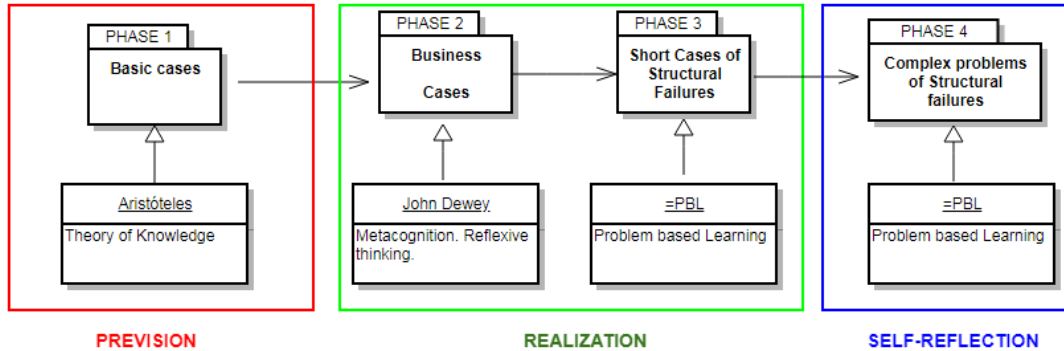


Figure 3. Pedagogical model proposed for forensic engineering course.
Source: Elaborated by Zulma S. Pardo V.

2.2. Other aspects

The domain of knowledge of the author is the structural engineering for this reason, the proposal is centered in this topic. However, the new course of forensic engineering has to involve other domains of knowledge. Developments more specific in these fields must be proposed for experts in these themes.

However, it is possible to cite that the course must involve minimum the following themes:

1. Engineering ethics
2. Structural systems.
3. Structural behavior.
4. Normative of structures.
5. Structural Pathology.
6. Engineering Legal applied to collapses.
7. Definition in law and in engineering of inexperience, imprudence and negligence.
8. Aspects of insurance policies.
9. Study of collapses and/or Failures based in problem.

The author recommends specific courses of forensic engineering, for example, if the theme is structural collapses only this topic must be tried. If the theme is hydraulic failure structural, the course must be only of hydraulics structures and so.

A course with the nine topics related, the author recommends minimum 60 hours and it is possible involve in an undergraduate civil engineering program of elective form.

An elective course because is important the motivation for the student in your learning process. The best guaranty for the performance of the new professional that learns topics that he considers interesting.

3. Lifelong learning

In the first proposal, it was suggested to offer courses of forensic engineering, periodically. In those moment, the author recommended the lifelong learning, and involve ITC. In this moment, it is available one virtual course developed for the author, 24/7, in the structural platform developed for her. (Pardo 2019).

The author recommends specific courses according the kind of collapse to analyze. It is more important to create groups for beginners and groups for non beginners, designing educational material of different complexity grade.

It is necessary to think in the teachers for these courses, they must be experts in the specific themes of the course and of different professions.

Interchanges with foreigners teacher is necessary if we want advance in the knowledge of these topics, for this second proposal, some suggestions of Spain teachers were important. In this version the topic insurance policies was included how a new aspect in the proposed course.

4. Conclusions and recommendations

1. The second version for a new course of forensic engineering was presented, where minimum the author considers must contain 9 topics, related previously.
2. It is proposed specific courses for type of collapse. The learning results are better that if different kind of collapses are studied. According (Pardo 2013)
3. The Colombian Universities for lifelong learning can offer courses of forensic engineering for different levels. Thus, when a collapse event occurs the country has some engineers, in ability to evaluate the problem. This aspect reduces the cost for the country of these evaluations.
4. The teachers for these courses require to be expert in evaluation of collapses.
5. The author recommends apply the knowledge theory of Aristoteles, the reflexive thinking of Dewey, the constructivist theory and the Problem Based Learning when these courses are offered.
6. The educational material for different levels must be designed for these courses.
7. The author applying the Information Technologies and of Communication (=ITC), developed a virtual course with the exposed topics in this article and it is available.
8. More important is that educational material of this theme in Spanish is limited for this reason the students must minimum be able to read in English.
9. The course must have practical examples solved in groups and with the teacher for retro feed of the student.
10. The second proposal of models communicative and pedagogical were presented for this course. When is available more information of other experts they could experiment changes

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