

## INCREASING THE PRESENCE OF A CIVIL ENGINEERING SCHOOL IN THE LOCAL AND SOCIAL CONTEXT: POPULARIZATION AND INSERTION ACTIVITIES

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**Abstract.** It is a widely recognized fact that over the past few years the interest for STEM studies in general and Civil Engineering in particular. In the particular context of the Escola Técnica Superior de Enxeñería de Camiños, Canais e Portos of the Universidade da Coruña this has translated from an excess in demand to an excess in offer regarding the number of spots to carry out a Civil Engineering degree. This fact was anticipated in 2013, so an intervention program was designed to take account of the shifting tide. While formerly students would steer towards CE studies by the prestige of the profession and high-paying job availability, the new context with an unfavorable job market and the decrease in profession interest due to the appearance of new, more “attractive” technical disciplines, the need appeared to raise awareness of the interest of our proposed studies, the job market and even of the existence of our School amongst Galician high-school students. The intervention program has been based on the following activities:

1. Outreach to middle- and high-school orientation services and recruiting initiatives as visits and talks among middle- and high-school students.
2. Presence in educational fairs.
3. Presence in Science Fair-type events with a stand devoted to Civil Engineering.
4. Participation in talk and activity programs within the A Coruña science museum network.
5. Funding requests for Citizen Science programs and Science Popularization programs from the national agencies.

These different activities are presented in detail, together with a description of the target groups and an attempt at an objective outcome evaluation in reference to the main goal of the activity program.

## 1 INTRODUCTION AND CONTEXT

We can date back to 2007 in the USA and 2008 in Europe the so-called official beginning of the economic crisis which has ruled over almost every aspect of society during the past few years. In the particular case of engineering education in Spain, the total number of students in engineering and architecture school has dropped by 26 % during that period [1]. In the particular case of the Escola Técnica Superior de Enxeñaría de Camiños, Canais e Portos (ETSECCP) of the Universidade da Coruña (UDC), the situation in 2007 was a full occupancy, with cut-off grades of around 7 in a scale of 5.5 to 10 in the *selectividad* average in both of the degrees that were taught at the time (Ingeniería Técnica de Obras Públicas, the 3-year degree, and Ingeniería de Caminos, Canales y Puertos, the 5-year degree). At present, after the reform which transformed all of the degrees in Spain into 4-year Bachelor's degrees and 1- or 2-year Master's degrees, we offer a 4-year, profession-oriented degree in Civil Engineering (*Enxeñaría de Obras Públicas*, EOP); a 4-year, academy-oriented degree (*Tecnoloxías da Enxeñaría Civil*, TEC), and the 2-year Master's degree which leads to the profession of *enxeñeiro de camiños, canais e portos* (MECCP). While the Master's degree is working as foreseen, with most of the students graduating from TEC signing up for MECCP, enrolment in the Bachelor's degree has been stagnant over the past four years at an all-time low of around 45 % of the available spots, with a cut-off grade of 5.5 out of 10 (minimum passing grade).

This trend was already foreseen by the authors in 2012, at a time when full occupancy was still achieved but with a drop in the cut-off grade. This grade, though not necessarily a predictor of individual achievement in university, is indeed related to the performance as a cohort for each promotion [2]. Since these studies are generally considered among the most difficult within the frame of Spanish university system, a concern was raised about whether the new promotions would be able to withstand the level of work needed to succeed in the newfangled degrees.

The ETSECCP-UDC is located in the town of A Coruña (Spain), in the autonomous community of Galicia. This factor is especially relevant when analyzing enrollment statistics, since the low mobility of Spanish students, due to the lack of sufficiently funded scholarships and the presence of at least one university offering each degree in each autonomous community, usually pushes them (once a particular field of study has been chosen) to enroll at the closest possible school. Galicia has a population of around 2 700 000 people, with around 400 000 living in the A Coruña metropolitan area. As of 2018, 95 % of national students come from Galicia itself, which is a relevant datum when considering the potential audience of any outreach program.

A Coruña also boasts a remarkable singularity: being a city of only 240 000, we can find within the city itself four science museums: first, the National Museum of Science and Technology (*Museo Nacional de Ciencia y Tecnología*, MUNCYT) (Figure 1a), the only Spanish national museum to have a site outside Madrid; second, the Scientific Museums of A Coruña (*Museos Científicos Coruñeses*, MC2) network, comprising the House of Sciences (*Casa de las Ciencias*)(Figure 1b), the House of Man (*Casa del Hombre*, DOMUS) and the Aquarium Finisterrae or House of Fish (*Casa de los Peces*). It is also home for the Galician delegation of the professional College of Engineers (*Colegio de Ingenieros, Demarcación de Galicia*).

The following description of the outreach program will show that all of these constraints and

singularities where taken into account into its design, working toward the objective of strengthening enrolment for 1<sup>st</sup> year students in the Civil Engineering degrees.



Figure 1: (a) MUNCYT (b) Casa de las Ciencias

## 2 MIDDLE- AND HIGH-SCHOOL OUTREACH

### 2.1 First wave: high school recruitment talks

The first approach undertaken, launched in 2012, was straightforward, which, in hindsight, also turned to be simplistic. Working from the non-evidence-based assumption that a better knowledge of what civil engineering is coupled with an attractive presentation would be a factor among Baccalaureate students (that is, the last two years of high school in Spain), a direct outreach program was designed. This would consist of the following:

- Forming a group of about 10 professors and 15 students (voluntary) on how to address teenagers. This formation was delivered by a specialist from *Artestudio*, a theatrical group and consulting company specialized in activities directed toward children and youths.
- Recording a series of professional video pieces which combined real prospective students asking questions about civil engineering, scenes from school life, engineering activities and time-lapse montages and interviews with former students.
- Contacting by phone, letter and e-mail with the high-school career advisor (*orientador*) in each and every high school in Galicia, which amounts to a total of about 300, offering the presence of a professor to give a talk to students any time along the school year.

This initiative was funded by a grant awarded to the Galician Foundation of Civil Engineering (*Fundación de Ingeniería Civil de Galicia*, FICGA) by the Galician Innovation Agency (*Axencia Galega de Innovación*, AGAIN). Funding covered formation, video production and travel expenses (note that talks to peripheral high schools in Galicia implies on occasion travelling up to 250 km).

Over the first two years, these talks were a two-person job, with a professor and a student in a point/counterpoint setting that eased high school students into participation and retention (Figure 2). During this period, high schools in the city of A Coruña that performed better in the *selectividad* test were prioritized, since we believed that they should conform the main source of first-year students for our school.

The success of this initiative was underwhelming. On any given schoolyear since 2012/2013, at most 35 centers would take up on the initiative, with the number dropping steadily since 2015. The reason for this drop was mainly the proliferation of education fairs, events that group together a number of higher education institutions in a “fair” context, with publicity stands, which maximizes efficiency from the point of view of invested school time. This type of event was almost non-existent in Galicia at the time our outreach initiative was launched. In addition, the University itself (UDC) had no similar outreach/recruitment program, a lack that has been increasingly corrected since 2014, when an institutional presence started to take place in such events.



**Figure 2:** High school outreach talk with the presence of a professor (left) and an undergraduate (center)

Coincidentally, after the first year of talks, the first major drop in first-year enrolment was registered, from 100 % occupancy the previous year to only 65 %. A series of surveys conducted in first-year students revealed that all the ones who hailed from high schools where a talk was delivered were aware of civil engineering studies and had decided to register *before* our talk, so the efficacy of this type of outreach was compromised. However, during the communication process to high schools, we discovered that a non-negligible (though not surveyed) number of career advisors were not aware that there was a civil engineering school at the UDC or that it was seeded in A Coruña, even among A Coruña metropolitan area advisors. There is indeed a cultural tendency to identify A Coruña with the architecture school and Ferrol (50 km away) with the industrial and naval engineering schools, all of them older than civil engineering, against which we discovered we have to work.

Since 2016, only about 10 of this type of activities are celebrated each year, in high schools with a tight link through family or tradition, and only one professor takes part (instead of the professor/student combination). This remaining presence is mostly kept as a service offered to high school career advisors rather than a proactive initiative from our school’s part.

## **2.2 Second wave: middle and high school outings**

After establishing that delivering talks to older high school students was not an effective

means of directly improving recruitment and trying a more systematic approach through literature reviews on the subject [1], efforts were redirected to a broader audience, with the goal to improve perception of civil engineering in general and our school in particular. Even though, as previously stated, informative talks are still delivered upon request, in this second wave we mostly play upon one of our schools most visible strengths: the Center for Technological Innovation in Construction and Civil Engineering (*Centro de Innovación Tecnológica en Edificación e Enxeñaría Civil*, CITEEC), the high-level laboratory facility annex to the civil engineering school. Visits to this laboratory featuring experimental simulations at the wind tunnel laboratory, the laboratory of ports and coasts, the urban hydraulics laboratory and the construction laboratory (Figure 3a) are offered. Nowadays about 20 of these visits take place per year, with a high rate of repetition from year to year, meaning that they are popular both among teachers and among students. The amount of visits is limited by the high economic and time cost for peripheral institutions, so most of the groups come from local centers. Also during this year and for the first time three Primary school groups (with 20 to 25 8-year old children per group) were hosted (Figure 3a); this initiative was featured in local television [3].



**Figure 3:** (a) Middle school and (b) primary school visits to CITEEC

Systematic evaluation of the outcome of this type of activity is hard to achieve, since its impact takes place on the overall perception of civil engineering and not directly in recruitment figures. However, the 100 % repetition rate and the increasing demand from middle schools to take part in this activity is an encouragement to its present and future development.

### 3 PARTICIPATION IN SCIENCE FAIRS

Science fairs are popular events during which schools and various institutions, both public and private, take advantage of an informal setting to portray in the form of interactive displays and activities the outcome of their Science studies (in the case of schools) or scientific aspects of their activity. In particular, two such events take place regularly in Galicia: the Day of Street Science (*Día da Ciencia na Rúa*) in A Coruña and the Santiago Maker Faire (sic) in Santiago de Compostela.

The *Día da Ciencia na Rúa* has a long-standing tradition in the city, reaching its 23<sup>rd</sup> edition in 2018, and has grown hand in hand with the MC2 network. It is organized yearly by the Friends of the House of Science Association (*Asociación de Amigos de la Casa de las Ciencias*, AACC). In the last edition over 50 kiosks from Galician schools plus 20 from other institutions were present. The ETSECCP-UDC is present in this fair since 2014 (Figure 4), being the only

college-level stand, except for the Faculty of Biology & Chemistry. During the fair, which takes place every year on a single Saturday in May, the following activities are carried out:

- Construction (and deconstruction) of a sectional scaled (4 m long) cable-stayed bridge (Figure 5)
- Material testing in a small scale manual testing frame (Figure 6)
- Geotechnical engineering demonstrations: reinforced soil and liquefaction (Figure 7)
- Concrete mixing workshop (Figure 8)
- Computer-based bridge building games
- Displays with several engineering-based materials: geology expo, steel and composite materials, aerial stereoscopy...



**Figure 4:** General view of the kiosk at the Día do Ciencia na Rúa



**Figure 5:** Model sectional cable-stayed bridge (patent pending)

The Día do Ciencia na Rúa proves to be an ideal setting to enhance and improve the image of civil engineering among the general population. Children of all ages become aware of the existence of the civil engineering school while associating it with a positive image. In the meantime, conversations can be held with accompanying adults about the field of civil engineering, research being done at our university, the situation of the job market...

The actual outcome of this activity is by nature almost impossible to quantify, but knowing that about 18000 people visit the fair in a single day, we can conclude that it is the single activity that raises awareness among the highest number of people, even though it is limited to the city of A Coruña.

The Santiago Maker Faire is a similar event, based on the promotion of the “maker” culture, which has been held on the past three years. This event has the added benefit of identifying civil engineering with a contemporary trend, surrounded by institutions and companies who promote technological development and “making” as a form of entertainment.



**Figure 6:** Model sectional cable-stayed bridge (patent pending)



**Figure 7:** Geotechnical engineering: reinforced soil and liquefaction



**Figure 8:** Concrete mixing workshop

## 5 COLLABORATION WITH NATIONAL SCIENCE AND TECHNOLOGY MUSEUM

Taking advantage of synergy with the ACHE (*Asociación Española del Hormigón Estructural*, Spanish Association of Structural Concrete) conference held in A Coruña in June 2017, our school launched a collaboration program with MUNCYT, our National Science and Technology museum. This collaboration consisted of a series of conferences and an activity program.

The conference cycle was mainly aimed towards an adult audience used to taking part in science popularization activities. The times were set to alternate Thursdays at 19:30 pm, enabling the audience to assist as an after-work activity while not “overloading” a potential repeat audience who might want to attend all of the talks. Three topics were chosen spanning different aspects of structural engineering:

1. *Redefining the planet: great Civil Engineering works*
2. *Concrete: daring to create a rock in a few seconds.*
3. *Building with timber: a world of possibilities*

The lecture cycle was advertised within MUNCYT’s own activity program Attendance to the lectures ranged from 40 to 60 people, composed mainly by students, former students or colleagues of the lecturers, together with their families. The outcome of this activity was satisfactory from the point of view of collaboration with the museum, but the main goal, that is, to appeal to a wider audience and increase awareness about Structural Engineering since the audience was mainly composed of people with a direct link to this area of knowledge.

The activity was conceived as an introduction to Structural Engineering for children. Five mini-lessons were devised, using as axes the history of Structural Engineering and the history of the city of A Coruña. The main tool for the development of these mini-lessons was a construction set consisting of a full suite of LUPO™ large size building blocks made from expanded polystyrene. The LUPO™ 7-piece system (<http://www.sistemalupo.com>, Figure 9) was created and patented by Fermín G. Blanco as a creativity and teaching tool for structural and architectural systems for both children and the general public wishing to delve into the basics of Structural Engineering. The system is available on a variety of materials and sizes and as a digital application for computers and smartphones; the version chosen as best suited for this activity was the one denominated Superlupo, which facilitates interactions between a number of children on the same construction through its larger size and reduced weight.

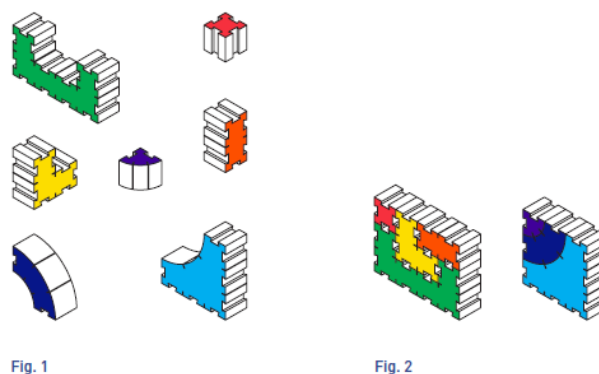


Figure 9: LUPO™ basic 7-piece set and assembly.



Each mini-lesson would start with a 10- to 15-minute introduction about the day's topic, a 10-minute introduction to the building block system, and a 30- to 40-minute work session on the day's structure or structures. Children were divided into two groups according to age (6 to 9-year olds in the first group, 10 to 12 in the second) after the introduction so each group could work on their structure separately (Figure 10). An exception to this was the last lesson, in which family groups with one adult per children at most were allowed.



**Figure 10.** (a) Aqueduct (b) Box girder (c) Obelisk landmark (d) Introduction to prestressing

This activity proved to be the most successful in the program. All the workshops were fully booked, and the museum was later contacted for repetitions. The activity was actually replicated in the Madrid site of MUNCYT with great success too. Children were highly receptive both to the introduction and to the gameplay session, getting to acquire basic structural concepts such as stability, the difference between flexure and compression, and prestressing. Also the perceived image and the importance of both civil and structural engineering in their everyday lives was enhanced, thanks to the inclusion of such components in the introduction and the presence of structures and buildings with which they were familiar.

## 5 “CAMINOS DE FUTURO”: A SYSTEMATIC APPROACH

Using the experience garnered during the past few years, presented in the previous sections, a more systematic approach was adopted. A project named *Caminos de Futuro* was presented to the Spanish Foundation for Science and Technology (*Fundación Española para la Ciencia y la Tecnología*, FECYT) grant call, and was awarded funding for its development. This project aims to familiarize students of secondary education, a key stage in the definition of vocations, with the world of civil engineering, within a social framework in which the stimulation of interest in education is recognized as fundamental for STEM disciplines. To do this, it seeks to highlight the basic role it plays in the development of civilized society; familiarize students

with scientific and technological concepts of civil engineering appropriate to their level of training and with immediate application; communicate the lines of research developed in civil engineering and the role they are playing in a sustainable, globalized and efficient society, and encourage the incipient vocations in civil engineering.

To achieve these objectives, three different actions are proposed:

1. Workshops on Civil Engineering and Society: face-to-face workshops given at secondary schools on safe and sustainable transport, water as a scarce resource and structural failures; Students are expected to analyze their environment from a scientific perspective. They are complemented with a general presentation about the world of civil engineering and research in that field.
2. Research in Civil Engineering in Galicia: organization of visits to the CITEEC.

This project features an approach that will allow the quantification and evaluation of the outcomes. A representative group of 30 schools will be selected to deliver the workshops. Out of these 30, 10 peripheral schools will be invited to visit the CITEEC. Priority will be given to those schools that are further away from Galician university centers.

Formal evaluation will be carried out through differentiated surveys conducted on teachers and students, before and after taking part in an activity program. In addition, surveys will be distributed to schools in Galicia that do not take part in the program, as a control group. A website and social media profiles will be established, which will allow measuring interactions and penetration in a different audience.

## 6 CONCLUSIONS

- A series of activities carried out by the School of Civil Engineering, Universidade da Coruña along the past five years to boost interest and awareness about the field of civil engineering among general audiences and children in particular with the ultimate goal of promoting enrolment in Civil Engineering studies has been presented.
- The straightforward approach consisting of recruitment talks to last year high school students has proven to be inefficient to achieve this goal.
- Outreach activities such as visits to the laboratory and workshops are very well received by teachers and students, even though their impact is hard to quantify.
- A systematic program funded by a national institution has been launched to achieve the aforementioned goals, together with a formal survey system to evaluate the outcome.

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