

# University research as a path for stronger University-Government linkage: CETSIM, developing a military vehicles driver simulator for the Mexican Defense Ministry

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## ABSTRACT

Nowadays, universities became institutions with organizational developed capacity not only to recombine old ideas and synthesize and conceive new ones, but also to translate them into use. Universities have come to play a new role in society because the creation, diffusion, and utilization of knowledge have become more directly involved in industrial production and governance. Thus, the relationship between universities and public and private institutions is a very important economic, technological and cultural development strategic measure for a developing country.

In this paper we highlight the importance of capitalizing scientific and technical knowledge in the context of an association between the University and the Government, and in this sense, we present a project developed by the Polytechnic Metropolitan University of Hidalgo (UPMH) together with the Mexican Defense Ministry (SEDENA) which consist on the development of a military vehicles driver simulator. By describing this project we try to focus the benefits obtained from the University-Government linkage on the development of advanced technology projects together. In the same way, opportunity areas found within the education policy and the development of high-level scientific research are mentioned.

The paper concludes highlighting the gained benefits from the University-Government linkage and addressing the need to implement updated high-level education policies which can redirect the efforts of actors such as researchers, academic institutions and government towards a sustainable development environment.

**Keywords:** University research, University-Government linkage, Knowledge transfer, Military vehicles driver simulator

## 1. INTRODUCTION

In a knowledge-based society, as the current society has been called, University becomes a key element of innovation system, both as a former of high-level human capital and as promoter of new companies and technologies. University, as an institution

that produces and disseminates knowledge, will have a greater role to play in innovation industry to the extent that knowledge will increase their importance in the innovation [1]

Nowadays, many authors agree that, excellence in college education and high-level scientific research are key elements for the development of a country, especially in developing countries. In this context universities must meet, in addition of their basic functions such as teaching and extension, another important role as a link between a great quantity of researchers and highly-qualified specialists in many knowledge areas and a demanding productive sector needed of human resources with an excellent academic background and trained in learning environments that promote projects which try to resolve real-life problems [2]

Within the short-term goals of Mexican higher education institutions (including UPMH), it should be considered to become into organizations where the public and private institutions requirements are contemplated into their education planning due to the material resources concentration, the high-level human resources formation process, and the scientific and technological production. This allows Universities to become favorable places where Government and Industry can acquire technological developments and turn into an expeditious way to generate applied knowledge solutions.

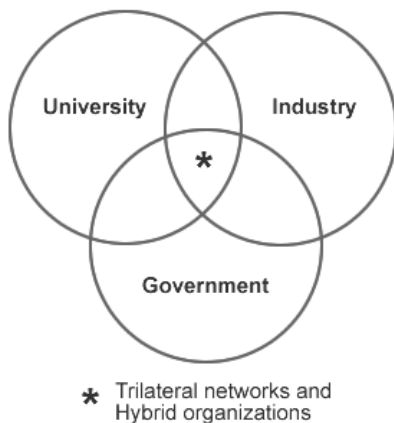
In this paper we describe the development of a military vehicles driver simulator. The project started as an initiative of the SEDENA who, in compliance with the Mexican national development plan, formed a strategic line (A022) which includes military research and development in coordination with public Universities. Through the development of advanced technology, the SEDENA try to enhance and reduce costs in the training process for military vehicles' drivers. Improving the driver safety is also considered. This project was developed together with UPMH, which is a high-level education institution which as part of its strategic objectives promotes the development of the technology through applied research involving full-time teachers and students. By describing this project we try to highlight the benefits obtained from the University-Industry partnership on the development of

advanced technology projects together. In the same way, opportunity areas found within the education policy and the development of high-level scientific research are mentioned, which requires updating to achieve economic, technological and cultural development.

The rest of the paper is organized as follows: In Section 2, we analyze the university-industry relationship. Section 3 provides a detailed explanation of the UPMH-SEDENA project. The obtained results and conclusions of the presented project are shown in Section 4.

## 2. INDUSTRY-UNIVERSITY-GOVERNMENT COLLABORATIVE VENTURES

There is a group of distinguish researchers which try to explain the new relationship between University, Industry and Government around what they called the “Triple Helix Model”. From this model, they propose a new configuration of institutional forces emerging in the innovation systems of countries [3-5]. According to this idea, core institutional forces which determine innovation systems are University, Industry and Government; and depending on the relationship established between them we can get different behaviors from each of its actors and to different innovation systems. In the triple helix proposed model, the three institutions overlap and interact with each other as shown in figure 1



**Figure 1** Triple Helix Model institutions interaction

Nowadays, we experiment a period of deep changes in the technical structure of production and its relationship to other areas of society, where the institutions based on knowledge predominate and set the guidelines for generating economic and social development. Universities play a very important role in achieving this objective. In order to change the current economic situation, we must work on the basis of knowledge institutions which stimulate and provide added value to meet social needs. In this context, universities have the responsibility to form human-resources producers of knowledge [6]

Historically, relationship between universities-industry-government is made through a transfer of knowledge by training students who in turn transferred their learning to society or by publishing researching results and consultancy that provided university professors to institutions. The

conception of the “return of investment” prevailed, where if there were cost these should be minimal for productive agents [2]. Thus, the relationship between universities-industry-government is a very important economic, technological and cultural development strategic measure for a developing country. One of the essential objectives for this linkage is to achieve greater technological advance which allows adequately compete in global economies and to support economic development with a better quality of life [7].

This relationship must be the central topic for the university’s agenda in the coming years, because the idea that public or private institution projects are strongly related to the priorities of universities is a trend becoming more important every day.

University-Industry-Government relationship is discussed currently on five specific aspects [6]:

- Relationship obtained through large investigations with externally consolidated projects.
- Relationship established in order to get complementary revenues, outside the university, mainly through consulting.
- To request funds for research
- Patenting the research results.
- To build companies based on research results.

However, these relationships are characterized by explicit differences between institution’s cultures, which cause conflict. From the standpoint of universities:

- Inclusion in this kind of activities is discussed.
- There is ignorance and fear for the business world. Universities generally do not have entrepreneurial mindset.
- It is possible to lose academic freedom

On the other hand, as Industry or Government institutions:

- There is a strong distrust of involving institutes and research centers to contribute industry projects.
- There is questions about the compliance of scheduled tasks with certain deadlines
- They feel fear about confidentiality of the achieved results

If the above considerations are taken as valid, we should accept that any solution would improve the perception of stakeholders about the nature of the productive business and add value to knowledge as essential and fundamental tool to ensure the success of the whole business in global markets, so that results in economic growth, development and wellbeing of the population.

The primary suggested solution to this problem is the strengthening of the relationship among university, industry and government through the implementation of actions which stimulate a two-way flow of knowledge and experience. This effort would help to resolve the differences already noted, by adopting if not a common culture, at least a culture of tolerance and respect, particularly in terms of the structural barriers which emerge when the particular characteristics of academic research and industry activity, are analyzed.

Finally, different authors [8-10] agree in the following list as strengths of the university-industry-government linkage:

- Formation of high-level human resources to respond to the current and potential demand of the productive sector
- Scientific, Technical and Educational overcoming of the country
- Promotion and development of research projects for the productive sector
- Increased demand for graduate and postgraduate studies
- The university forms professional human resources which employ scientific and technological knowledge to create small enterprises leading by themselves

### 3. PROJECT DESCRIPTION

#### Project proposal and benefits

This paper describes the development of a military vehicles driver simulator which started as an initiative of the SEDENA which try to enhance and reduce costs in the training process for military vehicles' drivers. Improving the driver safety is also considered. This project was developed together with UPMH, which is a high-level education institution and as part of its strategic objectives promotes the development of the technology through applied research involving full-time teachers and students.

The project characteristics can be described from different points of view; the most important are listed below:

- The project considered establishing strategic partnerships from both the militia and the university. It was necessary to create a joint steering group that included full-time teachers, school management staff and militia's officer in charge.
- It was very important to define a project management methodology in order to manage all the resources involved in the project and increase the likelihood of success in meeting the objectives. The methodology used was the standard of the Project Management Institute (PMI®), which consists of four to five process groups, and a control system. The methodology was used in order to intent to simplify and facilitate project managers' access to the project management approach, promote best practices and create a standardization of terminology.
- Work team integration where team members are committed to the success of the team and their shared goals for the project. Team members need to create an environment where together they can contribute far more than as individuals.
- Interpersonal skills measurement including the ability to discuss issues openly with team members, be honest, trustworthy, supportive and show respect and commitment to the team and to its individuals. Fostering a caring work environment is important including the ability to work effectively with other team members

Through development this kind of projects, university can get a lot of benefits. Here we list some important benefits:

- To get external funding for training courses, research, equipment and scholarship.
- Project involving students therefore develop teamwork skills, and develop the ability to solve real-life problems
- Continuous training of academics.
- National technologies develop and knowledge transfer.

#### Work team integration

In order to get success was necessary to integrate a multidisciplinary work team in the university and to make communication and collaboration works well. The entire project was divided in four teams (fig. 1):

1. Information Technologies and Software Engineering team (ITI).
2. Animation and Visual Effects Engineering team (IAEV).
3. Logistics and Transportation Engineering (ILT).
4. Aeronautics Engineering (IA).

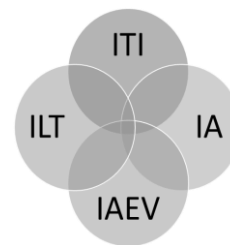


Figure 2. UPMH's Multidisciplinary work team

Each team was lead with a representative who was in charge to communicate the progress of the project to the steering group. This academic representative of each area directed academics and students activities to achieve goals. Tasks of each team are described below.

ITI team was responsible for analyzing the data requirements, developing the virtual world scenarios, user interface and database design. Was necessary the participation of academics in the virtual world modeling and programming of scripts in C# and JavaScript languages. The ITI team consisted of the following people; three research professors and six students of e Information Technologies Engineering program.

For virtual scenarios integration, was necessary 3D objects modeling by IAEV team. There are a wide variety of 3D models like cars, people, buildings, roads and elements of nature (trees and rocks) that integrate the virtual world. This team consists of two research professors and three students of the Animation and Visual Effects program.

Aeronautics area was responsible for building a structure to simulate the cockpit of a real military truck, also adapt drive controls, such as pedals, shift knob and steering wheel. Likewise IA team development of a communication interface for data acquisition (digital and analog signals). Aeronautics team was integrated by two researchers and five engineering students.

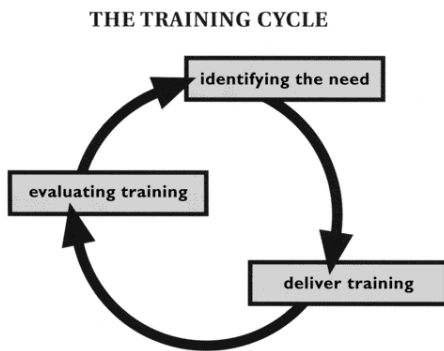
Logistics and Transportation group was responsible on establishing the play game logic and defined actual traffic regulations to be considered inside the scenarios. Also logistics

area proposed the simulator lessons analyzing the learning needs. Two research professors and three engineering students team up logistics team.

**Training program**

Fundamental to the delivery of any path project is the development of the team and the professional development of all individuals. At all levels there is an expectation that the skills, attitudes and knowledge required to deliver successful projects will be gained while these projects develop.

We started with an analysis of the training and development that is required. The starting point and the subsequent steps can be represented in ‘The Training Cycle’ or ‘The Systematic approach to Training and Development’. This is a widely recognized and used model of the processes involved in professional development, see Fig.3.



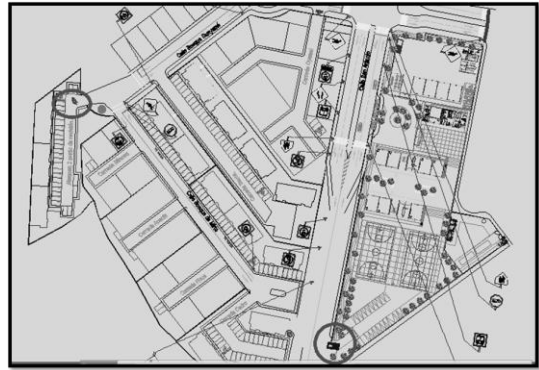
**Figure 3.** The Systematic approach to Training and Development

To ensure that the team was able to construct the prototype simulator for military vehicles including cab, pedals, and so on, was necessary training the work group in the following topics:

- Videogame development.
- Advanced programming in JavaScript and C# languages.
- Databases design and form report programming on Oracle.
- Data acquisition programming on Arduino.
- 3D Modeling on Maya and Zbrush.

**4. ACHIEVED RESULTS AND CONCLUSIONS**

The lessons for military vehicles driving training were designed by logistic area. The lessons include objective, environment description, symbology used and schema or map diagram (see Fig. 4).

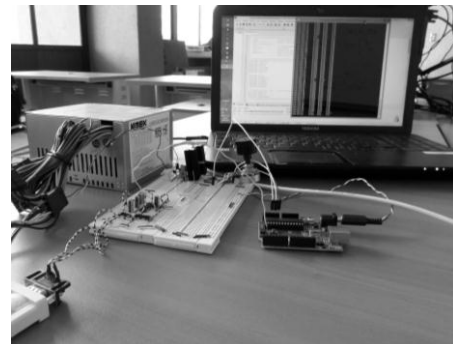


**Figure 4.** Sketch of the urban environment scenario.

Aeronautics area designed the cabin for the simulator in order to offers a real experience for the trainee. The cabin design is shown in Fig. 5. IA work team also designed the entire data acquisition card to read digital and analog signals like accelerator, brake, shifter, lights, etc. This card uses Arduino as part of its design. The acquisition card prototype is shown in Fig. 6.



**Figure 5.** Simulator’s cabin design.



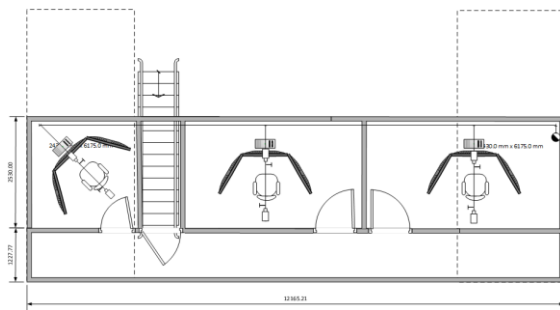
**Figure 6.** Design of electronic acquisition card.

The scenarios were develop on unity game engine by ITI work team, the scenarios include high quality 3D models, realistic environment with different conditions which the instructor can set or change, an example of the virtual world developed is shown in Fig. 7.



**Figure 7.** Simulator's urban virtual world.

Finally the integration of hardware and software components was performed, achieving the successful culmination of the project. As additional task, was conditioned a place storage for the simulator, this task was performed by aeronautics and Information Technologies teams. Design of this site (Fig. 8) was proposed to place the simulator cabin.



**Figure 8.** Conditioned place for the simulator.

As conclusion, we can say that this kind of collaboration between University and government offers so many benefits to these institutions, for example substantial streams of external funding, enhanced training opportunities for professors and university students, the opportunity to work on solving real-life problems which have a direct impact on society, in this case over Mexican Defense community. On the other hand there is the generation and transfer of groundbreaking technology develop in Mexico, which implies to reduce cost for governmental institutions.

The proper training of drivers of military vehicles is achieved with the development of military vehicles simulator and contribute to the reduction of the number of accidents. With the results of this project we are able for establish the basis for national technology development that contributes to get independency of foreign technology.

As future work would be interesting to review regulations for procurement of materials and equipment and reduce time delays in the completion of activities.

## 9. ACKNOWLEDGMENTS

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