INDUSTRIAL OUTREACH PROGRAM IN MEXICO MINI-REPORT QUERETARO 2003

WEST VIRGINIA UNIVERSITY
College of Engineering and Mineral Resources
(WVU-CEMR)

COUNCIL FOR SCIENCE AND TECHNOLOGY OF QUERETARO (CONCyTEQ)

UNIVERSIDAD AUTONOMA DE QUERETARO (UAQ)
College of Engineering

INSTITUTO TECNOLOGICO DE QUERETARO (ITQ)

This past Summer (2003), 12 students from West Virginia University and Queretaro's University (UAQ) and Institute of Technology (ITQ) teamed up to form four intermixed groups. Each group worked on practical engineering projects with local industries for six weeks in colonial Queretaro, Mexico.

Four challenging projects were conducted working alongside with engineering liaisons from industry and faculty members from West Virginia and Mexico.

The experience was an intense, yet rewarding and exciting professional engineering journey, with a cultural immersion twist.

Everyone involved learned and drew benefits and yes…, we also had lost of FUN!!!

JOIN US IN QUERETARO SUMMER-2004 !!

Objectives of the Program

The objective of this program is first and foremost, to add value to engineering education and to produce top quality engineering graduates, by providing a meaningful industrial exposure in a multicultural and multilingual professional environment.

The program also seeks to bring value to industry through the projects assigned to the participating students, who develop practical engineering skills as well as communication, leadership and human-relations skills.

Finally, this program seeks to bring faculty and engineers from industry to share expertise in formulating and solving engineering problems.

West Virginia and Mexico students visiting industrial sites in Queretaro Mexico.

Program description

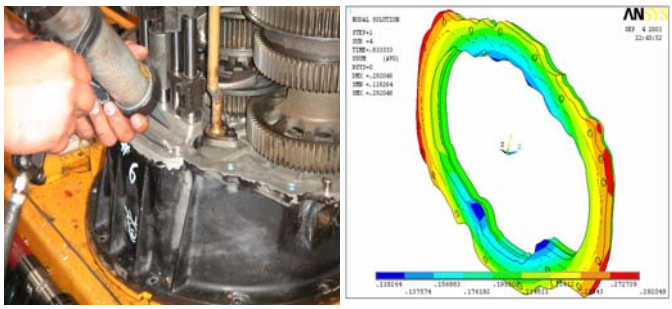
This year, twelve students from West Virginia University and eleven from Queretaro were grouped into small intermixed-teams (of four) and assigned an industrial project for a 6-week period. The students worked under the advice of a designated industrial liaison and three faculty members from West Virginia and Queretaro. Arrangements were made for WVU Students to live with local families while the companies provided logistic support for transportation and project development.

At the end of the six weeks, students prepare a professional presentation for the company on the findings and results of the project, which are delivered through a final oral presentation.

Mexican students are required to make their presentation in English, whereas WVU students are required to do half of their presentation slides in Spanish, regardless of the level of proficiency in the language. We gladly report that they all survived the challenge!!

Description of Sample Projects

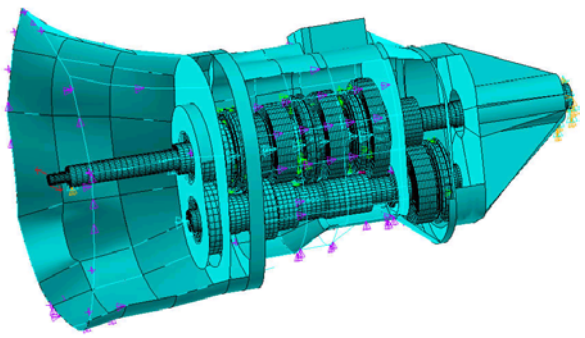
Project 1. Sealing Characteristics of Heavy Duty Transmissions. The host company was **TREMEC**, subsidiary of **Spicer Corporation** in the USA. In this project a finite element model was developed to assess the sealing characteristics of a flange used in a heavy-duty transmission. The work involved the finite element modeling of the transmission housing structure and experimental testing of transmissions to verify the models developed. Manufacturing and assembly issues were addressed that resulted in better understanding of the issues and produced several recommendations to improve in the process.



Heavy-duty transmission assembly operation and finite element model simulation of flange response to loads developed by WVU-Queretaro students.

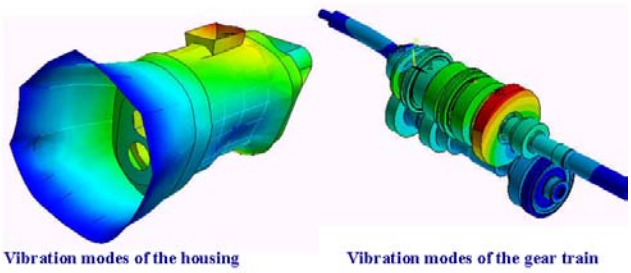
In this project students experienced the relation between design, performance and manufacturing operations with designers and suppliers from different countries.

Project 2. Noise reduction in automotive manual transmissions. The host company was **TREMEC**, subsidiary of **Spicer Corporation** in the USA. In this project a finite element model was developed for vibration analyses for noise reduction purposes. The model allows for gear tooth backlash effects to be included and will be useful for noise reduction studies.



Finite element model of a TREMEC transmission developed by the WVU-Queretaro team

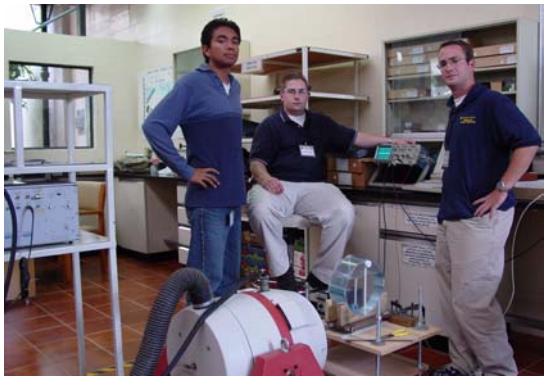
Experimental analysis was also conducted at the laboratory facilities of TREMEC for the assessment of vibration behavior of gear trains.



Modal Response of housing and gear train for an automotive standard transmission

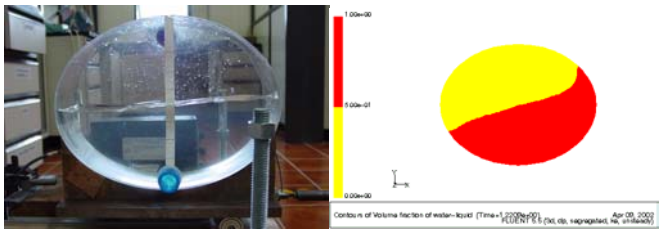
In this project, students experienced the relation between experimental vibration analysis and computational model simulation in actual automotive applications.

Project 3. Rollover stability of tanker trucks . The host was the Mexican Institute of Transportation (IMT). This Project involved the modeling and analysis of tanker trucks for the assessment of lateral stability with emphasis on the sloshing effects of the fluids in the tank. PEMEX fuel trucks were used for the study, in which a computational fluid dynamics (CFD) model of the tank was developed to determine the sloshing natural frequencies. Experimental verification was conducted with various scale models, which feature the geometry and baffle configurations of the tankers for various fill levels. Experimental vs. computational results were within 2% error for the critical fill levels.



WVU-Queretaro students conducting experiments on the sloshing of a tank model

A finite element model developed last year for a tanker truck, can now be used to conduct stability analysis and critical velocity studies for standard maneuvers in the operation of the trucks.

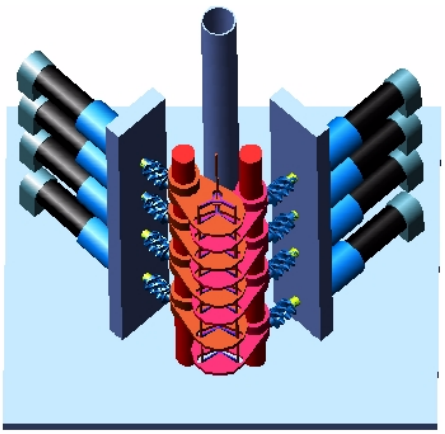


Experimental and computational sloshing models within 2% error

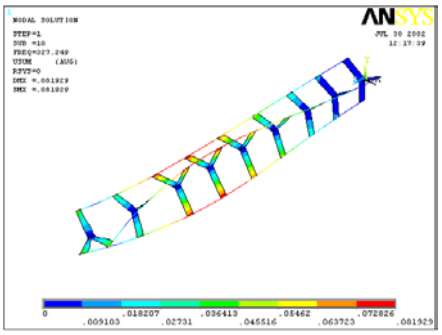
In this projects students addressed issues related to safety, transportation, fluids-structure interaction in the experimental sense as well as in the computational simulation sense.

Project 4. Design of a high precision balance structure for standards weights. The site was the National Center of Metrology CENAM (Mexico's NIST Equivalent). The project consisted of a conceptual design and analysis for a system for maintaining the standard for weights (up to a 100 gr), with a precision of one undredth of a milligram. The structure was to be designed to weight less than 10 gr.

The balance was to operate without dynamic effects, nor magnetic or heat perturbations. Students developed a design made of composite materials (graphite-epoxy) which rendered a structure less than 9 gr. Capable of sustaining the load under the prescribed constrains.



Conceptual design for a structure for a high precision balance developed by the WVU-Queretaro Team



FEM model of the supporting structure made of graphite-epoxy composite material, developed by the WVU-Queretaro Team

In this project, students dealt with the importance of standards in industry while confronting strict design requirements for high precision instruments. Use of finite element modeling techniques and composite materials was made to arrive at a proposed design.

Project 5. Development of a training program for operators of CNC Machinery. The host company was **In-Mec (Engineering and Mechatronics),** of Queretaro. This project dealt with the CNC-Machine-tool technology and its acceptance in the local industry. Currently, training programs exist to capacitate operators and technicians in the use of CNC-machine-tools, but many (if not most) of these programs lack some basic ingredients that render this technology not a widely accepted trait, specifically in the medium and small industry in Queretaro. The challenge here involved the

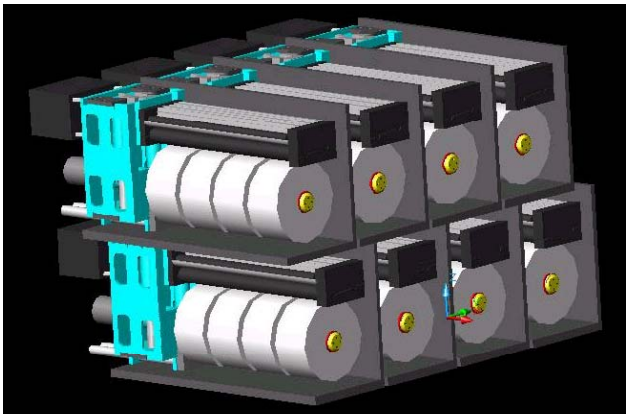
consideration of "technology culture" issues that are necessary to incorporate in standard training programs. For example, CAD/CAM technology acceptance by older operators, economics of CNC versus conventional machines, quality and productivity and job safety were all issues that need to be addressed in training programs.

Daily Time Table (Daily)	Curriculum Type	Hr	First Quarter	Hr	Second Quarter	Hr	Third Quarter	Hr	Forth Quarter
Two Hours	Operator and Technician Technical Curriculum	½	Mathematics	½	Material Sciences	½	Introduction to NC Machine Tools	½	Advanced CNC Machine Tool Process
		½	Metrology						
		½	Drafting	1	Conventional Machine Tool Basics and Machine Tool Processes	1	Introduction to CNC Machine Tools and Processes	1	Applied CNC Machine Tool Processes
	Operator and Technician Cultural Curriculum	½	Introduction to Machine Tooling Industry	½	Computer Basics	½	Basic Technical English	½	Quality and The Machining Process
Two Hours	Technician Cultural Curriculum	½	Manufacturing Economics	½	Computer Applications			½	Advanced Technical English
	Technician Technical Curriculum	½	CNC Installation	¾	Special Machining Processes	1	Advanced CAD	¾	Advanced CAM
		1	CNC Maintenance and Repair	¾	Introduction to CAD	1	Introduction to CAM	¾	CAD/CAM Application Project
Time Line (Year)			JAN FEB MAR		APR MAY JUN		JUL AUG SEP		OCT NOV DEC

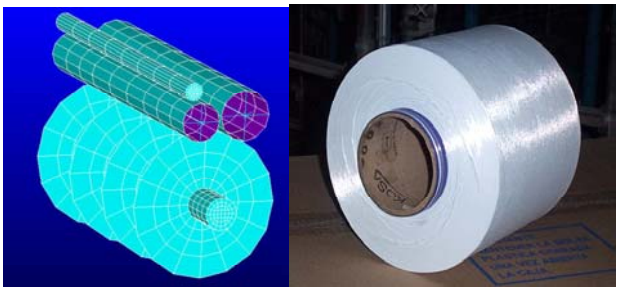
Basic training program proposed to In-Mec

In this project, the students had to visit several shops and small companies and conduct surveys and interviews with operators and technicians. They also visited and reviewed the educational programs at various technical schools; finally, students became familiar with the machine-tool components, the controls, the software and the operator manuals in order to identify the most important issues to address in the proposed program.

Project 6. Vibration signature analysis in fiber winding machinery. The host company was **KoSa** (Formerly Celanese). In this project, machinery for manufacturing polyester fibers was considered. A specific type of equipment used in the process has cantilever rollers, which are use to wind the fiber into packets. The high speed of the filament (thread) requires high (and variable) speeds of operation for the rollers, which in turn must operate very quietly (free of vibrations). The objective of the study was to characterize the vibratory signature of a bank of winding machines, for various filament speeds. Students modeled the rotors for one of the machines and were able to identify the changes in modal characteristics for various rotational speeds for the rotors. Banks of multiple machines are yet to be assessed in subsequent analysis.

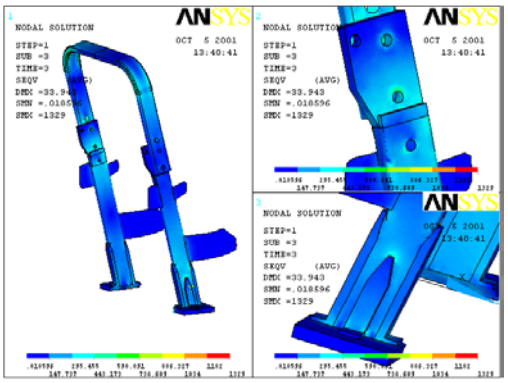


CAD Model of Polyester fiber winding machines studied by the WVU-Queretaro Team



High speed rotor mode for polyester fiber production studied by the WVU-Queretaro team

Project 7. Dynamic analysis of a ROPS (rollover protective structure) for an agricultural tractor. The host company was **New Holland de Mexico**. In this project, two tractor components were modeled for finite element analysis purposes. The first was a retractable rollover protective structure (ROPS), under static and equivalent dynamic loads, with emphasis on the strength of the welded joints and the design of the supports. CAD models developed by NH personnel were translated into a finite element mesh that was subsequently used to determine the behavior of the ROPS under design loads.



Finite element model of the ROPS under lateral load (elastostatic stress analysis)

Tractor for which the ROPS is being designed

The model developed by the team of WVU and Queretaro students is now available for dynamic impact analyses, for the assessment of design performance under actual dynamic conditions. FEM simulations will assist in anticipating design improvements on the ROPS to dissipate the impact energy of a rollover occurrence.

Seven Year Summary

After seven years, this program has involved a great number of people from various institutions, industries, and research centers from both countries.

Students, faculty and industrial liaisons have teamed up to work on 30 meaningful projects. (See summary Table below).

Some of the companies in Mexico have actually hired some of the alumni of this Program, and several US students that have participated in this Program are now working for US companies that had a relation with the company in Mexico.

Agreement between WVU, CNCyTEQ, UAQ and ITQ

For the next cycle (2003), an agreement between the participating institutions will be continued, which provides a formal frame for collaboration and support for this Program.

This Agreement is intended to extend further the outreach of this Program to industries of Queretaro and the USA, and provides the institutional framework to expand and support the program to engage into multidisciplinary and multicultural academic endeavors with a global perspective in mind.

The agreement was signed in 2001 by: Dr. Alejandro Lozano, Dierctor of **CONCyTEQ**; M. en C. Dolores Cabrera Muñoz, Rector of **Universidad Autonoma de Queretaro** and Ing. Carlos Fernandez Perez, President of **Instituto Tecnologico de Queretaro**. For **West Virginia University**: Dr. Eugene Cilento, Dean of the College of Engineering and Mineral Resources (**CEMR**); Dr. Donald W. Lyons, Former Chairman of the Department of Mechanical and Aerospace Engineering (**MAE**) and Dr. Daniel Weiner, Director of International Programs (**OIP**).

Cultural Highlights

While work in industry is intense (36 hrs/week), Queretaro offers magnificent opportunities for sightseeing during weekends such as “Pena de Bernal” and “La Sierra Gorda”, in addition to local attractions such as bullfights, state-fairs, markets and great restaurants!

In addition to inherent the teamwork activity, participating students from both countries have ample opportunities to socialize and become comfortable with each other’s cultures. Our network of host families provide a safe “family oriented” environment for a full cultural immersion.

Finally, after the projects are completed….yes, Acapulco awaits for a long and well deserved weekend.

Conclusion

Our Program is unique. It pursues the main objective of adding value to engineering education through an industrial exercise in an international setting. The program addresses issues that range from communication skills and cultural differences to human relations in the context of a practical engineering project.

This experience has brought forward not only the practical engineering dimension (from industry), but also the human dimension that comes with the territory.

Indeed, cultural differences actually exist. They come forward when people disagree, when people negotiate, when people reach agreements. In the concept of "value" as well as in attitudes toward life. But being able to anticipate and better yet understand cultural differences may be the difference between failure and success in professional situations in today's industry.

In an increasingly globalized professional environment and society, we are doing our share to meet the challenge.

	Institutions Involved	**Participant students**	**Faculty from both countries**	**Industrial Liaisons**	**Industries/Research Centers**	**Projects developed**
	• West Virginia University • University of Guanajuato • University of Queretaro • Institute of Technology of Queretaro • CONCyTEQ Queretaro • ITESM (Tec. De Monterrey)	• 49 (WVU) • 10 (UG) • 25 (UAQ) • 23 (ITQ)	• 3 (WVU) • 2 (UG) • 2 (UAQ) • 2(ITQ) • 1(ITESM	(2) GM (Gto) (4) TREMEC (Qro) (2) Transm-TSP (Qro) (1) Micro-Troq. (Qro) (3) IMT (Qro) (2) LAPEM (Gto) (2) I. TurboReact. (Qro) (1) Terramite (WV) (3) KOSA (3) New Holland (1) InMec (1) CENAM (2) ANSYS/Mexico (1) Irving de Mexico	• GM • TREMEC • Transm-TSP • Micro-Troquelados • IMT* • LAPEM* • I. TurboReact. • Terramite Corp.** • New Holland • KOSA • InMec • CENAM • Irving- Composites • Grupo SSC (ANSYS) * Research Centers ** From West Virginia	(1) GM Mexico (6) TREMEC (4) SPICER-TSP (1) Micro-Troq. (4) IMT (2) LAPEM (1) I. TurboReactors (1) Terramite Corp.** (3) KOSA (3) New Holland (2) CENAM (1) InMec (1) Irving ** From West Virginia
	5 Institutions	**107 Students**	**10 Faculty**	**27 Liaisons**	**14 Companies**	**30 Projects**

Seven-year summary table of people, companies and projects developed in this Program.

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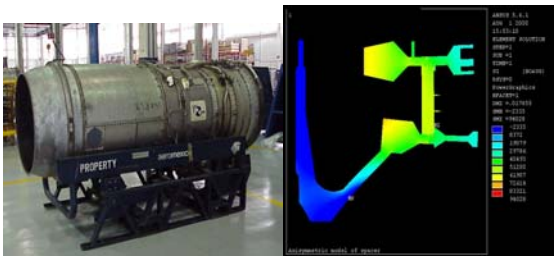
Site seeing opportunities

WVU-Queretaro group visiting Teotihuacan Pyramids

Visiting "Pena de Bernal" outside Queretaro

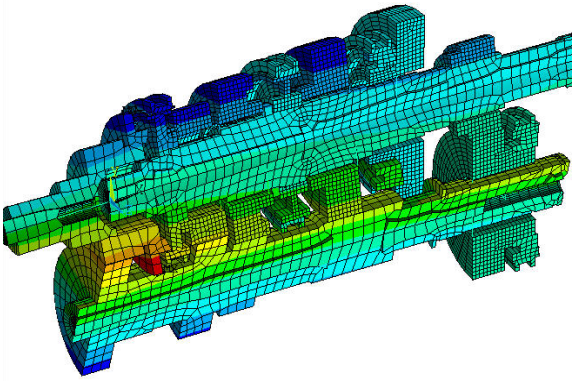
"Las Ranas" Archeological zone of Sierra Gorda Queretaro

Previous Year's Projects



*P&W Aircraft engine being serviced by **ITR***
*Axisymmetric model of a spacer with disks analysis done for **ITR***

*Compact construction equipment: Linkage finite element analysis for **Terramite Corporation** of WV*



*Finite element model of a gear train for dynamic analysis for **TREMEC***

Join us in Queretaro 2004!!