PD-ABG-487
83549

THIRD QUARTERLY REPORT
FY 1993

i. [brief statement of accomplishments, comparing actual accomplishments with specific program objectives and activities.]

OBJECTIVE #1: Planning for WPI Project Center and Faculty Development

Objective One was originally planned to be completed at the end of the first year (or near the beginning of the second year) of the UDLP between Worcester Polytechnic Institute and Escuela Superior Politecnica del Litoral, however changes in the ESPOL administrative structure delayed completion of the last activity (Activity #4) in this objective; i.e. the needs assessment. This was discussed at length in the second quarter report of FY 1993.

The new ESPOL administration, with the agreement of P.I. James Rollings, decided during the March 1993 workshop that the interrelationship of science, engineering and Ecuadorian society would benefit most through this UDLP by establishing a strong working relationship between ESPOL and WPI students, staff, faculty and administration in the areas of environmental and new business development studies. This should be the primary focus of all activities and/or objectives of this WPI/ESPOL UDLP. Several agenda items of the March 21-26, 1993 workshop centered on these topics (see). It was mutually agreed that the needs assessment should organically evolve between the two institutions through the development of case studies involving both graduate and undergraduate research.

OBJECTIVE #2: WPI Project Center Establishment in Ecuador

No specific activity was completed in this Objective. The only functions in this Objective dealt with ongoing activities.

OBJECTIVE #3: Faculty Development

No specific activity was completed in this Objective. The only functions in this Objective dealt with ongoing activities.

ii. [brief statement of on-going and completed activities compared to the annual workplan]

OBJECTIVE #1: Planning for WPI Project Center Establishment and Faculty Development

Activity Four: Needs Assessment of Objective One is an on-going activity as yet completed compared to the annual workplan. This activity requires direct input from the ESPOL faculty and administration. Although August, 1993 was the target date for this activity's completion, no response from ESPOL as to the means of accomplishing this task has been received to date. This topic will be addressed to ESPOL during Director Rollings' visit to ESPOL in August, 1993.

OBJECTIVE #2: WPI Project Center Establishment in Ecuador

All plans for the FY 1994 project center are progressing as anticipated. The actions listed in the Second Quarter FY 1993 for this Objective have resulted in recruiting eleven IQP students for three projects in the areas of environmental studies and sustainable development and in recruiting 5 MQP students for 1 technical project in Civil Engineering. Several memos received by ESPOL during this quarter have resulted in the project proposals as described below and further discussed in Appendix A.

WPI faculty have been invited to participate in co-teaching this second PQP for the Ecuador Project Center (Ecuador II). Director Rollings has arranged to "credit" WPI faculty for their efforts in their participation. (These WPI faculty are are also listed in Appendix B). The on-site WPI faculty advisor for this next B-term (mid-October to mid December, 1993) will be Professor Sue Vernon-Gerstenfeld.

IQP/MQP student team members: (declared majors of students)

Ecuador II: Team (1) on **Pollution Generated by productive activities**
Antoinette Burns, CE/EV
Spirit Joseph, CM/BB
Obadiah Plante, CH
and Rudy Soriano, MGE

Ecuador II: Team (2) on **Pollution generated by urban activities**
Allan Concepcion, MEB
Francisco Pereyo, ME
and Navin Rajashekar, CM
[an ESPOL student may be added to this project]

Ecuador II: Team (3) on **Resource management for sustainable development**
Todd DiNoia, CM
Laura Guillette, ED
Eduardo Mendez, CE
and Vail Mosier, CM

Ecuador II: Team (4) on **Study effects of mining activities of gold and related materials over land and water and the toxic consequences to agriculture and agriculture products**
Jenn Croft, CE environmental engineering
Kirstin DiPietro, CE environmental engineering
Ryan Johnson, CE environmental engineering
Jamey Pedro, CE environmental engineering
Kevin Worden, CE environmental engineering

The general and specific areas of interest to ESPOL and by agreement with WPI faculty (as determined via the past quarter's activities) were listed and sent to all members of the WPI planning team together with the list of WPI students who will attend the Ecuador project center First Quarter FY 1994 and requesting input. Input from one third of the WPI faculty planning team members were taken in to account in selecting the projects for the next team of WPI

One convenient way to view all the project areas (at either IQP, MQP or graduate research levels) is by a matrix composed of:

industrial sectors ....

A. industrial mining and oil production
B. industrial water resource uses
C. industrial aquaculture and/or agriculture
D. industrial inorganic materials manufacturing
E. eco-tourism
and F. urban housing and urban industries

coupled with; development sectors ....

1. business (impacts on) developments
2. national/local/regional [planning] (impacts on) developments
3. environmental [pollution prevention] (impacts on) developments
4. disaster [prevention] (impacts on) developments
and 5. technological (impacts on) developments

All of these (or at least many of these) topics <u>must</u> be integrated within the IQP (or MQP) for any particular project and are listed here, not to be thought of as separated topics, but only as a way of framing a specific project. All projects will, by there nature, cross several lines of this matrix; as all topics involve all lines of research. Director Rollings' reasons for structuring these topics in this linear fashion is only to retain a degree of order for planning purposes. His selection on matrix element linkages is (almost) arbitrary. This proposed structure is based on his discussions with other WPI faculty and on the input from ESPOL as viewed from the projects' develops.

Following this matrix structure, the selected IQP/MQP projects for Ecuador II are listed together with specific ESPOL faculty (liaisons) that will guide each project together with the students who are assigned to that project. The Civil Engineering Department will examine this matrix structure and their departmental needs/academic degree requirements in relation to this UDLP and their faculties' research foci and guide the one Major Qualifying Project (MQP) i.e. Ecuador II team (4). The ESPOL faculty have examined these projects separately, and have forwarded their comments to WPI. Their comments on these projects are given in Appendix A.

Pollution generated by productive activities ... assigned to:

Ecuador II: Team (1) on **Pollution Generated by productive activities**
Antoinette Burns, CE/EV
Spirit Joseph, CM/BB
Obadiah Plante, CH
and Rudy Soriano, MGE

In cooperation with the following listed ESPOL selected liaisons:

Ing. Roldolfo Paz
Ing. Francisco Romay
Ing. Jorge Duque

This project was mentioned by both bootstrap teams in their reports (see First Quarter FY 1993 report) and could involve assessing specific government policies in both regulatory and enforcement areas and examine industrial practices as well as environmental impact.

Amongst the coastal productive activities are shrimp (and other fish or marine organisms) aquaculture, mining (gold) developments, petroleum, timber, limestone, food processing (and other agricultural activities), textiles and pharmaceuticals. This project might be structured in two parts involving a general survey of all industries followed by a case study of a specific industry (e.g. the aquaculture industry). A component of this particular case study might focus on sustainable development of salt estuaries.

If the selected case study deals with either mining or aquaculture, excessive use of chemical nutrients in mining operations or shrimp farms should be examined in terms of their effects upon land, water and the effected food-chains. Other productive industries should be examined similarly. This study should involve assessing the shrimp farms or mining operations for chemical usage and their impact on the Guayas River (or other effected river's) watershed. Local and national government policies in both regulatory and enforcement areas should be explored for the IQP study and the MQP study should concentrate on the technical aspects of chemical usage.

Students should examine industrial practices as they relate to environmental impact and be included in this study.

I. <u>necessarily</u> crossing the matrix elements A.-3., B.-3., C.-3., D.-3., F.-3. and
II. <u>could</u> involve studies of elements A.-1., B.-1., C.-1., D.-1., E.-1.; F.-1.; A.-5., B.-5., C.-5., D.-5., E.-5. F.-5.;and
III. <u>in some specific case studies</u>, might include elements
[A.-2., B.-2., C.-2., D.-2., and F.-2.] or
[A.-4., B.-4., C.-4., D.-4., and F.-4.] or
[A.-5., B.-5., C.-5., D.-5., and F.-5.]

Suggested IQP/PQP co-advisors: WPI (Salazar, Hart, Rollings, Griffin, Johnson, Radzicki, Rissmiller) and Vernon-Gerstenfeld

Pollution generated by urban activities ... assigned to:

Ecuador II: Team (2) on **Pollution generated by urban activities**
Allan Concepcion, MEB
Francisco Pereyo, ME
and Navin Rajashekar, CM
[an ESPOL student may be added to this project]

In cooperation with the following listed ESPOL selected liaisons:

Ing. Daniel Tapia
Ing. Cristobal Mariscal
Ing. Alfredo Torres

This project was mentioned by both bootstrap teams in their reports (see First Quarter FY 1993 report) and could be designed as case study modeled after that performed by the environmental bootstrap team or involve detailed comparative industry studies either looking at parallel Ecuadorian industries or at U.S. operations verses Ecuadorian equivalents. Local industries include fish (including shrimp), agricultural processing (including coffee, cocoa, banana, and sugar), many small manufacturing processes and several cottage industries. Any dominate industry would make for good case studies. Industrial management practices should be part of these cases if chosen and other cases may lead to examining appropriate technologies for these advancing industries. There are several good problems ideas presented in the Agenda 21 document which is on your laptop computers.

This study must involve assessing the city of Guayaquil's water usage and handling of solid wastes. Local and national government policies in both regulatory and enforcement areas should be explored at some level (again see Agenda 21) and might make for excellent case studies.

I. <u>necessarily</u> crossing the matrix elements B.-1., B.-2., B.-3., F.-1., F.-2., F.-3. ... and
II. <u>could</u> involve more in-depth studies of elements B.-5.; F.-5.; if the focus becomes more technology based ... and
III. <u>in some specific case studies</u>, might include elements
[A.-2., B.-2., C.-2., D.-2., and F.-2.] if a planning emphasis is taken by the team or
[A.-5., B.-5., C.-5., D.-5., and F.-5.] if an appropriate technology focus is deemed necessary.
[xxx-1.] if an operational management approach is taken.

Suggested IQP/PQP advisors: WPI (Hart, Rollings, Griffin, Johnson, Gerstenfeld, FitzPatrick, Radzicki, Rissmiller) and Vernon-Gerstenfeld

Resource management for sustainable development ... assigned to:

Ecuador II: Team (3) on **Resource management for sustainable development**
Todd DiNoia, CM
Laura Guillette, ED
Eduardo Mendez, CE
and Vail Mosier, CM

In cooperation with the following listed ESPOL selected liaisons:

Ing. Alfredo Barriga
Ing. Hector Ayon
Inga. Sonia Pizarro
Ing. Mariano Montano
Ing. Rolando Martin

This project was mentioned by both bootstrap teams in their reports (see their reports) and could be designed as an extension of the petroleum case study performed by the environmental bootstrap team or involve new areas of exploration such as the future of mining gold or other non-renewable resources. Like in the earlier case study, assessing specific government policies in both regulatory and enforcement areas and in examining industrial practices as they relate to environmental impact should be integral to this study. For the mining case study, land-slide prevention studies should be included. This component would compliment greatly to the work of the MQP team dealing with mining activities. Although this latter subject was not discussed by either bootstrap team, this topic is currently of a national (Ecuadorian) concern and thus is a new IQP sub-topic introduced by the ESPOL administration.

If the selected case study deals with the effects of gold and related minerials mining activities on land, water, agriculture, etc., the students should look closely at the projects discussed by both bootstrap teams in their reports and could involve examining industrial practices as well as the environmental impact assessing specific regulatory and enforcement government policies. Disaster prevention strategies should be examined.

If the selected case studies deal with excessive use of chemical nutrients in shrimp farms and their effects upon land, water and the food-chain the students should look closely at the projects discussed by both bootstrap teams in their reports and could involve examining industrial practices as well as the environmental impact assessing specific regulatory and enforcement government policies.

Students should examine industrial practices as they relate to environmental impact and be included in this study. In cases where competition exists between existing industries, comparisons should be made to determine the successful verses the unsuccessful (main) business characterists to be used that yield a sustainable management outcome, potentially leading to innovative business practices.

I. <u>necessarily</u> crossing the matrix elements A.-1., A.-2., A.-3., A.-4. (for mining), A.-5., B.-2., B.-3., B.-5., C.-1., C.-2.; C.-3., C.-4.; C.-5., and
II. <u>could</u> involve studies of elements B.-4., C.-2., D.-2., D.-3.,

E.-1.; E.-2.; E.-3.; F.-2.; F.-3.; F.-5., [actually all of xxx-2., if the emphasis on the project is policy] and

III. in some specific case studies, might include detailed analysis in elements [A.-2., B.-2., and C.-2. if the project's emphasis is policy] or
[A.-4., B.-4., and C.-4 if the project's emphasis is critical technologies] or
[A.-5., B.-5., C.-5., and F.-5., if the project's emphasis is appropriate technologies].

Irrespective of the project's emphasis, environmental impact and business developments must be stressed.

Suggested IQP/PQP advisors: WPI (Johnson, Velazco, Gerstenfeld, Rissmiller, Salazar, Hart, Rollings, Griffin, Radzicki, Gottlieb) and Vernon-Gerstenfeld

The Pretraining Course (or PQP):

In order to prepare WPI students for their project experiences in Ecuador, a PQP will be conducted. This PQP will consist of a 30 hour lecture course (presented by 12 WPI faculty, with the assistance of 30 total WPI faculty) combined with a formal project proposal co-developed by the WPI student project team members. This course's structure is presented in Appendix B along with other relavent information such as participating WPI faculty and suggested readings.

Course Faculty: The following WPI faculty will formally present this course:

(numbers in parenthesis (#), refer to the designated course meeting number(s)... see course structure below).

The other scheduled IQP or MQP team meetings are listed next to the WPI faculty involved.

Professor S. V-G will schedule her meeting with the IQP teams and Professors Hart, Rollings and Salazar will set the times for the MQP team meetings.

Professor	(class meeting number)
Professor B. Addison	(5, 6, 7)
Professor P. Dunn	(4, 7)
Professor C. Ferreira-Pinto	(12)
Professor J. Groccia	(13)
Professor F. Hart	(8, 11, 15) + weekly meetings with MQP
Professor M. Radzicki	(4, 5)
Professor K. Rissmiller	(2, 14)
Professor J. Rollings	(1, 2, 3, 5, 8, 11, 14, 15) + weekly meetings with MQP
Professor G. Salazar	(1, 8, 11, 15) + weekly meetings with MQP
Professor L. Schachterle	(2)
Professor E. Velazco	(1)
Professor S. Vernon-Gerstenfeld	(1, 8, 11, 15) + weekly meetings with IQPs

Cooperating WPI faculty: For general information, the following WPI faculty are actively involved in the WPI/ESPOL UDLP development. Student team members may wish to discuss a component of their project with some of these faculty from their defined expertise or involvement in the linkage. Director Rollings has included these faculty's E-mail addresses so as to encourage students (and faculty) to compose specific questions to these individuals via electronic media prior to meeting with them. This should minimize time involved for all and maximize student learning/contact with all faculty participants.

Faculty	E-mail	Expertise
Guillermo Salazar	(salazar@wpi)	Civil Eng'g., GIS
Bland Addison	(addison@wpi)	History
Patrick Dunn	(pdunn@wpi)	History
Arthur Gerstenfeld	(ag@wpi)	Entrepreneurship

John Griffin	(griffin@wpi)	Environmental Economics
Hossein Hakim	(hakim@wpi)	Global resources
Elizabeth Jolie	(efjolie)	Everything
Robert Kinicki	(rek@wpi)	GIS data management
Charles Kornik	(cjkornik)	Logistical support
David Lucht	(dalucht@wpi)	Fire & disaster prev'tn
Thomas Probert	(probert@wpi)	Computing & info. mang't
Michael Radzicki	(mjradz@wpi)	Economics & sys. dynamic
Kent Rissmiller	(kjr@wpi)	Law & policy issues
Enio Velazco	(evelazco@wpi)	TQM, tele-ed & mang't
Ronald Cheetham	(cheetham@wpi)	Biology & ecology
Jim O'Shaughnessy	(jco@wpi)	Environmental eng'g.
Fred Hart	(flhart@wpi)	Environmental eng'g.
Bob Fitzgerald	(rfitz@wpi)	Civil & Fire Eng'g.
Malcolm FitzPatrick	(msf@wpi)	Urban planning
Ted Crusberg	(crusberg@wpi)	Environmental science
S.Vernon-Gerstenfeld	(sgerstenfeld)	Social science
James Groccia	(jegroccia)	Project assessment tools
James E. Rollings	(jerollings)	UDLP Head & Biochem Eng'
W. M. Clark	(wmclark@wpi)	Biochem & Environ'l Eng'
Frank Lutz	(fclutz)	Civil & Environ'l Eng'g.
Lance Schachterle	(lschachterle)	ISD projects
Roger Gottlieb	(gottlieb@wpi)	Humanities & Environment
Sharron Johnson	(sharon@wpi)	Management systems
Leon Graubard	(graubard@wpi)	Management

There are 15 biweekly class meetings (each of two hours in length) in the course design. Given that there are five "free" slots through each week, and that these 5-"free" times are to be divided between two (2) meetings each week, there is an "overlap" period (on W P.M.) that could be used to scheduled for either the early-week or late-week classroom meetings to be presented that week. In this discussion, Director Rollings has referred to class meetings by specific number (1-15). Odd numbered meetings can occur on W, Th, or F P.M.s at the times listed (see above). Even numbered meetings can occur on M P.M., W AM, or W P.M.. {Given the dual listing of W P.M., their might be a problem, but lets deal with that later ... if it happens.} What follows is the class schedule (by meeting number) together with the proximate dates and listed faculty for these specific meetings.

In Appendix B, attached to this report is the course structure and objectives that will be handed to the students on the first meeting day for your information. There may be changes, additions, etc. of your listed topics. **If you wish to modify your topic title, assigned readings, or have other specific requests that should be add to this list, PLEASE send Director Rollings these changes as soon as possible so that he can include them in this handout.**

NOTE: The times for meetings will effect the locations of the meetings!! I must know the meeting times in order to secure classroom space!!

Class Schedule:

Class Meeting Number	Approximate Date(s)	Faculty Listed
1	August 27, 1993	JER, GFS, EV, VG
2	Aug. 30 - Sept. 1	LES, KJR, JER
3	Sept. 1 - 3	JER
4	Sept. 8 (Labor Day week)	PPD, MJR, Pilar?
5	Sept. 9 - 10	JER, WABA, MJR,"
6	Sept. 13 - 15	WABA
7	Sept. 15 - 17	PPD, WABA, Pilar
8	Sept. 20 - 22(AM)	JER, GFS, VG, FH
9	Environmental Workshop	...GFS....
10	Environmental Workshop	...GFS....
11	Sept. 30 - Oct. 1	JER, GFS, VG, FH
12	Oct. 4 - 6	CF-P
13	Oct. 6 - 8	JEG
14	Oct. 11 - 13	JER, KJR
15	Oct. 13 - 15	JER, GFS, VG, FH

SECTION TWO: **PREPARATORY COURSE FOR ECUADOR II PROJECTS**

James Rollings (course organizer) Term A, 1993
831-5664 Meeting Time?
Goddard Hall 216 Meeting Place?

This team-taught course is designed to prepare students to carry out projects the WPI Project Center at the Escuela Superior Politecnica del Litoral in Guayaquil, Ecuador. Being the second set of project teams at the site, you ar collectively known as Ecuador II; teams number 1-4. Your team assignments are

IQP/MQP team members: (declared majors)

Ecuador II: Team (1) on **Pollution generated by productive activities**
Antoinette Burns, CE/EV
Spirit Joseph, CM/BB
Obadiah Plante, CH
and Rudy Soriano, MGE

Ecuador II: Team (2) on **Pollution generated by urban activities**
Allan Concepcion, MEB
Francisco Pereyo, ME
and Navin Rajashekar, CM
[an ESPOL student may be added to this project]

Ecuador II: Team (3) on **Resource management for sustainable development**
Todd DiNoia, CM
Laura Guillette, ED
Eduardo Mendez, CE
and Vail Mosier, CM

Ecuador II: Team (4) on **Study effects of mining activities of gold and related materials over land and water and the toxic consequences to agriculture and aquaculture products**
Jenn Croft, CE environmental engineering
Kirstin DiPietro, CE environmental engineering
Ryan Johnson, CE environmental engineering
Jamey Pedro, CE environmental engineering
Kevin Worden, CE environmental engineering

The course is designed to:

a. train students in certain research and organizational skills necessary to carry out a successful project on-site in Ecuador,

b. heighten student sensitivity to matters of cultural diversity and be better prepared to work as team members,

c. present background knowledge about political, social, ecological and economic factors in developing nations generally and particularly in Latin America and specifically in Ecuador,

d. introduce students to the fundamental features of Ecuadorian history and culture as they influence project development and daily operation of teams on site,

e. introduce students to environmental and entrepreneurial education, public policies, and research in Ecuador and particularly as ESPOL views its national mission(s).

NOTE !!! Your PRIMARY ASSIGNMENT is to complete your project proposals. This will occur in two steps:

(1) a preliminary proposal will be initially presented to the course faculty on Sept 20 (or 22), 1993 and again to the WPI/ESPOL task forces during the week of Sept. 22-29, 1993. These groups will reassign and/or re-scope your projects based on the needs of the UDLP linkage. Your project teams will necessarily be divided during this week as we have separated each group to maximize your individual and team's learning. The task forces may refine, re-focus or re-define specific activities for your projects. With this information/input, your teams will again present your (potentially) modified proposals to the WPI course faculty on Sept. 30 (or Oct. 1), 1993.

(2) a final proposal is due to Profs. Rollings and Vernon-Gerstenfeld and to your ESPOL assigned liaisons on October 14, 1993.

Final proposals are to contain a completed literature survey and clearly defined specific objectives including listed activities for your seven working weeks in Ecuador.

NOTE !!! Individual instructors may assign specific tacks as they see appropriate to your academic developments.

Course Textbook: North, South, and the Environmental Crisis, R. R. White, University of Toronto Press, Toronto (1993). The book provides a good summary of topics related to several areas of interest to each of the four Ecuador II projects. The book's References provide an excellent resume to more advanced readings in specific topics of interest to each project's development. (text is referred to in this overview as **RRW**)

Course Reference Materials: Each team will be provided a notebook computer with Windows and Word Perfect installed on Oct. 1, 1993. Each group is provided a detailed Procedures Manual (of approximately 250 pages) that contains significant background information on structuring projects. The manual will contain additional information on Ecuadorian history, culture, geography and GOE international relations with the United States. You will be referring to these materials throughout the course of this PQP and your on-site project execution. In addition, Agenda 21 (the primary document from the "Rio-Conference"; i.e. the United Nations Conference on Environment and Development ... or UNCED) is contained on your computers and will be useful as an acceptable framework for general assessment and specific potential impact analyses. (Agenda 21 is referred to in this overview as **A21**). Student or faculty groups requiring specific chapters of the report can E-mail request for Agenda 21 chapters to (jerollings@jake.wpi.edu). A copy of the Agenda 21 table of contents is attached to the bottom of this course overview.

Your projects are being built from the initial research of WPI's "bootstrap" (Ecuador I) projects. Copies of these two reports are available from Ms. Betty Jolie for check-out in the Project Center. Several other general or specific resources are available in the Gordan Library, Global Resources section. ESPOL faculty have also included a list of reference materials for each project (please refer to this list).

Course Faculty. The following WPI faculty will formally present this course: (at the designated course meeting number(s) and other scheduled IQP or MQP team meetings).
Professor S. V-G will schedule her meeting with the IQP teams and Professors Hart, Rollings and Salazar will set the times for the MQP team meetings.

Professor	(class meeting number)
Professor B. Addison	(5, 6, 7)
Professor P. Dunn	(4, 7)
Professor C. Ferreira-Pinto	(12)
Professor J. Groccia	(13)
Professor F. Hart	(8, 11, 15) + weekly meetings with MQP team
Professor M. Radzicki	(4, 5)
Professor K. Rissmiller	(2, 14)
Professor J. Rollings	(1, 2, 3, 5, 8, 11, 14, 15) + weekly meetings with MQP team
Professor G. Salazar	(1, 8, 11, 15) + weekly meetings with MQP
Professor L. Schachterle	(2)
Professor E. Velazco	(1)
Professor S. Vernon-Gerstenfeld	(1, 8, 11, 15) + weekly meetings with IQP teams

You shall meet with collections of WPI and ESPOL faculty during the week of September 22-29, 1993 in lieu of normally scheduled periods 9-10 of the course. Professor G. Salazar will provide a separate schedule of these activities.

Course Schedule. The following schedule anticipates 15 biweekly meetings of 2 hours each (see attached schedule). The lecturers listed for the various sections of the syllabus are suggested names of faculty who might be asked to handle a particular section. Similarly, reading assignments listed below are only to suggest an idea of the material to be covered. In addition to classroom lectures, students are expected to meet for one hour per week with the WPI technical adviser assigned to their IQP or MQP team (see team assignments) and are expected to prepare summaries/overviews of assigned readings where indicated.

MEETING #: (for Date... see attached schedule) **TOPIC: (reading assignments)**

1. Introduction to Ecuador II Projects on Environment and Entrepreneurship.
The mission of the Agency for International Development UDLP with WPI's sister institution The Escuela Superior Politecnica del Litoral of Guayaquil, Ecuador. (J. Rollings)

Environmental Issues in Ecuador (G. Salazar and F. Hart)
Ecuador I: "bootstrap"-team discussion

Entrepreneurial Issues in Ecuador (E. Velazco)
Ecuador I: "bootstrap"-team discussion
The Agency for International Development Cooperative Agreement between Worcester Polytechnic Institute and Escuela Superior Politecnica del Litoral (J.E. Rollings)

2. Developing a Project Proposal (L. Schachterle, K. Rissmiller, J. Rollings)

Defining Characteristics of Award Winning IQPs (L. Schachterle)
Assignment: (Read selected IQPs and **RRW** chapters 3,4 and 5.)

How to Analyze and Define a Research Problem (K. Rissmiller and J.E. Rollings)

3. The Geography and Topography of Ecuador (J. Rollings) and an introduction to environment and development topics

(Reading assignment: **A21** Chapters 1,2,5 and 8 and **RRW** Chapter 1.)

Team #1: will summarize **A21** chapter 1 & 2
Team #2: will summarize **A21** chapter 8
Team #3: will summarize **A21** chapter 5
Team #4: will summarize **RRW** chapter 1

NOTE !!! Student teams will formally present the material assigned to them in this period. Other student teams will grade the performance of the presenting team. The object here is for teams to teach teams important information related to their projects.

4. What is Modernization, Underdevelopment and the Environmental Crisis?

Colonialism, Nationalism, and Economic Imperialism (P. Dunn)
Reading Assign: (The Challenge to the South: The Report of the South Commission (1991).)

World Economic Systems (M. Radzicki)

Reading Assignment: **RRW** Chapter 2 ... **all teams are to prepare questions to be asked the two faculty members leading this period.**

5. Carrying out Research in Ecuador

Government and Public/Private Agencies in Ecuador (guest lecturer)

Ecuador Today--People, Culture, Politics (J. Rollings and B. Addison)
Reading Assign: (A. Eichler, Ecuador: A Land, a People, a Culture (1982).)

Reading Assignments:
Team #1: **RRW** chapter 7, **A21** chapters 4 & 30
Team #2: **RRW** chapter 9, **A21** chapters 7, 28 & 29
Team #3: **RRW** chapter 6, **A21** chapters 11-12 & 18
Team #4: **RRW** chapter 8, **A21** chapters 10, 13, 34

Each team will prepare a 15-20 min. presentation of material, from their

readings that relate to central components of their projects.

6. The History of Ecuador (B. Addison)

   Pre-Columbian Ecuador (PBS Film)
   Reading Assign: (A. Crosby, The Columbian Exchange (1972).)

   The Spanish Empire and the Struggle for Liberation (B. Addison)

7. Twentieth-Century Ecuador (film, guest lecturer ??, B. Addison and P. Dunn)

   Current Politics
   Reading Assign: (G. I. Blanksten, Ecuador: Constitution and Caudillos (1964).)
   Urbanization and Law ... Bananas and Economics
   Reading Assign: (F. Swell, Turnaround: The Political Economy of Development and Liberalization in Ecuador (1989).)
   Rainforests and Environmental Issues

   Assign: Read the two bootstrap (Ecuador I) project reports
   Teams #1 and #2 will summarize Ecuador I project on Entrepreneurship, and RRW chapter 10
   Teams #3 and #4 will summarize Ecuador I project on Environmental Issues and RRW chapter 11

8. Presentations of Initial Findings by Project Teams (J. Rollings, G. Salazar, S. V-G)

   Team #1: Pollution and productive activities
   Team #2: Pollution and urban activities
   Team #3: Sustainable development
   Team #4: Mining activities

Discussion and Critique. Each team has a 20 min. presentation with 10 minute Q&A (question and answer) period following.

<u>NOTE!! Following this meeting, the ESPOL faculty will arrive to work on specific task force assignments. This activity is being set by Professor G. Salazar. Your responsibilities will (for the next 7-days) be to assist these people and the WPI faculty in project developments. (see your assigned task forces). The next two biweekly meetings (#9. #10.) will occur in parts with your task forces. You will work approximately 15-20 hours this week on this activity.</u>

11. Formal debriefing with all groups following the ESPOL workshop. (J. Rollings, F. Hart, G. Salazar, S. Vernon-Gerstenfeld)

    Group sharing of collective experiences and restructuring of Ecuador II team projects

12. Ecuadorian Literature and Culture

    The "Indianist" movement, the "novela de fundacin," and the literature of social protest (C. Ferreira-Pinto)

Popular Culture (film, guest lecturer)

Class, Race, Gender
Assign: M. Mower, The Andean Past: Land, Societies, & Conflict
Customs in Ecuador--Religious and Secular
Spanish for Visitors to Ecuador (C. Ferreira-Pinto)

13. Cultural Awareness and the Psychology of Difference (J. Groccia)
    Turn in your team's final written proposal for the Ecuador II projects.

14. Conflict Resolution in the Global Village (J. Rollings and K. Rissmiller)

15. Final preparations for Ecuador II teamwork. (J. Rollings, G. Salazar, F. Hart, and S. Vernon-Gerstenfeld)

    Team #1: one half-hour oral presentation of project proposal
    Team #2: one half-hour oral presentation of project proposal
    Team #3: one half-hour oral presentation of project proposal
    Team #4: one half-hour oral presentation of project proposal

NOTE: Appendix C contains a copy of the Procedures Manual that will be followed by the student teams during the main projects development phases. Student teams will execute their projects during the first quarter of FY 1994.

This is the Table of Contents for Agenda 21 ... Any chapter that your group feels to be related to your project will be transmitted to you as you request. Send chapter requests to (jerollings@jake.wpi.edu). I will provide the Agenda 21 framework.

Jul 13 15:18 1992 (en.unced.documents Page 538): Table of Contents: **Agenda 21**

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OBJECTIVE #3: Faculty Development

Environmental Workshop development:

The Environmental Workshop is the primary activity in the Faculty Development Objective for this FY. This workshop is scheduled for third week September, 1993. The lead individuals selected for this activity are Prof. G. Salazar of the WPI Civil Engineering Department, P.I. James Rollings of the WPI Chemical Engineering Department and Prof. A. Barriga of the Mechanical Eng'g. Department at ESPOL. These three people have desigwill be involved in designing the first environmental workshop for this WPI/ESPOL/UDLP. This workshop will serve as a mechanism for creating environmental engineering and science research and educational proposals for WPI and ESPOL faculty, graduate students and undergraduate projects of joint institutional interest. The workshop will incorporate undergraduate student project work where appropriate. Students will be expected to present their preliminary project ideas to the selected workshop participants. Workshop participants will outline proposals for submission to funding agencies upon the 1993 WPI student team's work completion at ESPOL in December, 1993.

Prior experience has established that coordinated and focused developments of cross disciplinary and joint institutional workshops obligates concentrated time outside of normal academic year commitments. A similar successful workshop was developed in summer 1992 by the WPI planning team. This first "bootstrap" workshop was lead by Prof. E. Velazco summer, 1992. Appendix D contains material developed by Prof. Salazar for the September, 1993 Environmental Workshop. Two "template proposals" have been written by WPI faculty and staff (Associate Dean Schachterle and Director Rollings) and these documents are now being reviewed by WPI and ESPOL faculty for possible models to be used during this next workshop. A portion of the travel by WPI faculty and staff to Ecuador this next August will be spent on the issue of proposal development. This information is also included in Appendix D.

In preparation for many of these faculty development activity areas, WPI faculty and staff representatives will travel to Ecuador in August ... documentation on this trip is included in Appendix D.

WPI has admitted two ESPOL faculty as graduate students in the Management Department. Ms. Lisa Jernberg has activities ... will follow OIT guidelines !! Information on these activities are included in Appendix E.

A recent issue of the WPI Journal included a feature artical on the Globalization Program including this Project Center at Escuela Superior Politecnica del Litoral, Guayaquil Ecuador. Appendix F contains a copy of this issue.

iii. [major emphasis in the reports should be devoted to identify any problems which might have mitigated the achievement of established objectives and activities.]

No additional problems have been encountered during this quarter.

iv. [listing of travel requests for next three months]

(1) Travel request forms for all WPI faculty and staff members have been submitted earlier. These include four people; Director James Rollings, Profs. A. Gerstenfeld, S. Vernon-Gerstenfeld and Dr. R. Winner.

(2) Travel request forms for the ESPOL faculty to attend the WPI Environmental Workshop will be submitted in mid-August.

v. [expenditure reports not due with this report.]

ESCUELA SUPERIOR POLITECNICA DEL LITORAL

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Appendix A

Guayaquil, julio 19 de 1993

To: JAMES ROLLINGS

From: ALFREDO TORRES, Coordinador ESPOL|WPI

Estimado James:

Le estoy enviando la lista actualizada de los profesores que colaborarán con los grupos de trabajo.

GRUPO # 1: Pollution Generated By Productive Activities
RODOLFO PAZ
FRANCISCO ROMAY
JORGE DUQUE

GRUPO # 2: Pollution Generated by Urban Activities
DANIEL TAPIA
CRISTOBAL MARISCAL

GRUPO # 3: Resource Management for Sustainable Development
ALFREDO BARRIGA
HECTOR AYON
SONIA PIZARRO
MARIANO MONTAÑO
ROLANDO MARIN

GRUPO # 4: Study effects of mining Activities of Gold and related materials over Land and Water and the Toxic Consecuences to Agriculture and Agriculture Products
FRANCISCO TORRES

El Ing. Mariano Montaño prefiere trabajar en el grupo 3. Se ha agregado al grupo 3 al Dr. Rolando Marín, PhD. en Ingeniería naval.

Atentamente,

ALFREDO TORRES
Coordinador Programa
ESPOL|WPI

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Proposal

RESOURCE MANAGEMENT FOR SUSTAINABLE DEVELOPMENT

Proposing Group:
Alfredo Barriga
Hector Ayon
Sonia Pizarro
Jorge Duque

BACKGROUND

The practice of appropriate resource management is somewhat new and not extensively applied in Ecuador. Only in those productive areas where an excessive degree of resource exploitation has caused a negative or depredatory impact, an action to analyze or attempt to manage resource utilization has evolved.

Recent examples of this situation are given by the shrimp culture bussiness as well as by the opening of new oil fields in the Ecuadorean Western Jungle.

For the case of shrimp culture, problems appeared in different orders. On the one hand there were problems dealing with the sharp decrease of mangrove areas caused by the clearing of the mangrove to leave room for the shrimp farm. The decrease in mangrove sites brouhgt about a subsequent decreased in natural larvae as their habitat was hampered. There were some other less marked effects on weather and conditions on stuaries. Other problems were caused by the introduction of foreign shrimp varieties. Furthermore. there were problems asociated with coexisting activities, like agriculture production and shrimp farming - certain agricultural practices like the use of pesticides would, in certain cases, introduce toxic remnants to the shrimp ponds. Finally, the presence of pollution in the water surrounding the ponds could introduce adverse effects on the operation of the ponds.

The case for oil exploitation is somewhat different. The type of operation causes an effect on the oil fileds characteristics as well as on the surrounding areas. Deforestation, for one, is a side effect of the openning of new oil fileds. Oil spillage on the surroinging soil is another one, with varying effects depending of the particular charactristics of the exploitation site.

The use of wood is another case. Wood is used as feed-stock in the furniture and other wood-using industries, as well as a complement in the house construction industry. Wood is also used as a fuel in domestic, commercial and industrial applications. The amount of deforestation brought about by the use of wood for different purposes depends the conditions of the forests wood comes from, as well as on any reforestation practice - if any. It is a well known fact that the now-arid lands of the Peninsula de Santa Elena in the Guayas Province of Ecuador were formerly (as close as some forty years ago) forested areas.

There are two additional cases which should be also mentioned. The first one relates to the sustainable use of energy in rural applications. The second one deals with sustainable programmes of industrial development in particular regions. In both cases recourse should be made of all the interactions between productive activities, development and investment plans, and the miriad of socio-economic indicators which reflect well being and advance of the various communities.

2.0 OBJECTIVES

The basic objective of this study is to formulate an acceptable methodology for tne analysis of the sustainability of utilization of important resources, as well as to establish a practical approach to look at the interaction between intervening productive activities and socio-economic development.

3.0 METHODOLOGY

The proposal could be implemented through the following steps:

3.1 Apply and test, on documented cases, certain particular concepts of sustainable development.

3.2 Establish a methodology to identify limiting borders for a region, on the basis of geographical features, economic interaction, input of feed-stocks, energy supply, sites for agricultural and industrial production, towns and communities, etc.

3.3 Select a particular line of application. Likely candidates may be
- Sustainable Energy for Rural Development
- Sustainablility of Industry in the Guayas Province
- Sustainability of Small Scale Fish Culture in Coastal Regions
- Sustainability of Agricultural Production

3.4 Formulate a set of conditions needed for the sustainability of the selected case

3.5 Analyze the implication of interaction between intervening factors, like price subsidies, regional development plans, energy supply, provincial-government priorities vs national-level ones, etc.

3.6 Make an overall assessment of the approach.

4.0 DEPTH

The depth of the study will depend on the particular topic selected for case study, as well as the amount and worth of the information gathered. It is foreseen that a seven-week period will be enough to generate substantial ground work, even though an in-deth analysis of the case may not be carried out in full.

93 -07 -16

1. NOMBRE DEL PROYECTO:

ESTUDIO PARA DETERMINAR ALTERNATIVAS DE TRATAMIENTO DE EFLUENTES LIQUIDOS INDUSTRIALES QUE SE DESCARGAN A LOS RECURSOS HIDRICOS DE LA CIUDAD DE GUAYAQUIL.

2. LOCALIZACION GEOGRAFICA:

Cantón Guayaquil

3. ANTECEDENTES DEL PROYECTO

Al igual que muchas otras ciudades latinoamericanas, Guayaquil ha experimentado un rápido crecimiento en particular en los últimos 20 años cuando se ha acentuado aún más el fenómeno de la urbanización.

Según datos del INEC, la urbanización en el Ecuador se ha manifestado de la siguiente manera:

Años	Porcentaje de población urbana	Porcentaje de población rural
1950	28.5	71.5
1962	35.3	64.7
1974	41.4	58.6
1982	49	51
1991	55.4	44.6

Este fenómeno que ha venido teniendo lugar en los últimos 40 años, ha ido también acompañado de un crecimiento industrial localizado principalmente en las ciudades de Quito y Guayaquil.

En el caso de la ciudad de Guayaquil, tanto los residuos líquidos provenientes del sector doméstico como los provenientes del sector industrial han sido siempre dirigidos hacia el Río Guayas y el Estero Salado, los cuales hasta hace algunos años estuvieron en capacidad de asimilar tales descargas. Hoy en día, ante el incremento que ha tenido la población urbana y las industrias instaladas en el área, estos recursos hídricos no están más en capacidad de manejar tales descargas y esto es evidente a simple vista. Se vuelve entonces necesario buscar soluciones para el tratamiento de estas descargas para reducir así el impacto de las mismas sobre el río Guayas y el Estero Salado.

Instituciones como IEOS, DIGMER, INERHI, son las encargadas de vigilar y proteger los recursos hídricos del cantón Guayaquil y sus alrededores.

Existe igualmente la ley de aguas con su respectivo reglamento pero lamentablemente no se cumple en la medida que debería ser.

4. JUSTIFICACION:

El rápido desarrollo industrial acompañado de un acelerado crecimiento de las ciudades conocido con el nombre de urbanización que se ha dado en el Ecuador, en particular en los últimos 20 años, nos lleva a la necesidad de reconocer y comprender mejor las interrelaciones que existen entre el desarrollo tecnológico-económico, la contaminación, la salud y el medio ambiente en que vivimos. Esencialmente un programa de salud pública que tome en cuenta la prevención y control de la polución debe incluir las siguientes etapas:

1.- Reconocimiento del problema.

2.- Colección de la información.

3.- Definiciones de las fuentes y causas del problema.

4.- Selección e implantación de soluciones apropiadas.

Sin embargo, aún existiendo un reconocimiento adecuado del problema y de los principios y prácticas necesarias para una adecuada prevención y control de la contaminación, frecuentemente no se dispone de información suficiente (datos) sobre la fuente de la contaminación en áreas industriales y la caracterización completa del contaminante.

Cuando se afrontan problemas de esta naturaleza es imprescindible contar con un inventario de los tipos de contaminantes, sus fuentes,su localización,niveles de emisión etc. Un buen inventario de esta índole nos suministra información sobre:

1.- Rutas críticas del contaminante y sectores más afectados.

2.- Concentración del contaminante en el medio ambiente.

3.- Peligro a que está sujeta la población y el medio ambiente.

El proyecto se propone entonces abordar el problema de la contaminación de los recursos hídricos debido a los efluentes industriales, los mismos que son descargados en su gran mayoría sin tratamiento previo a los canales que van a desembocar al Estero Salado o al Río Guayas.

5. PROYECTOS RELACIONADOS Y/O COMPLEMETARIOS:

A nivel local la Universidad de Guayaquil finalizó en este año un proyecto auspiciado por el CONUEP, sobre "Caracterización y cuantificación de los efluentes industriales de la zona de la vía Carlos Julio Arosemena". Este proyecto estuvo orientado hacia la caracterización y cuantificación de los efluentes industriales del sector de la vía Carlos Julio Arosemena, que se

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descarga al Estero Salado.

Otro proyecto de naturaleza parecida ha sido presentado por la ESPOL ante el CONUEP y su ejecución está iniciándose. "Un estudio interdisciplinario sobre la contaminación marina del Estero Salado y el Golfo de Guayaquil".

Asimismo, la Fundación para Rescate del Estero Salado y el FODUR, cuentan con proyectos orientados hacia la recuperación del Estero Salado. Como ejemplo podemos citar: "Siembra de bacterias desnitrogenadoras", "Programa de Dragado", "Areación de las aguas del estero", etc.

Por otra parte, la Universidad de New Orleans de los Estados Unidos ha presentado a la Presidencia de la República una propuesta para ejecutar un estudio integrado de los recursos hídricos de la ciudad de Guayaquil, con la perspectiva de lograr su recuperación y plantear soluciones para el uso sostenido de los mismos.

6. MARCO INSTITUCIONAL:

RESPONSABLE: Ing. Rodolfo Paz Mora
FACULTAD DE INGENIERIA MECANICA, ESPOL

ENTIDADES DE APOYO:

- Instituto Ecuatoriano de Obras Sanitarias.
- Dirección General de la Marina Mercante.
- Instituto Nacional de Recursos Hidráulicos.
- Municipalidad de Guayaquil.
- Cámara de Industrias.

7. OBJETIVOS:

OBJETIVO GENERAL.-

Plantear alternativas de tratamiento de los efluentes de la ciudad de Guayaquil que contribuyan a la solución del problema de la contaminación de los recursos hídricos y promuevan un uso sostenido de las actividades Industriales en la zona.

OBJETIVOS ESPECIFICOS:

1.- Identificar la extensión de los recursos hídricos afectada por el desarrollo industrial de la ciudad de Guayaquil.

2.- Evaluar los daños causados por las actividades industriales desarrolladas en la zona.

3.- Caracterizar cuantitativamente y cualitativamente los efluentes industriales.

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4.- Plantear alternativas de tratamiento de los efluentes industriales.

5.- Identificar las restricciones que los recursos hídricos imponen a la actividad industrial en la zona

6.- Estimar la capacidad de asimilación de descargas de los recursos hídricos.

7.- Plantear alternativas de desarrollo industrial en el área.

8.- Estimar la naturaleza y magnitud de los cambios del entorno a corto, mediano y largo plazo, resultante de las actividades industriales.

8. ACTIVIDADES:

1.- Elaborar catastro industrial de la ciudad de Guayaquil.

2.- Clasificar por sectores, procesos, tipo de efluentes etc. las industrias de la ciudad de Guayaquil.

3.- Realizar inventario de descargas líquidas industriales.

4.- Caracterizar cualitativamente y cuantitativamente los elementos contaminantes que se descargan en los recursos hídricos de la ciudad.

5.- Identificar la extensión de los recursos hídricos afectada por las descargas industriales.

6.- Evaluar los daños causados por las descargas.

7.- Plantear alternativas de tratamiento de los efluentes.

8.- Identificar las restricciones que los recursos hídricos imponen al desarrollo industrial.

METODOLOGIA DEL PROYECTO

1.- Definición del área de estudio.

La selección del área de estudio dependerá del tipo de límites que se establezcan.Estos pueden ser:

- Físicos (ríos,carreteras, colinas, canales,etc).

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- Políticos (límites de la ciudad, cantones, parroquias,etc).

- Económicos (zona industrial, comercial, residencial,etc).

Cada categoría tiene sus méritos. Los límites físicos facilitan la evaluación de los impactos sobre componentes del sistema natural como son: ríos, canales, etc. Los límites políticos facilitan la tarea porque la información podría ser suministrada por las autoridades correspondientes en las áreas asignadas,y por último, la clasificación económica facilita la identificación del impacto ambiental con el futuro.

Todos estos criterios se tomarían en cuenta para definir el área de estudio y su forma de clasificación. Las fronteras serán escogidas de tal forma que permitan tener flexibilidad para realizar reajustes durante el desarrollo del proyecto.

2.- <u>Apoyo de otras instituciones.</u>

Se presenta la necesidad de tener acceso a información de instituciones tanto públicas como privadas que manejan el tema que nos concierne. En algunos casos es política de las instituciones suministrar la información libremente,en otros se hará necesario buscar el camino de cooperación.

3.- <u>Colección de la información.</u>

a. Estudio de la información existente en las instituciones públicas y privadas que tratan con el tema, como son IEOS,DIGMER,INHERI,INOCAR,INP, Universidad, etc.

b. Validación de la información reunida en a.

c. Diseño de un programa para recolección de información a través de mediciones directas; para esto se tomará en cuenta lo siguiente:

- Industrias existentes.

- Clasificación de las industrias según tipo de procesos.

- Identificación de parámetros a ser determinados.

- Determinación de la frecuencia de mediciones y el número de muestras.

d. Realización de encuestas y entrevistas cuando fuere necesario.

4.- <u>Análisis de los resultados</u>

Comprenderá.

- Clasificación, registro y codificación de los resultados.

- Técnicas analíticas que se utilizarán para obtener las conclusiones.

5.- Interpretación de datos

Es el estudio cualitativo y cuantitativo que permitirá afirmar, negar,o modificar las hipótesis planteadas. La validez de ello dependerá de la rigidez experimental, de la correcta planeación de las observaciones y de la seguridad de los procedimientos analíticos.

6.- Presentación de los resultados.

Comprenderá los reportes parciales a elaborarse durante la ejecución del proyecto y el reporte final al término del mismo. Se tomará en cuenta el aspecto integral del problema planteando alternativas de tratamiento de los efluentes industriales que promuevan el uso sostenido de estas actividades.

7.- Difusión del proyecto.

Se difundirán los resultados del proyecto en:

- Instituciones públicas y privadas.
- Medios de comunicación pública.
- Eventos nacionales e internacionales.

9. METAS:

1. Se caracterizará el sector industrial de la ciudad de Guayaquil en relación a su interacción con los recursos hídricos
2. Se conocerá la composición físico-química de los efluentes industriales lo cual permitirá planificar el tratamiento que deberá darse a estos líquidos.
3. Se identificará los efluentes de características físico-químico similares para los cuales se podría implantar un sistema de tratamiento común.
4. Permitirá identificar opciones para mejorar el sistema de colección y procesamiento de la información de las instituciones públicas y privadas
5. Se generará base de datos que servirá de apoyo a futuros proyectos.
6. Se identificarán las zonas críticas de contaminación de los recursos

hídricos.

7. Se generará conocimiento acerca de las limitaciones que los recursos hídricos imponen al desarrollo industrial del área

8. El conocimiento generado acerca de los efluentes industriales servirá de apoyo a la planificación del uso sostenido de los recursos hídricos.

9. La experiencia que se logre en este proyecto podrá ser incorporada en trabajos similares que se ejecuten en otras ciudades del país.

10. Se formará a nivel de ESPOL un grupo de trabajo con experiencia en el tratamiento de este tipo de problemática ambiental.

11. Se formará grupo de trabajo interinstitucional.

POLLUTION GENERATED BY URBAN ACTIVITIES

Ing. Daniel Tapia F. Ing. Cristóbal Mariscal

Julio 15, 1993

Lineamientos de trabajo

- Revisión de trabajos ESPOL
- Establecer zonificación urbana-industrial de la ciudad (en el plano) visita.

- Reconocimiento a sitios de depositación
  Botadero actual
  Relleno Sanitario "Las Iguanas"
  Río Guayas
  Estero Salado

- Visita a Industria. Entrevistas
- Revisión de sistema de recolección de desechos
- Determinación de desechos peligrosos(Industria Hospitales)
  Delinear clasificación
  Recomendaciones de recolección
  Recomendaciones de depositación

Bibliografía

- Consultar y traer a ESPOL
  Normas de clasificación de desechos
  Domésticos
  Industriales
  Peligrosos

- Literatura referente a tratamiento de desechos en siti de almacenamiento.

  Relleno sanitario
  Incineración
  Otros

- Normas y literatura referente a tratamiento clasificación de desechos clasificados como peligrosos

  Industriales
  Hospitalarios

- Estudios realizados en localidades de U.S.A.

Presupuesto

- Gastos de desplazamiento en ciudad	$750
- Adquisición de materiales (planos, mapas)	$150
- Copias xerox, oficina	$250
- Varios	$150

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ESCUELA SUPERIOR POLITECNICA DEL LITORAL

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Appendix B

Julio 27 de 1993

Para JAMES ROLLINGS

De ALFREDO TORRES

EStimado James:

Le estoy enviando el PQP del grupo 3 que consta de 3 páginas y el PQP del grupo 4 que consta de 1 página.

Hasta el momento se han enviado los resúmenes (propousals) y los PQP para los cuatro grupos.

Atentamente,

ALFREDO TORRES
Coordinador
PROGRAMA ESPOL|WPI

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Resource Management for Sustainable Development

WPI/ESPOL IQP 1993

List of Reference Material

By: Alfredo Barriga, ESPOL 26 July 1993

Following is a listing of books suggested by A.B. from ESPOL as background and reference material. It results from a partial search for the 1993 WPI/ ESPOL IQP on Resource Management for Sustainable Development. The present listing has been selected from a catalogue on Books by Post put forth by the Intermediate Technology Development Group of UK.

1.-Environmentally Sound Small-scale Forestry Projects: Guidelines for planning. Peter F. Ffolliott and John L. Thomas, 1983. VITA. (p4*)

2.-Reforestation in Arid Lands. Fred R. Weber with Carol Stoney, 1987. VITA. (p5*)

3.-Land, Food and Rural Development in North Africa. M. Riad El-Ghonemy, 1993. ITDG. (p7*)

4.-Land is life: land reform and sustainable agriculture. Edited by Nigel Dudley with John Madeley and Sue Stolton, 1992. ITDG. (p7*)

5.-Soil Conservation and Sustainable Land Use: And economic approach. J. de Graaff, 1992. Kit Press, ITDG^. (p7*)

6.-Sustainable Mountain Agriculture: A review of perspectives and experiences. N.S. Jodha with M. Banskota and T. Partap, 1992. ITDG. (p7*)

7.-Beyond the Limits: Global collapse or a sustainable future. D.H. Meadows and D.L. Meadows with J. Randers, 1992. Earthscan. (p15*)

8.-Building Sustainable Communities: tools and concepts for self-reliant economic change. Edited by Ward Morehouse, 1989. Bootstrap Press, ITDG^. (p15*)

9.-The Development Dictionary: A guide to Knowledge as power. Edited by Wolfgang Sachs, 1992. Zed. (p15*)

10.-The First Global Revolution: A strategy for surviving the world. Alexander King and Bertrand Schneider, 1992. Simon & Schuster. (p15*)

11.-Masatering the Machine: Poverty, aid and technology. Land Smillie, 1991. ITDG. (p16*)

12.-Our Common Future: Report of the World Commission on Environment and Development. Dr. Gro Harlem Brundtland and others, 1987. OUP. (p16*)

13.-Rural Development in the Crossfire: The role of grassroots support organizations (GSO^s) in situations of political violence in Peru. Michael L. Smith, 1991. IDRC, ITDG^. (p16*)

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* Refers to page number in the "Books by post" ITDG catalogue, 1993 Edition
^ ITDG acts as a trade distributor

14.-Sustainable Development: Exploring the contradictions. Michael Redclift, 1987. Methuen, (p17*)

15.-Agriculture and Natural Resources: A manual for development workers. Penelope Amerena, 1990. VSO, ITDG^. (p17*)

16.-Choosing Research Methods: Data colecction for development workers. Brian Pratt and Peter Loizos, 1992. Oxfam. (p17*)

17.-Defending the future: A guide to sustainable development. John Holmberg with Stephen Bass and Lloyd Timberlake, 1991. Earthscan. (p18*)

18.-Economic Analysis of the Environmental Impacts of Development Projects. John A. Dixon and others, 1988. Earthscan. (p18*)

19.-Equity and Efficiency in Economic Development: Essays in honour of Benjamin Higgins. Edited by Donald J. Savoie and Irving Brecher, 1993. ITDG. (p18*)

20.-Evaluating Social Development Projects. Edited by David Marsden and Peter Oakley, 1990. Oxfam. (p18*)

21.-For Earth's Sake: A report from the commission on developing countries and global change. IDRC, 1992. IDRC. (p18*)

22.-Making haste Slowly: Strengthening local environmental management in agricultural developmen. Edited by H. Savenije and A. Huijsman, 1991. KIT Press, ITDG^. (p19*)

23.-Managing Sustainable Development. Michael Carley and Ian Christie, 1992. Eartscan. (p19*)

24.-Power from the People: Innovation, user, participation and forest energy development. Matthew S. Gamser, 1988. ITDG. (p20*)

25.-Questioning Practice:NGOs and evaluation. Doug Porter and Kevin Clark, 1985. NZCTD. (p20*)

26.-Rural Project Management: A handbook for practitioners. Vincent Austin, 1984. Batsford. (p20*)

27.-Sustainable Industrial Development. Marilyn Carr, 1988. ITDG. (p21*)

28.-Values for the Environment: A guide to economic appraisal. J.T. Winpenny. 1991. HMSO. (p21*)

29.-The Appropriate Technology Sourcebook: Third edition. Ken Darrow and Mike Saxenian, 1992. VIA, IDTG^. (p22*)

30.-Cutting Edge Technologies and Microcomputer Applications for Developing Countries. BOSTID. ITDG. (p22*)

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* Refers to page number in the "Books by post" ITDG catalogue, 1993 Edition
^ ITDG acts as a trade distributor

31.-The Management of Technological Change: An annotated bibliography. Donnacadh Hurley with an introduction by Matthew S. Gamser, 1987. ITDG. (p23*)

32.-Science and Technology: Lessons for development policy. Edited by Robert E. Evenson and Gustav Ranis, 1990. ITDG. (p24*)

33.-Small and Medium Enterprises: technology policies and options. Edited by A.S. Bhalla with a foreword by Sergio C. Trindade, 1992. ITDG. (p34*)

34.-Roads are not Enough: New perspectives on rural transport planning in developing countries, 1993. ITDG. (p44*)

35.-Rainwater Harvesting: the collection of rainfall and runoff in rural areas. Arnold Pacey and Adrian Cullis, 1986. ITDG. (p47*)

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* Refers to page number in the "Books by post" ITDG catalogue, 1993 Edition
^ ITDG acts as a trade distributor

REFERENCES FOR MQP STUDENTS

1. Mercury pollution due to the gold mining in the Madeira River Basin, Brasil. Ambio Vol. 19 #1. USA, 1990

2. "Mercury". Thomas A. Clarkson. Trace element in human and animal nutrition. Volume 1. Academic Press, 1987.

3. The global Water Cycle. E. Kay Berner, H. Berner. Prentice Hall, Inc. New Jersey, USA, 1987.

4. Water Supply and pollution control. W. Viessman, M. Hammer. IV Edition. Harper-Row Publishers. N. Y. USA. 1985.

5. Mercury pollution. Accio Moura da Silva. Brasil, 1988.

6. Standard Methods for the Examination of Water and Wastewater. AWWA, 15th edition, USA 1985.

7. Impacto hidrológico por abandono de minas. Instituto de Geología y minas de ESpaña. Madrid, 1986.

8. Impactos del mercurio en países en vías de desarrollo por amalgamación del oro en la pequeña minería. Thomas Hentschel, Michael Priester. Alemania Federal, 1990.

9. La minería del oro y su impacto en el medio ambiente de las zonas mineras de Zaruma, Portovelo y Ponce Enríquez. Francisco Torres A. Tecnológica, Vol. 9, no. 1. Guayaquil, 1991.

OBSERVATIONS:

Please find out the references 1, 5 and 8. Read them very carefully. It would be very important to study chapter 8 from reference 4. Review the analytical techniques related with the project that are very well shown in the Standard Methods (reference 6). Some other papers to be reviewed in the next months will be sent later.

LABORATORY REQUIREMENTS FOR MQP STUDENTS:

Mercury hydride (flask of 125 g.)
Silver nitrate (125 g.)

Water sampling kit.
Flow meter kit (see Cole-Parmer catalog 1993, page 406)
Soil sampling kit.

I.N.T.E.R.O.F.F.I.C.E...M.E.M.O.R.A.N.D.U.M.

TO: WPI faculty invited to co-teach Ecuador II-PQP
FR: James Rollings, PQP coordinator
RE: Exact scheduling of specific classes for Ecuador II-PQP

You are cordially invited to participate in co-teaching this second PQP for the Ecuador Project Center. I have arranged to have "credit" (1/2 course equivalent for the classroom component and additional "credit" for project advising activities) assigned to your WPI instructional activities. In most cases, you are assigned only one or two contact periods (see attached course description). I realize that you are all busy with other teaching and/or research assignments and thus I am attempting to minimize your time while maximizing the students' learning.

I have studied the 16 students pre-registration schedules and have found (not surprisingly) that there are only a few times that minimum-conflicts in students' schedules exist. Generally, late P.M. (3:30 - 5:00) M, (2:30 - 4:30) W, Th, and F and early AM (8 - 11) W are "free" or have only one or two conflicts with the students' pre-registration schedules. **I am requesting that you provide me with exact dates for your specific in-class involvements.** For the three WPI faculty directly involved in project proposal advising of the four student teams, individual group meeting will be arranged separately.

There are 15 biweekly class meetings in the course design. Given that there are five "free" slots through each week, and that these 5-"free" times are to be divided between two (2) meetings each week, there is an "overlap" period (on W P.M.) that could be used to scheduled for either the early-week or late-week classroom meeting to be presented that week. I will refer to class meetings by specific number (1-15). Odd numbered meetings can occur on W, Th, or F P.M.s at the times listed in the paragraph above. Even numbered meetings can occur on M P.M., W A.M., or W P.M.. {Given the dual listing of W P.M., their might be a problem, but lets deal with that later ... if it happens.} What follows is the class schedule (by meeting number) together with the proximate dates and listed faculty for these specific meetings. Could you select the optimal specific times that you can meet with this class and return your response to me by E-mail at your earliest so that scheduling can be completed? Thank you in advance for your assistance in this venture.

Attached to this request is the course structure and objectives that will be handed to the students on the first meeting day for your information. There may be changes, additions, etc. of your listed topics. **If you wish for me to modify your topic title, assigned readings, or have other specific requests that I should add to this list, PLEASE send me these changes as soon as possible so that I can include them in this handout.**

NOTE: The times for meetings will effect the locations of the meetings!! I must know the meeting times in order to secure classroom space!!

Course Faculty. The following WPI faculty will formally present this course:

(numbers in parenthesis (#), refer to the designated course meeting number(s)... see course structure below).

The other scheduled IQP or MQP team meetings are listed next to the WPI faculty involved.

Professor S. V-G will schedule her meeting with the IQP teams and Professors Hart, Rollings and Salazar will set the times for the MQP team meetings.

Professor	(class meeting number)
Professor B. Addison	(5, 6, 7)
Professor P. Dunn	(4, 7)
Professor C. Ferreira-Pinto	(12)
Professor J. Groccia	(13)
Professor F. Hart	(8, 11, 15) + weekly meetings with MQP
Professor M. Radzicki	(4, 5)
Professor K. Rissmiller	(2, 14)
Professor J. Rollings	(1, 2, 3, 5, 8, 11, 14, 15) + weekly meetings with MQP
Professor G. Salazar	(1, 8, 11, 15) + weekly meetings with MQP
Professor L. Schachterle	(2)
Professor E. Velazco	(1)
Professor S. Vernon-Gerstenfeld	(1, 8, 11, 15) + weekly meetings with IQPs

Class Meeting Number	Approximate Date(s)	Faculty Listed
1	August 27, 1993	JER, GFS, EV, VG
2	Aug. 30 - Sept. 1	LES, KJR, JER
3	Sept. 1 - 3	JER
4	Sept. 8 (Labor Day week)	PPD, MJR, Pilar?
5	Sept. 9 - 10	JER, WABA, MJR,"
6	Sept. 13 - 15	WABA
7	Sept. 15 - 17	PPD, WABA, Pilar
8	Sept. 20 - 22(AM)	JER, GFS, VG, FH
9	Environmental Workshop	...GFS....
10	Environmental Workshop	...GFS....
11	Sept. 30 - Oct. 1	JER, GFS, VG, FH
12	Oct. 4 - 6	CF-P
13	Oct. 6 - 8	JEG
14	Oct. 11 - 13	JER, KJR
15	Oct. 13 - 15	JER, GFS, VG, FH

SECTION TWO: **PREPARATORY COURSE FOR ECUADOR II PROJECTS**

James Rollings (course organizer)
831-5664
Goddard Hall 216

Term A, 1993
Meeting Time?
Meeting Place?

This team-taught course is designed to prepare students to carry out projects in the WPI Project Center at the Escuela Superior Politecnica del Litoral in Guayaquil, Ecuador. Being the second set of project teams at the site, you are collectively known as Ecuador II; teams number 1-4. Your team assignments are:

IQP/MQP team members: (declared majors)

Ecuador II: Team (1) on **Pollution generated by productive activities**
Antoinette Burns, CE/EV
Spirit Joseph, CM/BB
Obadiah Plante, CH
and Rudy Soriano, MGE

Ecuador II: Team (2) on **Pollution generated by urban activities**
Allan Concepcion, MEB
Francisco Pereyo, ME
and Navin Rajashekar, CM
[an ESPOL student may be added to this project]

Ecuador II: Team (3) on **Resource management for sustainable development**
Todd DiNoia, CM
Laura Guillette, ED
Eduardo Mendez, CE
and Vail Mosier, CM

Ecuador II: Team (4) on **Study effects of mining activities of gold and related materials over land and water and the toxic consequences to agriculture and aquaculture products**
Jenn Croft, CE environmental engineering
Kirstin DiPietro, CE environmental engineering
Ryan Johnson, CE environmental engineering
Jamey Pedro, CE environmental engineering
Kevin Worden, CE environmental engineering

The course is designed to:

a. train students in certain research and organizational skills necessary to carry out a successful project on-site in Ecuador,

b. heighten student sensitivity to matters of cultural diversity and be better prepared to work as team members,

c. present background knowledge about political, social, ecological and economic factors in developing nations generally and particularly in Latin America and specifically in Ecuador,

d. introduce students to the fundamental features of Ecuadorian history and culture as they influence project development and daily operation of teams on site,

e. introduce students to environmental and entrepreneurial education, public policies, and research in Ecuador and particularly as ESPOL views its national mission(s).

NOTE !!! Your PRIMARY ASSIGNMENT is to complete your project proposals. This will occur in two steps:

(1) a preliminary proposal will be initially presented to the course faculty on Sept 20 (or 22), 1993 and again to the WPI/ESPOL task forces during the week of Sept. 22-29, 1993. These groups will reassign and/or rescope your projects based on the needs of the UDLP linkage. Your project teams will necessarily be divided during this week as we have separated each group to maximize your individual and team's learning. The task forces may refine, refocus or re-define specific activities for your projects. With this information/input, your teams will again present your (potentially) modified proposals to the WPI course faculty on Sept. 30 (or Oct. 1), 1993.

(2) a final proposal is due to Profs. Rollings and Vernon-Gerstenfeld and to your ESPOL assigned liaisons on October 14, 1993.

Final proposals are to contain a completed literature survey and clearly defined specific objectives including listed activities for your seven working weeks in Ecuador.

NOTE !!! Individual instructors may assign specific tacks as they see appropriate to your academic developments.

Course Textbook: North, South, and the Environmental Crisis, R. R. White, University of Toronto Press, Toronto (1993). The book provides a good summary of topics related to several areas of interest to each of the four Ecuador II projects. The book's References provide an excellent resume to more advanced readings in specific topics of interest to each project's development. (text is referred to in this overview as **RRW**)

Course Reference Materials: Each team will be provided a notebook computer with Windows and Word Perfect installed on Oct. 1, 1993. Each group is provided a detailed Procedures Manual (of approximately 250 pages) that contains significant background information on structuring projects. The manual will contain additional information on Ecuadorian history, culture, geography and GOE international relations with the United States. You will be referring to these materials throughout the course of this PQP and your on-site project execution. In addition, Agenda 21 (the primary document from the "Rio-Conference"; i.e. the United Nations Conference on Environment and Development ... or UNCED) is contained on your computers and will be useful as an acceptable framework for general assessment and specific potential impact analyses. (Agenda 21 is referred to in this overview as **A21**). Student or faculty groups requiring specific chapters of the report can E-mail request for Agenda 21 chapters to (jerollings@jake.wpi.edu). A copy of the Agenda 21 table of contents is attached to the bottom of this course overview.

Your projects are being built from the initial research of WPI's "bootstrap" (Ecuador I) projects. Copies of these two reports are available from Ms. Betty Jolie for check-out in the Project Center. Several other general or specific resources are available in the Gordan Library, Global Resources section.

Course Faculty. The following WPI faculty will formally present this course: (at the designated course meeting number(s) and other scheduled IQP or MQP team meetings).
Professor S. Vernon-Gerstenfeld will schedule her meeting with the IQP teams and Professors Hart, Rollings and Salazar will set the times for the MQP team meetings.

Professor	(class meeting number)
Professor B. Addison	(5, 6, 7)
Professor P. Dunn	(4, 7)
Professor C. Ferreira-Pinto	(12)
Professor J. Groccia	(13)
Professor F. Hart	(8, 11, 15) + weekly meetings with MQP
Professor M. Radzicki	(4, 5)
Professor K. Rissmiller	(2, 14)
Professor J. Rollings	(1, 2, 3, 5, 8, 11, 14, 15) + weekly meetings with MQP
Professor G. Salazar	(1, 8, 11, 15) + weekly meetings with MQP
Professor L. Schachterle	(2)
Professor E. Velazco	(1)
Professor S. Vernon-Gerstenfeld	(1, 8, 11, 15) + weekly meetings with IQPs

You shall meet with collections of WPI and ESPOL faculty during the week of September 22-29, 1993 in lieu of normally scheduled periods 9-10 of the course. Professor G. Salazar will provide a separate schedule of these activities.

Course Schedule. The following schedule anticipates 15 biweekly meetings of 2 hours each (see attached schedule). The lecturers listed for the various sections of the syllabus are suggested names of faculty who might be asked to handle a particular section. Similarly, reading assignments listed below are only to suggest an idea of the material to be covered. In addition to classroom lectures, students are expected to meet for one hour per week with the WPI technical adviser assigned to their IQP or MQP team (see team assignments) and are expected to prepare summaries/overviews of assigned readings where indicated.

MEETING #: (for Date... see attached schedule) **TOPIC: (reading assignments)**

1. Introduction to Ecuador II Projects on Environment and Entrepreneurship.
The mission of the Agency for International Development UDLP with WPI's sister institution The Escuela Superior Politecnica del Litoral of Guayaquil, Ecuador. (J. Rollings)

Environmental Issues in Ecuador (G. Salazar and F. Hart)
Ecuador I: "bootstrap"-team discussion
Entrepreneurial Issues in Ecuador (E. Velazco)
Ecuador I: "bootstrap"-team discussion
The Agency for International Development Cooperative Agreement between Worcester Polytechnic Institute and Escuela Superior Politecnica del Litoral (J.E. Rollings)

2. Developing a Project Proposal (L. Schachterle, K. Rissmiller, J. Rollings)

Defining Characteristics of Award Winning IQPs (L. Schachterle)
Assignment: (Read selected IQPs and **RRW** chapters 3,4 and 5.)

How to Analyze and Define a Research Problem (K. Rissmiller and J.E. Rollings)

3. The Geography and Topography of Ecuador (J. Rollings) and an introduction to environment and development topics

(Reading assignment: **A21** Chapters 1,2,5 and 8 and **RRW** Chapter 1.)

Team #1: will summarize **A21** chapter 1 & 2
Team #2: will summarize **A21** chapter 8
Team #3: will summarize **A21** chapter 5
Team #4: will summarize **RRW** chapter 1

NOTE !!! Student teams will formally present the material assigned to them in this period. Other student teams will grade the performance of the presenting team. The object here is for teams to teach teams important information related to their projects.

4. What is Modernization, Underdevelopment and the Environmental Crisis

Colonialism, Nationalism, and Economic Imperialism (P. Dunn)
Reading Assign: (The Challenge to the South: The Report of the South Commission (1991).)

World Economic Systems (M. Radzicki)

Reading Assignment: **RRW** Chapter 2 ... **all teams are to prepare questions to be asked the two faculty members leading this period.**

5. Carrying out Research in Ecuador

Government and Public/Private Agencies in Ecuador (guest lecturer)

Ecuador Today--People, Culture, Politics (J. Rollings and B. Addison)
Reading Assign: (A. Eichler, Ecuador: A Land, a People, a Culture (1982).)

Reading Assignments:
Team #1: **RRW** chapter 7, **A21** chapters 4 & 30
Team #2: **RRW** chapter 9, **A21** chapters 7, 28 & 29
Team #3: **RRW** chapter 6, **A21** chapters 11-12 & 18
Team #4: **RRW** chapter 8, **A21** chapters 10, 13, 34

Each team will prepare a 15-20 min. presentation of material, from their readings that relate to central components of their projects.

6. The History of Ecuador (B. Addison)

Pre-Columbian Ecuador (PBS Film)
Reading Assign: (A. Crosby, The Columbian Exchange (1972).)

The Spanish Empire and the Struggle for Liberation (B. Addison)

7. Twentieth-Century Ecuador (film, guest lecturer ??, B. Addison and P. Dunn)

Current Politics
Reading Assign: (G. I. Blanksten, Ecuador: Constitution and Caudillos (1964).)
Urbanization and Law ... Bananas and Economics
Reading Assign: (F. Swell, Turnaround: The Political Economy of Development and Liberalization in Ecuador (1989).)
Rainforests and Environmental Issues

Assign: Read the two bootstrap (Ecuador I) project reports
Teams #1 and #2 will summarize Ecuador I project on Entrepreneurship, and **RRW** chapter 10
Teams #3 and #4 will summarize Ecuador I project on Environmental Issues and **RRW** chapter 11

8. Presentations of Initial Findings by Project Teams (J. Rollings, G. Salazar, S. V-G)

Team #1: Pollution and productive activities
Team #2: Pollution and urban activities
Team #3: Sustainable development
Team #4: Mining activities

Discussion and Critique. Each team has a 20 min. presentation with 10

minute Q&A (question and answer) period following.

NOTE!! Following this meeting, the ESPOL faculty will arrive to work on specific task force assignments. This activity is being set by Professor G. Salazar. Your responsibilities will (for the next 7-days) be to assist these people and the WPI faculty in project developments. (see your assigned task forces). The next two biweekly meetings (#9. #10.) will occur in parts with your task forces. You will work approximately 15-20 hours this week on this activity.

11. Formal debriefing with all groups following the ESPOL workshop. (J. Rollings, F. Hart, G. Salazar, S. V-G)

    Group sharing of collective experiences and restructuring of Ecuador II team projects

12. Ecuadorian Literature and Culture

    The "Indianist" movement, the "novela de fundacin," and the literature of social protest (C. Ferreira-Pinto)

    Popular Culture (film, guest lecturer)

    Class, Race, Gender
        Assign: M. Mower, The Andean Past: Land, Societies, & Conflict
    Customs in Ecuador--Religious and Secular
    Spanish for Visitors to Ecuador (C. Ferreira-Pinto)

13. Cultural Awareness and the Psychology of Difference (J. Groccia)
    Turn in your team's final written proposal for the Ecuador II projects.

14. Conflict Resolution in the Global Village (J. Rollings and K. Rissmiller)

15. Final preparations for Ecuador II teamwork. (J. Rollings, G. Salazar, F. Hart, and S. V-G)

    Team #1: one half-hour oral presentation of project proposal
    Team #2: one half-hour oral presentation of project proposal
    Team #3: one half-hour oral presentation of project proposal
    Team #4: one half-hour oral presentation of project proposal

IQP/MQP team members: (declared majors)

Ecuador II: Team (1) on **Pollution Generated by productive activities**
Antoinette Burns, CE/EV
Spirit Joseph, CM/BB
Obadiah Plante, CH
and Rudy Soriano, MGE

Ecuador II: Team (2) on **Pollution generated by urban activities**
Allan Concepcion, MEB
Francisco Pereyo, ME
and Navin Rajashekar, CM
[an ESPOL student may be added to this project]

Ecuador II: Team (3) on **Resource management for sustainable development**
Todd DiNoia, CM
Laura Guillette, ED
Eduardo Mendez, CE
and Vail Mosier, CM

Ecuador II: Team (4) on **Study effects of mining activities of gold and related materials over land and water and the toxic consequences to agriculture and agriculture products**
Jenn Croft, CE environmental engineering
Kirstin DiPietro, CE environmental engineering
Ryan Johnson, CE environmental engineering
Jamey Pedro, CE environmental engineering
Kevin Worden, CE environmental engineering

OBJECTIVE #2: WPI Project Center Establishment in Ecuador

All plans for the B-term 1993 project center are progressing as anticipated. The actions listed in the First Quarter FY 1993 for this Objective have resulted in recruiting eleven IQP students for three projects in the areas of environmental studies and new business developments and in recruiting 5 MQP students for 1 technical project in the environmental science and engineering area. Two memos were sent to ESPOL in early April, 1993 requesting their direct input. ESPOL has responded by sending three FAXs back to us; one each from A. Barriga and J. Layana of ESPOL and one from Fundacion Natura, Guayaquil.

The general and specific areas of interest to ESPOL and by agreement with WPI faculty (as determined via the past quarter's activities) were listed and sent to all members of the WPI planning team together with the list of WPI students who will attend the Ecuador project center First Quarter FY 1994 and requesting input. Input from one third of the WPI faculty planning team members were taken in to account in selecting the projects for the next team of WPI students (Ecuador II). With this input, we are now in a position to approach ESPOL with more complete project ideas. In all cases, selected projects must conform to WPI's academic standards and serve the additional purpose of meeting AID/WPI/ESPOL/UDLP Objective #3: Faculty Development.

One convenient way to view all the project areas (at either IQP, MQP or graduate research levels) is by a matrix composed of:

industrial sectors ....

A. industrial mining and oil production
B. industrial water resource uses
C. industrial aquaculture and/or agriculture
D. industrial inorganic materials manufacturing
E. eco-tourism
and F. urban housing and urban industries

coupled with; development sectors ....

1. business (impacts on) developments
2. national/local/regional [planning] (impacts on) developments
3. environmental [pollution prevention] (impacts on) developments
4. disaster [prevention] (impacts on) developments
and 5. technological (impacts on) developments

All of these (or at least many of these) topics must be integrated within the IQP (or MQP) for any particular project and are not listed here to be thought of as separated topics, but only as a way of viewing a specific project. All projects will, by there nature, cross several lines of this matrix; as all topics involve all lines of research. My reasons for structuring these topics in this linear fashion is only to retain a degree of order for planning purposes. My selection on matrix element linkages is almost arbitrary. I'm basing my structure on discussions with other WPI faculty and on the input from ESPOL as I see these projects develop. I welcome your suggestions on restructuring the topics. Nevertheless, let me offer the following:

Following this matrix structure, the selected IQP/MQP projects for Ecuador II are listed together with a suggested set of WPI PQP advisors and project liaisons. The Civil Engineering Department will examine this matrix structure and their departmental needs/academic degree requirements in relation to this UDLP and their faculties' research foci.

Pollution generated by productive activities

This project was mentioned by both bootstrap teams in their reports (see First Quarter FY 1993 report) and could involve assessing specific government policies in both regulatory and enforcement areas and examine industrial practices as well as environmental impact.

Amongst the coastal productive activities are shrimp (and other fish or marine organisms) aquaculture, mining (gold) developments, petroleum, timber, limestone, food processing (and other agricultural activities), textiles and pharmaceuticals. This project might be structured in two parts involving a general survey of all industries followed by a case study of a specific industry (e.g. the aquaculture industry). A component of this particular case study might focus on sustainable development of salt estuaries.

If the selected case study deals with either mining or aquaculture, excessive use of chemical nutrients in mining operations or shrimp farms should be examined in terms of their effects upon land, water and the effected

food-chains. Other productive industries should be examined similarly. This study should involve assessing the shrimp farms or mining operations for chemical usage and their impact on the Guayas River (or other effected river's) watershed. Local and national government policies in both regulatory and enforcement areas should be explored for the IQP study and the MQP study should concentrate on the technical aspects of chemical usage.

Students should examine industrial practices as they relate to environmental impact and be included in this study.

I. necessarily crossing the matrix elements A.-3., B.-3., C.-3., D.-3., F.-3. and
II. could involve studies of elements A.-1., B.-1., C.-1., D.-1., E.-1.; F.-1.; A.-5., B.-5., C.-5., D.-5., E.-5. F.-5.;and
III. in some specific case studies, might include elements
[A.-2., B.-2., C.-2., D.-2., and F.-2.] or
[A.-4., B.-4., C.-4., D.-4., and F.-4.] or
[A.-5., B.-5., C.-5., D.-5., and F.-5.]

Suggested IQP/PQP co-advisors: WPI (Salazar, Hart, Rollings, Griffin, Johnson, Radzicki, Rissmiller) and Vernon-Gerstenfeld

Suggested Project Liaisons: Foundacion Natura, ESPOL (Ayon, Barriga, Chavez, Pizarro) and Vernon-Gerstenfeld

Pollution generated by urban activities

This project was mentioned by both bootstrap teams in their reports (see First Quarter FY 1993 report) and could be designed as case study modeled after that performed by the environmental bootstrap team or involve detailed comparative industry studies either looking at parallel Ecuadorian industries o at U.S. operations verses Ecuadorian equivalents. Local industries include fis (including shrimp), agricultural processing (including coffee, cocoa, banana, and sugar), many small manufacturing processes and several cottage industries. Any dominate industry would make for good case studies. Industrial management practices should be part of these cases if chosen and other cases may lead to examining appropriate technologies for these advancing industries. There are several good problems ideas presented in the Agenda 21 document which is on you laptop computers.

This study must involve assessing the city of Guayaquil's water usage and handling of solid wastes. Local and national government policies in both regulatory and enforcement areas should be explored at some level (again see Agenda 21) and might make for excellent case studies.

I. necessarily crossing the matrix elements B.-1., B.-2., B.-3., F.-1., F.-2., F.-3. ... and
II. could involve more in-depth studies of elements B.-5.; F.-5.; if the focus becomes more technology based ... and
III. in some specific case studies, might include elements
[A.-2., B.-2., C.-2., D.-2., and F.-2.] if a planning emphasis is taken by the team or
[A.-5., B.-5., C.-5., D.-5., and F.-5.] if an appropriate technology focus is deemed necessary.

[xxx-1.] if an operational management approach is taken.

Suggested IQP/PQP advisors: WPI (Hart, Rollings, Griffin, Johnson, Gersenfeld, Fitzpatrick, Radzicki, Rissmiller) and VG

Suggested Project Liaisons: ESPOL (Barriga, Armas, Layana) and VG

Resource management for sustainable development

This project was mentioned by both bootstrap teams in their reports (see their reports) and could be designed as an extension of the petroleum case study performed by the environmental bootstrap team or involve new areas of exploration such as the future of mining gold or other non-renewable resources. Like in the earlier case study, assessing specific government policies in both regulatory and enforcement areas and in examining industrial practices as they relate to environmental impact should be integral to this study. For the mining case study, land-slide prevention studies should be included. This component would compliment greatly to the work of the MQP team dealing with mining activities. Although this latter subject was not discussed by either bootstrap team, this topic is currently of a national (Ecuadorian) concern and thus is a new IQP sub-topic introduced by the ESPOL administration.

If the selected case study deals with the effects of gold and related minerials mining activities on land, water, agriculture, etc., the students should look closely at the projects discussed by both bootstrap teams in their reports and could involve examining industrial practices as well as the environmental impact assessing specific regulatory and enforcement government policies. Disaster prevention strategies should be examined.

If the selected case studies deal with excessive use of chemical nutrients in shrimp farms and their effects upon land, water and the food-chain the students should look closely at the projects discussed by both bootstrap teams in their reports and could involve examining industrial practices as well as the environmental impact assessing specific regulatory and enforcement government policies.

Students should examine industrial practices as they relate to environmental impact and be included in this study. In cases where competition exists between existing industries, comparisons should be made to determine the successful verses the unsuccessful (main) business characterists to be used that yield a sustainable management outcome, potentially leading to innovative business practices.

I. <u>necessarily</u> crossing the matrix elements A.-1., A.-2., A.-3., A.-4. (for mining), A.-5., B.-2., B.-3., B.-5., C.-1., C.-2.; C.-3., C.-4.; C.-5., and

II. <u>could</u> involve studies of elements B.-4., C.-2., D.-2., D.-3., E.-1.; E.-2.; E.-3.; F.-2.; F.-3.; F.-5., [actually all of xxx-2., if the emphasis on the project is policy] and

III. <u>in some specific case studies</u>, might include detailed analysis in elements [A.-2., B.-2., and C.-2. if the project's emphasis is policy] or [A.-4., B.-4., and C.-4 if the project's emphasis

is critical technologies] or [A.-5., B.-5., C.-5., and F.-5., if the project's emphasis is appropriate technologies].

Irrespective of the project's emphasis, environmental impact and business developments must be stressed.

Suggested IQP/PQP advisors: WPI (Johnson, Velazco, Gerstenfeld, Rissmiller, Salazar, Hart, Rollings, Griffin, Radzicki, Gottlieb) and Vernon-Gerstenfeld

Suggested Project Liaisons: Foundacion Natura, ESPOL (Armas, Layana, Perez, Barriga, Pizarro or Chavez) and Vernon-Gerstenfeld

The following WPI faculty are actively involved in the WPI/ESPOL UDLP development. You or your team members may wish to discuss a component of your project with some of these faculty from their defined expertise or involvement in the linkage. I've included these people's E-mail addresses so that you are encouraged to compose specific questions to these individuals via electronic media prior to meeting with them. This should minimize time involved for all and maximize your contact with all participants.

Faculty	E-mail	Expertise
Guillermo Salazar	(salazar@wpi)	Civil Eng'g., GIS
Bland Addison	(addison@wpi)	History
Patrick Dunn	(pdunn@wpi)	History
Arthur Gerstenfeld	(ag@wpi)	Entrepreneurship
John Griffin	(griffin@wpi)	Environmental Economics
Hossein Hakim	(hakim@wpi)	Global resources
Elizabeth Jolie	(efjolie)	Everything
Robert Kinicki	(rek@wpi)	GIS data management
Charles Kornik	(cjkornik)	Logistical support
David Lucht	(dalucht@wpi)	Fire & disaster prev'tn
Thomas Probert	(probert@wpi)	Computing & info. mang't
Michael Radzicki	(mjradz@wpi)	Economics & sys. dynamic
Kent Rissmiller	(kjr@wpi)	Law & policy issues
Enio Velazco	(evelazco@wpi)	TQM, tele-ed & mang't
Ronald Cheetham	(cheetham@wpi)	Biology & ecology
Jim O'Shaughnessy	(jco@wpi)	Environmental eng'g.
Fred Hart	(flhart@wpi)	Environmental eng'g.
Bob Fitzgerald	(rfitz@wpi)	Civil & Fire Eng'g.
Malcolm FitzPatrick	(msf@wpi)	Urban planning
Ted Crusberg	(crusberg@wpi)	Environmental science
S.Vernon-Gerstenfeld	(sgerstenfeld)	Social science
James Groccia	(jegroccia)	Project assessment tools
James E. Rollings	(jerollings)	UDLP Head & Biochem Eng'
W. M. Clark	(wmclark@wpi)	Biochem & Environ'l Eng'
Frank Lutz	(fclutz)	Civil & Environ'l Eng'g.
Lance Schachterle	(lschachterle)	ISD projects
Roger Gottlieb	(gottlieb@wpi)	Humanities & Environment
Sharron Johnson	(sharon@wpi)	Management systems
Leon Graubard	(graubard@wpi)	Management

This is the Table of Contents for Agenda 21 ... Any chapter item that your group feels to be related to your project will be transmitted to you as you request. Send chapter requests to (jerollings@jake.wpi.edu). I will provide the Agenda 21 frame work.

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Appendix C

ECUADOR PROJECT CENTER

WORCESTER POLYTECHNIC INSTITUTE

PROCEDURES MANUAL FOR FACULTY AND STUDENTS

1993 - 1994

James E. Rollings
Director
Ecuador Project Center
(508) 831-5664

Sue Vernon-Gerstenfeld
Project Center Advisor
(508) 831-5708

Projects Office
100 Institute Road
Worcester Polytechnic Institute
Worcester, Massachusetts 01609

ECUADOR PROJECT CENTER

Overview and Procedures Manual

A wealth of experience indicates that the accompanying OVERVIEW and PROCEDURES MANUAL provides a framework within which achieving the objectives of the Project Center program can be effectively attained.

This document is divided into three major sections:

Section One contains general information on hotel and transportation services, working with your liaison, and things to keep in mind throughout the project.

Section Two reviews the schedule of due dates for the individual sections of the proposal and final reports (i.e. from August, 1993 to December, 1993) and lists a schedule of meetings. Note You will be given the actual calendar for the term separately. This section also incorporates detailed procedures for all regularly scheduled meetings with advisors and liaisons.

Section Three contains specifications for the Proposed Work Plans and Summary Progress Charts that students fill out weekly. This section also is the Procedures Manual for the final report. It specifies the format and content requirements for the final document.

In addition, there are several appendices included in this procedures manual. These appendices are grouped into two classes. The first group (Appendices A, B, C, etc.) is a collection of general notes on Ecuador compiled by the U.S. State Department, tourist agencies, and two large appendices taken from the South American Handbook(1990), Prentice Hall Travel, Ben Box, editor and Managing Cultural Differences, Moran. You will be assigned an updated travel guide as part of your book purchases. The second group (Appendices I, II, etc.) are materials specifically concerned with the development of your projects. Appendix I contains samples of the Weekly Proposed Work Plan and Summary Progress Chart and other forms that will be used. Appendix II lists the project teams and the addresses and phone numbers of their primary contacts at ESPOL.

All procedures outlined in Section Two and Section Three are mandatory, unless the student, faculty, and organization liaison agree to an alternative mode of operation, which then may supersede those outlined in this memorandum. The only legitimate reason for such a change is that the educational quality of the project will be enhanced as a result.

The format guidelines for the FINAL REPORT have been developed with the student in mind. The guidelines are meant to allow the production of a report that meets all appropriate publication standards while eliminating wasteful use of time (a precious commodity in a seven-week term).

52'

SECTION ONE

I. City Lay-out.

A Detailed description of Guayaquil is given on page 643 of the South American Handbook(1990); Appendix D.

Although Guayaquil has a large population (1.6 million) and is the largest city in Ecuador, it has the feel of a much smaller (Worcester size) city. In part, this is due to the fact that more than half of the population live in poor shanty towns/squatter camps that are located in outlying regions of the city.

As in many Latin American societies, Ecuador has great disparities in economic distribution. This, in part, fuels petty crime (i.e. theft due to pickpockets and scams directed at newcomers/tourists). You are a newcomer to the environment and thus must be suspect of people who you don't know. You are directed to head the various warnings that you will read about or will be told to you by your advisor and Ecuadorian colleagues. In general, however, you are considerably safer in Guayaquil than you would be in large cities in the United States. As anywhere, avoid certain regions that are known to poseproblems. You will be given an orientation to Guayaquil by our hosts from ESPOL, and they will describe the city lay-out including specifics on each region of the city.

We will be housed in the Uni Hotel near the Parque Bolivar located in the city center a few short blocks from the Rio Guayas.

II. Mail, Amyl and Fax.

You may have mail directed to you at either the Uni Hotel, ESPOL or Ing. Daniel Tapia's personal mailbox in the post office located one block (across the street) from the Uni Hotel. The main city post office is the best place to send packages.

We will have access to E-mail (via Bitnet) at ESPOL and Fax services at both ESPOL and the Uni Hotel.

III. Telephones.

You will be responsible for all phone charges made. International phone charges to the United States from Ecuador can be very expensive. You will be told stories on this subject later. You are advised to ask your phone company in the U.S. for specific instructions on phoning to and from Ecuador. MCI has a good deal now that my wife and I will be using. Consult the appendices for further information regarding phones.

IV. Hotel.

We will be using the Uni Hotel (see city map on page 645 of the South American Handbook). Like WPI, the Uni Hotel has "two towers". The rooms in our tower are suites where 2 to 3 students will live. These rooms are equipped with kitchen facilities, etc. and will provide you more room than you are normally used to with on-campus housing. Our rooms will all be located near each other and assure your parents that the hotel is very secure.

Valuables (passports, etc.) can be left in the hotel safe if need be.

It is recommended that you take inventory of the contents of your rooms upon check-in. This is important so that we can insure that you will not be assessed damages for those that already exist. Keep a copy of this list and give another to your advisor and provide one to the hotel management. Keep the room assignments you receive.

V. Accommodations.

Each apartment is fully equipped with furniture, bed linen and towels. You will be doing much of your own housekeeping. The kitchens are equipped with enough glassware, utensils, silverware, dishes, and pots for survival. You may want to bring along a vegetable peeler and a favorite knife or two. You can readily purchase anything else you need, and you can share items with other groups in other apartments. You will need to check with your roommates and decide who will bring a hairdryer or audio equipment (walkman & speakers, etc.). Share music with each other; you can buy tapes inexpensively. You won't need three of everything in a room.

VI. Food.

Restaurants in large hotels offer international cuisine. But one must try Ecuadorian cuisine, which is tasty and varied. Each region has its specialties, influenced by three centuries of Spanish presence as well as ancestral customs of indigenous populations. Without trying to cover the entire range of national dishes, it is useful to know that Serranos the inhabitants of the mountain regions, prefer corn and potatoes, while Costeos prefer rice and bananas. Here are some specialties:

Arroz con pollo: Fried chicken cut in small pieces and cooked wi rice.

Ceviche: Many kinds of sea food (ceviche de mariscos), fish (ceviche de pescado), shrimp (ceviche de camarones), octopus (ceviche de pulpo), and prawns (ceviche de langostinos), cut up in small pieces and marinated in lime. They are served with raw onions, corn and sweet potatoes, not to be missed.

Churrasco: Not to be confused with the steak one finds in the United States or in Europe, Churrasco is a thick piece of fresh meat, eaten with rice, manioc, corn, hearts of palm or some other vegetable.
Preferably, it should be eaten grilled.

Cuy: Guinea pigs are such finicky rodents that they refuse to eat the grass they have just trod upon. They are vegetarians. Ecuadorians eat them grilled or stewed. Cuy con papas is one of the specialties of the Cuenca region. (It is pronounced kwee; the plural is cuyes, pronounced kwees.)

Empanada: Dough patty filled with meat or cheese.

Fritada: Fried pork.

Humitas: Pieces of chicken or pork wrapped in corn or banana leaves.
They are eaten with corn middlings and hot pepper (aji).

Llapingachos: Mashed potatoes with peanut oil and cheese.

Locro: The national soup. Generally it is made with potatoes, cheese and avocados. One adds a few pieces of meat.

Mote Pillo: Corn cooked with eggs, bacon and onions.

Sancocho: Stew with green bananas and corn.

Tostado: Grilled corn served with ceviche.

Drink mineral water. There is only one national brand: Gitig. Do not be surprised if the waiter suggests a gitig and not an agua mineral. It is generally carbonated. This product is safe for drinking and brushing your teeth too.

For cooking in your rooms, several large supermarkets are available within walking distance from the hotel. The green vegetable market is also within walking distance, but be sure to wash all food and cook it well before eating (see below and health precautions).

GENERAL PROCEDURES FOR FOOD PREPARATION

1) WATER

In general, all water in Ecuador must be considered unsafe unless it is bottled mineral water. The primary diseases carried by bad water are infectious hepatitis, cholera, diarrheal diseases and dysenteries. Water can be purified in three ways:

a) Boiling water for 20 minutes (The ONLY way to be sure that the hepatitis virus is killed).

b) Water Purification Tablets (Halozone) (Iodine) will kill most bacteria and parasites, but not the hepatitis virus.

c) Tincture of Iodine (the stuff you put on soars and cuts) Place 8 drops in each quart of water, and then let stand for twenty minutes.

Water for washing and bathing need not be boiled except when cleansing or soaking an infected area of the skin.

2) Vegetables and Salads

A delicious salad of thin-sinned vegetables such as carrots, tomatoes, cucumber and local vegetables can be prepared with perfect safety if the vegetables are thoroughly washed in boiled water and then carefully peeled. Green leafy vegetables such as lettuce, celery, and cabbage should be first washed with soapy water then boiled in water or soaked in a solution of iodine(8 drops per quart of water), chlorine, permanganate, etc.. After soaking, rinse thoroughly with clean water.

3) Fruits

Fruits should be peeled before eating. If the skin is broken or cracked, it may help to boil the fruit for 3 to 5 minutes before peeling. Soaking may also be used.

4) Meat, Fish, and Poultry

All beef, pork, fish, chicken, etc. should be cleaned with safe water and cooked well done to prevent the development of worms within your body.

VII. Transportation.

Currently there are problems with bus routes to the new campus at ESPOL. Taxis are relatively cheap and by pooling together, we might be best off using this means. There are bus routes from downtown to the campus and return for about 10-15 cents U.S. (100-150 sucre) each way. Local city-to-city buses are also available at reasonable rates and we will be using these on several weekends. Ing. Daniel Tapia and I are working on arranging for daily shuttle service that will be more convenient.

VIII. Medical Services, Health Precautions.

Generally, your stateside medical insurance will allow you to be treated in Ecuador. There is excellent medical care available. Good medical centers exist, like Clinica Kennedy, Alcivar, Pan Americana and others. ESPOL has a medical center at the campus and they are looking into other private physician options.

Consult the State Department notes on general health precautions, vaccinations, etc. Malaria and yellow fever vaccinations are needed for the Amazon. The U.S. Public Health Department has current information.

WPI HEALTH CARE AND LIABILITY GUIDELINES FOR TRAVELING ABROAD

I. Check with your health care provider to verify that coverages are available for injuries or sickness out side of the continental United States.

NOTE: Many plans exclude coverage or provide limited benefits.

II. If you intend to stay in a country(s) for any protracted length of time, it is likely that your health care provider will not provide benefits after a certain length of time(e.g., 1 or 2 months).

III. If you are going to stay in a foreign location for any length of time, you should purchase "short term" health and accident coverage in that country or, from the few plans available, through domestic carriers in the U.S.(Check claims handling, coverages and exclusions carefully).

IV. You should be prepared to pay for all foreign medical bills in full and to submit them to your provider for reimbursement upon return to the United States.

V. If you intend to drive in a foreign country, make sure that your bodily injury and property damage coverage complies with the country's requirements and are sufficient to cover your exposure. These coverages should be purchased through the rental car agency or other appropriate source in that country. Medical bills resulting from an auto accident for you(or passengers) may be covered on a limited basis under the auto policy purchased.

GENERAL NOTES ON MALARIA, CHOLERA, AND DIARRHEAS

1) Malaria

All equatorial nations around the world have in common the problem of malaria. What is malaria? This disease is a parasitic infection caused by a single celled organism that lives inside red blood cells. The mosquito is involved in transferring the the parasite from another person to yourself. A classical attack begins with an indefinite feeling of illness, shortly followed by a characteristic shaking chill with a rapidly rising temperature (103 - 105 degrees F). It is usually accompanied by headache, nausea, sometimes joint aches and pains, along with profuse sweating. After an interval free of fever, the cycle of chills and fever tend to occur ever other day or ever third day depending on the species of the organism which has caused the attack. Without treatment, these intermittent attacks, which can last from a week to a month or more, can occur again at irregular intervals for several years. At its extreme, malaria may cause such severe pathology within the body which can lead to the death of the individual.

The weekly prophylatic medication that one takes, does not prevent you from getting malaria organisms, it only prevents you from producing the above mentioned disease symptoms. As chloroquine represents only a barrier against a proliferation of malaria parasites sufficient to cause these symptoms, it follows that if the barrier is not great enough, symptoms will occur. Malaria is present in this country. There is only minimal risk of malaria in urban areas. Malaria is found only below 1500 meters. Primaquine treatment may be appropriate for those with prolonged or heavy mosquito exposure. Malaria risk in Esmeraldas, Guayas (incl. Guayaquil), Manabi and El Oro; and rural areas of Los Rios, Morona Santiago, Napo, Pastaza, Pichincha, and Zamora Chinchipe. Little or no risk of malaria in Quito vicinity and Galapagos Islands. Chloroquine-resistant malaria is found in All Malarious areas.

2) Cholera

Cholera is spread by fecal contamination of water and vegetables and is therefore preventable. The disease is characterized by severe fluid loss by so-called "rice water stools." with proper care of water (i.e., boiling or iodination), and cleaning of fruits and vegetables this disease can easily be prevented. Cholera immunizations can be given (2 shots 4 weeks apart, then one every 6 months). This disease is active in this country. Cholera vaccine is of limited usefulness and only about 50% effective. Cholera certificate is valid for 6 months after injection.

3) Diarrheas

By simple diarrhea, it is understood that few or several loose bowel movements per day are present without other symptoms. This diarrhea is usually dietary in origin, as the bowel is irritated by the introduction of unfamiliar food. All of us have bacteria in the lower intestinal tract. simply going from one environment to another, (i.e. U.S. to Ecuador) will cause a change in normal intestinal flora and minor diarrhea can result. Treatment of simple diarrhea is obtained through cutting down on the food intake and using a anti diarrheal medication such as by mouth pectin-paregorictablets, paregoric liquid, or lomotil. The eating of yogurt is also recommended for adapting to the new environment.

Diarrhea can also be the result of a worm inside the body. Roundworm infection can be contracted from food (usually fresh vegetables) that has been contaminated by infected excrement. Tapeworm infection can be obtained from eating inadequately cooked meat or fish. The treatment for both roundworms and tapeworms is simple. Special tablets can be obtained from a medical office, though it is essential that your stool be examined first.

4) Yellow Fever

This disease is active in this country. Vaccination is advised for all travelers over 9 months of age who will travel outside urban areas. Yellow fever in Morona-Santiago, Pastaza, Napo and Zamora Chinchipe provinces.

IX. Banking.

The most straightforward way to handle your money is by purchasing travelers checks before you arrive in Ecuador. If you or your parents are AAA members, you can get the travelers checks without charge. Remember to account for food, laundry, entertainment, and miscellaneous. If you have a credit card (Mastercard or VISA), you can receive a cash advance from any commercial bank. However, you are charged a fee for the service at the time that the advance is given. Most students find that the amount they budgeted is not enough--account for miscalculation because you cannot cash a Massachusetts check in Ecuador. Your parents can wire money to you through Western Union or to a commercial bank in extreme emergencies, or you can use your bank card at ATM machines at the Pacific Bank.

The best way to establish a bank account is at the Pacific Bank in Miami, FL. You can get cash at the Pacific Bank in Guayaquil if you have a major credit card. Generally, however, you should use travelers checks.

X. Banks, Change and Money.

Banks are open from 9:00 a.m. until 1:00 p.m., from Monday through Friday. If you are changing money, it is better to carry U.S. dollars and travelers checks. Be aware, however, that the Casas de Cambio, which are officially authorized, offer more advantageous exchange rates.

Foreign exchange rates vary daily. Money can be changed at hotels and banks, but it is advisable to go to the Casas de Cambio (exchange houses) because they are officially sanctioned. The hours do not necessarily correspond to those of banking establishments. It is better to find out beforehand. At any rate, the U.S. dollar is king. All other foreign currencies have less advantageous exchange rates. The exchange rate in July 1992 was 1550 sucre to one dollar.

The national currency is the sucre, named after the national independence hero, Marshall Antonio Jose de Sucre. One should not confuse the $ sign with the U.S. dollar(US$). There exist 5, 10, 20, 50, 100, 500 and 1,000 sucre bills. The sucre is divided into 100 centavos. There are 20 and 50 centavos coins as well as one sucre coins. Among the locals, dos reales means 20 centavos; un real, 10 centavos; and un medio, 5 centavos.

XI. Visas and passports.

You will need a current U.S. Passport and Ecuadorian Visa for stays longer than 90 days, but we should not exceed this limit. We will update you on this during the PQP. Make a Xerox copy of the data page of your passport and use this for identification, do not carry your passport with you, carry this copy so that if you loose it or have it stolen, you've lost nothing.

XII. Communication.

Communication between faculty and students at the Ecuador Project Center is usually easy. Two students will be designated as CONTACTS by the faculty. These students will be responsible for getting information to the rest of the students at the Project Center. For example, if the faculty advisor decide to change the time of a scheduled meeting, he or she will tell the Contacts who will have the responsibility of telling all other students.

XIII. Dress Code.

It is always summer in Ecuador. Temperatures range from the low 80's to the high 80's and it is humid. Bring summer cloths only and a light sweater or two for the mountains in case you stay overnight there. Obviously you will need bathing suits. Bring sun block; the tropical sun is dangerous. This is no joke. You will have a great tan after a few short days even if you wear sun block every day.

Professional dress is required at all times at the agencies. Follow the local customs.

IVX. Meetings.

Please note that all Center meetings and weekly faculty meetings at ESPOL are considered mandatory. If another meeting comes up that conflicts with these, make sure that you have prior approval of your faculty.

Occasionally, a group will feel some pressure to go beyond the bounds of what reasonably can be accomplished in seven weeks. If such is the case with your team, enlist the help of your advisors early to negotiate a way to contain the project.

XV. Required Books and Other Materials.

Bring your A-Term books and writing cribs. Also bring your stats manual if you are analyzing statistical data and software, etc. as needed for your project's mission.

1. Dictionaries for both English and Spanish.

2. The Modern Writer's Handbook by Frank O'Hare. This has grammar and punctuation rules, as well as rules for writing. It also has a sample of how to do a Bibliography.

XVI. Sightseeing.

Ecuador is rich in Hispanic heritage. There are numerous guide books commercially available to help you plan leisure time. Plan to get out of Guayaquil occasionally to see the sights. The South American Handbook has volumes of trips described. Don't leave the country!

XVII. Markets.

With the exception of Guatemala in Central America, Ecuador is the one Latin-American country to have the most beautiful local and regional markets. One can find there every popular handicraft product. Each city, in fact, has its "Indian market", which takes place on a different day of the week. Ecuador has such handicraft wealth that going to any market is an experience not to be missed. Nonetheless, the most famous is in Otavalo, on Saturday mornings, and the most important, in Ambato, on Mondays, Wednesdays and Fridays.

SECTION TWO

SECTION TWO: PREPARATORY COURSE FOR ECUADOR II PROJECTS

James Rollings (course organizer) Term A, 1993
831-5664 Meeting Time?
Goddard Hall 216 Meeting Place?

This team-taught course is designed to prepare students to carry out projects in the WPI Project Center at the Escuela Superior Politecnica del Litoral in Guayaquil, Ecuador. Being the second set of project teams at the site, you are collectively known as Ecuador II; teams number 1-4. Your team assignments are:

IQP/MQP team members: (declared majors)

Ecuador II: Team (1) on Pollution Generated by productive activities
Antoinette Burns, CE/EV
Spirit Joseph, CM/BB
Obadiah Plante, CH
and Rudy Soriano, MGE

Ecuador II: Team (2) on Pollution generated by urban activities
Allan Concepcion, MEB
Francisco Pereyo, ME
and Navin Rajashekar, CM
[an ESPOL student may be added to this project]

Ecuador II: Team (3) on Resource management for sustainable development
Todd DiNoia, CM
Laura Guillette, ED
Eduardo Mendez, CE
and Vail Mosier, CM

Ecuador II: Team (4) on Study effects of mining activities of gold and related materials over land and water and the toxic consequences to agriculture and agriculture products
Jenn Croft, CE environmental engineering
Kirstin DiPietro, CE environmental engineering
Ryan Johnson, CE environmental engineering
Jamey Pedro, CE environmental engineering
Kevin Worden, CE environmental engineering

The course is designed to:

a. train students in certain research and organizational skills necessary to carry out a successful project on-site in Ecuador,

b. heighten student sensitivity to matters of cultural diversity and be better prepared to work as team members,

c. present background knowledge about political, social, ecological and economic factors in developing nations generally and particularly in Latin America and specifically in Ecuador,

d. introduce students to the fundamental features of Ecuadorian history and culture as they influence project development and daily operation of teams on site,

e. introduce students to environmental and entrepreneurial education, public policies, and research in Ecuador and particularly as ESPOL views its national mission(s).

NOTE !!! Your PRIMARY ASSIGNMENT is to complete your project proposals. This will occur in two steps:

(1) a preliminary proposal will be initially presented to the course faculty on Sept. 20, 1993 and again to the WPI/ESPOL task forces during the week of Sept. 22-29, 1993. These groups will reassign and/or rescope your projects based on the needs of the UDLP linkage. Your project teams will necessarily be divided during this week as we have separated each group to maximize your individual and team's learning. The task forces may refine, refocus or define specific activities for your projects. With this information/input, your teams will again present your modified proposals to the WPI course faculty on Sept. 30, 1993. These steps are

(2) a final proposal is due to Profs. Rollings and V-G and to your ESPOL assigned liaisons on October 14, 1993. Final proposals are to contain a completed literature survey and clearly defined specific objectives including listed activities for your seven working weeks in Ecuador.

NOTE !!! Individual instructors may assign specific tacks as they see appropriate to your academic developments.

Course Textbook: North, South, and the Environmental Crisis, R. R. White, University of Toronto Press, Toronto (1993). The book provides a good summary of topics related to several areas of interest to each of the four Ecuador II projects. The book's References provide an excellent resume to more advanced readings in specific topics of interest to each project's development. (text is referred to in this overview as RRW)

Course Reference Materials: Each team is provided a notebook computer with Windows and Word Perfect installed. Each group is provided a detailed Procedures Manual that contains significant background information on structuring projects as well as Ecuadorian history, culture, geography and international relations with the United States. You will be referring to these materials throughout the course of this PQP and your on-site project execution. In addition, Agenda 21 (the primary document from the "Rio-Conference"; i.e. the United Nations Conference on Environment and Development ... or UNCED) is contained on your computers and

will be useful as an acceptable framework for general assessment and specific potential impact analyses. (Agenda 21 is referred to in this overview as A21). Student or faculty groups requiring specific chapters of the report can E-mail request for Agenda 21 chapters to (jerollings@jake.wpi.edu). A copy of the Agenda 21 table of contents is attached to the bottom of this course overview.

Your projects are being built from the initial research of WPI's "bootstrap" (Ecuador I) projects. Copies of these two reports are available from Ms. Betty Jolie for check-out in the Project Center. Several other general or specific resources are available in the Gordon Library, Global Resources section.

Course Faculty. The following WPI faculty will formally present this course: (at the designated course meeting number(s) and other scheduled IQP or MQP team meetings). Professor S. Vernon-Gerstenfeld will schedule her meeting with the IQP teams and Professors Hart, Rollings and Salazar will set the times for the MQP team meetings.

Professor B. Addison (5, 6, 7)
Professor P. Dunn (4, 7)
Professor C. Ferreira-Pinto (12)
Professor J. Groccia (13)
Professor F. Hart (8, 11, 15) + weekly meetings with MQP
Professor M. Radzicki (4, 5)
Professor K. Rissmiller (2, 14)
Professor J. Rollings (1, 2, 3, 5, 8, 11, 14, 15) + weekly meetings with MQP
Professor G. Salazar (1, 8, 11, 15) + weekly meetings with MQP
Professor L. Schachterle (2)
Professor E. Velazco (1)
Professor S. Vernon-Gerstenfeld (1, 8, 11, 15) + weekly meetings with IQPs

You shall meet with collections of WPI and ESPOL faculty during the week of September 22-29, 1993 in lieu of normally scheduled periods 9-10 of the course. Professor G. Salazar will provide a separate schedule of these activities.

Course Schedule. The following schedule anticipates 15 biweekly meetings of 2 hours each (see attached schedule). The lecturers listed for the various sections of the syllabus are suggested names of faculty who might be asked to handle a particular section. Similarly, reading assignments listed below are only to suggest an idea of the material to be covered. In addition to classroom lectures, students are expected to meet for one hour per week with the WPI technical adviser assigned to their IQP or MQP team (see team assignments) and are expected to prepare summaries/overviews of assigned readings where indicated.

MEETING #: (Date... see attached schedule) TOPIC: (reading assignments)

1. Introduction to Ecuador II Projects on Environment and Entrepreneurship.
   The mission of the Agency for International Development UDLP with WPI's sister institution The Escuela Superior Politecnica del Litoral of Guayaquil, Ecuador. (J. Rollings)

   Environmental Issues in Ecuador (G. Salazar and F. Hart)

   Entrepreneurial Issues in Ecuador (E. Velazco)

   The Agency for International Development Cooperative Agreement between Worcester Polytechnic Institute and Escuela Superior Politecnica del Litoral (J.E. Rollings)

2. Developing a Project Proposal

   Defining Characteristics of Award Winning IQPs (L. Schachterle)
   Assignment: (Read selected IQPs and RRW chapters 3,4 and 5.)

   How to Analyze and Define a Research Problem (K. Rissmiller and J.E. Rollings)

3. The Geography and Topography of Ecuador (J. Rollings) and an introduction to environment and development topics

   (Reading assignment: A21 Chapters 1,2,5 and 8 and RRW Chapter 1.)

Team #1: will summarize A21 chapter 1 & 2
Team #2: will summarize A21 chapter 8
Team #3: will summarize A21 chapter 5
Team #4: will summarize RRW chapter 1

4. What is Modernization, Underdevelopment and the Environmental Crisis

   Colonialism, Nationalism, and Economic Imperialism (P. Dunn)
   Reading Assign: (The Challenge to the South: The Report of the South Commission (1991).)

   World Economic Systems (M. Radzicki)

   Reading Assignment: RRW Chapter 2 ... all teams are to prepare questions to be asked the two faculty members leading this period.

5. Carrying out Research in Ecuador

   Government and Public/Private Agencies in Ecuador (guest lecturer)

Ecuador Today--People, Culture, Politics (J. Rollings and B. Addison)
Reading Assign: (A. Eichler, Ecuador: A Land, a People, a Culture (1982).)

Reading Assignments: Team #1: RRW chapter 7, A21 chapters 4 & 30
Team #2: RRW chapter 9, A21 chapters 7, 28 & 29
Team #3: RRW chapter 6, A21 chapters 11-12 & 18
Team #4: RRW chapter 8, A21 chapters 10, 13, 34
Each team will prepare a 15-20 min. presentation of material, from their readings that relate to central components of their projects.

6. The History of Ecuador

Pre-Columbian Ecuador (PBS Film)
Reading Assign: (A. Crosby, The Columbian Exchange (1972).)

The Spanish Empire and the Struggle for Liberation (B. Addison)

7. Twentieth-Century Ecuador (film, guest lecturer ??, B. Addison and P. Dunn)

Current Politics
Reading Assign: (G. I. Blanksten, Ecuador: Constitution and Caudillos (1964).)
Urbanization and Law ... Bananas and Economics
Reading Assign: (F. Swell, Turnaround: The Political Economy of Development and Liberalization in Ecuador (1989).)
Rainforests and Environmental Issues

Assign: Read the two bootstrap (Ecuador I) project reports
Teams #1 and #2 will summarize Ecuador I project on Entrepreneurship, and RRW chapter 10
Teams #3 and #4 will summarize Ecuador I project on Environmental Issues and RRW chapter 11

8. Presentations of Initial Findings by Project Teams (J. Rollings, G. Salazar, S. Vernon-Gerstenfeld)

Team #1: Pollution and productive activities
Team #2: Pollution and urban activities
Team #3: Sustainable development
Team #4: Mining activities

Discussion and Critique. Each team has a 20 min. presentation with 10 minute Q&A (question and answer) period following.

NOTE!! Following this meeting, the ESPOL faculty will arrive to work on specific task force assignments. This activity is being set by Professor G. Salazar. Your responsibilities will (for the next 7-days) be to assist these people and the WPI faculty in project developments. (see your assigned task forces). The next two biweekly meetings (#9. #10.) will occur in parts with your task forces. You will work approximately 15-20 hours this week on this activity.

11. Formal debriefing with all groups following the ESPOL workshop. (J. Rollings, F. Hart, G. Salazar, S. Vernon-Gerstenfeld)

Group sharing of collective experiences and restructuring of Ecuador II team projects

12. Ecuadorian Literature and Culture

The "Indianist" movement, the "novela de fundacin," and the literature of social protest (C. Ferreira-Pinto)

Popular Culture (film, guest lecturer)

Class, Race, Gender
Assign: M. Mower, The Andean Past: Land, Societies, & Conflict
Customs in Ecuador--Religious and Secular
Spanish for Visitors to Ecuador (C. Ferreira-Pinto)

13. Cultural Awareness and the Psychology of Difference (J. Groccia)
Turn in your team's final written proposal for the Ecuador II projects.

14. Conflict Resolution in the Global Village (J. Rollings and K. Rissmiller)

15. Final preparations for Ecuador II teamwork. (J. Rollings, G. Salazar, F. Hart, and S. V-G)

Team #1: one half-hour oral presentation of project proposal
Team #2: one half-hour oral presentation of project proposal
Team #3: one half-hour oral presentation of project proposal
Team #4: one half-hour oral presentation of project proposal

IQP/MQP team members: (declared majors)

Ecuador II: Team (1) on Pollution Generated by productive activities
Antoinette Burns, CE/EV
Spirit Joseph, CM/BB
Obadiah Plante, CH
and Rudy Soriano, MGE

Ecuador II: Team (2) on Pollution generated by urban activities
Allan Concepcion, MEB
Francisco Pereyo, ME
and Navin Rajashekar, CM
[an ESPOL student may be added to this project]

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Ecuador II: Team (3) on Resource management for sustainable development
Todd DiNoia, CM
Laura Guillette, ED
Eduardo Mendez, CE
and Vail Mosier, CM

Ecuador II: Team (4) on Study effects of mining activities of gold and related materials over land and water and the toxic consequences to agriculture and agriculture products
Jenn Croft, CE environmental engineering
Kirstin DiPietro, CE environmental engineering
Ryan Johnson, CE environmental engineering
Jamey Pedro, CE environmental engineering
Kevin Worden, CE environmental engineering

OBJECTIVE #2: WPI Project Center Establishment in Ecuador

All plans for the B-term 1993 project center are progressing as anticipated. The actions listed in the First Quarter FY 1993 for this Objective have resulted in recruiting eleven IQP students for three projects in the areas of environmental studies and new business developments and in recruiting 5 MQP students for 1 technical project in the environmental science and engineering area. Two memos were sent to ESPOL in early April, 1993 requesting their direct input. ESPOL has responded by sending three FAXs back to us; one each from A. Barriga and J. Layana of ESPOL and one from Fundacion Natura, Guayaquil.

The general and specific areas of interest to ESPOL and by agreement with WPI faculty (as determined via the past quarter's activities) were listed and sent to all members of the WPI planning team together with the list of WPI students who will attend the Ecuador project center First Quarter FY 1994 and requesting input. Input from one third of the WPI faculty planning team members were taken in to account in selecting the projects for the next team of WPI students (Ecuador II). With this input, we are now in a position to approach ESPOL with more complete project ideas. In all cases, selected projects must conform to WPI's academic standards and serve the additional purpose of meeting AID/WPI/ESPOL/UDLP Objective #3: Faculty Development.

One convenient way to view all the project areas (at either IQP, MQP or graduate research levels) is by a matrix composed of: industrial sectors....

A. industrial mining and oil production
B. industrial water resource uses
C. industrial aquaculture and/or agriculture
D. industrial inorganic materials manufacturing
E. eco-tourism
and F. urban housing and urban industries

coupled with; development sectors ....

1. business (impacts on) developments
2. national/local/regional [planning] (impacts on) developments
3. environmental [pollution prevention] (impacts on) developments
4. disaster [prevention] (impacts on) developments
and 5. technological (impacts on) developments

All of these (or at least many of these) topics must be integrated within the IQP (or MQP) for any particular project and are not listed here to be thought of as separated topics, but only as a way of viewing a specific project. All projects will, by there nature, cross several lines of this matrix; as all topics involve all lines of research. My reasons for structuring these topics in this linear fashion is only to retain a degree of order for planning purposes. My selection on matrix element linkages is almost arbitrary. I'm basing my structure on discussions with other WPI faculty and on the input from ESPOL as I see these projects develop. I welcome your suggestions on restructuring the topics. Nevertheless, let me offer the following:

Following this matrix structure, the selected IQP/MQP projects for Ecuador II are listed together with a suggested set of WPI PQP advisors and project liaisons. The Civil Engineering Department will examine this matrix structure and their departmental needs/academic degree requirements in relation to this UDLP and their faculties' research foci.

Pollution generated by productive activities

This project was mentioned by both bootstrap teams in their reports (see First Quarter FY 1993 report) and could involve assessing specific government policies in both regulatory and enforcement areas and examine industrial practices as well as environmental impact.

Amongst the coastal productive activities are shrimp (and other fish or marine organisms) aquaculture, mining (gold) developments, petroleum, timber, limestone, food processing (and other agricultural activities), textiles and pharmaceuticals. This project might be structured in two parts involving a general survey of all industries followed by a case study of a specific industry (e.g. the aquaculture industry). A component of this particular case study might focus on sustainable development of salt estuaries.

If the selected case study deals with either mining or aquaculture, excessive use of chemical nutrients in mining operations or shrimp farms should be examined in terms of their effects upon land, water and the effected food-chains. Other productive industries should be examined similarly. This study should involve assessing the shrimp

farms or mining operations for chemical usage and their impact on the Guayas River (or other effected river's) watershed. Local and national government policies in both regulatory and enforcement areas should be explored for the IQP study and the MQP study should concentrate on the technical aspects of chemical usage.

Students should examine industrial practices as they relate to environmental impact and be included in this study.

I. necessarily crossing the matrix elements A.-3., B.-3., C.-3., D.-3., F.-3. and
II. could involve studies of elements A.-1., B.-1., C.-1., D.-1., E.-1.; F.-1.; A.-5., B.-5., C.-5., D.-5., E.-5. F.-5.;and
III. in some specific case studies, might include elements [A.-2., B.-2., C.-2., D.-2., and F.-2.] or [A.-4., B.-4., C.-4., D.-4., and F.-4.] or [A.-5., B.-5., C.-5., D.-5., and F.-5.]

Suggested IQP/PQP co-advisors: WPI (Salazar, Hart, Rollings, Griffin, Johnson, Radzicki, Rissmiller) and Vernon-Gerstenfeld

Suggested Project Liaisons: Foundacion Natura, ESPOL (Ayon, Barriga, Chavez, Pizzarro) and Vernon-Gerstenfeld

Pollution generated by urban activities

This project was mentioned by both bootstrap teams in their reports (see First Quarter FY 1993 report) and could be designed as case study modeled after that performed by the environmental bootstrap team or involve detailed comparative industry studies either looking at parallel Ecuadorian industries or at U.S. operations verses Ecuadorian equivalents. Local industries include fish (including shrimp), agricultural processing (including coffee, cocoa, banana, and sugar), many small manufacturing processes and several cottage industries. Any dominate industry would make for good case studies. Industrial management practices should be part of these cases if chosen and other cases may lead to examining appropriate technologies for these advancing industries. There are several good problems ideas presented in the Agenda 21 document which is on your laptop computers.

This study must involve assessing the city of Guayaquil's water usage and handling of solid wastes. Local and national government policies in both regulatory and enforcement areas should be explored at some level (again see Agenda 21) and might make for excellent case studies.

I. necessarily crossing the matrix elements B.-1., B.-2., B.-3., F.-1., F.-2., F.-3. ... and
II. could involve more in-depth studies of elements B.-5.; F.-5.; if the focus becomes more technology based ... and

III. some specific case studies, might include elements [A.-2., B.-2., C.-2., D.-2., and F.-2.] if a planning emphasis is taken by the team or [A.-5., B.-5., C.-5., D.-5., and F.-5.] if an appropriate technology focus is deemed necessary. [xxx-1.] if an operational management approach is taken.

Suggested IQP/PQP advisors: WPI (Hart, Rollings, Griffin, Johnson, Gerstenfeld, FitzPatrick, Radzicki, Rissmiller) and Vernon-Gerstenfeld

Suggested Project Liaisons: ESPOL (Barriga, Armas, Layana) and Vernon-Gerstenfeld

Resource management for sustainable development

This project was mentioned by both bootstrap teams in their reports (see their reports) and could be designed as an extension of the petroleum case study performed by the environmental bootstrap team or involve new areas of exploration such as the future of mining gold or other non-renewable resources. Like in the earlier case study, assessing specific government policies in both regulatory and enforcement areas and in examining industrial practices as they relate to environmental impact should be integral to this study. For the mining case study, land-slide prevention studies should be included. This component would compliment greatly to the work of the MQP team dealing with mining activities. Although this latter subject was not discussed by either bootstrap team, this topic is currently of a national (Ecuadorian) concern and thus is a new IQP sub-topic introduced by the ESPOL administration.

If the selected case study deals with the effects of gold and related minerals mining activities on land, water, agriculture, etc., the students should look closely at the projects discussed by both bootstrap teams in their reports and could involve examining industrial practices as well as the environmental impact assessing specific regulatory and enforcement government policies. Disaster prevention strategies should be examined.

If the selected case studies deal with excessive use of chemical nutrients in shrimp farms and their effects upon land, water and the food-chain the students should look closely at the projects discussed by both bootstrap teams in their reports and could involve examining industrial practices as well as the environmental impact assessing specific regulatory and enforcement government policies.

Students should examine industrial practices as they relate to environmental impact and be included in this study. In cases where competition exists between existing industries, comparisons should be made to determine the successful verses the unsuccessful (main) business characteristics to be used that yield a sustainable management outcome, potentially leading to innovative business practices.

I. necessarily crossing the matrix elements A.-1., A.-2., A.-3., A.-4. (for mining), A.-5., B.-2., B.-3., B.-5., C.-1., C.-2.; C.-3., C.-4.; C.-5., and

II. could involve studies of elements B.-4., C.-2., D.-2., D.-3., E.-1.; E.-2.; E.-3.; F.-2.; F.-3.; F.-5., [actually all of xxx-2., if the emphasis on the project is policy] and

III. in some specific case studies, might include detailed analysis in elements [A.-2., B.-2., and C.-2. if the project's emphasis is policy] or [A.-4., B.-4., and C.-4 if the project's emphasis is critical technologies] or [A.-5., B.-5., C.-5., and F.-5., if the project's emphasis is appropriate technologies].

Irrespective of the project's emphasis, environmental impact and business developments must be stressed.

Suggested IQP/PQP advisors: WPI (Johnson, Velazco, Gerstenfeld, Rissmiller, Salazar, Hart, Rollings, Griffin, Radzicki, Gottlieb) and Vernon-Gerstenfeld

Suggested Project Liaisons: Foundacion Natura, ESPOL (Armas, Layana, Perez, Barriga, Pizzarro or Chavez) and Vernon-Gerstenfeld

The following WPI faculty are actively involved in the WPI/ESPOL UDLP development. You or your team members may wish to discuss a component of your project with some of these faculty from their defined expertise or involvement in the linkage. I've included these people's E-mail addresses so that you are encouraged to compose specific questions to these individuals via electronic media prior to meeting with them. This should minimize time involved for all and maximize your contact with all participants.

Faculty	E-mail	Expertise
Guillermo Salazar	(salazar@wpi)	Civil Eng'g., GIS
Bland Addison	(addison@wpi)	History
Patrick Dunn	(pdunn@wpi)	History
Arthur Gerstenfeld	(ag@wpi)	Entrepreneurship
John Griffin	(griffin@wpi)	
Hossein Hakim	(hakim@wpi)	Global resources
Elizabeth Jolie	(efjolie)	Everything
Robert Kinicki	(rek@wpi)	GIS data management
Charles Kornik	(cjkornik)	Logistical support
David Lucht	(dalucht@wpi)	Fire&disaster prev'tn
Thomas Probert	(probert@wpi)	Computing&info.mang't
Michael Radzicki	(mjradz@wpi)	Economics&sys.dynamic
Kent Rissmiller	(kjr@wpi)	Law & policy issues
Enio Velazco	(evelazco@wpi)	TQM, tele-ed & mang't
Ronald Cheetham	(cheetham@wpi)	Biology & ecology
Jim O'Shaughnessy	(jco@wpi)	Environmental eng'g.
Fred Hart	(flhart@wpi)	Environmental eng'g.
Bob Fitzgerald	(rfitz@wpi)	Civil & Fire Eng'g.
Malcolm FitzPatrick	(msf@wpi)	Urban planning

Ted Crusberg	(crusberg@wpi)	Environmental science
S.Vernon-Gerstenfeld	(sgerstenfeld)	Social science
James Groccia	(jegroccia)	Project assess. tools
James E. Rollings	(jerollings)	UDLP Head&Biochem Eng
W. M. Clark	(wmclark@wpi)	Biochem& Environ. Eng
Frank Lutz	(fclutz)	Civil & Environ.Eng.
Lance Schachterle	(lschachterle)	ISD projects
Roger Gottlieb	(gottlieb@wpi)	Humanities & Environ.
Sharron Johnson	(sharon@wpi)	Management systems
Leon Graubard	(graubard@wpi)	Management

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IQP - B TERM
Week 1. (week of Oct. 18, 1993)

Monday	Arrive Guayaquil met by Ing. Torres ... move in to Uni Hotel.
Tuesday 10:00 a.m.	Orientation meeting with Ing. Alfredo Torres, ESPOL project director at ESPOL. The purpose of the meeting as for the advisors and you to exchange information that will make the first week a smooth one. Your advisors will present some valuable pointers about the resources in Ecuador and how to get access to them. The advisors will also go over the schedule for the week, appoint CONTACTS, and explain their expectations for the first presentations on TUESDAY of week TWO. Faculty will suggest schedules for weekly meetings at ESPOL. Spend the day becoming orientated to Guayaquil and Ecuador. Daniel Tapia will set up meeting with the local WPI alumni.
Wednesday	Each student project group will meet with its liaison at ESPOL promptly at 9:00 a.m. The projects officially start then. At the first meeting with the liaison, ask for organizational information, including that needed to fill out the index cards to be given to Prof. Vernon-Gerstenfeld. Take detailed notes. Identify available information sources, including how to gain access to the ESPOL library, if it has one, for example. Ask for a regular meeting time each week with the liaison. Early Monday mornings is great!

Week 2. (week of Oct. 25, 1993)

Monday	Meet with your liaison at ESPOL. Practice your talks with your advisors. Prof Rollings arrives this evening.

Tuesday 8:00-12:00	Each team will make its first presentation. Each team member will speak for ten minutes. This first presentation is intended to convey to your classmates and advisor what the project will be. You may want to include a recap of the project as it was conceived in A-Term and whatever clarifications or changes are required now. Don't forget to use appropriate visual aids - flip charts, overheads, handouts, for example. Prepare your visual aids professionally and carefully and make sure they can be seen by the person in the last row. Critique your colleagues carefully. You have a fifteen minute period in which to do so. Mannerisms, grammar, voice projection, style, content, the logic of the presentation, the kind and quality of the visual aids are fair game for comments. You should also comment on where and how teammates who are not presenting place themselves while their colleague is speaking. Please remember that the two people who are not speaking to the audience should not be whispering to each other nor should the teams who are in the audience be whispering or giving last minute attention to their own presentations. Each team's presentation requires everyone else's full attention. Past experience dictates that the presentations, while anxiety producing at first, become extremely important to everyone because they provide a forum in which to give and receive honest, thorough, tough, but fair feedback. The detailed draft outline of the final report is due at the beginning of the meeting. Evening meeting with students and faculty at 7:30 in the faculty's apartment: Fill out 2 sets of Index Cards (see Appendix A). Often, there are minor problems to discuss or questions to ask. Sometimes there are feelings that need airing. Also arrange weekly meetings for faculty, liaisons and students.
Thursday	
Friday	First on-site meeting with advisors and liaisons. Schedule the final presentations at ESPOL during this meeting. Generally, this first meeting is an informal meeting designed to make sure everyone agrees on the direction and content of the project.

You should prepare carefully for the meeting, however, and perhaps prepare materials for your advisors and others from ESPOL who are involved with your work and who have been invited to attend. (See Appendix A of the Procedures Manual for suggested format of meeting.)

Summary Progress Chart for Week 1 and proposed work plan due for Week 2 (see Appendix A for forms, which you should copy and for directions on how to use them). Use theses forms each week.

Weekend

Day of the Dead Weekend!
Trip to Cuenca to study the culture of the native peoples of the Ecuadorian highlands.

Week 3. (week of Nov. 1, 1993)

Thursday

Second presentations. These presentations should be devoted to your methodology for collecting data and for analyzing them. By now you should have actively begun your research and your plan should be complete. You should know whom and how many people you will be interviewing, and you should have begun making appointments. If you are administering a questionnaire, it should already have been developed and pretested.

First Draft of Chapter III. (Literature Review) due before the presentations.

This week you should have arranged for your room for your final presentations. You must anticipate properly the correct size of the room you will need.

Friday

Weekly on-site meeting

Visits at ESPOL by Ecuadorian Project Center Director. Formal presentation instead for the faculty liaison and Director.

First draft of Introductions and Methodologies due by 6:00 p.m. to advisor.

Weekly presentations with faculty and other teams on Friday. The faculty may exercise the option not to have the Friday presentations.

Week 4. (week of Nov. 8, 1993)

Monday	Second drafts (detailed outlines) of Literature Review Due by 6:00 p.m. (attach first drafts)
Tuesday and Wednesday	Weekly On-site meeting
Friday	Weekly presentations with faculty and other teams. Focus on your data. Second drafts of Introductions and Methodologies due (attach first drafts) by 6:00 p.m.

Week 5. (week of Nov. 15, 1993)

Monday	Table of Contents, List of Table, List of Figures, Appendix A due by 6:00 p.m.
Tuesday and Wednesday	Weekly on-site meeting at faculty discretion.
Friday	Draft proposals due to liaisons and faculty (by 6:00 p.m.) No a.m. presentations at faculty discretion.

Week 6. (week of Nov. 22, 1993)

Tuesday and Wednesday	Weekly on-site meetings.
Wednesday	Exchange drafts. Advisors will announce in advance with whom each team will exchange. Draft authors submit one Xerox copy to student reviewers NO LATER THAN 6 p.m. Draft should clearly indicate which sections are incomplete with a detailed explanation of what they will contain. The three peer draft reviewers will mark up their copy and each will prepare a report critique. By sharpening your ability to be a critic for another team, you will develop the ability to critique your own work better.

Thursday 8:00 p.m.	Teams meet to give feedback to the team whose draft they reviewed and to receive feedback. The reviewers will orally present their critiques with special emphasis on the results chapter. (Please note: while reviewing the draft, do not ask the authors to explain what they wrote; the point of the review is to respond critically to what is on the typed page.) Draft reviewers will submit their marked-up copy to the team that wrote the draft immediately after the feedback session Thursday evening. The critique write-ups will be given to the faculty at the Friday morning session. There should be twenty-four write-ups.

Week 7. (week of Nov. 29, 1993)

Monday	Dress rehearsals. Faculty will announce schedule.
Tuesday	Dress rehearsals. Faculty will announce schedule.
Friday	FINAL PRESENTATIONS Break a leg!

Week 8. (week of Dec. 6, 1993)

Dec. 6 - Quito Independence Day

Tour of the Galapagos or other (to be arranged).

Return U.S. Dec. 12, 1992

SECTION THREE

Due to the heavy workloads that will be experienced during the term, certain procedures have been adopted to facilitate efforts. You will need to determine what access you will have to a word processor and become familiar with its format specifications as soon as you begin to work on your projects. Even though we will be bringing down portable computers, you may want access to facilities on site at ESPOL.

1. Everything submitted to the faculty advisor must be on the same size paper (either 8 x 10 1/2, government size, or 8 1/2 x 11 or closest metric size), and either stapled or punched with 3 holes and put in a loose-leaf binder.

2. Everything submitted must be dated and initialed and must have the name of the project and students on it. All drafts of chapters must be typed. No handwritten drafts will be accepted.

3. A Task Chart for the entire term project, written by the project team jointly, is to be submitted at the first weekly meeting with the faculty advisor.

4. At the weekly organization meeting with the faculty advisor, each team will submit a:

   a. Proposed Work Plan, identifying major tasks to be done in the next week by the group.

   b. Summary Progress Chart, briefly indicating the team's overall fulfillment of its Task Chart for the project. The Task Chart may be overhauled as necessary, but advisors must be given a copy of the Chart each time it is revised. Advisors should be able to understand the progress of the project by matching the tasks on the team's Task Chart to the Summary Progress Chart.

FORMAL GUIDELINES FOR FINAL REPORT

CONTENTS:

Letter of Transmittal
Title Sheet
Abstracts
Authorship Page*
Table of Contents

I. Executive Summary
II. Introduction
III. Literature Review (or Background Information)
IV. Procedure
V. Results
VI. Analysis of Results
VII. Conclusions
VIII. Recommendations
IX. Appendices
X. References

APPENDICES

A. Mission and Organization of the Agency
B.
C.

* This page is required by WPI for all group projects. It identifies which student holds primary responsibility for each section of the report.

FORMAT FOR LETTER OF TRANSMITTAL

(Business letter format, written to agency (ESPOL) liaison)

The Letter of Transmittal is a letter formally submitting the project report to the agency involved. A sample letter of transmittal is given below. The letter must contain the title of the report and include the following sentences:

"Copies of this report are being submitted simultaneously to (faculty advisors) for evaluation."

"Upon faculty review, the original will be catalogued in the Gordon Library of Worcester Polytechnic Institute."

The letter should close with a statement which thanks the liaison for his/her help.

(Sample Letter)

October 12, 1990

Mr. Louis C. Santone, Director
Office of Business and Legislative Issues
U. S. Department of Commerce
San Juan, Puerto Rico 009011

Dear Mr. Santone:

Enclosed is our report entitled The Impact of the Petro-chemical Industry of Unleaded Gasoline Production. It was written at the U. S. Department of Commerce during the period August 26 through October 12, 1990. Preliminary work was completed in Worcester, Massachusetts, prior to our arrival in Ecuador. Copies of this report are simultaneously being submitted to Dr. Lutz and Dr. Weinrich for evaluation. Upon faculty review, the original copy of this report will be catalogued in the Gordon Library at Worcester Polytechnic Institute. We appreciate the time which you and Mr. David Glancy have devoted to us.

Sincerely,

TITLE PAGE

Report Submitted to:

Name of WPI Faculty Advisor(s)

Ecuador Project Center

By

(typed names)	(signatures)
_____	_____
_____	_____
_____	_____

In Cooperation With

(names and titles of ESPOL liaison)

_____

(name of university and division)

_____

REPORT TITLE IN ALL CAPITAL LETTERS

(Date)

This project report is submitted in partial fulfillment of the degree requirements of Worcester Polytechnic Institute. The views and opinions expressed herein are those of the authors and do not necessarily reflect the positions or opinions of (Agency Name) (ESPOL) or Worcester Polytechnic Institute.

This report is the product of an education program, and is intended to serve as partial documentation for the evaluation of academic achievement. The report should not be construed as a working document by the reader.

ABSTRACT

The Abstract is of prime importance since it is used by readers for guidance as to subject, treatment and results. Often the quality of the Abstract will determine how much attention a decision-maker will devote to the rest of the report. Therefore, the Abstract must summarize the contents briefly and accurately, and be understandable independent of the text. It must not exceed 80 words in length and should contain no equations, figures or illustrations. The Abstract must contain the name of the organization with which you worked. It might begin, for example: "This report, prepared for the U. S. Department of Commerce..." The Abstract must be single-spaced.(This abstract, unless revised by the faculty advisors, will appear on your transcript.)

AUTHORSHIP PAGE

When a single, comprehensive written report is submitted for a project, each individual's contribution to the group effort must be clearly identified. The authorship page is either a simple list of individual chapters and their respective authors, or a statement in which each contributing group member is named as having carried out one or more specific tasks within the overall project effort.

ACKNOWLEDGMENTS

Students often insert an acknowledgments page if they wish to specifically acknowledge the assistance or involvement of particular people.

TABLE OF CONTENTS

This should be the last part of the report you do, because you cannot fill in the page numbers until you are finished with the report. However, you should have developed the Table of Contents early in the formulation of the report. It can serve as the basic outline of the paper.

I. EXECUTIVE SUMMARY

This will also be one of the last sections written. This section of the report, like the Abstract, should be understandable independent of the rest of the report. It should be able to stand by itself, and should be tightly written, concise and right to the point because this may be all that a top manager has time to read.

While the format for this section may vary from report to report, the following outline (all in very brief statements) may prove helpful:

Introduction
Objective
Background
Present Situation
Projections

Constraints
Alternatives
Comparison of Alternative
Results (or Recommendations of Conclusions)

The Executive Summary should be not more than 2 or 3 pages.

II. INTRODUCTION

The Introduction should contain a section on the significance of the subject matter. It usually runs about 4 to 5 pages in length and describes in general terms what the reader will read in the body of the report. The subject, goals, purposes, importance, method, audience, and anticipated form of the results for the project should all be touched upon. The Introduction must contain the following statement single-spaced:

> This report was prepared by members of Worcester Polytechnic Institute Ecuador Project Center. The relationship of the Center to the (name of organization) and the relevance of the topic to the (name of organization) are presented in Appendix A.

III. LITERATURE REVIEW (or Background Information)

Usually, a project topic will deal with several areas of knowledge. The literature review is a discussion of the theoretical background your topic and current and past research performed in the topic area. It provides the reader with the information necessary to understand your topic. It, also, leads the reader to understand how and why you formulated the problem in the way you did. Your project is intended to fill a gap in knowledge or add to the store of knowledge in the subject area. In some cases, when a project results in a product such as a script for a video tape, for example, the literature review is more difficult to conceptualize. However, even in such cases, the literature review creates the rationale for creating the product, which, in turn, will be used as a tool for actions that in the end will develop knowledge. If your literature review does not clearly provide a rationale for your project, you have not covered your field or you have not conceptualized the problem rationally. Your literature review from C-Term should provide you with a good start. But you are expected to greatly expand your own knowledge through new literature sources and to provide the reader with many more sources. Remember, people who have no knowledge in your project area may look at your report in Gordon Library. Your literature review should enable them to understand the basics in your topic area, the rationale of your methodology, the data you discuss, and your conclusions and recommendations. Remember to focus on points not on particular authors or sources, unless they are seminal works in the field that are so commonly recognized that the name of the author or work is immediately recognized.

O'Hare gives you examples of formats for citing sources and reporting references.

Citations should be embedded in the text by number and should be in last name of author and year of publication.

IV. PROCEDURE or METHODOLOGY

This chapter, one of the most important in the report, must present your methods of analysis in a way which will allow the reader to replicate your efforts with a different sample. The Procedure is the general, conceptual flowchart of the problem-solving approach. You must provide rationale for all procedures you elect. If, for example, you plan to conduct interviews, you must tell why you chose to conduct unstructured versus structured interviews. If you sent out questionnaires, why did you do so? Justify the type and size of your interview sample or your questionnaire sample.

Many project will NOT require statistical analysis. However, if your project did require statistical analysis, why did you choose one statistical procedure over another? What were the difficulties in choosing your sample? How did you pretest your interview questions or your questionnaire? What were the time, money, geographic and human resource constraints? If you did not choose a random sample, why not? If you stratified your sample, why did you stratify it that way? Use Bailey, K. Methods of Social Research (2nd ed.), or any other good social research methodology text for help in reviewing these concepts. Kidder, L. (1981) Selltiz, Wrightsman and Cook's, Research Methods in Social Relations (4th ed.), New York: Holt, Rinehart & Winston is also excellent and supplements Bailey.

Whenever possible and if appropriate for your topic, make sure that your methodology includes procedures that will allow you to quantify at least some of your results. For example, if you interviewed nine people using an open-ended interview schedule, you may still be able to tabulate your results in some way so that trends at least can be noted, reported in your Findings chapter, discussed in your Analysis chapter, and used for the basis of recommendations in your Conclusion and Recommendations chapter. Be complete and be specific.

In conducting your work, you may have had to modify the procedures you first intended to use. Explain what modifications you made and why. Hunches, even based on interviews, cannot be reported unless they are backed by data that has been analyzed systematically, even if not statistically. Systematic analysis requires organizing data according to criteria set up in advance. Usually systematic analysis means numbers are involved.

Some projects do not lend themselves to quantification. Talk to your advisors.

V. RESULTS

This chapter contains the presentation of the findings of your investigations. Start with the simplest material, but be specific. Your reporting and any arguments you make will be infinitely stronger if you use, whenever possible, tabulations of the the findings. An example is, "Six out of twenty people interviewed wanted the airport to be transferred to private ownership." Proceed to more complicated reporting. "In spite of the fact that so few people were in favor of private ownership, the majority - 18 out of 20 - felt that private ownership would result in more efficient service for passengers. Not all projects will lend themselves to this sort of reporting.

Tables may be used when doing so supplements but does not simply duplicate the text. Use as few as possible. In the text, tell the reader what to look for in the table, but discuss only the highlights. Do not use a table to take the place of text. Each table should be numbered and have a name. For example, the first table might be labeled as:

Table 1. Engineers by Field

Readers should be able to understand the table without explanation. Have others who are not in your team look at your tables and tell you what they mean. If the reader does not understand the table, revise it. Refer to the table by number: "High school students are more informed about the tasks of mechanical engineers than they are about those of electrical engineers (See Table 4)," for example; or "Table 4 shows the number of manufacturing plants that ...."

VI. ANALYSIS

The second part of your Procedure is the Analysis of your Results. The analysis focuses on the significance of patterns you see in your data. This chapter enables you to make recommendations and conclusions by focusing on the significance of patterns you discern in your chapter on Results. Hence, you will be able to say, "Seven out of the nine people indicated a preference for Classic Coca-Cola, indicating a trend." Or, "Since only four out of nine people believed the regulations should be changed, we cannot justify a recommendation to change the regulations. Nevertheless, our sample was so small that we cannot conclusively state that our findings constitute an adequate picture of the opinions of the total population from which the sample was drawn."

Remember that your samples will not be large enough to allow you to make statements about cause and effect. In order to do so, you would have had to use a classic experimental design in which you controlled for all variables except the ones you wished to test. You would, also, have had to use a large sample. Hence, while always referring back to your sample size for justification, you can talk only about trends and about their strength Provide the reader with alternate explanations for the outcomes of your data. When the majority of adopters of solar equipment are between the ages of 30 and 50, it is not because older people do not like or believe in

solar equipment as an energy saver but because older people have smaller access to media sources from which they can learn about solar equipment. Or they have lower incomes than the younger group, and, therefore, cannot afford solar equipment, for example. Do not reject data you feel will no support your hypotheses or that will not please your ESPOL.

As researchers you have an obligation to report and analyze all relevant data. Disproving a theory or stating that the evidence is inconclusive i always as important as proving a theory.

Sometimes the writing of the report will be more logical when the authors integrate their reporting of findings with the analysis of the data. Before electing to do so, discuss your rationale with your advisor and get their permission. Many of the projects report findings that do n lend themselves to a statistical reporting style. Check with your adviso

VI. CONCLUSIONS AND RECOMMENDATIONS

Be sure that all your conclusions are consistent with and follow from an analysis of your data. Everything in this chapter must grow logically from what you have presented in earlier sections.

The chapter indicates what policy recommendations you are making. Recommendations must follow from conclusions, which follow from your analysis, which follow from your data, which follow from your methodology, which follow from your hypotheses, which follow from your theoretical discussion.

While recommendations grow logically from your investigation, they do not necessarily grow logically from the opinions of ESPOL personnel no from the political climate of an agency. Upon occasion, recommendations may be contrary to what an agency may wish to hear. This is a delicate situation and will require tact on your part. Discuss controversial findings and recommendations with your liaison and advisors, but be true t your data and your analysis.

VII. APPENDIX A. MISSION AND ORGANIZATION (of Agency - ESPOL)

This Appendix should include a general background statement on the history and development of the agency or organization, recent budgetary trends, how and by whom its policy is set, and a specific statement of current mission, policies, goals and objectives. The original letter from the agency, identifying the topic, should be included as an exhibit. The final section should describe how your project topic is related to the agency's mission, the position and responsibilities of the people working with you in the agency (show an organization chart), and how the project topic's results would affect components of the organization.

GUIDELINES FOR FINAL REPORT

1. Use Roman numerals for Chapter Numbers, capital letters for Appendices.

   All Chapter Appendix titles should appear as follows:

   1. INTRODUCTION

      2 spaces

   When using subtitles, capitalize the first letter of each word and begin two lines lower.

2. All Figures, Tables and Exhibits in a particular Chapter or Appendix should be identified and numbered by Chapter or Appendix. Each must have a short descriptive title. For example:
   Figure I-2. Regional growth trends
   Table I-1. Energy consumption per capita (first figure in Chap. II)
   This procedure allows each chapter to be typed separately. (Page numbering can be completed at the end of the term.)

3. MARGINS - very important to observe in order to be able to bind all materials in a readable way. (Beware of 8 x 10 1/2 paper)
   From top of page and from right-hand side: 1 inch.
   From bottom of page: 1 1/4 inch.
   From left-hand side: 1 1/2 to 2 inches in order to leave room for binding.
   Nothing should appear outside these margins except the page number which should be centered at the bottom of the page.

4. FOOTNOTES - Footnotes should be embedded in the text in parentheses using the Chicago Manual of Style's preferred method (12th Edition, p. 374, chapter 16.5). This relatively newly preferred form takes the place of the older standard form for footnoting by numbers and puts the author's last name, year of publication, and when a direct quote is used, page numbers in parentheses. The full citation can be found alphabetically listed in the back of the document in a section called References. For example, (Jones, 1988:63) means that Jones wrote the book or article, published it in 1988 and you are using a direct quote from page 63. When you are not using a direct quote, the citation would be as follows: (Jones, 1988) or (Jones, Smith, Brown et al., 1988) or (Jones in Brown, 1977). In all examples you are using Jones' materials. In the second example, there were more than three authors to the book. In the last instance, Brown wrote the book and cited Jones or Jones had an article in Brown's book. In the References section, use standard citation forms for your full citations. See pages 384-388 for a guide (sections 16.46-16.68). You may also use the format given by the American Psychological Association the standard for social science research. O'Hare gives you a model. Do not call the References section "Endnotes" or "Footnotes" or "Bibliography."

You may also have referred to other books and articles from which you got general ideas but from which you have not draw specific enough material that warrants footnotes. In this case, you will want to have an Additional Bibliography section in which you alphabetically list in full citation form those sources.

5. REFERENCES - The References come at the end of your project report and should include all books, journal articles, newspaper articles, etc. that you used in researching your topic. The References section is an alphabetical listing according to author of all your listed References. If in the text you referred to (Walters, 1967), you must give the fullcitation in the References.

Example:

Walters, A. (1967). The Growth of American Industry. New York:Harper & Row.

NOTE: Periods follow the author's name and the title of the work. For journals:

Grant, R., Higgins, C., and Irving, R. (Spring 1988). "Computerized Performance Monitors: Are They Costing You Customers? Sloan Management Review. Vol. 29: 39-36.

(In this case, the article title is enclosed in quotation marks and the name of the magazine is underlined).

Fuller explanations of proper forms may be found in Kate L. Turabian, A Manual or Writers, the most recent edition or in The University of Chicago Press' A Manual of Style, the most recent edition, under Bibliographies, and O'Hare. There may be slight variations of style among authors.

SUPPLEMENTARY GUIDELINES FOR FINAL REPORT

DOUBLE SPACE all sections of your final report, EXCEPT:

the ABSTRACT
indicated sections of the Title Page
Quotations, References, Illustrations, Footnotes, and other items

that are normal single spaced.

Be consistent in footnote style. The Procedures Manual includes comments on proper footnote form and bibliographic form. If in doubt, consult Chicago Manual of Style.

COPIES OF THE REPORT TO BE SUBMITTED (Faculty will expect 4 copies, first 3 items below):

1) ONE COPY: for Project Center files (S. Vernon-Gerstenfeld). This copy will be used to duplicate your report for any agencies who wish to have a copy. Make sure, therefore, it is the cleanest copy possible with the highest white/black contrast.

2) ONE COPY: for Gordon Library

3) TWO COPIES: one for each of the faculty advisors

4) ONE COPY: for organization liaison

5) THREE COPIES: one for each member of the project team.

SUPPLEMENTARY GUIDELINES FOR ILLUSTRATIONS

Graphs, charts, and other illustrations are normally referred to as Figures. Tables are referred to as such.

If an illustration takes up 1/2 page or more, give it its own page. Place the illustration as closely as possible to the section of the text to which it refers to.

If a single illustration is more than 2 or 3 pages long, include it as an appendix to the report.

If the illustration is taken from or is a modification from an outside source, credit that source.

Source: Statistical Abstract of the U.S., 1966, p. 23 or Adapted from

Statistical Abstract of the U.S., 1966, p. 25.

This sort of reference appears below the illustration. Do not use an illustration if it is not referred to in your text.

Below is an example of a table:

Table 1. Fruit Grown in Massachusetts
(Given by town in percent of total yield of fruit in state)

	Leominster	Cambridge	Springfield
Apples	10.0	0.05	6.0
Oranges	3.0	0.01	0.0
Plums	2.0	3.00	17.0

Adapted from the U.S. Department of Agriculture, July 1990

SUPPLEMENTARY NOTE ON SPELLING

A few words commonly misspelled and/or misused are: liaison, effect/affect, methodology/method, which/that - check dictionary for correct usage; it's/its first is contraction of it is, second is possessive pronoun of it.

Appendix A: FORMS, FORMATS, AND MEETINGS

Complete These Index Cards Monday Night - first week

Card # 1.

Student's name

Social Security No.

Major

Room No.

Room Tel. No.

Parent or next of kin

Addresses

Telephone No.s

Card # 2

Students' Name

Name of Agency

Your Tel. # at Agency

Your Room # at Agency

Liaison's Name

Agency Room # for Meetings

Weekly On-Site Meetings of Advisors, Students, and Liaisons

It is students' responsibility to arrange this meeting and to invite people directly involved in the project.

Suggested Guidelines for Conducting the Meeting

1. Presentation of accomplishments to date. (Five-minute oral presentation by one member of the group backed by other's comments when appropriate.)

2. Presentation of procedures to be used to collect data and of techniques to be used to analyze data. Approximately 15-minute oral presentation with visual aids and handouts.

3. Discussion of data sources (three minutes).

4. Faculty-student interchange on adequacy and appropriateness of procedures and data.

5. Faculty may wish to waive the formal structure of the meetings and conduct the meetings informally. If so, it is, nevertheless, important for students to prepare handouts or overheads that will provide necessary information for the discussions.

SUMMARY PROGRESS CHART

Project Name: _____

Date: _____

Students: _____
_____
_____

Tasks	Draft Submitted To Advisor	Advisors Comments Obtained	Liaison Comments Obtained	Final Final Draft Copy Rewritten	Typed
1.					
2.					
3.					

Filling Out the Summary Progress Chart

The use of this form can be suspended and subsequently reinstated after the second week at the discretion of the faculty advisors.

1. Under "tasks," number all tasks worked on. Check off by date "Draft Submitted to Advisor," "Final Draft Rewritten," and "Final Copy Typed" only for chapters of final report. For other tasks, use only "Advisor Comments Obtained" and "Liaison Comments Obtained."

2. Tasks must be keyed to Tasks listed on Group Task Chart.

   Example: Conducting Interviews may be labeled "1", or Writing Chapter 3 may be task "2", Researching Literature Review "3".

3. Enter dates under appropriate columns as work progresses.

PROPOSED WORK PLAN

Project Name: _____

Organization: _____

Student Names: _____

_____

_____

From: _____ to _____
(date) (date)

TASK ACTIVITY

Task No.

Filling out the Proposed Work Plan

Each team should fill out one form each week

Under "Task," fill in the appropriate task nu ber. Under "Activity," give detailed explanation of how task will be acco plished. Identify all data sources. Identify all meetings and purpose o meetings.

TO: Jim Rollings
FROM: Lisa Jernberg
RE: Participant Training Update
DATE: August 2, 1993

Appendix E

Jim, the following is an outline of areas that have been resolved, or require further research, in regards to bringing the individuals from ESPOL to study in Worcester.

The following has been accomplished to date:

1. WPI has accepted two individuals from ESPOL (Victor Gonzalez, Edgar Iqouiero) to an M.B.A. and an M.S.M. Program. They are due to begin courses in January of 1994.

2. Carlos Becerra (ESPOL contact) has been notified via fax that these individuals have been accepted and that individual acceptance letters would be forwarded once the details of their stay at WPI were confirmed. Since you are traveling Quito on August 11, 1993, I will have you personally deliver these letters in order to avoid mail delay.

3. ESPOL has initially agreed to pay these individuals $400 per month. In addition, ESPOL will provide funding to cover their flight and English course costs.

4. WPI will categorize these students as RA's (Research Assistants). In exchange for 20 hours of research per week, students will receive a monthly stipend of $1,092 ($400 from ESPOL, a set amount to be determined from A.I.D., the remaining from WPI). This amount was set because the Ecuadorian currency is constantly deflating against the U.S. dollar. This amount will ensure that monthly adjustments need not be made. Further, the students will receive waived tuition each semester (including summer) with the specific number of credits waived determined by the schedule accepted by each student. Students will be required to pay a $50 deposit upon acceptance of our offer (to cover the G.S.O. and Orientation Fee). It will be noted in the acceptance letter, however, that the $100 additional deposit typically credited towards the first semester's tuition, will be waived for these students.

5. After some discussion with WPI's contact at A.I.D., Dr. Ruth Frischer (703-816-0252, Arlington, VA), I believe that WPI would be best served by following the standard Participant Training Guidelines in bringing these students to WPI. Because our program is not 100% A.I.D. funded, there was a question as to whether or not it was necessary to build additional steps into bringing the students to Worcester (Participant Training procedures) or if the regular procedure for bringing foreign students to WPI could apply. After some discussion with Dr. Frischer, and since WPI is entering a relationship that will continue for an undetermined period of time, I feel it is best to follow established protocol in order to avoid any potential difficulties in the future. **A.I.D.'s primary concern is that students go back to their country once their program of study is completed.**

6. Dr. Frischer suggested that I speak with Sarah Salama (Program Coordinator) at the University of North Carolina (919-966-2382) as she has processed paperwork for two students thus far. Sarah suggested that WPI should follow the Participant Training Guidelines to "be safe". She also indicated that most of the paperwork was generated by the Mission and that her paperwork took approximately 1 hour to complete once the

needed information was received. The University of North Carolina's program is 100% A.I.D. funded.

6. The Management Department at WPI had initially agreed to waive the TOEFL for the applicants. However, since we will be following the Participant Training Guidelines, students will be given a provisional acceptance based on their successful completion of a TOEFL (A.I.D. requires minimum score of 500).

7. Four distinct educational outlines have been developed to facilitate each student's program completion here at WPI. These outlines will be included in the initial packet to the students. The schedule selected will determine the length of stay at WPI. Students will be advised that the 19-20 month program is considerably more challenging than the 24 month program of study. It will be specified in the acceptance letter that students must maintain the academic standards required by WPI and that they will be required to do thesis work (6 - 9 credits).

8. To get the Participant Training requirements of the students' stay under way, I contacted Linda Walker (handles VISAs) at O.I.T. and asked that she forward any forms or documentation required for bringing these students to Worcester.

9. Further, I spoke with Regina Himmons (handles Participant Data Forms) at O.I.T. and asked that she send out the forms that WPI must complete to get students here. A couple of items noted by Regina is that the PDF's cannot be completed until WPI has obtained a project # (UDLP Cooperative Agreement DAN-5063-A-00-1111-00?), PIOP #, on-board date (day individual actually arrives in the U.S.), and estimated completion date (day individual actually leaves U.S.). It also must be noted on the PDF that a "medical certificate is on file for the individuals in XXX office". This form should be forwarded to Dr. Frischer once completed.

10. I was informed that O.I.T. currently has no consultants on staff who can assist WPI with the Participant Training Program requirements. These positions have not been filled given some internal restructuring currently taking place. Normally, O.I.T. consultants would be available to walk us through each required phase of the process. However, with no such person on staff, WPI is required to piece together the requirements as we move forward.

11. I was informed by Linda Walker that the A.I.D. Mission in Ecuador is responsible for issuing the required PIOP form, J1 VISA documentation, and for obtaining the students' medical certificates (must be no more than 3 months prior to travel to U.S.). Jim, I understand that you have a meeting scheduled with the A.I.D. Mission in Quito on August 13, 1993 at 12:00 p.m. Before you leave for Ecuador, I will outline items that need to be discussed with the A.I.D. Mission (issuance of the PIOP, VISA, and medical clearance) at that time. I will need to verify who handles the Travel Request Forms (A.I.D. Mission or Betty Jolie at WPI). In addition, could you please obtain the name of the primary A.I.D. Mission contact for future correspondence.

12. Additional names of individuals given to talk with at O.I.T. given were Tom Donnelly (PIOP forms), Paul Knepp (former O.I.T. consultant - 202-663-2692) and Ethel Brooks.

13. We need to verify that the A.I.D. monthly allowance is $865 for Worcester.

ESCUELA SUPERIOR POLITECNICA DEL LITORAL

ESPOL

"Ciencia, Tecnología y Educación al servicio del País"

Guayaquil, July 21, 1993

TO: Lisa Jernberg
Director Graduate Management Program

FROM: Carlos Becerra, ESPOL

Dear Lisa:

I hope every thing is going fine in the admission procedure of V. H. Gonzalez and E. Izquierdo. They are expecting news in order to begin internal faculty procedures and so forth.

With respect to this point, as I have explained it to J. Rollings, ESPOL is able to provide amounts for covering their flight and English course costs.

Besides that, ESPOL is willing to maintain Gonzalez and Izquierdo's salaries during their graduate studies at WPI, which means quantities in the order of 400 dollars per month for each one. Now, we need to know the amount they would receive from the WPI/ESPOL Program during their studies at WPI to complete a reasonable monthly amount for covering their living & food and other expenses. Please send information about this. Thanks for your cooperation.

Best regards,

C. Becerra

GUAYAQUIL: CAMPUS PROSPERINA KM 30.5 VIA PERIMETRAL • APARTADO 09-01-5863 • TELEX 4-3008 ESPOL E-CD • FAX (593-4) 884829

MEMORANDUM

DATE: July 22, 1993

TO: Carlos Becerra, ESPOL

FROM: Lisa Jernberg, Director of Graduate Management Programs

SUBJECT: Status of Graduate Applications

DEPARTMENT OF MANAGEMENT

Thank you for your letter. I wanted to promptly respond to let you know that both Victor Gonzalez and Edgar Iqzuierdo have been accepted to the programs to which they each applied (M.S.M. and M.B.A. respectively). As per their applications, we are working to have them arrive for the January 1994 semester, unless otherwise indicated. I have not yet sent out formal notification, however, because I've been working with Jim Rollings to compile a complete outline of what is required to get the students to WPI and to appropriately implement the ESPOL/WPI agreement. I will be contacting A.I.D. this week to get specific answers to some of the questions identified.

In the meantime, however, I will plan to send a letter of acceptance to each of these individuals, but I will make note that a second letter will be forthcoming detailing the specifics of their arrival.

If you have any questions, please contact me as soon as convenient. I will pass a copy of your letter on to Jim Rollings as it answers several of the questions identified.

Thank you for your patience.

cc: Jim Rollings

WORCESTER POLYTECHNIC INSTITUTE

Department of Management
100 Institute Road
Worcester, MA 01609-2280
(508) 831-5218
FAX: (508) 831-5720

Post-It™ brand fax transmittal memo 7671	# of pages ▸ 1
To Linda Walker	From Lisa Jernberg
Co. OIT	Co. WPI
Dept.	Phone # 508-831-5561
Fax # 703-875-4346	Fax # 508-831-5720

July 29, 1993

Ms. Linda Walker
Office of International Training
Washington, DC

Dear Linda:

Per our phone conversation today, Worcester Polytechnic Institute has accepted two individuals from Ecuador who will be traveling to WPI in January to pursue graduate management degrees under the AID/OIT Participant Training Program.

In order to get this process started (and to help establish internal procedures for future trainees), could you please send me any materials that you have detailing the VISA requirements (forms, guidelines, etc.) for these individuals.

Please mail the requested information to:

Lisa Jernberg
Director, Graduate Management Programs
Worcester Polytechnic Institute
Department of Management
100 Institute Road
Worcester, MA 01609

If you have any questions, I can be reached at (508) 831-5561. Thank you in advance for your assistance.

Sincerely,

Lisa M. Jernberg

Lisa M. Jernberg
Director, Graduate Management Programs

100

DRAFT

August 2, 1993

Mr. Edgar E. Izquierdo
P.O. Box 09-04-164
Guayaquil - Ecuador

Dear Edgar:

Your application for admission to graduate study at Worcester Polytechnic Institute has been carefully considered by the faculty of the Management Department. In accordance with their recommendation, I am pleased to offer you a provisional admission to the full-time graduate program leading to the Master of Business Administration degree for the January 1994 semester.

Originally, WPI had agreed to waive the TOEFL requirement of your admission. However, we have completed detailed discussions with A.I.D. and have been informed that WPI must follow the A.I.D. Participant Training Guidelines in processing your visit to WPI. A.I.D. requires that you submit official TOEFL scores (500 or better) to show your proficiency with the English language. Thus, this is the provision of your admission. I am enclosing the forms needed to register for the October TOEFL. It is important that A.I.D. requirements be satisfied in order to receive the appropriate support and clearance for your stay.

You have been accepted as a Research Assistant at WPI. With this, you will receive a monthly stipend of $1,092 ($400 funded by ESPOL, portion funded by A.I.D., portion funded by WPI) and a waiver of your tuition, in exchange for 20 hours per week of research activities for the duration of your stay.

With regards to the specific issues pertaining to your arrival at WPI, the A.I.D. Participant Training Program requirements are currently being verified (e.g. obtaining your J1 VISA, Medical Certification, Training Authorization Forms, Travel, Health Insurance, etc.). You will receive a separate letter detailing the process and paperwork required to "get you to Worcester" at a later date.

With regards to your program options, I am forwarding four potential schedules from which you should select <u>ONE</u>. Although there is some flexibility with the courses being taken when listed, please note that the 19-20 and 24 month options have been designed to facilitate the timely completion of your degree. You will be required to chose between a 6 or 9 credit thesis, as outlined by the options provided. Please note that whichever program of study you select, you will need to maintain the academic standards required by WPI.

Should you decide to accept our offer of admission, a deposit of $50.00, payable to WPI, should be forwarded to the Management Department by October 1, 1993, along with the enclosed response card. This non-refundable deposit covers $20 for the Graduate Student Organization Fee, and $30 for the Orientation Fee. The $100 additional deposit typically received from students has been waived.

Sincerely,

Lisa M. Jernberg
Director, Graduate Management Programs

ESPOL - Recommended Student Schedule - Draft

January 1994 - July or August 1995

If 9-Credit Thesis Option Selected: **(19 months if done by end of July, 20 months if August needed to complete thesis work)**

Spring 1994	3 courses	(9 credits)		MG540	Operations Management
				MG550	Statistical Methods
				MG547	Project Management (MBA elective)
				MG542	Quality Planning & Control (MSM elective)
	1/3 Thesis	(1 credit)			
Summer 1994	1 courses	(3 credits)		MG530	Organizational Science
	1 Thesis	(3 credits)			
Fall 19	4 courses	(12 credits)		MG510	Management Accounting
				MG570	Computers in Business
				MG580	Economic Theory
				MG531	Managing Organizational Change
			OR	MG590	Management and Society (MBA elective)
				MG527	Risk Management
			OR	MG548	Productivity Management (MSM elective)
Spring 1995	3 courses	(9 credits)		MG520	Financial Management
				MG560	Marketing Management
				MG591	Business Policy
	2/3 Thesis	(2 credits)			
Summer 1995	1 course	(3 credits)		MG595	Business Law & Ethics
	1 Thesis	(3 credits)			
Total:	15 courses	(45 credits)			

If 6-Credit Thesis Option Selected: **(19 months if done by end of July, 20 months if August needed to complete thesis work)**

Spring 1994	3 courses	(9 credits)		MG550 Statistical Methods
				MG547 Project Management (MBA elective)
				MG590 Management & Society
			OR	MG598 Breadth elective (MBA elective)
				MG542 Quality Planning & Control (MSM elective)
				MG598 Independent Study MSM elective
			OR	Other MSM elective
Summer 1994				MG530 Organizational Science
Fall 199				MG510 Management Accounting
				MG570 Computers in Business
				MG580 Economic Theory
				MG527 Risk Management
				MG548 Productivity Management (MBA or MSM elective)
Spring 1995	3 courses	(9 credits)		MG520 Financial Management
				MG560 Marketing Management
				MG591 Business Policy
	2/3 Thesis	(2 credits)		
Summer 1995	2 courses	(6 credits)		MG595 Business Law & Ethics
				MG540 Operations Management
Total:	15 courses	(45 credits)		

Note: Either of the above is expected to be an extremely challenging program of study.

January 1994 - December 1995

If 9-Credit Thesis Option Selected: **(24 months)**

Spring 1994	3 courses	(9 credits)		MG540 Operations Management MG550 Statistical Methods MG547 Project Management (MBA elective) MG542 Quality Planning & Control (MSM elective)
	1/3 Thesis	(1 credit)		
Summer 1994	1 course	(3 credits)		MG530 Organizational Science
	1/3 Thesis	(1 credits)		
Fall 1994	3 courses	(9 credits)		MG510 Management Accounting MG570 Computers in Business MG580 Economic Theory
Spring 1995	3 courses	(9 credits)		MG520 Financial Management MG560 Marketing Management MG591 Business Policy
	1/3 Thesis	(1 credits)		
Summer 199.	1 course	(3 credits)		MG595 Business Law & Ethics
	2/3 Thesis	(2 credits)		
Fall 1995	1 course	(3 credits)		MG590 Management & Society
			OR	MG593 International Management (MBA elective) MG592 Entrepreneurship & New Venture Management
			OR	Other MSM Elective
	1 1/3 Thesis	(4 credits)		
Total:	15 courses	(45 credits)		

If 6-Credit Thesis Option Selected: **(24 months)**

Spring 1994	3 courses	(9 credits)		MG540 Operations Management
				MG550 Statistical Methods
				MG547 Project Management (MBA elective)
				MG542 Quality Planning & Control (MSM elective)
	1/3 Thesis	(1 credit)		
Summer 1994	1 courses	(3 credits)		MG530 Organizational Science
	1/3 Thesis	(1 credits)		
Fall 1994	3 courses	(9 credits)		MG510 Management Accounting
				MG570 Computers in Business
				MG580 Economic Theory
	1/3 Thesis	(1 credit)		
Spring 1995	3 courses	(9 credits)		MG520 Financial Management
				MG560 Marketing Management
				MG591 Business Policy
	2/3 Thesis	(2 credits)		
Summer 1995	1 course	(3 credits)		MG595 Business Law & Ethics
Fall 1995	2 courses	(6 credits)		MG590 Management & Society
			OR	MG593 International Management (MBA elective)
				MG592 Entrepreneurship & New Venture Management
			OR	Other MSM Elective
				MG??? Free elective
	1/3 Thesis	(1 credit)		
Total:	15 courses	(45 credits)		

WPI Journal

WORCESTER POLYTECHNIC INSTITUTE SPRING 1993

Appendix F

Giving Students a Global Perspective

WPI Journal

VOLUME XCVI NO. 2 SPRING 1993

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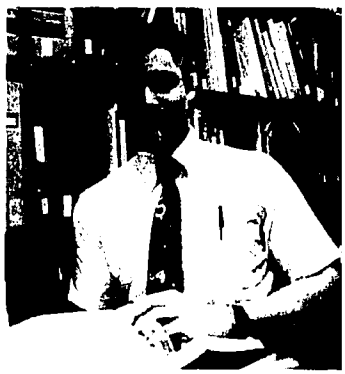

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19 The United Nations of WPI

While the Institute's students travel the globe to learn about other cultures, special programs on campus are bringing the world to WPI. So check your passport and fasten your seat belt as we tour the Cultural Festival and the African Marketplace.

25 The Law of the Frontier *Michael Dorsey*

Patent law is dull, right? Not according to WPI alumni who work in what's been called the hottest area of legal practice today. What's more, an engineering or science degree is the ideal start for this challenging and creative profession.

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Front Cover: Global Program Officer Hossein Hakim, second from left, with, from left, Naomi E. Carnegie '93, Jennifer L. Greenhalgh '94 and Michael A. Kaliski '93. Carnegie completed an Interactive Qualifying Project in San Juan, Puerto Rico; Greenhalgh did an IQP in Bangkok; Kaliski did his IQP in Venice. The photo was taken inside the Mapparium, a 30-foot stained glass globe at the Boston headquarters of the Christian Science Publishing Society. The globe was completed in 1935 and shows the world as it looked then. Story on page 5. Photo by Janet Woodcock. **Opposite:** Pakamas Tongcharoensirikul, a graduate student in chemistry, performs a traditional Thai dance known as the Srinual during WPI's 1993 Cultural Festival. More photos begin on page 19. Photo by Janet Woodcock. **Back Cover:** More than 5,000 graduates and their guests gathered on the Quadrangle for WPI's 125th Commencement on May 22. The theme of this year's ceremony was "Engineering and Science Education: A Future Agenda." Photo by Michael Dorsey.

Staff of the WPI Journal: Editor, Michael W. Dorsey • Alumni News Editor, Ruth S. Trask • Writers, Diane Benison, Bonnie Gelbwasser and Neil Norum • Designer, Carol Hoyle Ballard • Photographer, Janet Woodcock • **Alumni Publications Committee:** Samuel Mencow '37, chairman • Paul J. Cleary '71 • James S. Demetry '58 • Judith Donahue SIM '82 • William J. Firla Jr. '60 • William R. Grogan '46 • Carl A. Keyser '39 • Robert C. Labonté '54 • Roger N. Perry Jr. '45 • Harlan B. Williams '50 • The *WPI Journal* (ISSN 0148-6128) is published quarterly for the WPI Alumni Association by the Office of University Relations. Second class postage paid at Worcester, MA, and additional mailing offices. Printed by The Lane Press, Burlington, Vt. Printed in the U.S.A.

Diverse views presented in this magazine do not necessarily reflect the opinions of the editors or official WPI policies. We welcome letters to the editor. Address correspondence to the Editor, WPI Journal, WPI, 100 Institute Road, Worcester, MA 01609-2280. Phone: (508) 831-5609, FAX: (508) 831-5604, Electronic mail (Internet): mwdorsey@wpi.wpi.edu. Postmaster: If undeliverable, please send form 3579 to the address above. Do not return publication. *Entire contents ©1993, Worcester Polytechnic Institute.*

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Globalization: The Next Big Wave

BY RONALD L. ZARRELLA '71

It's difficult to pick up a business or economic journal these days without reading something about the management of global marketing, global technology, global manufacturing or global finance. Globalization has joined total quality management as one of the most written about and talked about subjects in American business and industry. And as with TQM, successful globalization of business activities will be a fundamental element of competitive survival for the world's major industrial companies in the 1990s.

To appreciate why this is so, one need only look at America's changing economic role in the world. In constant dollar terms, the world's economy, expressed as total Gross Domestic Product, was $2 trillion in 1970; 20 years later, it was $15.7 trillion. In 1970, the U.S. economy was $1 trillion, fully half of the world's Gross Domestic Product. By 1990 it had dropped to a third of the world economy, or $5.4 trillion—still an enormous number, but with considerably less impact than it had two decades ago.

What has happened to Japan, our largest economic competitor? In 1970 its $200 billion economy made up 10 percent of world GDP. But by 1990, it had grown to $3.2 trillion, exceeding 20 percent of world GDP and doubling its economic influence. The world's third largest economy belongs to Germany. Somewhat surprisingly, its relative economic strength remained fairly constant over that same 20-year period, constituting around 10 percent of world GDP.

Another measure of relative economic strength is exports. This has been an area of strength for the U.S., where exports grew from 4 percent of GDP in 1970 to over 7 percent of GDP ($400 billion) in 1990. Japan's exports remained fairly constant at around 9 percent of GDP over that 20-year period (though they actually dropped from a high of 11 percent of GDP in 1980); they reached about $300 billion in 1990. Germany is the champion exporter, with 25 percent of GDP ($410 million) in 1990. Of course, net exports paint a much different picture, with the U.S. running a significant negative balance of trade over the last decade, and Japan and Germany running large, positive balances.

The last measure of relative economic strength I'd like to talk about is productivity. If we use Gross Domestic Product per worker as our measure, the U.S. is still the most productive nation in the world. In 1990 we produced $50,000 of GDP for every worker, compared to $30,000 in Japan and only $15,000 in Germany. But our enormously productive farming industry and our large financial and retail institutions distort this measure in our favor. If we look just at manufacturing productivity, the Germans are 10 percent more productive than we are and the Japanese are 20 percent more productive. In fact, the Japanese rate of productivity improvement is three times what ours is per year, although that gap is narrowing.

America is still the world's largest economic force and the world's largest market. We're an enormously productive people; we just don't have the dominance we had 20 years ago. We have to learn to play on equal terms with our economic competitors. We're no longer the only game in town. Many of us don't like that, but those of us who learn to do business in this new international economic environment will be the winners of the next decade.

Perhaps the most telling measure of industrial globalization is the percentage of revenue derived from outside the home country. For America's 100 largest industrial companies, the percentage of non-U.S. revenues grew from 14 percent in 1970 to almost 40 percent in 1990. For Japan's largest companies, the percentage is 57 percent; for Germany's, it is 69 percent. Furthermore, for U.S. companies, those revenues have shifted from being

derived largely from exports to being derived largely from products manufactured outside the country.

This last phenomenon is supported by a 15-fold increase in investment by U.S. companies manufacturing outside the U.S. In the same period, however, there has been a 30-fold increase in foreign manufacturing investment in the U.S. Both measures accelerated dramatically in the last half of the 1980s.

Consider Bausch & Lomb. As late as 1985, less than 20 percent of our revenues were derived from businesses outside the U.S. In 1992, 51 percent of our $1.8 billion in revenues came from outside the U.S. In 1985, 7 percent of our profit was derived outside the U.S.; in 1992, more than 60 percent was. In 1985, more than 80 percent of our products sold outside the U.S. were exported from the U.S.; in 1992, 80 percent of our products sold outside the U.S. were made outside the U.S.

This shift in the center of gravity of U.S. corporations has had significant implications for the way those corporations are organized and operated and for the kind of people who operate them. "Think globally, act locally" is today's catch phrase for organizational theory, but how to do that effectively is the subject of much debate and research. It is dependent on many factors, like the uniformity of products, the nature and cost of technology development, the location of core competencies and, probably most important, the corporate cultures involved.

A few traditional models define both ends of the organizational spectrum. On one end, there is the "global company." In the global company, functions—finance, marketing, manufacturing, product development and so on—are managed on a worldwide basis. Sales is the only real local function. Communications are simple: they flow out from the center and back into the center. The decision chain is also simple, with all key strategic decisions being made at the center. Companies organize this way because it is efficient.

Companies that have traditionally organized globally are those that have a high technology content, that are very capital intensive, or that have strong global brand names. Japanese companies are typically organized globally, as are the giant U.S. pharmaceutical companies. Coca-Cola is organized globally.

The other end of the organizational spectrum is the multinational. A multinational is organized around strong, independent, self-contained country units. The country general manager is the strongest executive in the corporation. Marketing, manufacturing, product development and finance are all done at the country level. The role of the corporate center is, simplistically, to collect the money and change the country management when there's no money to collect.

Companies organize this way because it puts decisions closest to the customer and best meets the needs of the local market. Many of America's great consumer packaged-goods companies and food companies are organized as multinationals. Unilever is a good example.

Harvard Business School professors Christopher Bartlet and Sumantra Ghoshol have developed the concept of the "transnational company," which they described in an important book called *Managing Across Borders*. In a transnational company, there is no real home country mentality. A transnational tries to achieve all the efficiency and synergy of a global company, with all the local responsiveness of a multinational. The structure fits with the corporate culture, but in a transnational, structure is less important than the operating mechanisms put into place to make the organization run.

A transnational makes the best use of its core competencies regardless of where in the world they are located. In a transnational, employees recognize that, while they are paid to perform a specific job in a specific location, they are part of a global enterprise. They have an obligation to learn from and contribute to that global enterprise, so they are better able to perform their specific jobs in their specific locations. The transnational creates an environment of continuous global learning. It creates a series of networks within the organization that do the work of the organization.

Advances in communications have made transnational companies possible; in fact, advanced communications are a critical requirement for them to work effectively. Today, relevant information is being made available on a real-time basis—and deeper into these organizations than ever before possible. Teleconferencing, videoconferencing and local-area networks interconnected on a worldwide basis are now being used widely, avoiding the need for large groups of people to jump on planes in order to meet face to face.

Networks of functional managers have worldwide information available to them. Product managers have market research on new and existing products from a number of different countries; marketing managers have competitive information available on global competitors; financial managers can coordinate currency hedges in multiple locations to protect a corporate balance sheet line item.

The strength of these communication technologies really comes into play in global product development. Television advertisements for the Ford Escort trumpet it as the "world car." Parts of it are manufactured and assembled in countries around the world, with final assembly in the U.S. At Bausch & Lomb, we've developed similar "world products" by learning to meet local market needs from a common technical platform.

We make a product called Interplak. The electromechanical design for this home plaque-removal device is done in the U.S.; the ergonomic design is done in Japan. The batteries are supplied from Japan, the motors are built in the People's Republic of China, the charging base is made in Hong Kong, the precision-molded plastic pieces are manufactured in Atlanta,

Bausch & Lomb's Interplak is a true world product, built from parts made around the world and modified to meet the needs of customers in 30 countries.

the brush head is made in Ohio, and the final assembly is done in Mexico.

To meet local, retail and consumer needs in 30 countries around the world, there are 50 variations of the same basic Interplak design. There are marketing managers, product design engineers, cost analysts and manufacturing managers in nine locations, all of whom work on product development for these products. Design and specifications are computerized at the design locations and electronically transmitted to the manufacturing sites for the various parts and assemblies around the world. When it is necessary to change a specification, the worldwide file can be updated on a real-time basis.

There is a network of 20 people who bring new products in this category to market, managing the process from idea generation to product launch. They meet face to face maybe twice per year. All the work gets done on an interconnected information network with regular use of video conferencing.

Here's another example. Ten years ago Bausch & Lomb's primary business was the manufacture of contact lenses, and that is still an important business for us today. The typical age profile of a contact lens wearer is 18 to 35. In the 35 to 40 age range, presbyopia starts to set in and a contact lens wearer needs bifocals. There really is no effective mass-market bifocal contact lens; the known technology simply doesn't work. As a result, a percentage of our market every year switches to wearing spectacle bifocals.

The technology does exist to individually manufacture a bifocal contact lens for a specific eye. On the surface, this is not a particularly interesting business for a company that makes millions of contact lenses at very low cost. The many design parameters that need to be taken into account in an individually manufactured bifocal contact lens result in hundreds of thousands of variations.

But an engineer in Holland came up with a concept that could manufacture these individually designed lenses at a very low cost. A doctor in Europe or the Middle East could call an 800 number in Ireland and access a voice-activated program. He would then input the specific values for the design parameters, which he would have measured on his patient.

The digitized information would be fed into a computer-controlled laser, a system developed by a U.S. company working in concert with engineers in the U.K., who, in turn, worked with scientists from the University of Manchester. The laser would cut the digitized design into a special polymer; within a minute of the information being taken from the doctor, a finished bifocal lens would be in a package ready to be mailed for delivery within 48 hours.

Making contact lenses for people ages 18 to 35 is an important part of Bausch & Lomb's business. A way of making individually designed bifocal contact lenses at a reasonable cost may open up the over 35 market for the company.

The production unit I've just described could manufacture up to 5,000 individually designed bifocal contact lenses a day at a cost well within the range of financial reasonableness. Four of these units, located strategically throughout the world, could supply worldwide market needs.

The skills required to succeed in this kind of environment have definite implications for scientific and engineering education. The hardware—the core science and engineering curricula and the way it is taught—is in place and is effective. University-level education in science and engineering in this country is widely regarded as the best in the world. The only criticism I have of the hardware is the lack of appropriate attention to the concepts and application of total quality management, although a groundswell is beginning to develop for additions to the curricula in this area.

The software—the nonscience-based classroom work and the experience outside the classroom—is a different matter. The fostering of acceptance and awareness of cultural diversity (further than that, the development of an intense, intellectual curiosity about cultural diversity) is a necessity in the educational program. But it is not really evident on college campuses today; in fact, the reverse seems to be true.

There has to be a recognition that because something is different, it's not necessarily better or worse—it's simply different. This skill doesn't come as naturally to us as it does to Europeans, nor do we work as hard at it as the Japanese. A Japanese company wouldn't think of sending executives to America to negotiate a business deal if they didn't speak English. Nor would those executives ask to have dinner at a sushi bar if they were with their American counterparts.

Yet American language capability is notoriously bad. We too often try to sell products designed only for U.S. markets, and we try to force our values and lifestyles onto our international counterparts.

There are many ways a college or university can encourage cultural diversity and perspective: language studies, specific cultural studies, increasing the number of foreign students, hiring international scholars, serving international food and creating diverse cultural support systems. All of these can work with the support and commitment of the leadership and the faculty.

WPI is uniquely positioned to provide national leadership in global science and engineering education. I was a senior when the faculty approved the WPI Plan. The guiding objective of the Plan is simple: to educate humane technologists.

By pursuing that objective, WPI has already put in place most of what is needed to create successful global technologists, including the requirement that students work on cross-functional teams to solve problems; the requirement that they supplement scientific studies with studies in the humanities and social science, including, for many, work at global project centers; and the courses and projects that give them the ability to work on real problems in different cultural environments.

The Plan puts WPI on the leading edge of the wave. And I firmly believe it will be a very big wave.

Zarrella is president of Bausch & Lomb Inc., a leading worldwide manufacturer of health-care and optics products. This essay was adapted from Zarrella's address to the WPI Workshop on Internationalizing Science and Engineering Education held in Waterville Valley, N.H., in October 1992.

The Whole World in Their Hands

By Diane Benison

Through WPI's Global Perspective Program, students have traveled the world to complete professional-level projects. The program is also building a growing base of globalization programs and curricula here on campus. The goal is to help students better understand their roles as working professionals and citizens on an ever shrinking world.

Marshall McLuhan's 1967 book, *The Medium is the Message*, became famous for its observation that, "the new electronic interdependence recreates the world in the image of a global village." That easy to grasp word-picture had a vividness that resonated instantly for his readers. But more than two decades ago, the interdependence McLuhan described was still an abstraction for most people.

Today, the global village no longer refers merely to the real-time connection of people via phone, fax, modem and satellite. Now, human society around the world is being transformed by the melding of hundreds of national economies into a single world market (see Input, page 2).

Volumes have been written about the globalization of business, technology, manufacturing and finance. In 1992, *Business Week* marshaled the efforts of nearly 200 reporters, editors and other staffers to produce a special issue on the global economy and its impact on the United States. If the U.S. is to retain its vitality as a nation and a world-class economy, the editors concluded, new ways of thinking and acting are needed.

Part of the responsibility for changing our ways of thinking and acting will fall to educators. From elementary school to graduate school, educational institutions are grappling with the need to develop curriculums and classroom experiences that prepare students to function effectively in a future that promises greater contact between cultures and more diversity in all aspects of life.

Those young men and women will find a world waiting for their skills. A recent survey by McKinsey & Co. found that most corporate CEOs recognize the increasing importance of international markets to the success of their companies. These firms will be looking for employees with the experience, skills and cultural awareness to help them succeed internationally.

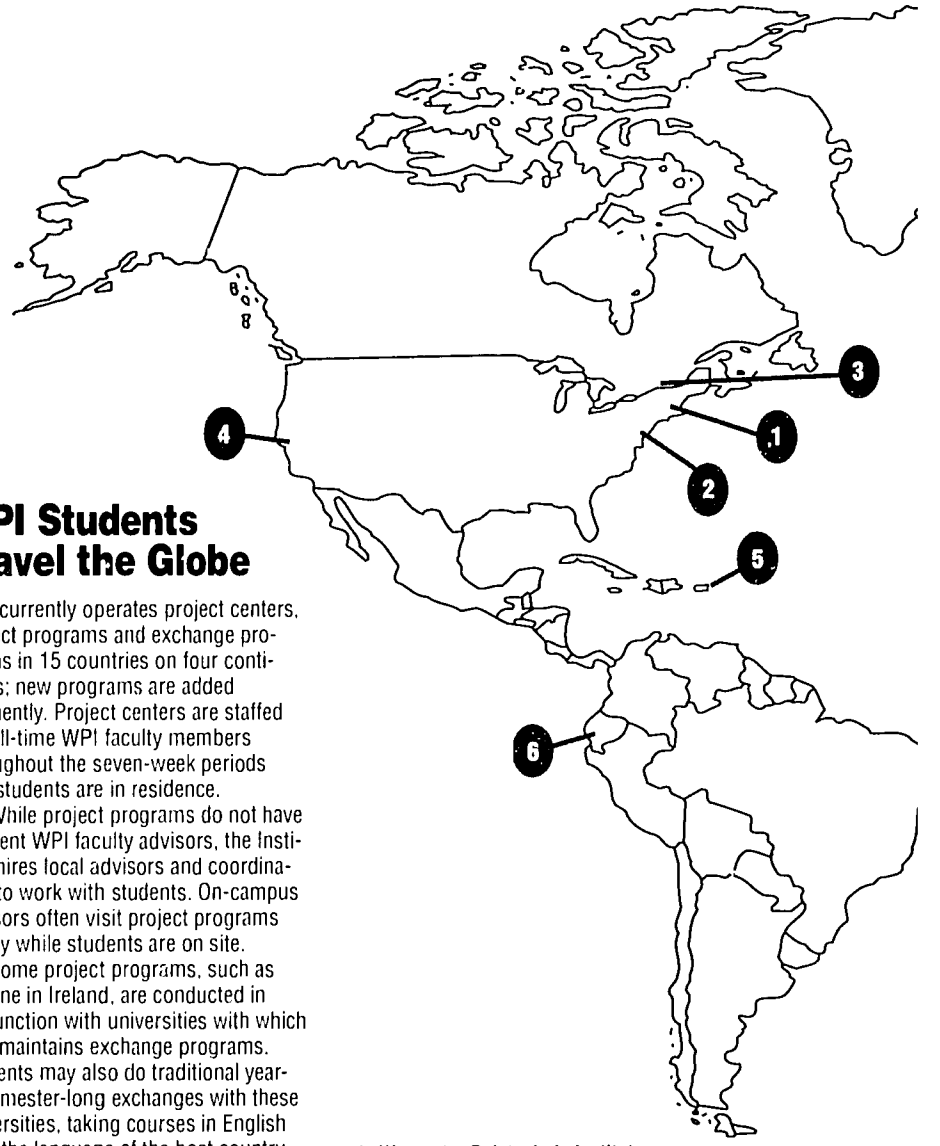
That means being able to design and build products that will sell in diverse markets around the world and to work effectively with fellow employees, consultants and customers who live in other nations. And it may well mean being ready to relocate to corporate offices, divisions and subsidiaries outside the U.S. In short, it means that the professionals of tomorrow must be more than competent engineers, scientists and managers. They must be true citizens of the world.

WPI Students Travel the Globe

WPI currently operates project centers, project programs and exchange programs in 15 countries on four continents; new programs are added frequently. Project centers are staffed by full-time WPI faculty members throughout the seven-week periods that students are in residence.

While project programs do not have resident WPI faculty advisors, the Institute hires local advisors and coordinators to work with students. On-campus advisors often visit project programs briefly while students are on site.

Some project programs, such as the one in Ireland, are conducted in conjunction with universities with which WPI maintains exchange programs. Students may also do traditional year- or semester-long exchanges with these universities, taking courses in English or in the language of the host country. Some students complete a project during their exchange.

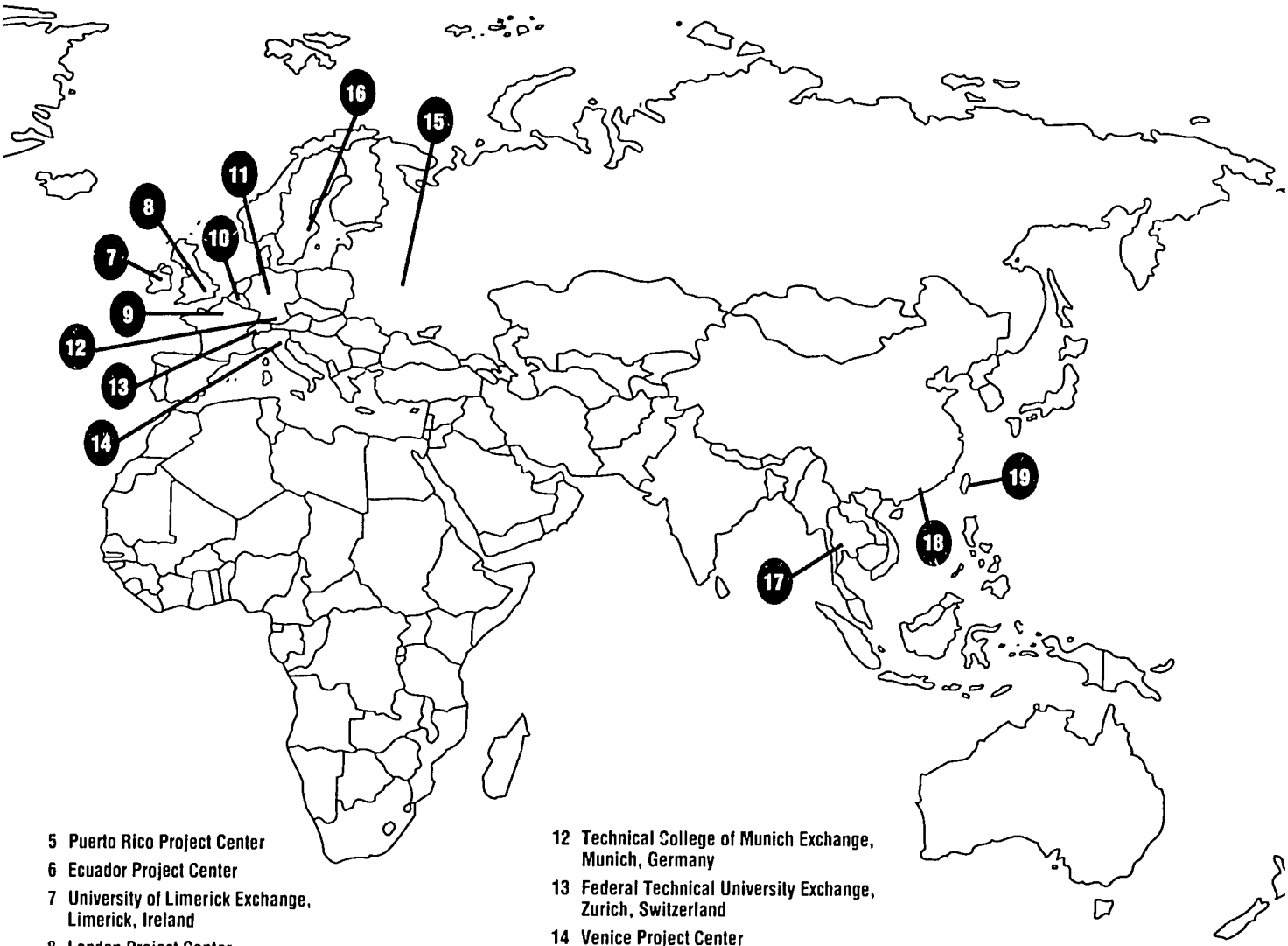


1 **Worcester Polytechnic Institute**
2 **Washington, D.C., Project Center**
3 **Ecole Polytechnique Exchange, Montreal, Canada**
4 **San Francisco Project Center**

Worcester Polytechnic Institute has been on the cutting edge of the globalization of technological education for two decades. Among experts familiar with WPI and with science and engineering education in the United States, the Institute is considered the national leader.

In 1992, Maurice Harari, a nationally known leader in international education, was asked to evaluate the Institute's global programs. Harari, dean emeritus at the Center for International Education, California State University at Long Beach, delivered his report in January. "I have no hesitation in asserting that WPI is way above the national average for its type of institution in terms of what it has already accomplished in the field of global education," he wrote.

"The flexibility and innovative character of its curriculum through the IQP, MQP, and Humanities Sufficiency, and the flexible WPI calendar arrangements, have contributed greatly to the achievements of WPI to date. Yet, its potential in global education is considerable and because of its rather unique institutional character and high quality, WPI is very well-positioned to aspire to a national and international leadership role in higher education. Its interest and experience in working at the intersection of



5 Puerto Rico Project Center
6 Ecuador Project Center
7 University of Limerick Exchange, Limerick, Ireland
8 London Project Center
9 Ecole des Mines and The University Marne-La-Vallee Exchange, Paris, France
10 Catholic University Exchange, Leuven, Belgium
11 Technical University of Darmstadt Exchange, Darmstadt, Germany
12 Technical College of Munich Exchange, Munich, Germany
13 Federal Technical University Exchange, Zurich, Switzerland
14 Venice Project Center
15 Moscow Institute of Engineering Physics Exchange, Moscow, Russia
16 Royal Institute of Technology Exchange, Stockholm, Sweden
17 Bangkok Project Center
18 Hong Kong Project Center
19 Taipei Project Program

technology, the sciences and social issues, represent a sound and invaluable base for yet another quantum leap forward in quality, service, innovation and international reputation."

WPI's leadership can be measured in several ways. For example, a recent Institute of International Education survey of study-abroad programs at colleges and universities, found that about 71,000 students enrolled in accredited U.S. institutions studied overseas in 1989-90. Of that number, only 1.3 percent were engineering majors. During that same period, 111 WPI students completed project work abroad. Among those 111 students were 86 engineering majors. They represented nearly 10 percent of all U.S. engineering students who studied overseas that year.

Currently, about a third of all WPI undergraduates participate in an off-campus academic experience by the time they graduate. The Institute's strategic plan calls for increasing that to half of all undergraduates by 1995. "I don't think that's an unrealistic goal," says Susan Vernon-Gerstenfeld, adjunct associate professor of interdisciplinary studies. "So far, the quality of the students who participate has been quite high. This is a selective program, but we're not just taking the superstars. We're also taking the steady, hard workers who show real promise.

"This is not a junior year abroad program of the kind that are common at liberal arts colleges. It is also not an internship. These students are not pouring coffee and running errands. They're working on applied research that is substantive and important to the sponsoring organizations. And, those organizations *use* the results of the students' work; I think that's a critical thing to understand."

The Institute laid the groundwork for national leadership in global education when it created the WPI Plan in the early 1970s. Two elements of the Plan have been key to the evolution of the Institute's global program. The first is the Interactive Qualifying Project (IQP). One of

Hossein Hakim, left, and Lance Schachterle have played pivotal roles in launching and sustaining WPI's Global Perspective Program. Schachterle helped establish the Institute's first overseas academic endeavors. Hakim helped start the Center for International Studies and is now WPI's Global Program Officer.

three projects required of all undergraduates, the IQP requires students to look at th intersection of science, technology and soc ety. The second critical element is an academic calendar based on seven-week terms

Lance Schachterle, associate dean of un dergraduate studies and chairman of the Interdisciplinary Studies Division, says WPI's globalization efforts occurred as a natural, though unanticipated, outgrowth of the Plan. "When the Plan shifted the focu of learning at WPI from a traditional pure course work approach to a project-based model, the integration of learning into real-world experiences became the basis for earning an undergraduate degree," he says.

"It occurred first to the faculty and then to the students that the IQP offered us an opportunity unavailable at all other universities. Students have to complete this degree requirement in any case; why couldn't they carry it out beyond the bounds of the campus? In fact, there seemed no reason why this requirement couldn't be met anywhere in the world. It made a lot of sense for students who were looking for an opportunity to gain international experienc within their four years to do so through a project abroad, rather than through an extr summer or semester."

Making that idea even more attractive was WPI's seven-week term system. In seve weeks, a student can do significant project work off campus without losing ground in meeting the rigorous and extensive course requirements typical of colleges of engineer ing and science. The semester system common at other engineering and science institutions can pose more of a barrier, Schachterle says.

Schachterle, who joined WPI in 1970 to teach modern British literature, played a pivotal role in launching the Institute's globalization program more than two decades ago. Though he had done his doctoral dissertation on Charles Dickens, Schachterle had never been to England. When he made plans to travel there in the summer of 1971, WPI, which had made contact with a university in London, asked him to help pursue an exchange program with that institution.

"That led directly to the first WPI students carrying out any kind of academic work overseas," he says. In addition to the London exchange, an exchange program was also established in Zurich during the 1973-74 academic year. The first overseas IQPs were completed through these programs. The Institute's first resident project center was founded in Washington, D.C., in 1974; a project program was launched in San Francisco a few years later.

Studying Culture and Computers in Switzerland

Paul Szymkiewicz, left, and Steven Vassallo pose before the backdrop of the Swiss Alps. The students completed an IQP that looked at how Switzerland's unique culture affects the way people react to new computer technology.

"Change is inevitable in a progressive society. Change is constant." Benjamin Disraeli was referring to the society of 1860s Britain when he wrote those words, but most leaders in our technological society would agree they seem more true today.

Paul M. Szymkiewicz '93 and Steven P. Vassallo '93 spent their junior year as exchange students in Switzerland, where they took courses and completed an Interactive Qualifying Project titled "The Cultural Implications of Computerization in Swiss Banking." The students' project explored the reciprocal relationship between culture and the implementation of new technology.

Through personal interviews and a survey (both completed in German), as well as personal observations, the students analyzed the impact of culture and technology on the organizational and work processes within Swiss banks. Robert E. Kinicki, associate professor and head of the Computer Science Department, and Lyle E. Wimmergren, associate professor of management, were the project advisors.

While in Switzerland, Szymkiewicz studied computer science at the Engineering School HTL in Brugge-Windisch; Vassallo studied mechanical engineering at the Swiss Federal Institute of Technology in Zurich.

Vassallo prepared for the exchange by completing a six-course Humanities Sufficiency (the equivalent of a humanities minor) in German at WPI. He then continued his studies in Germany for two months before traveling to Zurich in August 1991. Szymkiewicz emigrated with his family from Warsaw to West Germany in 1986 and completed high school there. The family moved to Worcester in 1989.

The idea for the IQP came from Kinicki, who spent a year as a visiting professor at the Business School in St. Gallen, Switzerland. He observed that the Swiss were still in the process of scrambling to implement information technology in their everyday lives, and that the difficulties seemed rooted in Swiss culture.

"We recognized that introducing new technology into an organization can affect the values, norms and assumptions of the members," says Vassallo. "We were aware that because Switzerland has been geographically, economically and, perhaps, emotionally isolated, the country has traditions and a culture all its own."

"We knew that Swiss banks were some of the most technologically advanced in the world," adds Szymkiewicz. "But we hypothesized that, because of workers' cultural resistance to change and the inherent differences between banking and computer subcultures, the Swiss might have been reluctant to accept the new computer technology. We called this phenomenon 'cultural inertia.'"

The students created a survey geared to the average Swiss citizen; additional questions were added for those who interact with computers and banking as professionals. They found that younger respondents were most likely to recognize the need for technological change. Nonetheless, regardless of the bankers' ages, efficiency triumphed over tradition and technology was accepted.

But just as important as the project's ultimate outcome, was the profound impact it had on its two designers, Vassallo says. "As exchange students in Zurich, we had an incredible opportunity to gently open a very closed culture and have a look inside. Most impressive, however, was not what we saw, but rather how we now see."

"As Americans, as engineers, as students—most generally speaking, as humans—we see the world in a certain way," adds Szymkiewicz. "We evaluate the world without ever evaluating the lens through which we are looking. It is only when we leave behind our old perceptions and try looking through a different lens that we really make a shift in the way we see the world."

—Bonnie Gelbwasser

Ireland became a regular destination for student project teams in 1983 and the first overseas project center, in London, was inaugurated in 1987. More recently, project programs have been established in Venice and Bangkok (1988), Hong Kong (1989), Taipei (1990), Puerto Rico (1991) and Ecuador (1992). Today about 200 students each year work at project centers and programs in 18 locations in Europe, Asia, North America and Latin America (see map, pages 6 and 7).

The international projects program fed on its own success, and succeeding years saw a growing demand among students for overseas project opportunities. At the same time, there was a groundswell of interest in cross-cultural issues among the faculty and administration. In 1988, that interest culminated in the creation of the Center for International Studies on campus. The center sought to expand opportunities for international studies at WPI by arranging study groups and lectures, organizing tours abroad, and encouraging faculty to develop and advise on-campus projects with an international orientation. Hossein Hakim, associate professor of electrical engineering, led the efforts to establish that center.

"Historically, international education has meant study abroad," he says. "We now realize that, at least for the U.S., study abroad is not just a route to understanding people in other countries. It is also a way of understanding and learning to cooperate with other Americans who have come from other parts of the world—people like myself."

An Iranian native who is now a naturalized U.S. citizen, Hakim had long believed in the benefits of globalizing education. He says he saw the center as one more way to encourage a world perspective at WPI. But he says he and others at WPI didn't feel it was enough. They believed that international issues and cross-cultural perspectives needed to be interwoven into on-campus courses and activities, as well.

By 1990 it was clear that WPI had the interest and the capacity to take the next step on the road to global education by making a concerted effort to make global issues an integral part of all aspects of a WPI education. Hakim, Schachterle and several other faculty members and administrators persuaded the Institute to establish the Global Perspective Program. The program was launched in 1991 with Hakim assuming the additional responsibilities of Global Program Officer.

"The goal of the program is to extend WPI's commitment to global education far beyond the international exchange and project programs," Hakim says. "It calls for globalizing all aspects of WPI programs—on campus and off—by incorporating global perspectives throughout every discipline on campus, as well as within nonacademic activities."

By 1991, when the Global Perspective Program was started, WPI had a small cadre of faculty members and administrators who were dedicated to the globalization of engineering and science education. To help spread the word and build enthusiasm among the rest of the WPI community, Hakim organized an off-campus workshop on internationalizing science and engineering education in October 1992. Forty-five faculty members, administrators, trustees and friends attended the weekend seminar in Waterville Valley, N.H.

An additional seminar was held on campus in February 1993. Both meetings examined the changing nature of national economies, the history and present state of "internationalization" in higher education, and most important, the history and future

Professor John Zeugner, left, and Phanjar Ngamtrakulpanit '93 of Thailand look over a map of Southeast Asia. Zeugner, who directs WPI's project programs in Asia, helped get the first Asian program started in Bangkok, Thailand, in 1988.

Breaking Down Barriers in Russia

In August 1992, Ronald Passerini '94, a computer science major, turned a nearly lifelong affection for all things Russian into a four-month exchange in the former Soviet Union. He was the first WPI student to fulfill some of his degree requirements in Russia; he was also the first foreigner to study at the Moscow Engineering Physics Institute (MIFI), a prestigious, 3,500-student university. Until recently, the institution was closed to outsiders because its curriculum focused on fields of special interest to the government, including atomic power and space research.

"My interest in Russian history, language and literature started when I was about 6 and became close friends with a boy whose family had emigrated from Russia," Passerini says. "I became close to his family, who invited me to share many of their traditions and celebrations." Passerini studied Russian for four years at Austin Preparatory School in Reading, Mass., and another three years at Holy Cross College after enrolling at WPI.

Valentin Boriakoff, associate professor of electrical and computer engineering, was Passerini's faculty advisor. Boriakoff, who was born and educated in Argentina but maintains close ties to Russia, his parents' homeland, traveled to Moscow during the summers of 1991 and 1992 to set up the exchange.

"Interest in computer science in Russia is very high," Passerini says. "Unfortunately, there aren't that many computers available. About 10 years ago Russia stopped producing computers and now it is difficult to buy them from the West because of the exchange rate."

In his IQP, titled "From the Abacus Bead to the Photon: A History of Computer Technology in Russia," Passerini investigated the causes of the decline in the use of computers. "He determined that a wrong government decision derailed a creditable native computer industry," Boriakoff says. "MIFI faculty were interested in his project because they are studying the same problem. Ron researched aspects of Russian computing history completely unknown in the West.

"Because Ron has made such a fine impression on the people he worked with, we expect to offer more WPI students opportunities to study and complete IQPs and MQPs in Russia in the future. Ten students have already expressed interest in these projects."

In addition to his IQP work, Passerini took two courses in Russian. "When I first got to Moscow I thought, 'I'm 5,000 miles from home, I don't know anyone, and I'm not fluent enough in the language to get thro this.' But everything worked out fine."

An unexpected opportunity presented itself to Passerini during his Russian visit. "One day I was feeling homesick and craving American food, so I walked downtown to the Pizza Hut on Tverskaya Street," he says. "I was wearing a WPI sweatshirt and when I took off my jacket, a guy sitting across from me jumped up and said, 'I don't believe it. I graduated from WPI in 1963!'"

It was Harold Taylor, manager of international programs for United Technologies Corp., who travels frequently between Moscow and company headquarters in Windsor Locks, Conn. "We became friends and he invited me to send him my resume before I graduate," Passerini says. "I'd love to work there for a few years, but not forever. America will always be home."

—Bonnie Gelbwasser

MICHAEL DORSEY

Back from a four-month exchange in Russia, Ronald Passerini, right, reviews his experiences with his faculty advisor, Professor Valentin Boriakoff.

of WPI's own Global Perspective Program.

The program has also gained momentum through a two-year, $123,000 grant from the U.S. Department of Education. Hakim is using the grant in a variety of ways to further the infusion of globalization at WPI. Some of the money is helping faculty members revise course content and further their development and interest in globalization.

One of those faculty members is Karen Ruhleder, assistant professor of management, whose research focuses on management information systems, social and organizational aspects of computing, and computer-supported cooperative and collaborative work. Ruhleder is developing a teaching case study based on the formal unification of the East and West German governments.

Although Berlin is once again the seat of government for the unified Germany, some critical work is still done in Bonn. The two cities will be connected with modern information and communication technologies, Ruhleder says. She will investigate a government-sponsored project called POLIKOM, "a multiphase, multiparty effort to design and implement the technological and organizational changes required to support work across such physical distance," she says.

Probing Environmental Issues in Ecuador

In December 1992, John P. Coyle '94, Daniel R. Dibiase '95 and James A. Watson '94 comprised one of two project teams that inaugurated WPI's new project center in Guayaquil, Ecuador. The students completed an Interactive Qualifying Project that has already had an impact on the future of the center and WPI's work with ESPOL, a technological university in Guayaquil.

The students first prioritized Ecuador's major environmental issues and developed a plan for future projects by WPI students. They next analyzed the environmental and socioeconomic impacts of the new Esmeraldas-Santo Domingo Poliduct, a 160-kilometer pipeline that transports oil and gas to Ecuador's coastal region. They determined that the country's poliducts have had negative consequences, including land scarring, erosion, and damage to vegetation and wildlife caused by leaks or ruptures in the pipeline.

"The good news," they note, "is that because of heightened social concerns about the poliducts in recent years, the Ecuadoran government has felt pressure to enforce environmental protection laws. While the laws can sometimes be contradictory, they can ultimately be used effectively to reduce the impact of the pipeline."

An Ecuadoran student (center, without shirt) poses with, clockwise from left, John Coyle '94, Joshua Dobbelaar '94 and Daniel Dibiase '95. In late 1992, Coyle, Dobbelaar and Dibiase were part of the first group of WPI students to complete projects at the new Ecuador Project Center.

James E. Rollings, associate professor of chemical engineering, served as the first director of the Ecuador center. He is also director of the Latin American Project Programs at WPI and a W.K. Kellogg National Leadership Fellow. Along with Guillermo Salazar, associate professor of civil engineering, and Daniel Tapia Falconi, co-project director at ESPOL, Rollings served as advisor for this initial project.

"It was important for the students to see the relationship between technology and society," Rollings says. "By looking at one example—the new poliduct—they could see the interrelationships that develop with other sectors of society. The insights they gained enabled them to identify six areas of environmental concern specifically related to the poliduct: the impact of the oil industry on the Amazon River, reforestation, low-technology projects, the pollution of the Guayas River, the impact of the mining industry, and ecotourism. These will be considered as potential topics for future IQPs."

Francis C. Lutz, dean of undergraduate studies at WPI, Carlos Becerra, ESPOL's vice rector, Frederick L. Hart, associate professor of civil engineering at WPI, and Salazar have applied for funding to promote the exchange of faculty between the two institutions and to initiate the development of joint research by establishing a database system to be used in identifying and addressing

"The participants see POLIKOM as a testbed for other members of the European Community and for international corporations."

Ruhleder says she believes a case study based on POLIKOM can be used in courses in management information systems, telecommunications, international business and public policy. "To consider non-U.S. scenarios, students must relinquish their ideas and expectations about how things work and refine their own understanding of the cultural factors that contribute to organizational decision-making and the mobilization of support for potentially controversial projects," she says.

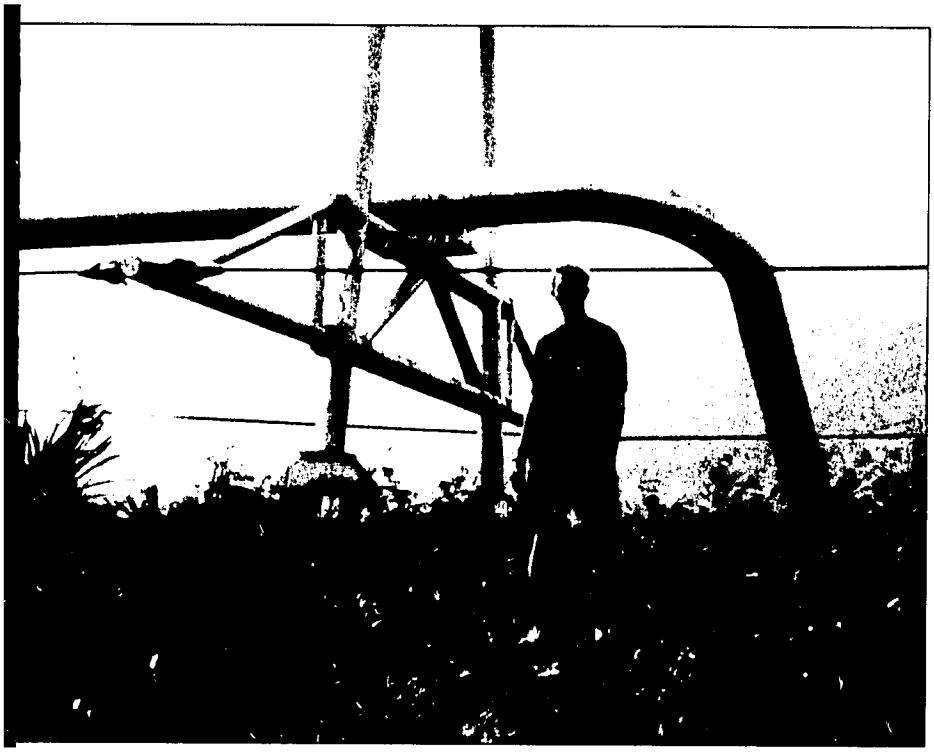
"She's going to learn something that will help in her research," Hakim says, "but her experiences will also help her revise her courses on management information systems. She'll bring something back to the college that will help students." Hakim says he is using the Education Department grant in a similar manner to help other faculty members infuse global issues into many other areas of the WPI curriculum.

Hakim is also using the grant to provide seed funding for international student programming, cultural festivals and similar activities. The grant also brought SCOLA (Satellite Communications for Learning) to campus. SCOLA delivers TV news from more than 30 countries in 20 languages to television sets across campus, providing a non-U.S. view of world events and allowing students to hear other languages spoken by native speakers.

And, the grant is being used to support the WPI-Worcester Public Schools Alliance for Global Education. Through the alliance, WPI faculty are working with public school teachers to develop a global education program for grades K through 8.

Hakim recently completed a cost analysis of the Global Perspective Program. "The results were quite interesting," he says. "One might think that maintaining programs at 18 sites around the world would require a huge investment. But the analysis indicated that the academic work done off campus would actually cost more if it were done on campus."

Hakim says there are several reasons for this. One is the support the program receives from alumni and friends around the



James Watson '94 stands beneath a section of the 160-kilometer Esmeraldas-Santo Domingo Poliduct, an oil and gas pipeline in Ecuador. Watson, Coyle and Dibiase looked at the potential environmental impacts of the poliduct.

environmental issues for the Guayaquil region.

The proposed research includes a provision for an ESPOL faculty member to spend two years at WPI studying for a master's degree; the plan of study would include courses in environmental engineering, construction management and computer information systems. "The faculty member would also work with a WPI research assistant on the database project, lecture and assist with our ongoing projects at the Ecuador Project Center," Salazar says.

"The database we propose will help us address issues that relate to the pollution of the Guayas River," he says. "The students' work complements what we are proposing. They did a first-class job of organizing and classifying areas for major future research and have given us a strong foundation upon which to build this and future proposals."

—Bonnie Gelbwasser

world, all of whom volunteer their services. Another is that, for the most part students pay their own transportation and housing costs when they travel overseas. (WPI subsidizes housing costs in Washington, D.C., where living expenses are quite high, and some students receive additional financial aid when they are abroad to partially offset their expenses.)

Some economies result from the fact that the average size of an overseas project team is three students, versus two students for a typical IQP team on campus. In addition, resident faculty advisors at project centers work with an average of 15 students at a time, a project advising load that would be difficult to handle back on campus. And, since one-third of students who go abroad to do projects do so during the summer, when they must pay additional summer-session tuition, the program actually brings in extra revenue for the college.

"Although the financial analysis of the program looks quite positive," Hakim says, "we should not limit our analysis to cost comparisons. There's no way to put a dollar value on what the experience does for WPI's graduates. In letters and conversations, alumni have told me and other faculty members how their experiences abroad have given them a competitive edge in their jobs. We plan to do a survey of alumni this summer to better understand this impact.

"It's also difficult to quantify the value of diversity. If you want a more diverse campus, you have to have people who think differently. I think the Global Perspective Program helps create a more tolerant environment on campus. And, it's also difficult to measure the important role the program plays in attracting—and retaining—students, something not to be overlooked in the fiercely competitive environment for higher education today.

"Many of our competitors look at their global programs as a way to make themselves more attractive to students. There is a growing interest among students in such programs, and these schools are increasing their investments in them. We must be careful not to lose our lead."

As he looks to the future of the Global Perspective Program, Schachterle says he is pleased that several faculty members are expanding the global projects program beyond the IQP by developing programs through which students will complete their Major Qualifying Projects—the capstone project in a student's major field of study—in England, Germany and several other countries. Opportunities are also growing for completing cooperative education abroad, he says, and the globalization program may well play a significant role in the development of the Institute's graduate programs and research collaborations.

Earlier this year, the faculty voted to modify the humanities requirements to enable students to cap their humanities course work with a full term of project work abroad. "This is a wonderful chance for WPI students to study theater in London, for example, or the arts in Venice," he says.

"Through initiatives like these, WPI is poised to achieve the role of national leader in global education within the community of engineering and science institutions. Companies that need technically able professionals who can live and work effectively in cultures new to them increasingly will look to WPI graduates to fill that need, because our students, among all graduates of engineering and science colleges and universities, will be uniquely qualified to help their employers compete successfully in the global village."

Faculty members who have advised IQPs abroad or helped launch overseas project programs and centers recount similar tales about what can sometimes be a difficult process. All say one must first educate potential sponsors about the WPI project orientation and its seven-week terms and then convince them that WPI undergraduates can indeed function as professional consultants.

Veterans of the process, like Schachterle,

From left, Mary A. Burke '93 and Matthew R. Boutell '93 discuss their Interactive Qualifying Project with Susan Vernon-Gerstenfeld, director of the Puerto Rico and Washington, D.C., project centers. Working for the Concillio de Diseno y Technologia in Puerto Rico, Burke and Boutell developed strategies to help Puerto Rican apparel manufacturers market their products in the U.S.

Vernon-Gerstenfeld and history professor John Zeugner say foreign-born alumni have often lent their reputations and support to help WPI gain a toehold in their home countries. Once the college, with the help of these graduates, has laid the groundwork with an inaugural student project, other prospective project sponsors are often significantly more receptive to the idea of working with WPI's undergraduates.

Zeugner is director of the International Scholars Program and the Asian Projects Program. The International Scholar designation is a special notation on a graduate's diploma and academic record indicating he or she has completed a Humanities Sufficiency involving a foreign language or culture, and either completed an IQP or MQP at a foreign project site or spent at least a half year as an exchange student at a foreign university. Twenty-four graduates have earned the designation since the program was started in 1989; 19 candidates are enrolled in the Class of 1994.

Zeugner taught in Japan for four years, first as a Fulbright Senior Lecturer between 1976 and 1978, then as a visiting professor of American culture in Tokyo between 1981 and 1983. Next year he will return to Japan as the Bryan Drake Guest Professor at Kobe University. He has also lectured in Manilla, Bangkok and Taipei for the United States Information Agency. At WPI, it's his job to make sure the college has projects in Asia, and that students have housing, on-site advisors, WPI advisors, and any other assistance and guidance they need.

His story about launching the first project in Thailand illustrates the role cultural differences can play in the process. "WPI has a lot of good contacts in Asia," he says, attributing many of them to Yi Hua Ma, professor of chemical engineering, Roy A. Seaberg Jr., director of special admissions, and WPI's active network of alumni in Thailand. "Making initial contacts was relatively easy. But Thais prefer face-to-face contact for conducting new business, and that meant the usual WPI preparation process had to be altered as the first Thai project was getting underway.

"Normally, the preparatory work includes doing background stuff on the country and its culture, completing a preliminary bibliographic assessment for the project, and writing a full project proposal that is sent to the sponsor. The sponsor reacts to the proposal and gives you feedback before you arrive, so everybody agrees what they're doing."

To ensure a successful start in Thailand, Zeugner traveled there with the first team of students to get them set up, to make sure the sponsor and the team had the same understanding of the project's goals, and to be sure the sponsor was comfortable working with undergraduates.

"The biggest hurdle we have in Asia is similar to the hurdle we face in London," he says. "There is a profound cultural assumption that undergraduates are children and not suitable for any kind of serious intellectual endeavor or rigorous academic inquiry. In London and in Bangkok, the assumption is that they're just not mature, that they can not do serious, competent work. These are societies that value age.

"It's important for our undergraduates to learn things and be taken care of, but when we go to Bangkok and say, 'our students can perform work and do analysis for you that you will find helpful,' it's like me saying to an American, 'I've got these fourth graders who will help you.'"

To overcome this cultural bias, WPI has allied itself with universities where the faculty believe undergraduates—especially WPI students—can do useful work. Another strategy WPI employs in countries where the cultural imperative works against taking undergraduates seriously, is to do the first projects with nonprofit organizations, as they are usually quite receptive to the idea of free help.

"In Taipei, for example," Zeugner says, "I could get 100 projects in the area of technology to assist disabled children. In fact, we've had a wonderful series of projects

Improving Commercial Fishing Safety in Washington

Being a commercial fisherman involves more than just casting a line or hauling in a net full of cod. Studies indicate that many boats are unsafe and crew members often unprepared to deal with the complexities of trawling for seafood.

One of the U.S. Coast Guard's main responsibilities is maritime safety. The passage of the Commercial Fishing Industry Vessel Safety Act of 1988 established a comprehensive set of safety regulations for the industry and gave the Coast Guard the authority to enforce them. The problem is that there is no effective, cost-efficient way to reach owners of vessels to inform them of the regulations, making enforcement a hit-or-miss proposition.

Trevor G. Hebert '94, Shannon M. Willems '94 and Stephen J. Lanczycki '94 worked at Coast Guard Headquarters during a seven-week stay at WPI's Washington, D.C., Project Center in 1992. While there, they created a database that will enable the Coast Guard to provide detailed demographic information on the owners of state-numbered commercial fishing vessels which represent 76 percent of the commercial fishing fleet.

The students also created *The Commercial Fishing Safety Communication Manual.* It includes detailed descriptions of how Coast Guard personnel can obtain a list of state-numbered commercial fishing vessel owner from the 30 coastal and Great Lakes states. It provides the name and address of the person or office in each state to whom inquiries should be sent, the name and address of each state's boating law administrator, the cost of obtaining the information, the number of state-numbered commercial fishing vessels operating in each state, and any special procedures required by individual states to obtain information.

"The project filled a void the Coast Guard wasn't able to address because of limited resources and time," says Tim Farley, a civilian fishing safety specialist for the Coast Guard's Fishing Vessel and Offshore Safety Branch. "They determined how best to disseminate information to the many diverse fishing communities nationwide."

Hebert, Lanczycki and Willems recommended that a coordinated effort by the Fishing and Offshore Safety Branch, the Auxiliary, Boating and Consumer Affairs Division of the Office of Navigation Safety and Waterway Services, and the Management Division in the Office of Marine Safety, Security and Environmental Protection be established. These divisions could collect the new data and combine it with information on documented vessels that is contained in an existing database known as the Marine Safety Information System.

They also recommended that the Coast Guard create and use the database to distribute safety information nationwide, preferably in the off-season, and to distribute information and advertise local regional safety programs. "A coordinated effort to distribute safety information could have a major impact on improving safety in the industry," they concluded in their report to the Coast Guard. "Direct mailing will probably be the most effective method of communication. With a complete and accurate database of all commercial fishing vessel owners, nearly all can be contacted."

"Our officers have discussed and evaluated the students' recommendations and will ultimately coordinate implementation with Coast Guard programs having expertise in data processing and communications," Farley says. "These programs will then assume responsibility for carrying out the steps necessary to achieve the desired results—better communication with all fishermen working in the United States."

—Bonnie Gelbwasser

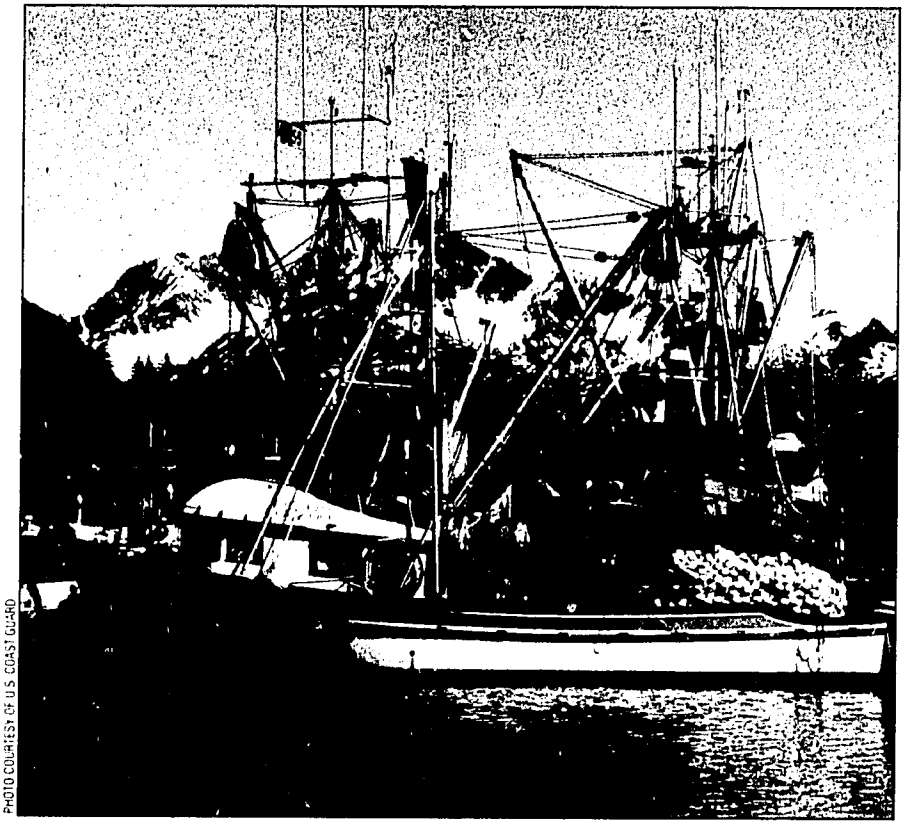


PHOTO COURTESY OF U.S. COAST GUARD

To help it fulfill its mission of protecting the safety of the nation's commercial fishing fleet, the U.S. Coast Guard sponsored a team of WPI students who compiled information that will help the agency reach fishing boat owners.

in that area, which is an important issue in Taiwanese culture." The project that won WPI's 1992 President's IQP Award was done in Thailand with a nonprofit agency (see story, this page).

After the Bangkok project program was established, Zeugner hired Prapaipit Chamsuksai as the on-site advisor for IQP projects in Thailand and also made contact with Supawan Tantayanon. Among more than 60 WPI alumni in Bangkok, both women received their doctorates at WPI and are professors at Chulalongkorn University. Chamsuksai won WPI's outstanding teaching assistant award in 1988, the year she received her doctorate in chemistry. "They have been absolute gems in terms of advising projects, getting projects and making the connection between WPI and Chulalongkorn," he says.

Zeugner says he believes the projects completed over the last few years have begun to change people's perspective about WPI students. "I think we're also getting more sophisticated in making contacts," he says. "We now have many more projects than we can staff in Bangkok. We recently turned down a major corporation because the students weren't interested in that project."

WPI's new emphasis on Latin America began in 1991 when the college received a $150,000 grant from the Xerox Foundation to establish a project center in San Juan, Puerto Rico. "Puerto Rico is interesting," says Vernon-Gerstenfeld, who directs the Puerto Rico and Washington project centers and the Ireland project program. "While it is part of the United States, it is also part of Latin America. The island acts as a bridge. We conceived of it as a place where our students would get good training in multicultural issues and gain intercultural experience by working in an environment that is Latin, and yet still quite familiar.

"Puerto Rico looks a bit like Miami and has the same stores you see in Worcester or Boston. But when you're working in an office, the environment is much more Latin. Also, people from elsewhere in Latin America come to Puerto Rico to live and work, so you learn about Cubans, Ecuadorans and so on. It's a tremendous place to learn about other cultures.

"One of our explicit goals in San Juan is to help correct misperceptions about Puerto Rico and Puerto Ricans. We want to help students understand that their stereotypes are just that and don't have

Reaching Out to Slum Dwellers in

Last year Jason D. Herrick '93, Michael R. Passe '93 and Gunther Schrappe '94 completed their Interactive Qualifying Project with the Duang Prateep Foundation (DPF), a nonprofit organization in Bangkok, Thailand. The students studied the chemical storage policies of the Port Authority of Thailand (PAT). The foundation was interested in this information because in March 1991 a chemical explosion leveled three warehouses at the PAT facility in Klong Toey, a heavily populated Bangkok slum. The explosion killed five people and injured countless others.

DPF, which is devoted to improving life for residents (especially children) of the Klong Toey community, asked the WPI students for help in educating slum dwellers about the chemicals involved in the explosion and in preventing future accidents. The team analyzed the effects of the explosion and did a series of chemical investigations to find out how the explosion might have occurred.

PAT, which stores chemicals adjacent to the slum, never released a full listing of the chemicals kept there. "PAT put out a list of 10 chemicals," notes John F. Zeugner, professor of history and the students' advisor. "The students, through their investigation, drove that list up to 53 chemicals. Using soil and water residues, they did their analysis with the help of Professor Prapaipit Chamsuksai at Chulalongkorn University. They also interviewed slum dwellers about the symptoms they experienced. The students noted that many unidentified chemicals had been stored at the warehouses."

Team members reviewed international storage procedures and studied chemical explosions. They designed and wrote a pamphlet for DPF to distribute to doctors, community leaders and residents and a poster for distribution within Klong Toey. They were interviewed by local television and they wrote a commentary for the op-ed page of *The National*, a major English-language newspaper in Bangkok.

Although PAT had not announced any

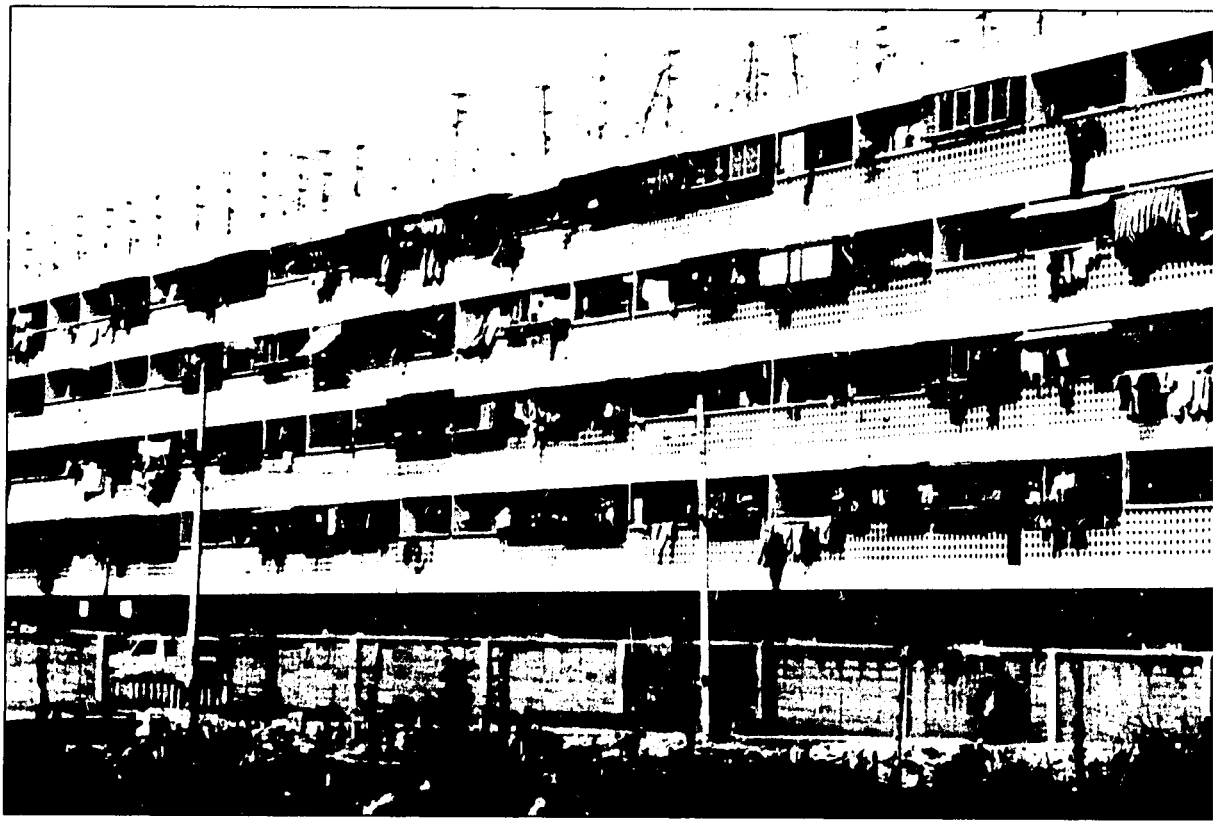
Bangkok

intention to modify its storage facilities or practices by the time the students left Thailand, the team's work prompted a public outcry over the policies of the Port Authority and a consensus that the government needed to do more for the victims of the explosion.

Prateep Ungsongtham Hata, the founder and president of the foundation, grew up in Klong Toey. Her work to improve life for residents of the slum has been recognized locally and internationally. In Thailand, when she was awarded the Magsaysay Award, the King commissioned 100 commemorative coins to honor her. She was so pleased with the WPI team's work that she gave each member one of those coins. The judges for the 1992 competition for WPI's President's IQP Award were also pleased. They awarded the honor to Herrick, Passe and Schrappe.

—Diane Benison

Gunther Schrappe '94 (far left, back row), Michael Passe '93 and Jason Herrick '93 (third and fourth from left, back row) pose with staff of the Duang Prateep Foundation in Bangkok. Foundation founder Prateep Ungsongtham Hata is in the front row, second from right. Working with the foundation, the students analyzed the aftermath of a chemical explosion in the Klong Toey slum and developed programs to educate residents about the effects of the chemicals. Below, the Flats, part of Klong Toey, sits next to the remains of a residential area destroyed in the explosion. The foundation is dedicated to improving life for slum residents, especially children, opposite.



a whole lot to do with reality. When our students come back, their views are very much altered. For many, the experience helps them understand that stereotypes don't hold true for individuals. That's part of our intercultural training that we hope to impart to students."

That process cuts both ways, she says, because for some Latin Americans, WPI students help dispel the stereotype of the gringo from North America: "brash, loud, unknowing about other cultures and thinking the only place worthwhile is the United States. Stereotypes like that come from tourists who've seen inconveniences—or what they perceive as inconveniences—as negative aspects of another culture."

Professor James Rollings directs WPI's project programs in Latin America. He's seen here with items from Ecuador, where he served as one of the first resident advisors of WPI's new Ecuador Project Center in Guayaquil.

Vernon-Gerstenfeld's background in clinical psychology makes her keenly aware of the emotional impact immersion in a foreign culture can have. She talks to students about it before they go, while they're away and after they get back. "We want to teach students to ask themselves, 'What are you feeling; what are you acting on?,'" she says. "Instead of their colonizing and becoming defensive, we hope they'll explore the issues and then, perhaps, give up the colonizing."

She recalls one student who went to Ecuador and spent most of his free time watching television in his hotel room. As he began to realize that his television habit was a way of dealing with his discomfort with the culture, he relied on it less and less. "As we prepare these kids to go abroad, we need to teach them about the variety of feelings they may have and suggest strategies for handling the ones that make them uncomfortable."

After students return from a project site, they meet with the next set of teams scheduled to travel there. The returning teams discuss their experiences and offer tips on everything from how to use public transportation to how to do laundry. "I think it works," Vernon-Gerstenfeld says. "The vast majority of our kids end up being tremendously intrigued by what happens to them."

James E. Rollings, associate professor of chemical engineering and director of the Latin American Project Program, is himself evidence of the transforming power of living and working in a culture other than one's own. Rollings, who has served as the resident faculty advisor at WPI's newest project center in Guayaquil, Ecuador, created in 1992 with a five-year, $500,000 grant from the U.S. Agency for International Development, joined the Peace Corps after getting his bachelor's degree in biochemistry. He taught chemistry and biology from 1972 to 1975 in Mombasa, Kenya.

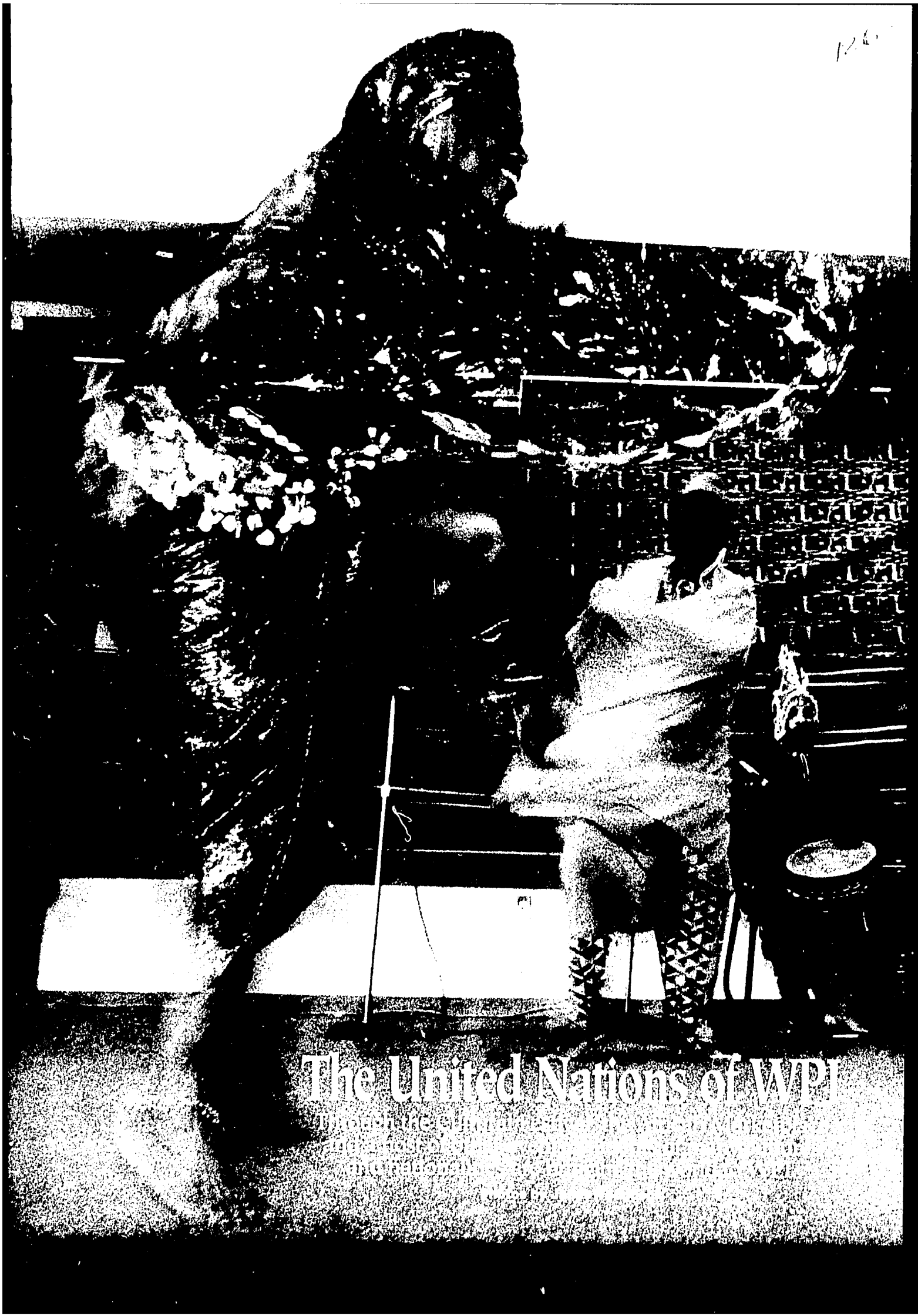
When he returned to the states he earned a second bachelor's degree in chemical engineering before going to graduate school and studying for a doctorate in biochemical engineering. He'd come back from Africa with the thought that he wanted to make an impact on some of the social problems he'd seen while he was in the Peace Corps. He says WPI's project-based curriculum and the Global Perspective Program have enormous appeal to him as ways to combine his views about the importance of expanding cultural horizons with his work as a teacher and scientist.

Rollings says he believes that despite the useful work achieved through IQPs, MQPs and Humanities Sufficiencies done abroad, the greatest benefit is the way the Global Perspective Program changes WPI students. "In reality," he says, "by going away you'll make a greater change in your own society than you will in the society you visit. By providing students with that external moment, we're giving them a view of the world they would never have had except by leaving home and seeing how another culture functions.

"The culture shock is greater when you return than when you leave, because some of your assumptions may have been exposed. The experience of having been in another culture makes it possible to more clearly see—and perhaps question—one's own cultural assumptions."

Zeugner says he is "absolutely convinced that the most educational thing anybody can do is to sit in an alien culture for an extended period of time—not as a tourist, but as someone trying to function the way people in that culture function. That experience calls into question all your assumptions about how the world works. All the unconscious assessments you make to get through the day suddenly become conscious. I'm absolutely, passionately convinced that nothing else we do will have as profound an impact on students.

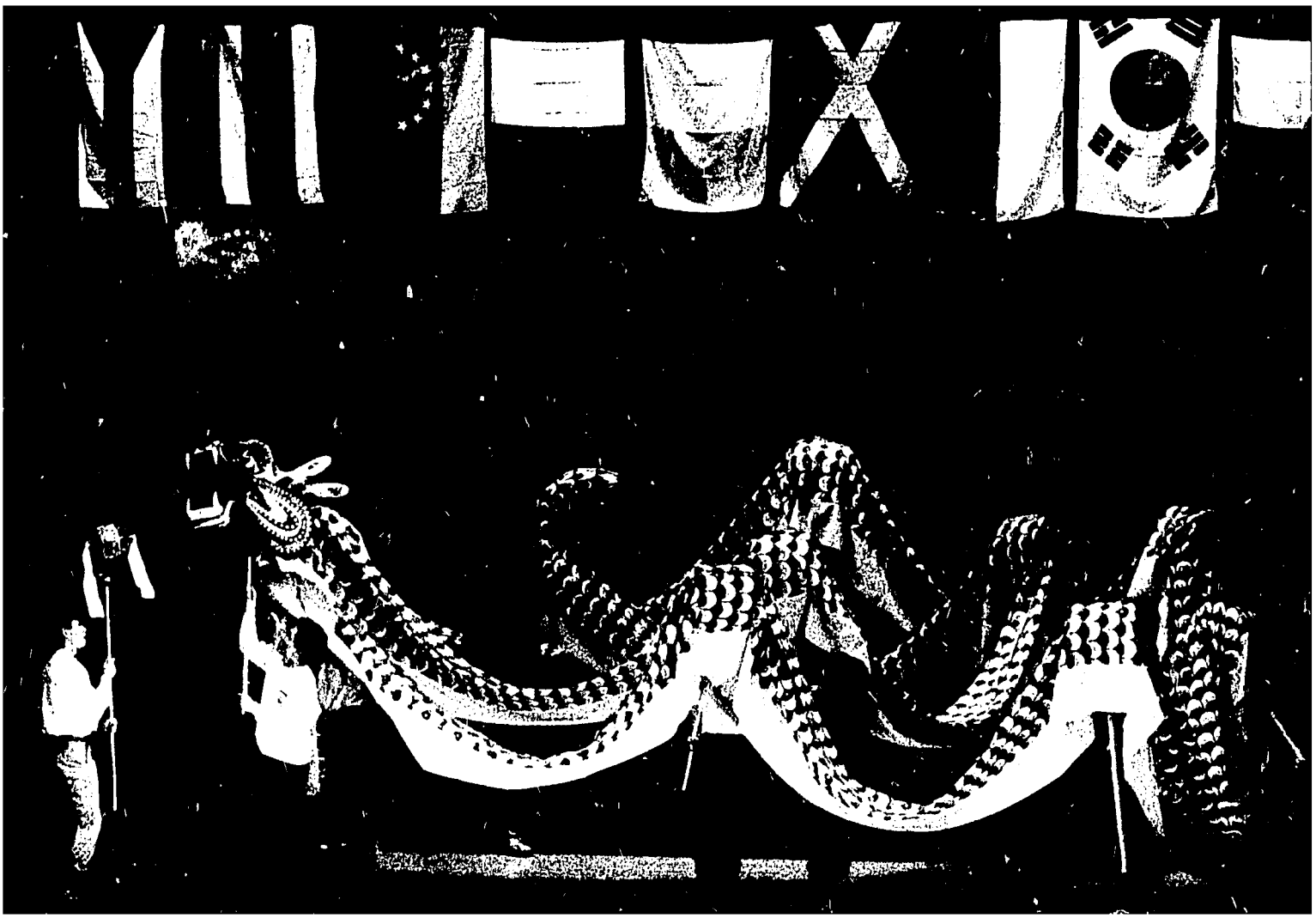
"Is that experience really worth it? From an educational point of view, absolutely. It will transform people and open them up. Studying the aftermath of a chemical explosion in a Bangkok slum is going to make someone a different kind of engineer. Somebody like that will understand that cultural assumptions have a terrific impact on the kinds of technological interactions that become the life circumstance of engineers. They're not going to think about them in the same way again."

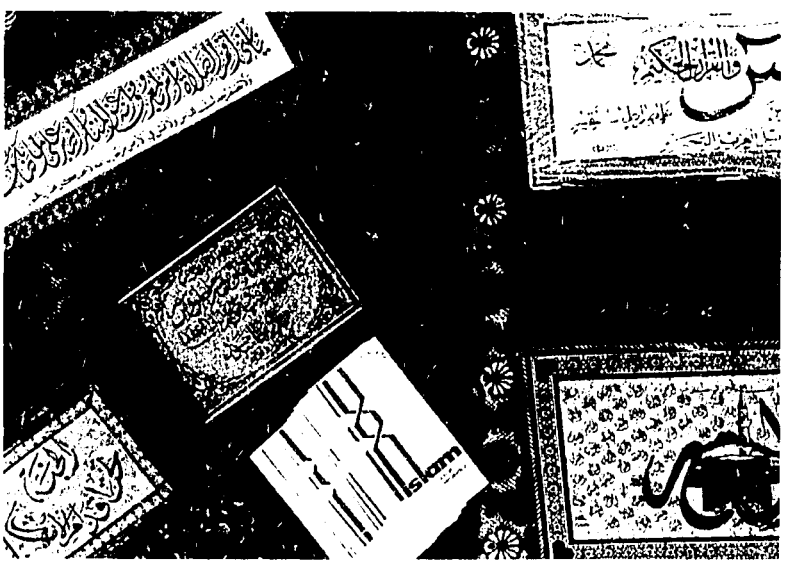

The United Nations of WP

THIS SPRING, THE LOWER WEDGE was filled with the sights and sounds of Africa, as the Institute enjoyed the first African Marketplace. The event, sponsored by the Black Student Union and the Black History Month Committee, brought a number of vendors to campus to display their wares and show off African artifacts, including crafts from Kenya supplied by a Worcester business, bottom, left.

The New York City dance and drum troupe "Message From Our Ancestors," opposite page and page 19, performed for an appreciative audience that included Lachelle R. Hatten '94, right. Yvonne V. Harrison, director of the Career Development Center, bottom, right, read a poem by Frances Ellen Watkins Harper, one of several readings during the day.

The Marketplace was just one of a host of events held on campus during the year by WPI's international students, who make up about 10 percent of the undergraduate student population and about half of the college's full-time graduate students, in concert with other students from a variety of backgrounds and cultures. The events





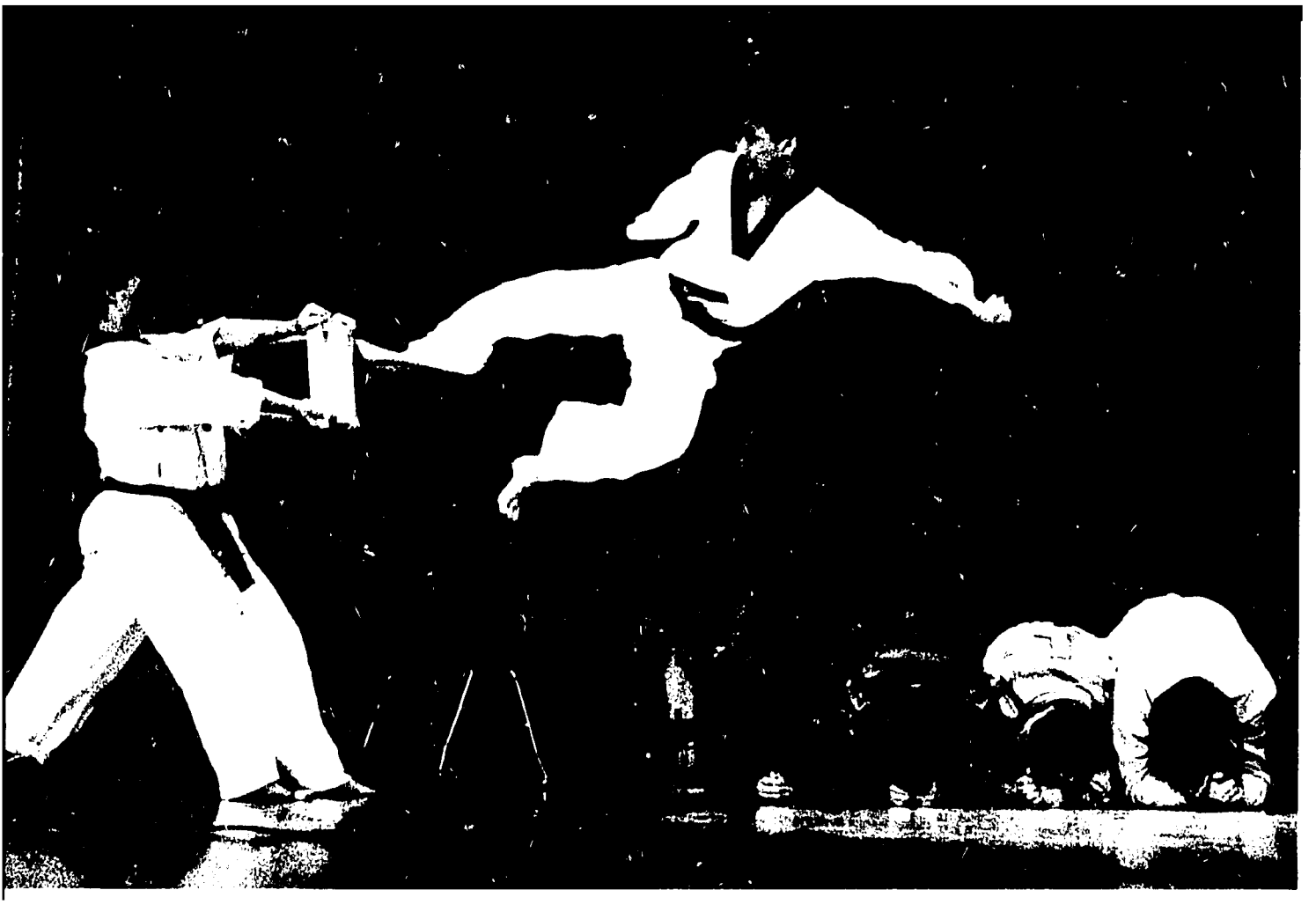
were designed to let the students share their traditions, crafts, cuisines and arts with the WPI and Greater Worcester communities.

A major annual event aimed at achieving that goal is the Cultural Festival, which observed its eighth anniversary this spring. Sponsored by WPI's International Student Council, the festival offers visitors the chance to sample arts, crafts and food from the cultures of WPI's international students. Performances and demonstrations, planned and mounted by the students themselves, run continuously on stage throughout the four-hour event.

At this year's festival, visitors were treated to Latin dances by a troupe that included Carlos A. Zapata '95, a native of Venezuela, and Leila J. Carvajal '96 from Ecuador, opposite. The dancers were members of the Hispanic Student Association. The Chinese Student Association purchased a 110-foot ceremonial dragon, top of page, which they paraded around Alden Memorial in a highlight of the festival. In China, the dragon dance is a traditional part of the New Year's festivities.

Students also shared dishes from their homelands, prepared by WPI's food service, and displayed crafts and artifacts from their cultures (see bottom photo, next page). These included an assortment of Islamic items provided by the Muslim Student Association, above. Richard H. Kim '95, in midair, next page, was part of a team that put on a demonstration of Tae Kwon Do, a form of Korean martial arts.

The annual festival is open to the entire Worcester community, and each year many students from Worcester-area schools stop by to enjoy the sights, sounds and tastes. A snowstorm kept most schoolchildren from enjoying the 1993 festival, but more than 1,500 students came in 1992. In 1991, the City Council declared the day of the Cultural Festival "International Student Day" in Worcester.



Outreach to the public schools has become an important mission of the Institute's international students. This year some 40 students visited Worcester public schools to talk about their cultures. Their efforts are part of a project called Globalizing the Curriculum, being undertaken by WPI and the Worcester School System. Funded in part by a U.S. Department of Education grant, the project seeks to help young students understand and appreciate other cultures.

Tom H. Thomsen, associate dean of student life and international student advisor, says he hopes WPI students can share many elements of their cultures with Worcester schoolchildren, as they did this year with the WPI community through a Chinese film series, an Asian Dinner that featured food from Indonesia, Korea, Thailand and Vietnam, and Hispanic Awareness Week, complete with a speaker, a band and movies.

Thomsen says these many activities are clear evidence that at WPI, globalization is a two-way street. He says that just as spending seven weeks in another country can broaden a student's horizons, interacting with students from other nations and backgrounds on campus can be a powerful and effective way to learn about other cultures.

"Living with an international roommate, for example," he says, "can be just as effective an introduction to another culture as traveling to an overseas project center. We want all students, including those who for whatever reason can't leave campus, to be able to say they have truly been exposed to people from other cultures before they graduate."

The Law of the Frontier

Once thought of as stodgy, patent law today is anything but. Patent attorneys are helping shape the leading edges of science and technology, trying cases where millions of dollars hang in the balance, and working to bring greater harmony to patent systems around the world. The best part? Opportunities abound for technically trained men and women.

BY MICHAEL W. DORSEY

It is, to be sure, a quiet revolution. But in law firms across the country, attorneys are noticing a striking trend. After decades of relative obscurity, the law of intellectual property —patents, copyrights, trademarks, trade secrets and unfair competition—is emerging as one of the hottest areas of legal practice. As a recent article in the *ABA Journal*, the magazine of the American Bar Association, put it, "Forget the trendy law practice areas of the 1980s, such as mergers and acquisitions, real estate and antitrust. Intellectual property is where the action will be in the 1990s."

If intellectual property is hot, patent law is truly incandescent. "A good demonstration of that is the fact that many of the major general law firms around the country are attempting to purchase or acquire smaller patent law firms," notes Paul N. Kokulis '45, senior partner at Cushman, Darby & Cushman, one of the largest intellectual property firms in Washington, D.C. "These firms all have real estate sections, banking sections, antitrust sections, environmental sections and so on. Now they want to have intellectual property sections, as well."

Kokulis, whose areas of expertise include biotechnology and biochemistry, says the explosive growth of new technology around the world is one factor in the renewed interest in patents and patent law. "In addition," he says, "of all the areas of legal practice, intellectual property is probably the most resistant to economic downturns. It's certainly not recession-proof, but in tough times, when corporations aren't doing as much research and development, they want to protect their existing business areas more vigorously. And that creates more activity in the patent field."

All this translates into growing opportunities for young lawyers in a field that has rarely—if ever—been oversaturated, notes Lawrence F. Scinto '51, partner with Fitzpatrick, Cella, Harper & Scinto in New York City, among the largest intellectual property firms in the nation. "This field is just beginning to realize its potential," he says. "With the growing demand by corporations for protection for their intellectual property and the rising awareness of the importance of intellectual property assets, people entering the profession today will find they are joining a truly growing field."

The American patent system, authorized by Article I of the U.S. Constitution, was the invention of Thomas Jefferson, who also served as the first commissioner of patents. As conceived by Jefferson and formally codified in the federal patent statutes (the first patent act was signed into law by George Washington in 1790), a patent is a legal monopoly granted to an inventor.

A patent gives an inventor the right to exclude others from using his or her invention for 17 years from the date the patent is granted. A patent holder can license the patented technology to others, who pay royalties for the privilege of using it. Patents can also be bought and sold like other personal property. Patent protection is designed to encourage the kind of innovation and technical progress that can benefit the nation as a whole.

Not every invention is patentable. The task of deciding what "process, machine, manufacture or composition of matter, or any new and useful improvements thereof," is worthy of patent protection falls to the more than 1,400 patent examiners who work in the modern facilities of the U.S. Patent and Trademark Office in Crystal City, Va. In making their decisions, they are guided by several key principles.

First and foremost, an invention must truly be new. Examiners will search through the millions of patents on file in Crystal City to make sure a patent has not already been granted for the invention. In addition, they'll want to be sure the device or process was not already in use or described in print before the inventor supposedly thought of it.

While it is possible to get a patent for an improvement on an existing device, process or composition of matter, if the examiner determines that the improvement would have been "obvious" to anyone skilled in the art to which the invention relates, the patent will be denied.

The invention must also be useful. In other words, the inventor must be able to demonstrate that what he or she has created has practical value. Finally, the examiners must decide if the inventor has adequately disclosed the details of the invention in a manner that will allow others skilled in the art of the field to reproduce it.

"The real reason for patents—the reason the government gives you this right to exclude—is that you are telling the world about your invention," says C. Marshall Dann '35, former U.S. commissioner of patents and trademarks who is now largely retired from the firm of Dann, Dorfman, Herrell and Skillman in Philadelphia. "Once your patent runs out, everyone else will be free to use it. So it's important that the invention be disclosed in a sound, technical manner."

While most of the early patents granted in the U.S. went to individual inventors, today a large share are owned by corporations. In fact, patents have become a cornerstone of our modern industrial society, since they help companies maintain a technical edge over their domestic and foreign competitors. Corporations are, of course, under no obligation to patent their inventions, and some decide instead to keep their technology trade secrets. But that route has its risks, Dann says.

"There aren't many things you can keep secret for long. You might be able to conceal some little process wrinkle. But if it's anything a competitor can tell from your product—or something he can discover independently—it's fair game. And employees move about a great deal today. Even if they don't intentionally steal your secrets, they can transmit a good deal of information to their new employers. And, of course, there's a certain amount of commercial espionage.

"If you have something good, you can keep it out of your competitor's hands by protecting it with a patent—assuming it's a good patent. Or you can make some money licensing it. The bottom line is that most companies simply can't afford to ignore patents."

"If you have something good, you can keep it out of your competitor's hands by protecting it with a patent.... The bottom line is that most companies simply can't afford to ignore patents."

Patent attorneys beginning their careers today will find a legal system far more friendly to their work than the system Dann, Kokulis, Scinto and most of the more than 40 WPI alumni who work as patent attorneys discovered when they entered the field.

In the 1930s, the tradition of protecting the rights of American inventors ran afoul of growing antitrust sentiment. "The Temporary National Economic Committee, a joint executive-legislative body established in 1938 to curb monopolies, made a lot of noise about corporate abuse of patents," Dann notes. "They started out to prove a preconceived notion and in the process painted the whole patent system pretty blackly."

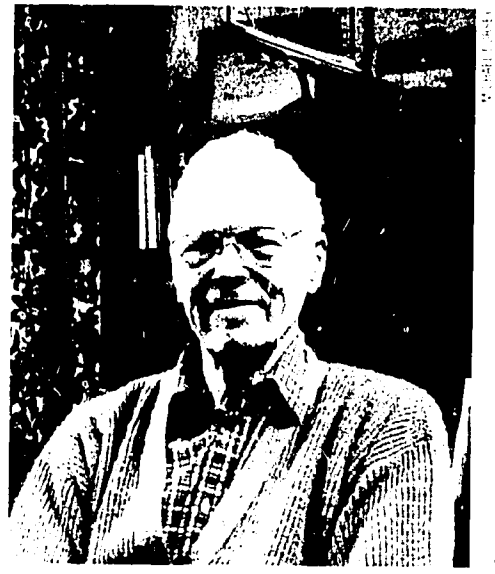
According to Paul M. Craig Jr. '45, consulting attorney at Dow, Lohnes & Albertson in Washington, D.C., at least some of the antitrust fever was justified. "In the 1920s and 1930s, some companies were pooling patents to fix prices or to keep outsiders out," he says. "That helped give the patent system a bad name."

The anti-patent sentiment that emerged in the courts in the 1930s and 1940s persisted for decades and came to play an important role in how attorneys approached patent-related court cases, says Scinto, whose specialty is patent litigation. Until recently, patent cases were tried in 10 federal circuit courts that had disparate records on patent litigation. "Some circuits didn't hold a patent valid for 10 to 15 years," Scinto says. "Others were more hospitable. It was a common

(Continued on Page 28)

PATENT PROFILES

C. Marshall Dann '35



After he graduated from WPI in 1935 with his degree in chemistry, C. Marshall Dann settled down at DuPont for what seemed like the start of a long career in chemistry. But in 1945, Dann was assigned to a patent liaison group in DuPont's Pigments Department. "I thought patent law seemed like a pretty good field," he says. "I decided if I was going to be in it, I'd rather be all the way in rather than halfway."

For four years, Dann worked in DuPont's Washington, D.C., office as a patent agent while attending Georgetown University at night. In 1949, with his bachelor of laws degree in hand, he returned to the company's Wilmington, Del., headquarters as a patent attorney. One of his first assignments was to help out with a major antitrust case the federal government had filed against DuPont and Imperial Chemical Industries of Great Britain. (That case would also figure prominently in the start of Paul Kokulis' career as a patent attorney; see page 30.)

When the antitrust case was over, Dann worked on patent cases involving new organic chemicals, including polyurethanes, which were just then being introduced. In 1954, he was promoted to assistant manager of DuPont's Patent Department. At that time, Dann says, DuPont was filing about 800 patent applications a year and receiving about 500 new patents.

"During those years, I was concerned with patent matters across the board, rather than specific cases," he says. "But there were a few lawsuits I was directly involved in." In one case, DuPont sued Phillips Petroleum Co., alleging the corporation had infringed its patent for linear polyethylene, a plastic used in containers, electrical insulation and packaging. After three years, the case was settled out of court, with Phillips receiving a license to make the compound in return for financial and other considerations.

Dann was named DuPont's chief patent counsel in 1968. Six years later, after nearly 30 years with the company, he received a job offer. "I got a call from a gentleman who said, 'I'm from the White House,'" Dann says. "I sat up a little straighter. He said, 'Have you ever thought about taking early retirement and becoming commissioner of patents?'"

At first reluctant to leave Wilmington, Dann finally accepted. "I had been sitting in the same corner office for quite a number of years and a change began to seem attractive," he says. One of the major challenges he faced during his three years in Washington was resolving a conflict between the Commerce Department, which includes the Patent and Trademark Office, and the Justice Department over a proposed patent reform bill.

The bill, which grew out of a set of far-reaching recommendations of a Johnson administration commission on patent reform, was amended to include a troublesome provision that would have made it easier for corporations to avoid antitrust action when they granted licenses on their patents. "That had the effect of getting the Justice Department involved," Dann says.

Justice prepared its own reform bill that would have greatly complicated the process of prosecuting patents. "It seemed to me, as it did to a lot of other people, that the bill as it stood would have discouraged many inventors who wanted to protect their property," Dann says.

One of the duties of the commissioner of patents is to revise or expand the formal rules governing the operation of the Patent Office, as needed. Dann put in place new rules that incorporated the better parts of the Justice Department bill, but which were less burdensome to potential patentees. "Justice backed off and lost interest after that," Dann says. "The rules had the desired effect of stopping all the activity aimed at radically remaking the patent laws."

In 1977, after the election of Jimmy Carter, Dann joined the intellectual property firm of Dann, Dorfman, Herrell and Skillman in Philadelphia. Over the next 10 years he served as an expert witness in numerous interference and infringement cases around the country, including 45 that made it to the courtroom. "I testified about patent procedure and about the meaning of the claims in a patent," he says. "Claims define the patentee's right to exclude others, and they must always be interpreted by the court."

While he testified on behalf of all manner of plaintiffs and defendants—from major corporations like Dow, American Can, Pfizer and 3M, to individual inventors—one case was especially rewarding, Dann says. "An Illinois farmer named Billy Watkins had invented a device used in tractor-pull contests. It slowly increased the weight on the tractor as it pulled forward, so the tractor would eventually stop. He sued the National Tractor Pull Association, which had ignored his patent. He eventually won an injunction."

(Continued from Page 26)
tactic in those days to bring an action in a circuit you believed would look more favorably on patents."

In the early 1980s, alarmed at the apparent lack of uniformity of the country's patent system, which resulted in this so-called "forum-shopping," the U.S. Congress decided the time had come for change. "One thing that pushed Congress to act was concern about the trade deficit and foreign competition," Dann says. "Fifty years ago, 90 percent of all U.S. patents were obtained by U.S. citizens. Now it's about 50 percent. If you destroy the incentives for U.S. inventors to file patent applications, you're giving the competition an edge."

In 1982, Congress created the Court of Appeals for the Federal Circuit. Formed by combining the Court of Customs and Patent Appeals and the Court of Claims, the new body became the sole jurisdiction for appealing patent cases from any federal district court around the country. The Federal Circuit Court removed much of the preexisting regional anti-patent bias and "put a lot of vitality back into the patent system," Craig says.

While the new court has raised the value of patents in all industries, it's had a particularly profound effect on makers of computers, notes high-technology specialist William L. Anthony Jr. '61, a partner with Brobeck, Phleger & Harrison in Palo Alto, Calif. "Before the creation of the Federal Circuit Court, patents were virtually unenforceable in California, the home of a substantial portion of America's high-technology industry," he says.

Before 1982, Anthony notes, high-technology companies were more likely to license their technology for meager fees than to attempt to enforce their patents. And companies came to rely on trade secrets, rather than patents, to protect their inventions. Even so, technology moved relatively freely from company to company as engineers changed jobs or started their own firms. In fact, he notes, the explosive growth of the high-technology industry in the 1970s is attributable, in part, to "the peculiar mores of Silicon Valley (commonly referred to as 'piracy' in other parts of the world)."

Today, most high-technology companies have beefed up their patent departments and their patents are garnering respectable royalties. Companies like Texas Instruments and Motorola, which bucked the trend in the 1970s and stockpiled patents on their inventions, are now reaping the rewards of those higher royalties. In fact, insiders say, these and some other major companies now earn more from their patents than from sales of their products.

William L. Anthony '61, a partner with Brobeck, Phleger & Harrison in Palo Alto, has made a specialty of high-technology patent litigation.

"Fifty years ago, 90 percent of all U.S. patents were obtained by U.S. citizens. Now it's about 50 percent. If you destroy the incentive for U.S. inventors to file patent applications, you're giving the competition an edge."

"People often think a patent gives them some property," Dann says. "But it really doesn't give them anything until a court says it's a good patent." The truth of that statement is illustrated by the marked increase in patent-related court cases that followed the creation of the Federal Circuit Court. In addition to increasing the value of patents—and the incentive to fight for them—the court raised the stakes in patent litigation.

When federal courts were as likely to rule a patent invalid as to sanction an infringer, corporations were less inhibited about helping themselves to patented technology. But the Federal Circuit Court is far more prone than earlier courts to come down hard on infringers, imposing damages and fees that make those levied by those earlier courts seem tame.

"At one time it was the norm for a damage recovery in a patent case to be limited to a reasonable royalty," Scinto

(Continued on Page 31)

Protecting Intellectua Property on Campus

With their mission to pursue and disseminate new knowledge, it's not surprising that colleges and universities have long been hotbeds of intellectual property. But it has only been in recent years that many research institutions have become aggressive about protecting the inventions and other creations of their faculty members and students and putting that property to use to generate revenue.

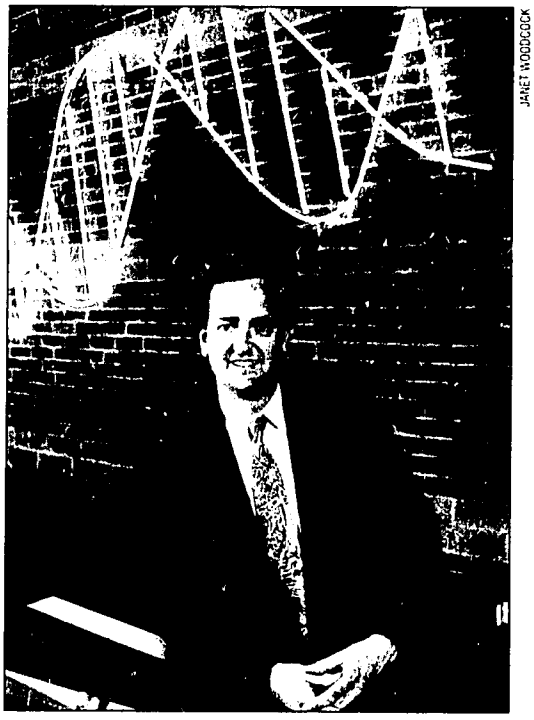
WPI developed its first intellectual property policy in the early 1970s. Among other things, the policy specifies when the Institute is entitled to the rights to patents, copyrights and trademarks for intellectual property created by its faculty and students and spells out how royalties generated by that property will be shared by the college and the inventors or authors.

During the last year, a committee of faculty members has been at work updating that policy. One of the key changes they plan to recommend will require the college to determine whether a faculty or student invention has commercial potential before deciding whether to pursue a patent for it.

"These days, with the competitive pressures of a global economy, it is often wise to apply for patents in several nations, not just in the U.S.," notes Kevin A. Clements, dean of graduate studies and research. "It costs a lot of money—perhaps $20,000 to $30,000—to go through that process. So we have to decide early on whether an invention is commercially viable and, therefore, worth patenting."

To help it make that decision, WPI recently joined with six other Worcester-area research institutions in creating the Unified Office of Technology Transfer at the Massachusetts Biotechnology Research Institute in Worcester. Heading that office is Skip Irving, whose jobs include helping the institutions identify commercially viable inventions, monitoring the process of patenting those inventions, brokering licensing agreements with companies and other partners, and providing assistance to faculty and students who may wish to license their own inventions from the Institute to start new companies.

Currently, WPI owns about a dozen patents and has applications pending on several more. Several other inventions are being evaluated, including at least a few that have been developed as part of undergraduate student projects. In fact, Irving says, one student project is now the subject of negotiations with a major medical products manufacturer and the prospects for licensing look good.



JANET WOODCOCK

Skip Irving of the Unified Office of Technology Transfer helps WPI decide what's worth patenting.

In addition to these, a few faculty members have patented their own inventions. At least one company has been founded based on faculty inventions and more are currently in the works.

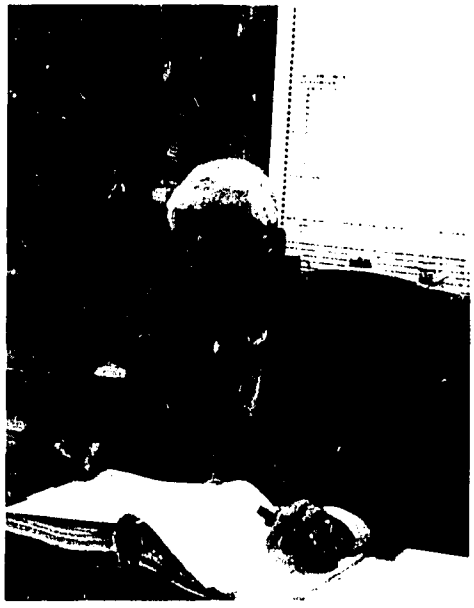
Irving says he hopes to see these numbers rise as more faculty and students become aware of the advantages of protecting their inventions. "There are some misconceptions we have to overcome," he says. "Some concern the conflict between patenting and publishing and how patenting fits into the mission and culture of an academic institution."

Irving says patenting and publishing should not be in conflict. With a little lead time, a U.S. patent can be applied for prior to publication, preserving the right to patent on a worldwide basis. "I want people to publish," he says. "That's my best advertising. That paper will be read by peers and by people at corporations. There's no conflict at all; in fact, the two should work in synergy."

Irving says that while the Institute will ultimately receive some income from its investment in intellectual property, the most important benefits will not be measured in dollars and cents. "For faculty members, patenting is an opportunity to get their research into the hands of people who can turn it into commercial products or processes," he says. "For students, it helps them develop an entrepreneurial spirit and teaches them something about the commercialization of technology. That experience will serve them well when they leave academia."

PATENT PROFILES

Paul N. Kokulis '45



MICHAEL DORSEY

Paul Kokulis has made a specialty of patent interferences, proceedings that seek to determine the rightful holder of a patent when two or more companies or individual inventors claim that right. "I would guess that most patent attorneys have one or two interferences in a lifetime," he says. "I juggle 15 to 20 such cases in a typical year."

Kokulis says patent law was the farthest thing from his mind when he received his degree in chemical engineering from WPI in 1944. He went to work for the Naval Research Laboratory as part of the Manhattan Project team, but left engineering after World War II. He left, in part, he says, because he felt other members of his research group, most of whom had advanced degrees, "were way ahead of me in their thinking. I didn't feel creative enough to make a contribution."

For a time he considered taking a job as a science teacher and a baseball and basketball coach in the Springfield, Mass., school system. But one day classmate Philip H. Sheridan, who is now a partner with Sheridan, Ross & McIntosh in Denver, urged him to apply for a post at the law firm of Cushman, Darby & Cushman in Washington, D.C., which was looking for someone with experience in chemistry.

"They offered me the position and paid my way through law school," says Kokulis, who earned his bachelor of laws degree at George Washington University by taking classes at night. "It was exactly what I needed. It has been a wonderful combination of science and the law. And it has allowed me to work with people at the frontiers of science."

Shortly after he joined the firm, a federal judge, in a major antitrust decision, ordered DuPont and the British company Imperial Chemical Industries (ICI) to terminate an agreement under which each company had filed for patents on the other's inventions in its own country. Faced with the need to pursue its own American patents, ICI turned to Cushman, Darby & Cushman.

"I was one of just two chemistry people at the firm then," Kokulis says. "One day an ICI man walked into my office with 400 pending patent applications, one or two appeals and some interferences. It was a wonderful opportunity for someone who was just beginning law school."

ICI has remained a principal client. In the 1950s, Kokulis worked with ICI and other companies on patents involving the highly competitive field of fibers and fabrics for clothing. He handled several interferences involving new reactive dyes, permanent press finishes and stretch fabrics.

The 1950s and 1960s also saw the growth of the pharmaceutical industry, and Kokulis found himself handling patents on major new drugs, including Halothane (an ICI invention that replaced ether as the anesthetic of choice in surgery), beta blockers (drugs used to treat angina and other heart ailments) and tamoxifen (the treatment of choice for breast cancer).

In the early 1980s, a significant amount of Kokulis' focus shifted to the emerging field of biotechnology. Today this discipline constitutes much of the work he does for clients that include major U.S. and foreign companies, universities and research institutions. The technologies he has been involved with range from blood growth factors to AIDS test kits to DNA fingerprinting.

"My involvement has been right there at the forefront of biochemistry," he says. "It's certainly been an exciting field to work in. If I were a young man starting out in patent law, I'd concentrate my efforts on this field, because there are some tremendously satisfying opportunities out there."

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says. "It was rare that a successful patentee could receive an award of lost profits. Of late, with more imagination going into damage calculations, awards are getting more significant and companies are looking at their patent portfolios as profit centers."

"Patent damage awards have become so substantial that many major corporations factor litigation-driven settlements and damages into their revenue projections as if they were expected income," Anthony says. "Texas Instruments, for example, has generated more than $600 million in royalties in recent years as a result of zealous patent litigation."

Anthony notes that the Federal Circuit Court is also more likely to invoke a provision for granting treble damages in cases where a defendant knowingly infringes a patent. All this has resulted in some staggering awards: $56 million for an antibiotic patent in Pfizer v. International Rectifier; $125 million for a patented cookie recipe in Procter & Gamble v. Nabisco; and $205 million for a patent covering the design of a rock drill bit in Smith Industries v. Hughes Tools.

In the most celebrated outcome, a judge awarded Polaroid more than $900 million after ruling that Kodak had infringed its instant photography patents. But Anthony says a new precedent may be in the wings: in a current case, Hughes Aircraft Co. is accusing the U.S. government of infringing its patents for satellite attitude-control systems. "Hughes has requested $3.3 billion," he says. "It is considered by many to be a reasonable estimate."

While most companies can absorb "reasonable royalties" into their bottom lines, the consequences of today's larger damage awards can be more severe. "Companies are being put out of business," Dann says. "That's why any company in any business where there might be inventions must pay attention to patents. Not only is it important to protect their own intellectual property, but they better make sure what they're doing doesn't infringe someone else's patents."

While the change in the judicial landscape has made corporations more cautious—and emboldened individual inventors, who in the past might not have taken on large corporate infringers—the escalating costs of bringing a patent case to trial can still tip the balance in favor of larger companies, Craig says. "Litigation has become terribly expensive," he says. "We are pricing it out of the reach of most individual Americans."

Last year, the firm of Morrison & Foster estimated that a patent trial can easily cost between $1 million and $4 million. "It can take $50,000 to $100,000 just to get a case on file," Craig notes. "More and more, small companies just can't afford to enforce their patents. And because litigation costs are deductible, the company with the deepest pockets has a advantage that enhances its chances of prevailing."

With so much at stake, strategy has become critical i patent litigation. One key strategic decision that must b made early on is whether to bring a case before a judge or jury, Scinto says. "When I started in patent litigation, attor neys were more likely to try cases before the court, rathe than a jury. There is an active trend today for exercising th constitutional right to a jury trial.

"Patentees often feel that juries will be more favorabl inclined to a patent that has survived the scrutiny of a govern ment review than to a challenger who says everything in th patent was obvious from the prior art." In addition, individua inventors involved in actions with corporations often choos juries because they feel jurors will be more likely to fee empathy with the little guy, Craig says.

"Patent litigators discovered juries about 10 years ago," Anthony says. "While the early indi cations of a jury's propensity to hol patents valid were impressive (wit about 80 percent of patents being up held), it appears over the long term that juries are not quite as much of a blessing to patent owners, but they're a blessing nonetheless."

In fact, Anthony says, judges are nearly as likely as juries to uphold patents. That's an important consideration, given the fact that jury trials are more expensive, time-consuming and difficult to schedule than non-jury trials. "The demand for a jury should not be a knee-jerk reaction of patent plaintiffs," he says.

Regardless of whether a case goes before a judge or a jury, the complexity of the issues involved in patent disputes, the intricacies of modern technology, and the increasingly crowded federal dockets (which may make judges less generous with the time they allow attorneys to present their cases) place a premium on preparation. "Preparation is the key in any kind of litigation," Craig says. "You can't leave a stone unturned."

An important part of preparing is finding the most effective way to present the details of a patent case. More and more, that means using television, computers and other modern communication technologies, Scinto says. "You make your case in a more rapid fashion, but you use computer animation, simulation—that sort of thing—to distill it down and make it understandable to the judge, who may have no technical training, and to the jurors, who may have no education beyond high school."

"Effective trial aids will not convert bad facts into good facts," Anthony adds. "But they can tip the balance in close cases. And by removing the cloud of confusion from a high-technology case, you demonstrate that you are doing your

"More and more, small companies just can't afford to enforce their patents. And because litigation costs are deductible, the company with the deepest pockets has an advantage that enhances its chances of prevailing."

best to impart an understanding of the facts to the judge or jury."

Two "clouds of confusion" that often surround patent suits are the issue of obviousness and something called the doctrine of equivalents, Scinto says. "Sometimes you can avoid the literal language of the claims of a patent and end up with the same results," he says.

"But the Supreme Court says that if you've reached that result by doing substantially the same thing in substantially the same way, you have not really avoided the patent and are guilty of infringement. That issue is the subject of a great deal of litigation."

Defendants in patent suits often claim that the patent in question is invalid because the invention would have been obvious to others skilled in the prior art. "Sometimes, you can arrive at a pretty reasoned opinion as to whether something was obvious, but often it will depend on the nature of the evidence produced at the trial, and you never know what that will be in advance. In the end, you are relying on the experience and knowledge of the person rendering the opinion."

"Sometimes you can avoid the literal language of the claims of a patent and end up with the same results.... That is the subject of a great deal of litigation."

If I were advising young people considerng careers in patent law about what fields to get preparation in, I'd say computers, semiconductor technologies, bioengineering, biotechnology and genetic engineering," Craig says. In fact, the computer and biotechnology industries have proven hotbeds of patent activity in recent decades.

Makers of computer software have traditionally turned to copyright law to protect their products (copyrights protect expressions of ideas—like books, plays and musical scores—rather than the ideas themselves), but patents have been granted to fundamental advances in software design. Patents are, perhaps, more critical for advances in computer technology, where such fundamental advances as the integrated circuit and memory design can be worth billions of dollars in royalties.

The rapidly changing nature of computer technology has given rise to a myth that patents—which can take several years to be granted once an application is filed—are not worth pursuing when a new chip might be obsolete a year or two after it goes on the market.

"In truth," Anthony says, "basic technologies are retained, albeit in a much improved form, as a product evolves into more advanced designs. For example, a patent basic to a dynamic random access memory (DRAM) disclosed in a one-kilobyte context, may be equally applicable to a one-megabyte design."

The explosion of patent work in biotechnology can be traced to the invention of genetic engineering in the early 1970s and to a pivotal Supreme Court decision in 1980. In Diamond v. Chakrabarty, the court ruled for the first time that manmade microorganisms can be patented. Later court rulings extended that protection to genetically engineered plants and multicellular animals, and patents have also been granted for individual genes and proteins—both natural and manmade.

Patents have proven especially important in biotechnology for a number of reasons. One of the most compelling is the high cost of the research, development and testing needed to bring a genetically engineered product to market. In 1991, biotech companies spent $3.2 billion on R&D—an average of 47 percent of their incomes. Pharmaceutical companies, in contrast, spend about 15 percent of their incomes on research and development.

If that investment were not enough reason for protecting biological and biochemical inventions with patents, the relative ease with which such inventions can be copied or "reinvented" should be. For example, once a company has begun clinical trials for a new genetically engineered protein, a competitor may find it easy to get a sample of the compound, analyze it, and determine the sequence of the gene needed to make it.

But outright piracy is only one of many ways a company can try to wrest control of a new market from its competitors or steer around its rivals' patents in the brave new world of biotechnology. Kokulis has been involved in some of the most written-about and closely studied interference cases in this emerging and challenging field.

Some of those cases concern Amgen Inc. in Thousand Oaks, Calif., one of the world's largest biotechnology companies. Amgen has focused much of its efforts on a group of biological compounds called blood cell growth factors, chemicals made by the body that stimulate the growth of the various cells that constitute human blood. One of its first targets was erythropoietin (EPO), which boosts the production of red blood cells. The compound can benefit patients on kidney dialysis, who often suffer from anemia brought on by the destruction of red blood cells.

EPO is produced by the kidneys in very small amounts, but isolating enough of the natural compound for commercial production would be prohibitively expensive. Therefore, Amgen and other companies—most notably, Genetics Institute in Cambridge, Mass.—set out to isolate the gene that codes for the protein. It was an arduous search; at times, both companies came close to giving it up. But in the end, Fu-Kuen Lin at Amgen isolated the gene and Amgen obtained patents for it and a host cell for manufacturing EPO using the isolated gene.

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PATENT PROFILES

Paul M. Craig '45

Paul Craig, a German native, arrived in the U.S. as a young man and entered WPI as a classified freshman with the Class of 1945. Due to a lack of a deferment, he had to interrupt his studies during his senior year. He served in the U.S. Navy from 1944 to 1946 and returned to WPI to complete his bachelor's degree in electrical engineering a short time later.

His entry into the field of patent law, he says, was purely accidental. "I was invited by RCA to come to Camden, N.J., for a job interview in the fall of 1946. On the advice of a neighbor, who worked with a Worcester patent law firm, I extended my trip so I could visit Washington. I was immediately hired as a patent examiner in an electrical division of the U.S. Patent Office."

Craig started work in December 1946 and enrolled at Georgetown University to work toward his law degree at night. After receiving his bachelor of laws degree in 1950, he became a patent advisor for the U.S. Army's Office of Chief of Ordnance. "All of the Army's arsenals reported to that office," Craig says. "Some of the work I handled came from the Redstone Arsenal, where German scientists under Wernher von Braun were working on rocket technology. I handled claims, filed patent applications and worked on infringements."

While working for the Army, Craig earned a master's degree in law at George Washington University. He left the Army in 1952 and went into private practice, where his knowledge of foreign languages would prove to be a major asset with future European clients.

While most of the work he did over the next several decades was in his area of specialization, patent litigation, he spent a good part of the 1950s and 1960s in general law practice with his father, also Paul Craig (both Paul Craigs were admitted to the bar on the same day in 1950).

In 1983, he split off from the Washington, D.C., intellectual property firm of Craig & Antonelli, which he had founded, and started the firm of Craig & Burns. Three years later that firm merged with a law firm in Indiana. "The Indiana firm had a policy that required partners to retire at 67," he says. "I was worried that the policy might keep me from continuing to serve a longstanding client who insisted on my representation, so I left the firm in January 1989 and since then have been associated with Dow, Lohnes & Albertson, a large general practice law firm in Washington."

When Craig began his patent law practice in the 1950s, the leading-edge technologies included nuclear energy and electronics. In the electronics area, corporations were working to develop and commercialize technologies developed during World War II. In his last year at the Patent Office, he became involved in major interferences that involved all the major U.S. firms that had access to the MIT Radiation Laboratory in a fight for the rights to an important development in radar, the "Magic T" antenna, which could send and receive microwave signals.

Over the years, he has done a great deal of work for electronics and automobile manufacturers. He has handled a broad range of work in the intellectual property area, including litigation, for European automotive clients such as Damiler-Benz, BMW and Porsche, and several Japanese companies, including Hitachi. He was involved for more than a decade in the Kearns litigation, in which David Kearns sued many automakers for alleged infringement of his intermittent windshield wiper patents.

Craig says he has enjoyed his career in patent law, but he notes that the profession has its pluses and minuses. On the plus side are salaries that are generally higher than those most engineers or research scientists can expect, as well as the opportunity to use one's technical education in an exciting and creative field, he says.

"But this is also a time-consuming and time-demanding profession," he says. "That can be a detriment. I remember when my daughter was 12, I asked her what she wanted to be when she grew up. She said she wasn't sure, but she knew she wasn't going to be a lawyer, because she wanted to spend time with her kids."

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In theory, that should have concluded the race, but Genetics Institute had a surprise in store for Amgen. Just before the awarding of Amgen's patent, GI had obtained a patent for a purified sample of EPO the company isolated from human urine. Genetics Institute argued that its patent also covered the synthetic form of EPO Amgen planned to make with its patented gene and process.

A lower court agreed with GI, but the decision was overturned on appeal to the Federal Circuit Court. Both the lower court and the appeals court found Amgen's patent valid and infringed by GI. Kokulis says the story of EPO also involved several interferences (special proceedings to determine who was the first inventor of something, and therefore the rightful patent holder) over Amgen's gene and process.

The interferences, in which Kokulis was involved, were determined favorably to Amgen by the U.S. Patent Office, although appeals are pending. An important ruling in the litigation and the interferences, Kokulis says, is the finding that, with gene inventions, conception of the invention and its reduction to practice occur simultaneously.

Kokulis says there is an important weakness in current patent coverage for biotechnology. "To illustrate this," he says, "let's say you are the first to isolate the gene for a protein that exists naturally in the body and that has been known about for some time. The protein is old, but your method for making it is new and you get a patent in the U.S. on the gene, and not on the protein it codes for.

"A company in Japan uses your gene to make the protein and then exports it to the U.S. As things stand now, that company will have no infringement problems, because it has not used your gene in the U.S. And since you hold no patent on the protein itself, it can be exported to this country.

"An apparently easy answer to the problem is to obtain patent coverage for the process for making the protein using the gene, since current law specifies that the importation of a product made by a process that would infringe a U.S. patent if made in the U.S., is itself infringement. But such process coverage is not always available."

That was the issue at the heart of litigation filed a few years ago by Amgen against Chugai Pharmaceutical, a major Japanese biotechnology company. Before the award of the Amgen gene patent, Genetics Institute had given Chugai the gene and host cell needed to make EPO and entered into a joint venture with the Japanese company to sell the protein in the U.S. Amgen protested the arrangement to the U.S. Trade Commission, but lost. "There have been proposals for legislation that would remedy this type of situation," Kokulis says, "but to date none have passed."

Perhaps the most publicized interference Kokulis has been involved in concerned the isolation of the virus that causes AIDS and the development of the first AIDS test kit. The case pitted Robert Gallo, discoverer of interleukin-2 and the first human retrovirus, HTLV-1, against French virologist Luc Montagnier and the Pasteur Institute.

In 1983, while Gallo's lab raced with the French lab to be the first to find the virus responsible for AIDS, Montagnier sent Gallo a sample of LAV, which he believed to be the culprit. A short time later, Gallo announced the isolation of what he called HTLV-III, as well as an AIDS test kit based upon it. The NIH was later granted a patent for the kit.

Montagnier claimed HTLV-III was really the Pasteur Institute's LAV and charged misconduct in the creation of the test kit. The institute, in the meantime, had developed its own test kit and an interference was begun to determine which one deserved the right to patent protection. After numerous meetings in Washington and Paris, a settlement was reached.

> *"The interference....was to determine who developed the [AIDS] test kit first. As far as I am concerned, Gallo and his people were the first to do that, as they discovered the way to produce enough of the virus to make useful kits."*

"Both sides agreed that they had benefited from information the other had shared with them," says Kokulis, who was asked by the federal government to handle the Gallo case in what was seen as an unusual move (the Justice Department normally defends the government in interferences, he says). "In a settlement disclosed in a historic announcement in Washington by the presidents of France and the U.S., Gallo and Montagnier agreed that they were joint inventors of the test kit.

"The newspapers tended to overlook an important point in that case," Kokulis adds. "The interference was not about who isolated the virus first. It was to determine who developed the test kit first. As far as I am concerned, Gallo and his people were the first to do that, particularly as they discovered the way to produce enough of the virus to make useful kits. To do that they had to find an immortallized cell line that the virus would not kill. That was a great contribution."

Since the Gallo case, Kokulis and his firm have handled a number of patent-related cases for the NIH. One in particular has been the subject of controversy. That case began in August 1992 when the agency filed for patents on the research of former NIH scientist J. Craig Venter. Venter isolated more than 3,000 partial human genes known as expressed-sequence tags. The sequences can be used as probes to isolate the exact position of useful genes. The NIH says it wants to secure the intellectual property rights to the sequences so they will be available to anyone who needs them for research.

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PATENT PROFILES

Lawrence F. Scinto '51

Like many patent attorneys, Lawrence Scinto didn't set out to pursue a career in law. A native of New York City, he enrolled at Brooklyn Polytechnic Institute after high school, and then served in the U.S. Army in the Pacific Theater for two years at the end of World War II.

"When I got out of the service, I decided to take advantage of the G.I. Bill and began looking for a college outside of New York," Scinto says. "I had relatives in Worcester who told me about WPI." Scinto was admitted and earned a bachelor's degree in civil engineering in 1951.

In his senior year, he took a course in engineering and the law and became intrigued. When he returned to New York, he enrolled at St. John's University and pursued a bachelor of laws degree at night while working at various engineering jobs during the day. He received his degree in 1956 and went on to earn a master's degree in law at New York University in 1959.

Still, he didn't intend to work as a patent attorney; he says he thought a knowledge of the legal field would be helpful in his work as an engineer. But after spending a year as a contract administrator at an engineering firm, he took a job as a patent attorney for American Machine and Foundry Co. and has never looked back.

For American Machine, he prosecuted patents on technology used in such devices as bowling pin-spotting machines, cigarette-making and -packaging machines, and bread-wrapping machinery. In 1960 he joined the New York firm of Morgan, Finnegan, Durham & Pine. Three years later he joined Ward, Haselton, McElhannon, Orme, Brooks & Fitzpatrick, where he eventually became a partner.

In 1971, he joined with other attorneys in forming Fitzpatrick, Cella, Harper & Scinto, where he is a senior partner today. With 65 attorneys in the main office on Park Avenue, another 22 in an office in Washington, D.C., and three lawyers in a Los Angeles office, the firm is one of the largest intellectual property practices in the country.

Over the years, Scinto, who was recently elected to membership in the American College of Trial Lawyers, has focused more and more of his energies on patent litigation, which he has pursued for such clients as Exxon, DuPont, Merck, Monsanto, S.C. Johnson & Son, and Emerson Electric. The cases he has handled have run the gamut of technical disciplines and industries.

Early in his career, he worked on cases involving the high-speed manufacture of replacement radiator hoses for cars. He brought suit for DuPont against Hercules Chemical Co. over a patent for the photosensitive material used in making printed circuit boards. And he successfully defended Merck in a suit over its patents for crystalline and highly refined forms of vitamin B_{12}.

More recently, he worked on a case for DuPont and its licensees involving a patent for a plastic material used to make the expandable balloons for aortic catheters. Also working for DuPont, he was able to prove that a patent granted to another manufacturer for the use of the space-age plastic Kevlar in brake linings was invalid because previous DuPont publications already covered that application. Currently in litigation is a case that pits client Emerson Electric against General Electric in a fight dealing with brushless permanent-magnet motors.

"Everyday it's something new," says Scinto, who notes that working as a patent attorney has dispelled a myth he once had about the field. "I had the misconception that patent law was a very dull, stodgy area of legal practice. I could not have been more wrong. To me, it's among the most exciting and challenging areas. It's not always exciting, of course, but by and large it's the kind of thing I look forward to coming to work for every day."

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While the agency says it will be willing to transfer the rights to these sequences to biotechnology companies that can put them to good use, those same companies fear that granting the NIH patents on the gene segments will make it harder for them to get patents on the full genes, since knowledge of the sequences may make the genes obvious. "It will be interesting to see what the future holds for patenting efforts of this type," Kokulis says.

If there was only one patent system in the world, life—while not easy—would be a great deal simpler for patent attorneys. In fact, nearly every nation maintains its own patent system and within those many systems are a host of conflicting requirements and rules.

As global competition in business and industry has intensified in recent decades, the need for companies and individual inventors to protect their intellectual property outside of their home countries has grown. One indication of this is the changing nature of the clientele of the U.S. Patent Office.

"Foreign companies are getting about one of every two patents granted by our patent office today," Scinto notes. "In 1992, four of the top five companies getting patents issued in their names were non-U.S. firms. The Japanese, in particular, are quite sophisticated about using, not only our system, but patent systems around the world."

With the growth of international patenting, has come a rising interest in "harmonizing" the rules governing the many national patent offices. The goal is to make the process of applying for patents in multiple countries easier and fairer. In the long term, such efforts may someday bring about a truly international patent, which would provide access to patent protection in many—if not all—countries with a single application.

An important step along this road was taken more than a century ago when a number of countries signed the Paris Convention for the Protection of Industrial Property. About 100 nations now adhere to the Paris Convention, which requires a signatory country to treat applicants from other countries exactly as it does those within its own borders. It also grants inventors one full year from the time they first file an application in any member country to file applications in other nations. During that year, the inventor can preserve his right of priority, should priority of invention become an issue.

Students Pursue Patent Careers and Projects

While the majority of WPI's graduates go on to careers in the disciplines in which they major, a growing number are using their engineering and science degrees as stepping-stones to other types of professional occupations. Each year, about six of those students go on to study law, according to Kent J. Rissmiller, assistant professor of social science and policy studies and one of two advisors for WPI's pre-law program.

"For the first time this year, most of those students are interested in patent law," Rissmiller says. "They are selecting law schools because of their patent law programs and expect that the field is the best way for them to combine their education in engineering or science and their interest in law.

"I think it shows, in part, that students are a little nervous about the availability of engineering jobs and about what kinds of jobs they'll be qualified for if they have only a bachelor's degree. They don't want to ignore or set aside their four years at WPI; they just want to find other ways to use that education."

Rissmiller says students with a technical background often have an advantage in applying to graduate programs that specialize in technical areas of law, like the law of intellectual property, utility regulation and the environment. "In general," he says, "I tell students that having an engineering or science degree is no handicap whatsoever in getting into law school. These schools don't put a lot of weight on an applicant's major. They're looking for someone who can handle graduate education."

Through WPI's pre-law program, students receive special advising about career opportunities, preparing for law school exams, and applying to law school. In addition, students can take a sequence of law courses in the areas of management, history and social science.

"These courses expose students to the kinds of problems, the kinds of cases, and the kinds of materials they will encounter as law students," Rissmiller says. "We want them to see if they find it interesting and if they can adapt to learning through the case format used in law courses."

Patent law has also played an important role in WPI's undergraduate project program. For nearly two decades, students have been completing Interactive Qualifying Projects (IQPs) with the U.S. Patent and Trademark Office while in residence at the Institute's Washington, D.C., Project Center.

The relationship with the Patent Office began in 1974 with the assistance of C. Marshall Dann '35, who was then commissioner of patents and trademarks. It has continued since then, making it WPI's longest relationship with an off-campus project sponsor. Over the years, more than 20 projects have been completed with the office.

The projects have focused on such areas as the classification system used by the Patent Office and the use of modern automation technology in patent searches and other patent-related functions. Many have used data about patenting activity to learn about

There are currently a few regional patent offices that enable inventors to file a single application and be granted patents in multiple countries. The European Patent Office covers 14 nations on that continent. Other such arrangements cover the English- and French-speaking nations of Africa and the Benelux nations.

In the early 1980s, a movement began to bring even greater uniformity to the international patent community. Since then, the World Intellectual Property Organization (WIPO), a special agency of the United Nations, has drafted a treaty aimed at harmonizing international patent procedures. Marshall Dann, who attended meetings of the WIPO when he was U.S. patent commissioner in the 1970s, says that if the U.S. is to ultimately sign this treaty (as several nations have already done), it will have to make a fundamental change in its patent system.

"Everywhere else in the world, with the exception of the Philippines, they have a first-to-file system," he says. "We've stayed with our first-to-invent system." A first-to-file system grants a patent to the first inventor to get his application into the patent office. The U.S. system is careful to award a patent to the first person to actually realize a new technology.

"There are virtues to a first-to-invent system," Dann says. "Because he doesn't have to worry about somebody stealing his idea, an inventor has time to develop and perfect it before running to the patent office. In theory, that results in higher quality patents.

"The U.S. will have to abandon the first-to-invent rule sooner or later."

"The great virtue of the first-to-file system is its simplicity. It also eliminates the need for interferences, which can be burdensome. One key argument against the system is that it might encourage sloppy and incomplete patent applications, which could result in more rejections and more vulnerable patents."

Dann says a first-to-file system may also favor large companies, which have the resources to file patent applications quickly. He says because most large U.S. companies patent their inventions overseas, they already operate as if the U.S. had a first-to-file system.

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the process of creating and using new technology in the U.S. and about the social and economic implications of technology.

Jane Meyers, the Institute's primary contact in the Patent Office, says one project that particularly impressed her examined the impact of maintenance fees on patent holders. The fees, first assessed in the early 1980s, must be paid by inventors every four years to keep a patent valid.

"This project alerted us to the fact that we weren't notifying inventors adequately about the fact that these maintenance fees were due," she says. "As a result, the office instituted new procedures to notify inventors. We took the students' report, condensed it and published it. We distributed that publication to a lot of people."

A 1985 project looked at how placing the Patent Office's vast collection of patents on CD ROM affected the way people use those patents to do searches. The project was advised by Susan Vernon-Gerstenfeld, adjunct associate professor and director of the Washington Project Center. She used the data the students gathered under her direction to complete a Ph.D. dissertation that predicted how comfortable Patent Office employees would be adopting the new technology. "The male patent examiners who had been there the longest were the most reluctant users," she says.

"Projects like these can be of real value to the Patent Office," Vernon-Gerstenfeld says. "They don't have enough personnel to do this work or enough resources. So sponsoring a project is a good way to get a lot of talented labor. And our track record with them is very good, or they wouldn't have kept coming back for nearly 20 years."

That assessment is confirmed by Meyers: "The students have often planted seeds for further research on our part and in many cases we have followed through. I've got all the reports here in my office and we do use them—even the ones with older data—for reference."

When WPI opened the London Project Center in 1985, the Institute's track record with the U.S. Patent Office opened the door to the British Patent Office, where projects have been conducted regularly since then. Later, the British connection would help lay the groundwork for a series of projects with the Office o Registrar General in Hong Kong, which is responsible for all area of commercial law on the island.

In Britain, many patent-related projects have focused on the satisfaction users feel with the services they receive from the British Patent Office. "The patent office perceived the enormous value of having WPI students, who are disarming and nonthreatening, gathering impartial responses from users," says Lance Schachterle, associate dean of undergraduate studies and director of the London Project Center.

The first project done with the British office looked at whethe the creation of the European Patent Office might make the services of the British office obsolete. "The students came up with what we were told was a better, more accurate report than one the patent office had commissioned from a professional consulting firm," Schachterle says.

The report found that many British inventors would prefer to use their own patent office over the European office because it offers the services they need at a lower cost. "The patent search arm of the British Patent Office had thought it might go out of business," Schachterle says. "The students' report convinced them they had a future."

Morgan D. Rosenberg '95 has been looking into these questions for his Interactive Qualifying Project, which will examine how the transition to a first-to-file system might affect inventors in the U.S. He says he has concluded from his research that many of the fears about first-to-file may be unfounded.

"People who are for the first-to-file system say that while, in theory, small inventors could be hurt, it doesn't seem to happen in the real world," he notes. "And the level of quality of patents really depends on what individual countries require in the way of disclosure, rather than on whether or not they have a first-to-file system. Right now the U.S. has the strictest level of disclosure requirements of any country. If we switch to a first-to-file system, we'd probably retain those."

"The U.S. will have to abandon the first-to-invent rule sooner or later," Craig says. But he notes that many nations are more concerned about other provisions in U.S. law they consider discriminatory. "For example," he notes, "the patent system now favors U.S. inventors, because you cannot establish the date of your invention by activities abroad, such as conception of the invention or reduction to practice."

"Some say this gives U.S. companies a big advantage in interferences," Dann says. "It's true that we say that our law treats everybody the same—if you develop something in the U.S., you are on a par with us. That sticks in the craw of foreign companies.

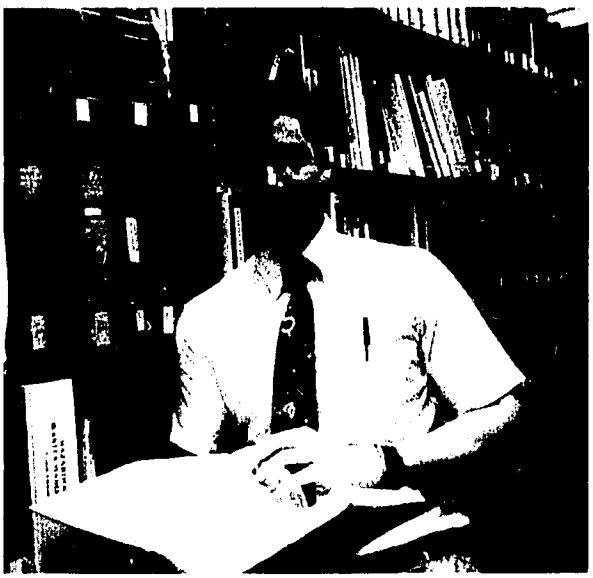
"I don't know how the U.S. is going to come out on this," Dann adds. "There are a great many people—including, I think, the current administration—who favor the U.S. becoming like everybody else. A great many other people cherish the first-to-invent system. They note that the U.S. will get little in return for giving it up. We'll just have to wait and see."

Patent law is an interesting field," Dann says. "It's a nice combination of law and technology. You can use what you know of science and engineering and you'll always find yourself at the leading edge of technology, because every application that you get into is, by definition, new."

How does a young man or woman get into the field? To begin with, Kokulis says, a technical degree is a must, because of the complex nature of the material a patent attorney must deal with. "All but a few of the people in our firm have a scientific background, and many started out by working in a scientific area," he says. "The few who do not have technical degrees work in trademarks and copyrights."

Once a prospective attorney has earned a law degree, what is the next step? "There are three common ways to break into the field," Craig says. "You can go to work for the Patent Office as a patent examiner and attend law school at night. This way you learn the rules and the thinking of the Patent Office, which is valuable. You can work for a firm. In Washington, people are hired right out of college; they do searches at first while they earn their law degrees at night.

"Or you can work for a company, especially one that has a Washington office for training patent attorneys. To take advantage of the opportunity to choose from among a wider range of law schools, however, companies are cutting back on their Washington training offices."



Morgan Rosenberg '95 says his research for an IQP on patent harmonization convinced him that many objections to the first-to-file system are unfounded.

Each option has advantages and disadvantages, Kokulis says. "At the Patent Office you'll gain a lot of experience quickly and probably have more responsibility. At a firm you'll progress more slowly, but you'll have greater variety in the work you do. At a corporation you'll have a narrower exposure, because your cases will concern whatever technology the company specializes in."

Craig says there is a fourth alternative not often considered—serving as a clerk to a judge, especially a judge of the U.S. Court of Appeals for the Federal Circuit. "This will give you exposure to all sorts of cases," he says. "Many law firms pay a premium for attorneys who have had such experience."

What are the prospects for a new patent attorney? Currently, the demand for young men and women in this field is so great many firms are "growing" their own patent attorneys, the *Boston Globe* recently reported. One Boston firm is sending engineers to law school at its own expense.

New patent attorneys will join a small but growing fraternity. According to the American Intellectual Property Law Association, there are about 12,000 intellectual property lawyers in the U.S.—fewer than 2 percent of all attorneys listed by the American Bar Association. Those professionals might find they have an important advantage over their peers, Kokulis notes.

"Young people ask me about the practice of law," he says. "I tell them that if you go into criminal law, you'll probably get rather disenchanted with human nature. And I can see how one might find domestic relations law, where you are constantly confronted with people in turmoil, a bit depressing. But patent law mostly has ups. You are dealing with people who are out there making new inventions that, hopefully, will contribute to everybody's well-being and happiness."

Playing Matchmaker to Methane

Sometimes called marsh gas or firedamp, methane constitutes about 85 percent of natural gas and is also produced by the decomposition of organic matter. In addition to its use as a fuel, methane has long been an important starting point in a host of commercially important chemical processes.

In the petrochemical industry, for example, methane is often used to make synthesis gas (carbon monoxide and hydrogen), which is used, in turn, in the manufacture of methanol and ammonia. Since methane is abundant and cheap, a major goal of the industry is to find a way to convert methane to ethylene, a chemical building block used to make ethylene glycol, polyvinyl chloride, styrene, polyethylene, fabric finishes, latex paints and a host of other products.

To make ethylene in this way, two molecules of methane must be combined in a process known as oxidative dimerization. In practice, this is a difficult process to control and produces poor yields, generally in the range of just 25 to 30 percent, says Yi Hua Ma, professor of chemical engineering and director of WPI's Center for Inorganic Membrane Studies.

"It is not easy to put two methane molecules together," Ma says, "since methane does not readily react with itself. To make the reaction work, you must control the oxidation of the methane. When you burn methane, you completely oxidize it, producing carbon dioxide and water. But in the dimerization reaction, you partially oxidize the methane molecules, producing some carbon dioxide and water and some useful products."

With a three-year contract for $690,590 from the U.S. Department of Energy, Ma and chemical engineering professors Anthony G. Dixon and William R. Moser are attempting to develop an inorganic membrane system that will significantly increase the yield of the dimerization reaction by both controlling the rate at which oxygen mixes with the methane and promoting the coupling of the methane molecules.

From left, William Moser, Anthony Dixon and Yi Hua Ma are developing an inorganic membrane system to convert methane into ethylene.

Inorganic membranes are generally made by building up increasingly fine layers of inorganic materials like alumina, zirconia and glass. The finest layers have a uniform network of tiny pores that let some compounds pass through, while holding others back. The properties of a membrane can be controlled by depositing various compounds—including catalysts—inside the pores.

In their research, the WPI team is developing a tube-shaped membrane with oxygen-permeable and catalytically active layers lining the interior of the tube. Methane will flow through the center of the tube while oxygen diffuses in from the outside to partially oxidize it.

The team is currently experimenting with ways to control the structure of the membrane to permit only oxygen to pass through. In addition, they plan to deposit electrically conductive materials inside the pores of the membrane to enhance the movement of the electrically charged oxygen molecules.

"We are looking at various oxides that will allow oxygen to permeate through at the high temperatures normally used in the methane dimerization process," Ma says. "By choosing the right material, we hope to be able to control the partial pressure of oxygen and, in turn, control the reaction to produce the best yield possible."

By the end of the three-year contract period, Ma says the team hopes to have developed a mechanism for increasing the yield of the dimerization reaction and to have determined how best to scale the membrane system up to a large enough size to handle the huge volumes of inexpensive methane that are produced by industry.

"For the project to be successful, the process must be economically feasible," Ma says. "We may find that even though the membrane works, it is too expensive to build. Or it may not be easy to use for mass production in an industrial setting. We are hoping we can overcome all these difficulties, but it is a very, very difficult problem. Otherwise, someone would have done it.

"However," he adds, "if the technique works and the conversion rate is high enough, this membrane system could be worth billions of dollars to the chemical, petrochemical and plastics industries."

The Inorganic Membrane Center was established in 1988 to study how the membranes work, how best to make them and how to apply them in a broad range of industries, including the chemical and biotechnology industries. The center includes faculty and graduate students from the Chemical Engineering, Biology and Biotechnology, and Mechanical Engineering departments. Current industrial sponsors include Mobil Oil Corp. and Amoco Oil Co.

—Michael Dorsey

Richard Hansen Is Helping Power Up the Developing World

Felipe Martinez can now regularly keep his country store open past sundown and the local community center can extend its programs well into the evening. Why is that news? Well until a few years ago, there was no reliable source of electricity for lighting in the rural town of Bella Vista in the Puerto Plata region of the Dominican Republic. If the store and community center were occasionally open evenings, shoppers and center visitors were disturbed by the fumes from kerosene lamps.

PHOTOS COURTESY OF ENERSOL ASSOCIATES INC.

Richard Hansen '76, a professional engineer who received his bachelor's degree in mechanical engineering from WPI and his M.B.A. from Boston University, is the catalyst for these electrifying changes. Nine years ago he founded Enersol Associates Inc., a nonprofit international development organization in Somerville, Mass., that specializes in solar-based rural electrification. He's served since then as Enersol's executive director.

Enersol's goal is to foster rural solar electrification around the globe. Its approach to business, which it calls SO-BASEC, makes use of recent advances in photovoltaic technology and local human and institutional resources to bring power and light to communities beyond the reach of existing distribution networks.

"It's impractical to run traditional electric lines through heavily wooded or remote terrain," says Hansen, a former manager of industrial and manufacturing engineering for Westinghouse. "Besides, it would be bad for the environment."

Hansen went to the Dominican Republic in April 1984 to install one of his first cost-effective, small-scale PV systems at the Martinez home and store in Bella Vista. The system, typical of others installed since then as a result of Enersol's efforts, included a solar photovoltaic module, an automotive battery and a simple control-junction box.

"It provided enough power to run the family's television and radio and to keep lights operating throughout the home and market," Hansen says. "Community members visited, discussed the system, and soon were convinced that the technology suited their needs."

Ydalia Alcantara, a Dominican seamstress, works under an electric light powered by one of Enersol's solar electric systems. The systems have replaced dim and smelly kerosene lamps in homes and businesses.

In such a low-income area, paying for systems up front was a problem. So in December 1984, Enersol helped 10 families organize themselves into ADESOL, a solar energy development association. The organization maintains a revolving loan fund that enables people to buy home systems. "It may well be the first solar electric revolving credit fund in the Third World," Hansen says.

The U.S. Agency for International Development mission in the Dominican Republic provided $2,000 in seed money for the fund. By March 1985, five systems had been financed, with users paying about $10 a month for energy services. Buyers pay back the $500 cost for a system over four years. With a community-based credit mechanism in place, Enersol then tackled the problem of system servicing and sales.

"We worked with a local entrepreneur to establish a small hardware and electrical supply store," Hansen says. "The store became the solar service center for the region, a place where customers could order new systems, buy spare parts, request service or arrange short-term financing. Business boomed. Typically, a successfully installed system would result in a number of other sales."

Enersol next trained six local youths to install and service solar home systems. As the young technicians were completing their training, ADESOL received a $3,500 USAID grant to finance systems for eight additional homes and businesses. The work gave the youths immediate practical experience. Peace Corps volunteers attended the second training session, then spread word of the technology to communities where they worked.

With a grant from the U.S. Department of Energy, Enersol and the University of

Massachusetts—Lowell prepared a case study of the organization's activity in the Dominican Republic. The 150-page report described this unique experience of a U.S. company disseminating photovoltaic technology at the grass-roots level in a developing country. It also provided important lessons to others who might choose to follow in Enersol's footsteps.

Between 1984 and 1992, about 4,000 home lighting systems were installed by Dominicans; about half of these can be traced directly to Enersol's training and financing initiatives. Owners say they are pleased with their systems, because they put them in control of their own electrical power. One noted that rural solar system owners are better off than city dwellers who depend entirely on centralized electricity. "While the lights go out daily in Dominican cities," he said, "they stay on in Bella Vista."

Now that solar electric technology has gained a foothold in the Dominican Republic, Hansen is planning similar programs in other countries in Latin America and the Caribbean. He says solar systems can provide these nations with power and light for homes, farms, schools, health clinics and community centers. Unlike other rural energy options, he notes, solar energy systems emit no acid rain or greenhouse gases, use no power lines, and require no dams, mines or refineries.

Enersol has developed a comprehensive program to foster solar-based rural electrification at the community, national and international levels. Its Energy Enterprise Development Activities encourage the creation of local photovoltaic service enterprises that sell, install and maintain systems in remote rural communities. Institutional Support Activities help groups start solar-based rural electrification programs. And Public Outreach and Education Activities provide information about the economic, environmental and technological aspects of photovoltaic systems and their application in the developing world.

Enersol's efforts to aid developing countries have not gone unnoticed. Its Dominican Republic program has received international recognition and support from such institutions as the World Bank, the Central Bank of the Dominican Republic, the USAID Office of Energy, the U.S. Peace Corps, the Electric Power Research Institute, Sandia National Laboratories, Oak Ridge National Laboratory, the United Nations, and the National Rural Electric Cooperative Association.

Technicians Milo Martinez, left, and Cesar Hiraldo carry a solar electric system to a rural home in Bella Vista. Enersol is planning similar programs elsewhere in Latin America and the Caribbean.

Richard Hansen, far right, Enersol's executive director, and Eric Johnson, second from left, the organization's training coordinator, pose with a group of Dominican technicians at a training site in Bella Vista. The technicians install and service Enersol's home solar photovoltaic systems. Since 1984, more than 2,000 systems have been installed in the Dominican Republic as a result of Enersol's efforts.

Early on, Hansen's efforts also caught the interest of WPI Professor Edward N. Clarke, who was then planning WPI's Center for Solar Electrification. The two presented a workshop at WPI on solar electrification in developing countries. One of the first Interactive Qualifying Projects completed through the center, *PV Promotion for Rural Electrification*, was done by Visarut Asvaraksh '88 and Aswin Pinsuvana '89 from Tailand, who benefited from Hansen's early experience in the Dominican Republic.

"We've been encouraged by the results of our efforts to date," says Hansen, who has recently been involved in feasibility studies in Belize, Guatemala and Bolivia, and has served as a consultant under contract with the World Bank for the introduction of solar electric technology in Yemen. "But there is still much to be done by everyone. Globally, an estimated two billion people have no electricity."

—Ruth Trask