



CUTC

Canadian
Universities
Technology
Consortium

**THAI-CANADIAN HRD PROJECT
CUTC-SUT INSTITUTIONAL LINKAGE PROJECT
CIDA PROJECT # 906/14868**

ANNUAL PROGRESS

AND

FINANCIAL REPORT

APRIL 1, 1996 to MARCH 31, 1997

***Submitted to:
The ARA Consulting Group Inc.
April 1997***

***Prepared by:
Ryerson International***

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**ANNUAL PROGRESS
Reporting Semi-Annually
AND**

FINANCIAL REPORT

Linkage Project Title:	Institutional Linkage Project
Canadian Partners:	Ryerson Polytechnic University (Canadian Lead Partner) Guelph University University of Waterloo Technical University of Nova Scotia
Thai Partners:	Suranaree University of Technology
Project No.:	906/14868

Report

**Covering the Period
April 1, 1996 to March 31, 1997**

**Submitted to ARA
April 1997**

by

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PART 1

1.1 PROJECT SUMMARY

1. Project Start: July 15, 1993 **Finish:** March 31, 1998

CIDA Contribution: \$ 995,484

2. Summary of Project Management

- Semi-Annual and Financial reports for the period April 1 to September 30, 1996 were produced and submitted to the ARA Consulting Group.
- Dr. Stalin Boctor, Technical Advisor to the Canadian Project Implementation Unit met with SUT academic administrators to discuss a number of issues related to the CUTC-SUT International Engineering and Applied Science program, as well as various project management matters in February, 1997. See Appendix , "SE Asia Deans of Engineering Conference and Mini-PRC (SUT/CUTC) February 10-14, 1997.
- Ryerson International (Dr. Sam Mikhail, Dr. Stalin Boctor) met with Roger Griffin, ARA, to discuss the implications of government funding cutbacks to SUT in terms of the planning, implementation and delivery of the remaining project activities. ARA acknowledged the challenges faced by other Thai universities, given government cutbacks. ARA, in principle, agreed that the project could cover key activities that could be implemented before March 31, 1998 which would support the goals of sustainability and mutual benefits.
- SUT advised CUTC at the Mini-PRC in February of government budget cutbacks of 15% for 1997 resulting in SUT's inability to financially support project activity. The remainder of the IUP program curriculum scheduled to be delivered in Thailand is now cancelled. (3rd Trimester, 4 teaching assignments) Curriculum for the Food Technology Program remains as planned for September 1997.
- The 4th Project Review Committee (PRC) meeting was held in Halifax at the Technical University of Nova Scotia (DalTech) on April 3 and 4, 1997. The 4th PRC determined specific activity which can be achieved through the support of project funds and consistent with the overall goals of sustainability.. A copy of the minutes is attached in Appendix .
- The 5th PRC meeting is scheduled for January 12-13, 1998 at SUT, Thailand.

3. Progress and Achievement to Date

a) Accomplishments

Through liaison with SUT, CUTC partners, and the ARA Consulting Group, the CUTC Project Implementation Unit has planned, implemented and evaluated the following activities in Program 2 and 3.

Program 2: International Academic Programs

Activity A2.11: Academic Program Planning

Dr. Stalin Boctor, Technical Advisory to the Canadian Project Implementation Unit met with SUT academic administrators for a Mini-Project Planning and Review Meeting February 12, 1997 to discuss a number of issues related to the CUTC-SUT International Engineering and Applied Science program. (*Appendix A*)

Details of these activities are provided in Part 2 of this report.

Program 3: University-Industry Linkage Program

Three seminar assignments for Canadian consultants were reconfirmed. SUT and the CUTC will be organizing the seminars during the 1997/98 final year of the project.

(*See Appendix G: PRC meeting, Halifax, April 1997*)

Program 4: Project Management

A4.32 Ten CUTC-SUT members participated in the Project Review Committee meeting held at TUNS on April 3 and 4, 1997. Dr. Tavee Lertpanyavit, Dr. Pongchan Na-Lampang, and Ms. Mantana Thammachoit participated from SUT. Dr. Bill Caley, Robert Eagle Feridun Hamdullahpur from Technical University of Nova Scotia and Dr. Gerry Schneider from University of Waterloo, and Dr. Jim Shute, University of Guelph, Dr. Stalin Boctor and Mary Jane Curtis were CUTC's official representatives at the meeting.

b) Schedules

Based on the decisions taken in April at the 4th PRC meeting in Halifax, SUT and CUTC partners, the Canadian Project Implementation Unit has decided to cancel the IUP Program based on budget restraints. Project funding has therefore been re-allocated to support new activities as follows: (*See Appendix E - Dr. S. Boctor letter to ARA, project status*)

A 2.4 Workshop on Postgraduate Engineering Programs and Quality Control
proposed for November 10-12, 1997, 7 Canadian consultants

- A 2.5 Academic Research Exchange for Thai Faculty
5 Thai faculty to Canada, two-week programs
to be completed by December 1997

c) Expenditures

For the period October 1 to March 31, 1997 \$128,658 was budgeted to support the implementation of proposed project activities. Funds expended totalled \$ 95,085.

4. Progress Toward Achieving Project Objectives and Deliverables

a) Reached

The CUTC -SUT Institutional Linkage Project is currently in the 11th quarter of the project. As of March 31, 1996 the following deliverables have been completed:

- Activity A 2.11b S.E. Asia Deans of Engineering, Feb 10-14, 1997
By 4 CUTC participants
- Activity A 2.21 Ph.D. candidates and Advisors selected by
Canadian Members
- Activity A 2.26 2 Thai Advisor visits to Canada
- Activity A 2.31a. Work Placements in Canada, for 4 Thai Students
- Activity A4.21d Canadian Management Team and Project
Implementation Unit (Year 4)
- Activity A 4.32 Project Review Committee meeting in Waterloo
(October 1996) and in Halifax, Canada, April 1997.

b) Scheduled - See Appendix F, Dr. Boctor's April 22 letter to ARA, for details

- Activity A 2.23 Ph.D Research, 1 assignment October 1997
- Activity A 2.25 Post Doctoral Research Fellowships
1 additional fellow, May-June 1997
- Activity A 2.32b Work Placements - Canada, 1 additional student,
activity to be completed in September 1997
- Activity A 3.23 Industrial Seminars by Canadian Consultants
3 industrial seminars to be completed by March 98

New Activities Proposed:

- Activity A 2.4 Workshop for Postgraduate Engineering Programs Development and Quality Control, 7 Canadian consultants, November 1997.
- Activity A 2.5 Academic Research Exchange for Thai Faculty, 5 Thai faculty members for 2 week visits to be completed by December 1997.

Can ARA Help?

No assistance from ARA is requested at this time.

PART 2

2.1 REPORT ON PROJECT MANAGEMENT

2.1.1 Project Managers

Canada: Professor Samih Mikhail, Director, Ryerson International, Ryerson Polytechnic University, Canada

Thailand: *Dr.Tavee Lertpanyawit, Vice Rector, Academic Affairs, Suranaree University of Technology, Thailand

** effective October 1, 1996*

2.1.2 Project Management Issues/Concerns/Problems and the Actual or Proposed Solutions

The Project Review Committee Meetings have provided the opportunity for the project partners to meet at SUT to review progress to date within the project, and facilitated discussions between the new SUT project management and implementation teams, and CUTC members.

2.1.3 Sustainable Institutional Relationship

CUTC and SUT have developed strategies within the project to support sustainable linkages once CIDA funding ends. Examples of this are the Joint PhD and Program Development for International Engineering and Applied Science programs. The important issue at this stage of the project is to ensure that the appropriate foundations are laid for the sustainability of these programs.

2.2 REPORT ON PROJECT DELIVERABLES

Deliverable No: A2.11 b

Deliverable Title: Academic Program Planning

Narrative

Four Canadian CUTC representatives presented papers at the S.E. Asia Deans of Engineering Conference held at SUT February 11-14 1997. The CUTC representatives also attended the Mini-PRC meeting on February 12, 1997 which is referred to under Project Management (*Appendix A - Papers*)

Activity Planned Next Quarter

Activity completed. No activity scheduled for next quarter.

Anticipated Challenges

There are no major challenges anticipated.

Progress Toward Completion

This activity is now complete

* * * * *

Deliverable No: A2.21**Deliverable Title: Selection of Thai Supervisors and
Ph.D. students by Canadian Faculty Members****Narrative**

At present, three SUT faculty members are Ph.D. candidates at TUNS, one in Industrial Engineering, one in Electrical Engineering and one in Chemical Engineering. Two more SUT faculty members have been chosen as Ph.D. candidates and are expected to arrive at TUNS by September 1997, one in electrical Engineering and one in Civil Engineering. Only the Ph.D. candidate in Chemical Engineering has co-supervisors at TUNS and at SUT. No further activities are expected this deliverable.

Progress Toward Completion
completed

* * * * *

Deliverable No: A 2.26**Deliverable Title: Thai Advisors visits to Canada****Narrative**

Dr. Kontorn Chammiprasart and Mr. Rawat Vipia .

University of Waterloo: November 4-8, 1996

Dr. Kontorn was given an overview of the faculties and laboratories in the Mechanical Engineering Department, including: wind tunnel, heat trans, fluid mechanics, robotics and library. Dr. Kontorn was provided with the undergraduate manual for the 3B academic term. Mr. Rawat meeting eith personnel from the Electrical and Computer Engineering Department. His key area of interest was in special constructions requirements for a high voltge lab for undergraduate and graduate study research. (*Appendix B, Reports*)

Activity Planned During Next Quarter

None

Anticipated Challenges

None

Progress Toward Completion

Activity completed

Changes in the Status in the Next Quarter

Not applicable

* * * * *

Deliverable No: A 2.31a**Deliverable Title: Co-op 16-week Program
for Thai Students in Canada****Narrative**

4 Student have completed their programs. 2 at the University of Guelph and 2 at TUNS

Podjana Chumkhunthod, and Piyachat Sintudeacha School of Food Technology, Institute of Agricultural Technology, SUT - assignment at University of Guelph, June-December 1996

Hathaikarn Nilawat, School of Technology of Resources, Chemical Engineering, September to December, 1996, TUNS. Program: Literature search, data analysis, presentation and experimental investigation of dynamic surface tension of industrial streams. Academic Supervisor: Dr. Al Taweel, TUNS,

Mr. Atit Koonsruisk, SUT, Co-operative Education: 4 month assignment, September to December 1996, Department of Mechanical Engineering, Supervised by Dr. Feridun Hamdullahpur in the Two-Phase Flow Research Laboratory at TUNS in the area of "Fluidization".

See Appendix C - four reports

Activity Planned During next Period

Activity A 2.31 b to be completed in December 1997

Anticipated Challenges

None

Progress Toward Completion

Activity completed

Changes in the Status in the Next Quarter

Not applicable

Deliverable No: A 2.32 b)**Deliverable Title: Co-op Program in Thailand for
Canadian students - 16 week program****Narrative**

Mr. John Soehl, Mechanical Engineering, Computer Applications, TUNS: Completed his Assignment at Babcock Hansa, Khorat, September - December, 1996.

One student from Food Science at Guelph is currently engaged in co-op placement in thailand, and one additional Food Science students from Guelph has an approved co-op assignment starting in May 1997.

Activity Planned During Next Quarter

Two additional students, 1 from Guelph and 1 from TUNS are scheduled for 16 week work placements in Thailand from May to August, 1997

Progress Toward Completion

Assignments will be completed by September 1997

Changes in the Status in the Next Quarter

One additional Canadian students was added to the budget. Total number of co-op placements in this deliverable has been changed from 4 to 5 assignments as agreed with the CUTC-SUT partners

Deliverable No: A4.11**Deliverable Title: Thai Project Implementation Unit****Narrative**

There has been a change in the project manager for the Thai management team. Dr. Tavee Lertpanyavit Vice Rector for Academic Affairs, SUT, has been appointed Project Manager. Dr. Tavee was able to participate in the April 1997 4th PRC meeting. He was involved in the early stages of the project and brings that knowledge to the position to provide continuity and direction.

SUT submitted a Semi-Annual Report for the period July-December 1997. *(See Appendix G)*

Activity Planned During Next Six-Months:

Joint planning with the Canadian management team to implement the project activities scheduled for the next six months.

Anticipated Challenges

No anticipated challenges at this time.

Progress Toward Completion

Ongoing for life of project.

* * * * *

Deliverable No: A4.21d**Deliverable Title: Canadian Management Team and Project Implementation Unit****Narrative**

In consultation with CUTC institutions, SUT and ARA, the CUTC project implementation unit designed, implemented and evaluated the various project activities and deliverables.

On February 12, 1997 a Mini-PRC meeting was held at SUT and attended by 4 CUTC representatives to discuss the progress of the project. SUT indicated that the 15% government budget cutback for the current year would affect their ability to support the scheduled project activities, particularly with respect to the IUP Program. Four teaching assignments (Third Trimester/SUT) in Electrical Engineering scheduled from May-September were cancelled. A meeting was called by the Canadian CUTC partners on March 11, 1997 at Ryerson Polytechnic University, Ryerson International to discuss strategies and solutions. Dr. Sam Mikhail, Project Manager and Dr. Stalin Boctor, Program Manager, met with R. Griffin, ARA, to advise of the constraints faced by SUT and to determine what future activities could be supported by the remaining project funds.

The required Semi-Annual progress and financial reports were submitted to ARA.

Anticipated Challenges

None

Progress Toward Completion

On target according to the project plan

Changes in the Status in the Next Quarter

None.

Deliverable No: A 4.32**Deliverable Title: Project Review Committee, Canada****Narrative**

Ten CUTC-SUT members participated in the Project Review Committee meeting held at TUNS on April 3 and 4, 1997. Dr. Tavee Lertpanyavit, Dr. Pongchan Na-Lampang, and Ms. Mantana Thammachoit participated from SUT. Dr. Bill Caley, Robert Eagle Feridun Hamdullahpur from Technical University of Nova Scotia and Dr. Gerry Schneider from University of Waterloo, and Dr. Jim Shute, University of Guelph, Dr. Stalin Boctor and Mary Jane Curtis were CUTC's official representatives at the meeting. (See Appendix G - PRC minutes)

Activity Planned During Next Quarter

None

Progress Toward Completion

Completed according to the project plan

Changes in the Status in the Next Quarter

5th PRC meeting schedule at SUT, January 12, 13, 1998, under deliverable A 4.311

2.3 FINANCIAL REPORTS

2.3.1 FINANCIAL REPORTS

FOR

CIDA FUNDED EXPENDITURES

Deliverable	Current Half Year			Project to Date			Estimated Expenditures to Completion	Delivery Completed
	Actual Oct-Mar/97	Budget Exp. Oct-Mar/97	Variance	Actual Exp. to Mar 31/97	Budget Exp. to Mar 31/97	Variance		
1. Institutional Capacity Building Program								
A1.11a) Training Academic Administrators (4)	0	0	0	36,789	36,789	0	0	Mar/95
A1.11b) Training Academic Administrators (1)	0	0	0	5,276	5,276	0	0	May/95
A1.21) Training Faculty Members	0	0	0	50,524	50,524	0	0	May/95
A1.31) Training Support Personnel	0	0	0	81,557	93,164	11,607	0	Oct/96
A1.32) Institutional Support Services	0	0	0	8,936	14,949	6,013	0	Oct/96
A1.41) Evaluate ESL Needs	0	0	0	9,095	9,095	0	0	Dec/93
A1.42) Study Tour ESL	0	0	0	16,581	16,581	0	0	Feb/94
A1.5) CUTC Additional Mgt Activities	0	0	0	31,500	31,500	31,500	0	Apr/96
Program 1 Sub-total	0	0	0	240,258	257,878	49,120	0	
2. International Academic Program								
A2.11a) Academic Program Planning	0	0	0	24,172	37,512	13,340	0	Oct/96
A2.11b) Academic Program Planning	16,709	0	(16,709)	16,709	0	(16,709)	0	Apr/97
A2.11c) Academic Program Planning	0	0	0	0	0	0	21,681	
A2.12a) Curriculum Implementation	0	19,200	19,200	21,840	25,600	3,760	0	Oct/96
A2.12b) Curriculum Implementation	0	0	0	0	19,200	19,200	0	Cancelled
A2.12c) Curriculum Implementation	1,695	0	(1,695)	1,695	0	(1,695)	3,005	
A2.12d) Curriculum Implementation	0	0	0	0	0	0	12,800	
A2.21) Selection Supervisors/PHD	4,600	0	(4,600)	15,835	10,637	(5,198)	0	Apr/97
A2.23) Ph.D Research	0	0	0	0	0	0	6,900	
A2.25) Post Doct. Research Fellowships	8,338	20,000	11,662	25,038	20,000	(5,038)	34,762	
A2.26) Thai Advisors visit to Canada	8,073	5,000	(3,073)	8,073	5,000	(3,073)	0	Apr/97
A2.27) Collaboration co-supervisors	0	5,670	5,670	0	7,560	7,560	0	Cancelled
A2.31a) Work Placements - Canada	8,000	8,000	0	16,000	8,000	(8,000)	0	Apr/97
A2.31b) Work Placements - Canada	4,000	0	(4,000)	4,000	8,000	4,000	12,000	
A2.32a) Work Placements - Thailand	0	16,000	16,000	16,000	16,000	0	0	Oct/96
A2.32b) Work Placements - Thailand	8,000	0	(8,000)	8,000	16,000	8,000	12,000	
A2.4) Workshop-Post-grad. Eng Prog/Control	0	0	0	0	0	0	51,100	New
A2.5) Academic Research Ex. Thai Faculty	0	0	0	0	0	0	31,500	New
Program 2 Sub-total	59,415	73,870	14,455	157,362	173,509	16,147	185,748	
3. University-Industry Linkage Program								
A3.11) Training Co-op Program	0	0	0	7,234	7,234	0	0	May/95
A3.21) Industrial Training Framework	0	0	0	3,775	3,400	(375)	0	Oct/96
A3.22) Training Seminars by Canadian Consult.	0	0	0	33,225	31,350	(1,875)	0	Oct/96
A3.23) Additional Ind. Seminars in Thailand	0	0	0	0	0	0	19,600	
A3.31) Monitor Co-op Students	0	3,400	3,400	3,775	3,400	(375)	0	Oct/96
Program 3 Sub-total	0	3,400	3,400	48,009	45,384	(2,625)	19,600	
4. Project Management								
A4.21a) Canadian Management Team -yr 1	0	0	0	34,320	34,320	0	0	Mar/95
A4.21b) Canadian Management Team -yr 2	0	0	0	35,759	35,759	0	0	Mar/95
A4.21c) Canadian Management Team -yr 3	0	0	0	32,881	32,881	0	0	Mar/96
A4.21d) Canadian Management Team -yr 4	16,848	18,105	1,257	34,416	36,210	1,794	0	Mar/97
A4.21e) Canadian Management Team -yr 5	0	0	0	0	0	0	38,002	
A4.31) Project Review Committee - Thai	0	0	0	22,298	22,298	0	0	Dec /95
A4.311) Project Review Committee - Thai	0	0	0	0	0	0	25,560	
A4.32) Project Review Committee- Can	10,225	14,100	3,875	24,491	28,200	3,709	0	Apr/97
A4.33a) Project Management	0	0	0	24,144	26,957	2,813	0	Oct/96
A4.33b) Project Management	5,873	14,435	8,562	5,873	14,435	8,562	20,539	
A4.33c) Project Management	0	0	0	0	0	0	25,000	
A4.41) Communication/Support	2,724	4,748	2,024	7,451	12,827	5,376	13,773	
Program 4 Sub-total	35,670	51,388	15,718	221,633	243,887	22,254	122,874	
Total	95,085	128,658	33,573	667,262	720,658	84,896	328,222	

THAI CANADIAN HRD PROJECT
PROJECT #L3004-91063
CIDA#906-14868

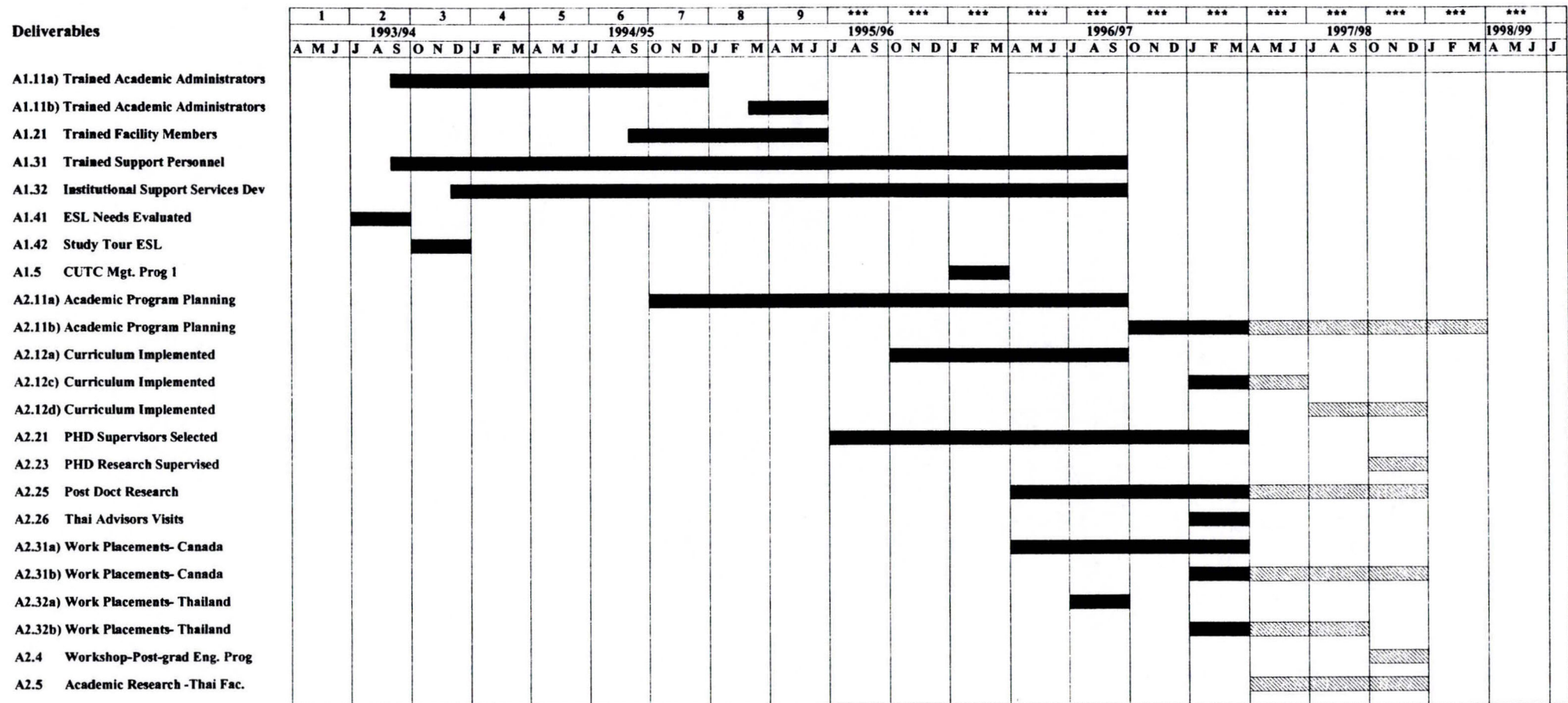
CIDA FUNDED EXPENDITURES
Forecast of Expenditures
As at March 31,1997

	Actual 1993/97	Budgeted 1997/98			Forecast 1998/99	Total Actual/ Budgeted	Total Contract	Variance
		1st Half	2nd Half	Total				
		Apr-Sept97	Oct-Mar98	Apr-Mar98				
Program 1								
Fees	118,642			0		118,642	118,642	0
Travel	121,616			0		121,616	121,616	0
Other				0		0		0
Subtotal	240,258	0	0	0	0	240,258	240,258	0
Program 2								
Fees	34,320	14,700	24,900	39,600		73,920	73,920	0
Travel	118,402	56,611	82,315	138,926		257,328	257,328	0
Other	4,640	4,360	2,862	7,222		11,862	11,862	0
Subtotal	157,362	75,671	110,077	185,748	0	343,110	343,110	0
Program 3								
Fees	15,300	3,000	1,500	4,500		19,800	19,800	0
Travel	32,709	10,067	5,033	15,100		47,809	47,809	0
Other				0		0	0	0
Subtotal	48,009	13,067	6,533	19,600	0	67,609	67,609	0
Program 4								
Fees	142,056	22,601	22,601	45,202		187,258	187,258	0
Travel	72,125	31,949	31,950	63,899		136,024	136,024	0
Other	7,452	6,887	6,886	13,773		21,225	21,225	0
Subtotal	221,633	61,437	61,437	122,874	0	344,507	344,507	0
Total	667,262	150,175	178,047	328,222	0	995,484	995,484	0

THAI CANADIAN HRD PROJECT
PROJECT IMPLEMENTATION SCHEDULE

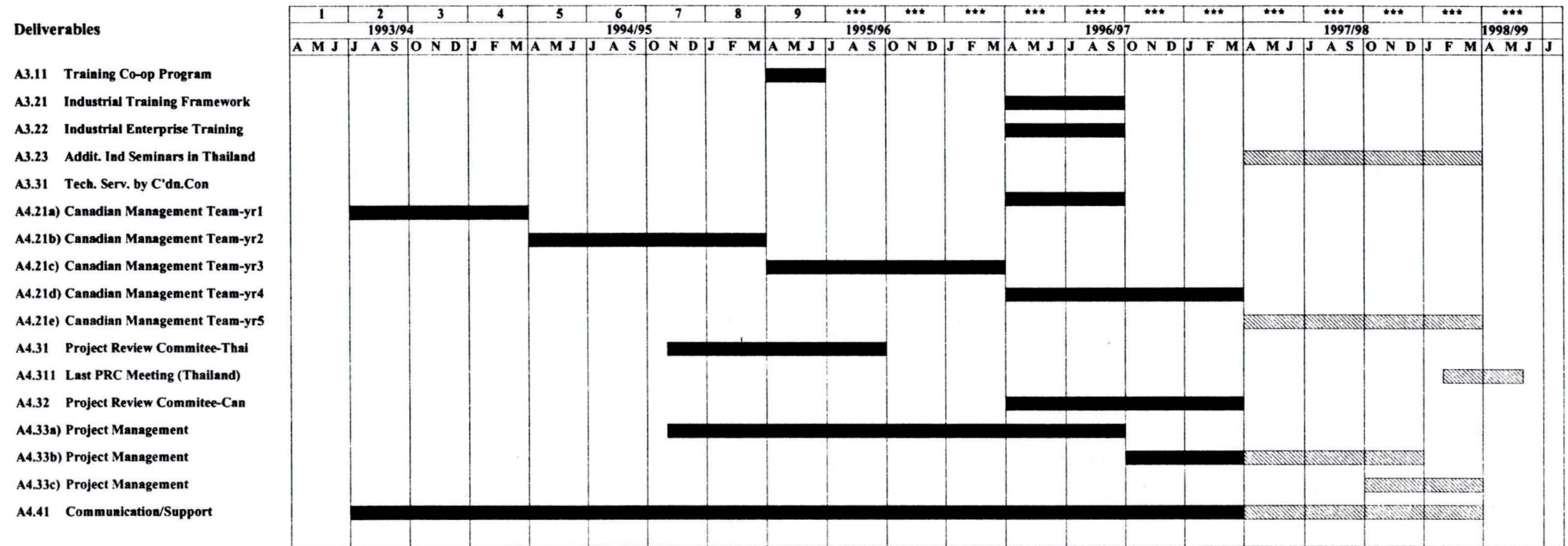
LINKAGE -CUTC & SUT
PROJECT NUMBER - L3004
START: JULY 15/93 FINISH : MARCH 31/98

Planned Actual



LINKAGE -CUTC & SUT
PROJECT NUMBER - L3004
START: JULY 15/93 FINISH : MARCH 31/98

Deliverables



2.3.2 FINANCIAL REPORT
FOR
CONSOLIDATED PROJECT EXPENDITURES

THAI CANADIAN HRD PROJECT
Linkage - CUTC & SUT
Project #L3004-91063
CIDA #906-14868

CONSOLIDATED PROJECT EXPENDITURES
Contract Summary
As at March 31, 1997

	1993/94 Actual	1994/95 Actual	1995/96 Actual	1996/97 Actual	1997/98 Budget	Total Actual/Budget	Contract Value	Variance
Program 1								
Fees	59,962	74,914	77,597	54,633		267,106	267,106	0
Travel	58,939	31,522	53,099	36,319		179,879	179,879	0
Other	0					0	0	0
Subtotal	118,901	106,436	130,696	90,952	0	446,985	446,985	0
Program 2								
Fees		6,000	9,000	746,190	263,644	1,024,834	1,024,834	0
Travel		10,663	29,365	252,620	641,867	934,515	934,515	0
Other		0		216,029	202,875	418,904	418,904	0
Subtotal	0	16,663	38,365	1,214,839	1,108,386	2,378,253	2,378,253	0
Program 3								
Fees		0	8,242	28,800	8,100	45,142	45,142	0
Travel		0	5,585	46,075	15,100	66,760	66,760	0
Other		0		80,000		80,000	80,000	0
Subtotal	0	0	13,827	154,875	23,200	191,902	191,902	0
Program 4								
Fees	77,900	80,298	83,302	88,446	127,087	457,033	457,033	0
Travel	2,833	11,896	27,170	45,849	71,479	159,227	159,227	0
Other	1,408	3,457	1,891	3,331	25,194	35,281	35,281	0
Subtotal	82,141	95,651	112,363	137,626	223,760	651,541	651,541	0
Total	201,042	218,750	295,251	1,598,292	1,355,346	3,668,681	3,668,681	0

Method of statement preparation: We are unable to accurately calculate the in-kind contribution of CUTC and SUT partners.
Therefore, we have apportioned each partner's contribution based upon CIDA's contribution and the partner's budgeted in-kind contribution.

Deliverable	Current Year - Apr 96-Mar/97			Project to Date			Estimated Expenditures to Completion
	Actual	Original Budget	Variance	Actual Exp. to March/97	Budget Exp. to March/97	Variance	
1. Institutional Capacity Building Program							
A1.11a) Training Academic Administrators	0	0	0	83,118	83,118	0	0
A1.11b) Training Academic Administrators	0	0	0	7,917	7,917	0	0
A1.21 Training Faculty Members	0	0	0	102,716	102,716	0	0
A1.31 Training Support Personnel	44,622	65,600	20,978	156,210	177,188	20,978	0
A1.32 Institutional Support Services	14,830	25,800	10,970	16,756	27,726	10,970	0
A1.41 Evaluate ESL Needs	0	0	0	17,578	17,578	0	0
A1.42 Study Tour ESL	0	0	0	31,188	31,188	0	0
A1.43 ESL Course Thailand	0	0	0	0	0	0	0
A1.5 Additional Management Activities	31,500	31,500	0	31,500	31,500	0	0
Program 1 Sub-total	90,952	122,900	31,948	446,983	478,931	31,948	0
2. International Academic Program							
A2.11 Academic Program Planning	28,949	32,814	3,865	73,596	77,461	3,865	27,559
A2.12 Curriculum Implementation	822,381	1,454,462	632,081	822,381	1,454,462	632,081	690,720
A2.21 Selection Supervisors/PHD	16,597	8,858	(7,739)	26,978	19,239	(7,739)	0
A2.22 PHD Courses Provided	100,000	600,000	500,000	100,000	600,000	500,000	100,000
A2.23 PHD Research	0	0	0	0	0	0	30,285
A2.25 Post Doct. Research Fellowships	75,725	58,400	(17,325)	75,725	58,400	(17,325)	106,022
A2.26 Advisors Monitor PH.D	11,687	7,400	(4,287)	11,687	7,400	(4,287)	0
A2.27 Collaboration Co-Supervisors	0	19,560	19,560	0	19,560	19,560	0
A2.31 Work Placements - Canada	75,500	19,200	(56,300)	75,500	19,200	(56,300)	45,300
A2.32 Work Placements - Thailand	84,000	112,000	28,000	84,000	112,000	28,000	17,500
A2.4 Workshop-Post grad Eng Prog./Control			0			0	59,500
A2.5 Academic Research Ex-Thai Faculty			0			0	31,500
Program 2 Sub-total	1,214,839	2,312,694	1,097,855	1,269,867	2,367,722	1,097,855	1,108,386
3. University-Industry Linkage Program							
A3.11 Training Co-op Program	0	0	0	13,827	13,827	0	0
A3.21 Industrial Training Framework	13,275	12,900	(375)	13,275	12,900	(375)	0
A3.22 Industrial Enterprise Training	128,325	126,450	(1,875)	128,325	126,450	(1,875)	0
A3.23 Additional Ind Seminars in Thailand			0			0	23,200
A3.31 Monitor Co-op Students	13,275	12,900	(375)	13,275	12,900	(375)	0
Program 3 Sub-total	154,875	152,250	(2,625)	168,702	166,077	(2,625)	23,200
4. Project Management							
A4.11 ThaiProject Implem. Unit	25,875	23,288	(2,587)	87,975	85,388	(2,587)	51,750
A4.21a) Canadian Management Team	0	0	0	57,200	57,200	0	0
A4.21b) Canadian Management Team	0	0	0	59,598	59,598	0	0
A4.21c) Canadian Management Team	0	0	0	54,802	54,802	0	0
A4.21d) Canadian Management Team	57,360	60,350	2,990	57,360	60,350	2,990	0
A4.21e) Canadian Management Team	0	0	0	0	0	0	63,337
A4.31 Project Review Committee - Thai	0	0	0	28,394	28,394	0	32,360
A4.32 Project Review Committee- Can	31,124	35,400	4,276	31,124	35,400	4,276	0
A4.33 Project Management	14,936	28,511	13,575	36,242	49,817	13,575	51,119
A4.41 Communication/Support	8,331	17,229	8,898	15,088	23,986	8,898	25,194
Program 4 Sub-total	137,626	164,778	27,152	427,783	454,935	27,152	223,760
Total	1,598,292	2,752,622	1,154,330	2,313,335	3,467,665	1,154,330	1,355,346

Method of statement preparation: We are unable to accurately calculate the in-kind contribution of CUTC and SUT partners.
Therefore, we have apportioned each partner's contribution based upon CIDA's contribution and the partner's budgeted in-kind contribution.

The Challenges of Co-operative Engineering Education

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Introduction

The challenges of the co-operative system of Engineering education will be discussed. Our concern will be with the usefulness of the system with respect to the purposes of education, although some mention of organizational, administrative, and financial issues will be included.

Co-operative education has been widely praised as a highly effective system of education, particularly by those institutions that have adopted the system. However, there is no system that cannot be improved in some way and the claimed advantages of the system do not come without some associated cost. A true measure of cost-effectiveness has yet to be realized; thus, much of this article will necessarily be qualitative in nature.

Co-operative education has been remarkably successful at the University of Waterloo. It is largely responsible for raising the institution to be a major force in Canadian (North American) higher education within the short span (in university measures) of 40 years. Waterloo employs the conventional, alternating work and academic terms, co-operative program that is mandatory for the 3600 undergraduates enrolled in the Faculty of Engineering at Waterloo.

In the following pages, some background for the co-operative Engineering program at Waterloo will be provided followed by some of the issues and challenges affecting this system of study in an Engineering education environment.

Background

Co-operative education was introduced into Canada with the organization of the University of Waterloo in 1957. Seventy-five (75) students were enrolled in that year in a mandatory co-operative Engineering program in Chemical Engineering. The program expanded rapidly in enrolment and into disciplines other than Engineering. At present the co-operative enrolment is approximately 9,000 students comprising about 60% of the total undergraduate enrolment. Of these, 3600 are enrolled in Engineering making Waterloo the largest Engineering school in Canada. The co-operative program at the University of Waterloo is the second largest in North America.

Waterloo uses the conventional system of alternating periods of on-campus academic study interspersed with practical work experience at employer organizations. There are eight academic

terms and six co-operative work terms. Engineering students enrol in the co-operative program in September and complete their first academic term on campus. The freshman intake is about 750 students per year. Beginning in the following January, approximately one-half of the students begin their first four-month work term in a business, industry, or government setting while the remaining students continue on-campus to complete their first year of studies. In the following May, the two groups of students exchange the nature of their activity and this establishes the alternating academic/work term sequence on a year-round basis. This alternating schedule is maintained until the fourth year of academic studies. The fourth year students entering 4A (the first academic term of fourth year) in the fall term continue for eight months in their academic studies. All students are again on campus for their 4B (final) term of academic studies.

Students must successfully complete a minimum of five (of the possible six) successful work terms in order to graduate. Employers complete a performance evaluation for the student(s) they employ, discuss the evaluation with the student(s), and submit the evaluation form(s) to the University for entry on the students' co-operative record file. In addition to the requirement for five successful work terms, students must submit at least four work-term reports that are graded satisfactory or better. These work-term reports must report in detail on some technical aspect of their work term and are judged for analysis and design as well as for communication skills including layout, organization, grammar, spelling, and clarity of presentation.

The administration of the work terms at the University of Waterloo is performed by the Department of Co-operative Education and Career Services (CECS). Although faculty members are not directly involved in this aspect of the program, close ties are maintained between CECS and the Faculty on a personal level and via committees within the Faculty on which CECS has contributing and voting members. Examples of such committees include Engineering Faculty Council, Engineering Faculty Undergraduate Studies Committee, and Engineering Examinations and Promotions Committee. Much of the formal communication between the Faculty and CECS has traditionally been undertaken through the Associate Dean of Engineering for Undergraduate Studies; however, recently a Director for Liaison with CECS and the PEO (Professional Engineers of Ontario) has been appointed who reports to the Associate Dean. Close contact and liaison between the Faculty and CECS is deemed to be sufficiently important to warrant such a dedicated position, albeit not a full-time one.

At Waterloo, assignment of students to jobs takes place during the on-campus academic term immediately prior to the work term at hand. It is expected that a student will return to his/her employer for at least a second term if a job is available. Each term, approximately 1500 engineering students require co-operative employment, including those that will be returning to their employer for a second (or third, etc) work term. Traditionally, 85-90 % of the students obtain jobs in the private sector with the balance being employed in various federal, provincial, or municipal agencies, governments, or organizations. Of approximately 2,500 potential employers of Engineering students contacted each term, about 450-500 actually hire students. While there are about 12 employers who hire more than 20 students each term, the majority hire fewer than three students and about 60 % of employers hire only one student. In the Canadian (North American) economic climate, the trend is to have increasingly more employers each of which is hiring, on average, increasingly fewer students.

The Challenges

In the following, some of the challenges facing co-operative Engineering education will be presented. These will be presented in brief form, with the issues identified and succinctly described. In some cases, the issues will be culturally dependent as to their importance; some issues related to local economy and culture may have been missed entirely. A discussion of all of the challenges of co-operative Engineering education is highly perspective dependent. Nevertheless, some of the important challenges are presented below.

Industrial Linkage

It is crucial to form strong links with industrial and government concerns. The nature of this linkage must reflect a commitment from the industry to the continued participation in the co-operative program. There are responsibilities that the industry must fulfill including student performance evaluation, job description preparation, interview participation, and co-ordinator interview participation. This commitment must in turn reflect the recognition by the industrial 'partner' that this is **not** a student aid or training program; the industrial partner must be convinced of the actual benefits that accrue to it through the program. The remuneration package must be an appropriate full-time rate for a student Engineer. In some countries this will represent a cultural barrier that must be overcome.

Institution Commitment

The University must demonstrate commitment to the concept of co-operative education. This requires a significant infrastructure within the University, some of this being physical and much of this being human resource in nature. The 'co-ordinators' are required to interact with the students both on campus and on the job. Job development personnel are required to continuously develop (secure) jobs from partner industries and government offices. Internal record-keeping is required for promotion, evaluation, communication and discipline purposes.

Meaningful Jobs

The jobs that are offered as part of the co-operative Engineering education program must be meaningful and appropriate for the student and for the employer. A co-operative job is **not** just a job! The job must provide a meaningful learning, employment, and contributing environment for the student yet it must also provide a return on investment for the employer. The employer should want to participate because it recognizes the benefit to itself.

Responsible Students

The admissions process must develop a student population that has a strong work ethic, understands the co-operative education process, and understands the students' responsibility in this process. The student must be willing to accept that not all jobs will meet his/her expectation but that this is part of the process. The student must act responsibly on the job and contribute to the goals of the employer. The student must understand that the purpose of the co-operative work term from the his/her perspective is to produce a superior Engineer on graduation and not to simply finance his/her education. Here again, there may be some cultural barriers to overcome.

Faculty Commitment

Individual faculty members must be committed to the concept of co-operative Engineering education. They will be involved in marking work reports, their classes will be disrupted by students coming from and going to job interviews, some students will want special arrangements for job-related matters, etc. Where faculty members do not appreciate the benefits of the co-operative education environment, they will become resentful and impose barriers to the smooth and cooperative implementation of the program.

Government Commitment

There are additional expenses involved in running a co-operative education program in excess of those required for a 'regular' program. These expenses are not insignificant and place an additional financial burden on the University. Where government funding is used to operate the University, it would be very useful if the University grants recognized these additional burdens in a tangible way. Unfortunately, the government recognition generally does not come in the form of additional financial support.

Graduate Student Population

Engineering graduates from a co-operative Engineering program generally are far better prepared to enter the work force and begin contributing in a meaningful way than are the graduates from the 'regular' programs of conventional Universities. Industry is generally eager to acquire these graduates, offering them very attractive salaries. As a result, graduates move directly into industry under the temptation of high salaries and do not consider graduate school as an option. It can be argued that we lose some of our best students to industry in this manner.

Academic Term Dynamics

The nature of a co-operative program of study is one of constant interchange between the work term and the academic term. Students must frequently travel significant distances in making the transition, and when they arrive on campus, because of their short term time, there is no time to spare. Students and instructors must move into high gear immediately. Exams must occur every four month term, and as a result the 'teaching time' is further reduced so that the time on campus must be used very effectively.

University Identification

Normally, a four year residence at a university builds identification and loyalty. The residency is not only an important learning experience for the student but is an important bridge for the University to alumni support. Co-operative students, with their frequently interrupted attendance, are often unable to live on campus. Even when they do, the lack of continuity and of long periods at the University considerably hinders their ability to identify with the University. A strong group identity does develop in the co-operative program but it is restricted to the group or stream with whom students make their way through the program. A lesser identification occurs with the program as a whole, and an even lesser identification occurs with the University.

Social Isolation

A problem analogous to the one above is that of developing contacts with students in other disciplines besides Engineering. Movement between the work term job and the campus and frequent changes in housing arrangements hinders the building of long term friendships based on a living group, on clubs, or on other student activities. In many cases clubs and student government offer students invaluable training in leadership and administration but the intermittent presence of the students on campus makes it difficult for co-operative students to take on officer positions. University athletics poses a similar problem.

Closure

The foregoing presents some of the challenges facing the implementation of a co-operative Engineering education program. As can be seen, they are many so the task is not an easy one. However, the benefits are great. Benefits to the student and to the University include the following: increased learning through the experiences that the students bring to the classroom; increased learning through the interactions of students with each other; research ideas and challenges that come to the University from the students' work experiences; increased student maturity through the work-term experience; increased student maturity through the requirement to change venue every four months; research funding and opportunities through the employer-student identification of potential need/expertise alignment; innovation that results from the non-conservative co-operative environment; in situ sensors of change in the workplace in the form of students; and, soon to be realized in Ontario, reduced experience requirements for professional registration as a result of the work experience gained on co-operative work terms. As noted in the introduction, however, a true measure of cost-effectiveness has yet to be realized.

At Waterloo we are firmly convinced that the benefits of co-operative Engineering education far outweigh the costs of implementation.

Thai-Canadian Collaboration in Human Resource Development

The SUT/CUTC Project

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Dr. W. Caley and Dr. F. Hamdullahpur, Technical University of Nova Scotia

INTRODUCTION

In 1991, CIDA decided to provide \$10M to support ten HRD collaboration projects between Canadian universities and corporations and their Thai counterparts, intended to enhance the development of human resources in Thailand, particularly the Engineering, Business and Technology related disciplines, and encourage long term collaboration between the Canadian and Thai partners in these fields. Dr. Wichit Sris-an and the Ministry of University Affairs were the projects' main driving force in Thailand, and through their excellent coordination and planning the ten projects were launched in 1993.

THE SUT/CUTC PROJECT

One of the first projects to be launched was the SUT/CUTC project, with a total budget of about \$6.0 M, of which CIDA's contribution is about \$1.0 M. The Thai partner is the newly established Suranaree University of Technology, and the Canadian partner, the "Canadian Universities Technology Consortium," consists of four institutions: Ryerson Polytechnic University, University of Waterloo, Technical University of Nova Scotia and the University of Guelph. Over the five year duration of this linkage project, the approved activities and deliverables are designed to provide mutual benefits and ultimately result in sustainable and enduring institutional relationships, particularly in the field of Human Resource Development.

The Project Activities and Deliverables

To achieve the goals of this novel institutional linkage and technical cooperation project, three specific programs were designed to provide the project deliverables.

I) Institutional Capacity Building Program

To support the institutional development and capacity building of SUT, four major activities were implemented:

1. Development of Academic, Administrative and Management Framework at SUT

Customized programs were designed for five SUT academic administrators in the areas of academic planning, policy development,

system of governance, curriculum planning and development, research administration, academic standards and promotion, and admissions procedures. The exposure of the SUT personnel to these areas of academic activities at the CUTC institutions provided them with various ideas to assess the benefits of implementing similar or modified management procedures at SUT.

2. *Development of Academic Programs and Curricula at SUT:*

Seven academic chairs and coordinators visited the CUTC partner institutions on customized programs to assess the curriculum development and planning activities, laboratories, equipment, computer facilities, and research programs in various areas of applied science and engineering disciplines.

3. *Development of Institutional Support Services*

Customized training programs were designed for 10 SUT personnel in the areas of library automation, computerized management and information systems, and maintenance of scientific equipment, at the various campuses of the CUTC partner institutions. Also, Canadian consultants visited SUT to assess and provide recommendations about library automation, management information systems (MIS) and computer support systems.

4. *Establishment of ESL Centre at SUT*

Two SUT professors in ESL visited various ESL centres in Canada, and a Canadian consultant assessed and provided planning and curriculum related recommendations about the establishment of the ESL centre at SUT. This centre has now been in operation for about three years and provides valuable language proficiency services to all of SUT's students.

II) International Academic Program

Three major areas of activities constitute the novel components of this program:

1. *International Applied Science and Engineering Programs (IUP):*

Curriculum planning and implementation activities were undertaken by CUTC professors in collaboration with SUT professors to design and deliver four international undergraduate engineering and applied science programs in the fields of Mechanical, Electrical and Chemical engineering and Food Technology. These programs anticipated serving international students from South East Asian countries in those critical engineering areas which are essential in support of the expansion of industrial developments in SE Asia. The language of instruction in all of the curriculum course material is English. The curriculum design takes into

account the opportunities available to the undergraduate students in these programs to transfer to the CUTC partner universities to complete their degree requirements, either after the first or the second year(s) of their undergraduate programs. Hence the curriculum for at least the first two years were mostly transplanted from the partner Canadian universities. This also implied that those transfer students could then earn Canadian bachelor degrees and become eligible to be licensed as Professional Engineers in Canada.

This is the second year of implementation of these IUPs. As many as twelve Canadian professors have been assigned to SUT to help in the delivery and curriculum development of the different course material. Thai students in Mechanical Engineering have already transferred to Canadian universities, and another group of Electrical Engineering students are expected to transfer this year.

We expect that these programs once they overcome the growing pains, will have long-term impact on the human resource development in Thailand and the SE Asian countries. This is also an area of enduring and sustainable relationships.

2. Joint Research and Ph.D. Program

Junior faculty members at SUT, with the support of scholarships for the Thai Ministry of University Affairs, are given the opportunity to pursue their graduate studies to obtain their Ph.D. degrees at the CUTC partner universities. At present, three such doctoral candidates are enrolled at TUNS and it is anticipated that another three candidates will take part in this aspect of the project. To strengthen the collaborative nature of these activities and its long-term sustainability, the Canadian graduate supervisors will visit SUT to discuss and explore the long-term continuation of such research activities with their Thai counterparts. Further, four postdoctoral scholarships were provided to SUT faculty members, to renew and expand their research activities at the CUTC partner universities. We expect that such postdoctoral research opportunities will also lead to on-going sustainable research collaboration in the future. Also, three senior professors from the CUTC partner universities will provide consultancies to SUT to support, and collaboratively plan the development of postgraduate engineering programs at SUT.

3. Co-op Student Exchange Program

Through this program 8 Thai and 8 Canadian students will be assisted by the project in securing co-op placements in Canada and in Thailand

respectively. The objective of this activity is to provide seed funding to convince industrial and governmental institutions of the viability and benefits of cross-cultural and cross-technological exposure of undergraduate students in both countries to the international development occurring in their fields. To date, seven Canadian students and four Thai students have completed their co-op assignments.

III) University-Industry Linkage Program

SUT, through its newly established Technopolis and its Centre for International Affairs, has established many university-industry linkages, particularly in the areas of continuing education and specialized industrial seminar series and conferences. Canadian professors from the CUTC partner universities and industrial consultants have contributed to these activities and provided seminars and lectures in such fields as University-Industry linkage projects, water resource management, environmental management issues, Internationalization of Higher Education, Computer Integrated Manufacturing, etc. This is another area that promises sustainable and mutually beneficial long-term collaboration.

Project Management and Project Review Committee (PRC)

An important aspect of the project was the unique management structure adopted in the early stages of the project design. Each of the partners, SUT and the CUTC, established a steering sub-committee. Frequent dialogue and on-going communications between these sub-committees, together with the annual meeting of the whole PRC (in Canada and in Thailand) helped overcome perceived and anticipated difficulties even before they arose. Through these PRC meetings, review and assessments of completed activities were discussed, and planning for implementation and/or minor changes in the project deliverables and activities took place in a collegial and friendly atmosphere. This open and frank dialogue helped immensely in steering the project towards its successful completion.

CONCLUSION

The authors wish to express their pride in taking part in this exciting, stimulating and gratifying project, and also wish to express their sincere thanks to CIDA, SUT and the Thai Ministry of University Affairs for making this project a reality. The achievements of this project and its goal of mutual benefits and sustainable institutional relationships provide an excellent viable example for international cooperation and collaboration. We hope to see many such linkage projects established in the near future, ushering in a new century of open markets, global exchanges and communications and maybe one day a borderless world.

QUALITY ASSURANCE IN ENGINEERING EDUCATION ENGINEERING ACCREDITATION IN CANADA

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Introduction

The practice of the engineering profession in Canada is governed by legislation at the provincial level. Like most professional fields of endeavours that involve public liability issues, society needs to be assured of the quality, qualifications and ethical conduct of those people practising the profession. Each of the ten provinces in Canada has its own Professional Engineering licencing body. In order for a graduate engineer to be able to practice his/her profession, he/she must be a member of and licenced by the provincial body where he/she expects to be employed.

Instead of a system involving provincial licence examinations in each of the engineering disciplines, as is the case in the United States, the Canadian provincial engineering associations formed the Canadian Council of Professional Engineers (CCPE). One of the four standing boards of the CCPE is the Canadian Engineering Accreditation Board (CEAB). The main objective of the CEAB is to conduct cyclical assessments of the 33 colleges of engineering, at the various Canadian universities and undertake a thorough review of each of the engineering programs offered at the various Faculties. The successful evaluation by the CEAB of the engineering programs at a specific university provides an indication to all of the provincial licencing bodies that the graduates of these "accredited" programs are eligible for licencing, after an internship period (three to four years) and after successfully completing the "Professional Practice and Ethics" examination. A new engineering program is usually assessed for the first time while the final year of the program is being implemented, i.e. just before the graduation of the first class of graduants. The quality assurance assessment conducted by the CEAB and the exhaustive parameters used for these evaluations are of prime importance to all of the Faculties of Engineering at the various Canadian universities; particularly in the design of the undergraduate engineering curricula and in the establishment of the engineering educational environment.

This paper will briefly discuss the evaluation parameters and the procedure used to assess the quality of engineering programs in Canada.

Accreditation Criteria

These criteria, which fall under three categories, are formulated to ensure that the graduates of a specific program are provided with an academic education that meets or exceeds the professional registration requirements, placing special emphasis on the quality of the graduates, the academic and support staff and the educational facilities (such as laboratories, library, computer centre, etc.).

I - General Criteria

- The engineering undergraduate program must develop an individual's ability to use appropriate knowledge and information to convert, utilize and manage resources optimally through effective analysis, interpretation and decision making (i.e. the design process).
- Overspecialization in curricula is discouraged, exposure to fundamental knowledge of other branches of engineering and innovative educational development are encouraged.
- The graduate must be adaptive, creative, resourceful and responsive to changes in society, technology and career demands. The graduate must also be aware of the role and responsibilities of the professional engineer in society and must be able to communicate effectively within society at large.

II - Curriculum Content

Judgement is applied to both the qualitative and quantitative aspects of each of the criteria used to assess a specific program's curricular content.

An accreditation unit (AU) is used to assess quantitatively the various components of the curriculum. One AU is 1 lecture hour, or two tutorial or laboratory hours. For example, a three-hours lecture/two-hours laboratory per week, in a course offered over a 13-week semester, would be equivalent to 52 AU. An activity that is not properly described by specific contact hours, like Thesis Projects and Design Assignments, can be evaluated by multiplying the credit units assigned by the university to such activity by a mathematically derived proportionality factor, to arrive at the equivalent AU units. The minimum content of each curricular category is defined as follows:

Mathematics: 195 AU, including algebra, differential and integral calculus, differential equations, probability and statistics and numerical analysis.

Basic Science: 225 AU, including elements of physics, chemistry, life and earth sciences. These subjects are intended to impart an understanding of natural phenomena and relationships.

Engineering Science and Engineering Design: 900 AU of the combined subject matter, but no less than 225 AU in each category. The remaining 450 AU could be any combination of Engineering Science and Design as deemed desirable by the specific program and institution. Engineering Science subjects have their roots in basic science and mathematics but carry the knowledge further towards creative applications, like modelling and numerical techniques, simulation procedures, materials, fluid mechanics, thermodynamics, electrical and electronic circuits, computer science, soil mechanics, control systems, aerodynamics,

transport phenomena, environmental studies, etc.

Engineering design integrates mathematics, basic and engineering science and complementary studies to develop systems, elements, processes to meet specific needs. Such activity is characterized by its creative, interactive and often open-ended nature.

Appropriate content requiring the application of computers must be included in this component of the curriculum.

Complementary Studies: 225 AU, covering studies in humanities, social sciences, literature, management, economics and communications, that complement the technical content of the curriculum. Considerable latitude is provided in the choice of suitable courses, but this category must include studies in engineering economics, the impact of technology on society and must develop the students' capability to communicate effectively.

The remaining 235 AU can be assigned to any category as deemed appropriate and desirable by the program. The entire program must include a minimum of 1800 AU. Laboratory experience must be an integral component of the engineering curriculum. The total instructional AU content of a given course does not include final examination and can be split between different categories (normally two).

III - Program Environment

The emphasis here is placed on the qualitative evaluation of the program's environment, including:

- Quality of students, faculty, support staff, teaching assistants, administration of the program, the laboratories and computing facilities, library resources and other supporting facilities.
- The moral, commitment, experience and engineering competence of the faculty members. The majority of the faculty must be full-competence of the faculty to assure adequate levels of student-faculty interaction, curricular counselling development and control of the curriculum.
- Faculty teaching workload should allow time for adequate participation in research and professional development activities.
- Faculty members teaching the engineering science and engineering design component of the curriculum are expected to have a high level of competence and dedication to the engineering profession. This criteria is assessed through faculty qualifications, experience, level of scholarly activities, participation in professional and learned societies and registration as professional engineers.
- The Deans and Chairs of engineering programs are expected to provide effective

leadership and to have achieved a high standing in the engineering community. They are expected to be professional engineers.

- The Engineering Faculty Council, or equivalent, must have effective control of the engineering programs and their curricula.
- The academic admissions, promotion and graduation policies adopted by the Engineering Faculty must verify that the students have demonstrated competence in the courses taken. The definition of competence should be acceptable to the CEAB.

Accreditation Procedures

The CEAB reassesses all of the accredited programs (about 210) at intervals not exceeding six years. At the invitation of an institution to the CEAB, by January 1 of the year in which the visit is to take place, the CEAB sends documentation to the institution, including structured questionnaires, documents required by the visiting team, schedule of events and procedures to be followed before, during and after the accreditation visit. A visiting team chair, usually a board member of the CEAB is selected, and the chair selects his team, which normally includes a vice chair and a program visitor specialist for every program to be assessed at the specific institution. The composition of the team members is specified by the Professional Engineering Licensing Association in the province of the assessed institution. All members of the visiting team must be professional engineers. At least six weeks before the date of the visit (usually in October or November), each member of the team must receive the appropriate documents requested from the institution.

The Accreditation Visit

The accreditation visit normally takes two days. The team members assess qualitative factors such as environment, morale, professional attitudes, quality of students, staff and faculty; and may request clarifications regarding certain issues raised through the questionnaire submitted by the institution. The activities undertaken by the visiting team include:

- a) interviews with the President, the Vice President (Provost), the Dean of Engineering and the Chairs of the engineering programs being assessed;
- b) interviews with faculty members, staff members and students;
- c) tour of the facilities such as labs, computing facilities, libraries, etc;
- d) review of recent examination papers, laboratory manuals, student transcripts, sample student work, reports and projects, course outlines (management sheets) and textbooks used in the various courses of the programs' curriculum;
- e) before the end of the visit, an exit interview is conducted between the team members and the Dean and Chairs of Engineering, to review the perceived strengths and weaknesses of the programs and to indicate areas of concern.

Reports and Decision

Six to eight weeks after the accreditation visit, the chair of the visiting team sends a written report, including the individual findings of the team members, to the CEAB and then to the Dean of Engineering at the institution. The Dean and the Chairs could respond to the team's report and may advise on improvements being implemented in the current academic year.

The CEAB board meets normally in June, to assess the institution's dossier, including the original submission, the visiting team's report and the institution's response to the report. The Dean is invited to respond to any questions from the (13) board members and may make a presentation to the board if he/she wishes. The accreditation decision is then made at the conclusion of the board meeting, regarding each of the programs being assessed.

If the CEAB board has no concerns, the program is deemed to meet the accreditation criteria and is granted the maximum six-year accreditation term. Accreditation for a term less than six years, normally three, is granted to programs when the board feels that certain concerns need to be overcome. A reassessment visit may then take place near the end of the accreditation term. Depending on the nature of the concerns, the board may require a report (instead of a visit) to be submitted to the CEAB at the end of the three-year term and upon favourable review, the board may extend the accreditation term for another three years before the revisit occurs.

If the CEAB judges that significant weaknesses currently exist in the program being assessed, either a limited term termination notice or denial of the accreditation decision is made. Before the end of the term termination notice, an institution may write a report to the CEAB explaining the major improvements made to the program(s). The CEAB, upon reviewing such a report, may then re-initiate a new cycle of assessment visit, or may decide to terminate the accreditation on the end date of the termination notice.

The accreditation decision is conveyed by letter to the Dean and the President of the institution whose programs are being assessed. The Dean could then convey the CEAB's decision to the faculty, staff and students.

Conclusion

For over 30 years, the experience of the Canadian universities with the engineering education quality assurance process provided by the CEAB accreditation procedure, has been favourable. At times, some institutions may have confronted some difficulties. However, through feedback and discussions, the process has been fine-tuned over time and does indeed provide a very valuable service to the profession.

UNIVERSITY-INDUSTRY LINKAGES IN ENVIRONMENTAL ENGINEERING

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SUMMARY

Linkages between university and industry in environmental engineering is presented in terms of educational programs and research activities. The current state of the environmental industry and the driving forces for the demand of environmental products and services are also reviewed. Government is found to play the most important role in creating the demand and also provides most of the research funding for environmental research, which is becoming increasingly a multi-disciplinary effort.

1. INTRODUCTION

Before considering environmental engineering linkages between university and industry in Canada, it is useful to look at the environmental industry itself. It is important to realize that the environmental industry is only about ten years old even though environmental issues have been addressed in different industries for many decades. It should also be understood that environmental engineering as a discipline is relatively new and much of the environmental activities are still found in traditional engineering disciplines, such as civil and chemical engineering. They deal mainly with the environmental aspects of the pulp and paper industry, petrochemical and related industries, mining industry, manufacturing industry, and the municipal sector. Although the evolving environmental engineering discipline and industry cover the same areas, they are interested in a broader spectrum of environmental concerns, including the remediation of past mistakes and the introduction of new environmental management process and technology. For this reason environmental engineering has a significant multi-disciplinary component.

Environmental attention of many product manufacturers, such as the consumer product industry, has shifted from production processes to the product itself. Today, product R&D has to take into account a large amount of government regulations and market requirements, such as the recycling and re-use of packaging, energy efficiency and emissions standards in use, and take-back guarantees

at the end of service life. An excellent example is the disposable diaper industry which has been forced to redesign the product to make it more environmentally acceptable. The industry has spent millions of dollars on life-cycle analyses to determine the cradle-to-grave impact of the diapers and on the development and promotion of recycling methods, such as composting.

2. ENVIRONMENTAL INDUSTRY

The Canadian environmental industry consists of about 5000 companies which provide technologies, processes, products and services. Although there are some large multinational corporations, the majority of companies are small to medium-sized, employing less than 50 people. However, like many growing industries with a large number of small companies, the environmental industry is undergoing restructuring and consolidation as smaller companies are being bought up by larger ones. The total employment is probably in excess of 150,000 engineers, scientists, technologists and technicians.

Canada's domestic market for environmental goods and services in 1994 was about \$11 billion and is expected to increase at a rate of 10% per year to \$22 billion by the year 2000. About 70% of environmental companies sell services, such as waste handling and facility operation, consulting services, environmental pollution and related field services, environmental research, natural resource conservation and protection. Waste handling and environmental facility operations is the largest component of the service sector, accounting for 65% of the total service sector income of \$5 billion in 1994. Consulting services and construction contribute about 20% and 10%, respectively.

The other 30% of the companies represent the environmental manufacturing sector with yearly revenues of \$6 billion. Equipment for water pollution control accounts for 40% of the equipment manufacturing income, followed by air pollution control equipment (25%) and solid waste management/recycling equipment (25%). The remaining 10% includes the production of monitoring, chemicals (especially chlorine for water treatment plants), laboratory equipment, noise control equipment, and equipment for natural resource conservation.

Canada's share of the world market for environmental products and services was 3.5% in 1994 but is growing rapidly. The primary market for Canadian exports is the United States. In general, the total world market for the environmental industry is expected to reach \$600 billion by the year 2000, with the U.S. market alone being \$200 billion. However, the fastest growing markets (perhaps an average of 15% per year) during the next few years are expected to be the industrialized nations of central and eastern Europe, Latin America, The Pacific Rim and Southeast Asia.

3. DRIVING FORCES

The driving forces for the demand of environmental goods and services can be summarized as follows:

1. Compliance with ever increasing federal, provincial and municipal legislation and policies.

2. Economic growth, which creates the need for environmental goods and services at new industrial plants to meet environmental standards.
3. Population growth, which generates the demand for water and waste water treatment, and solid waste management facilities.
4. The increasing demand by consumers for environmentally-friendly "green" products.
5. Increased corporate environmental consciousness resulting from a public relations need to show a strong environmental record.
6. The general acceptance of the concept of sustainable development which forces governments and industry to consider long term environmental implications of economic and social growth. (Brundtland, 1987)
7. Improved competition, such as resulting from ISO 14000.
8. Increased profits due to minimization of waste and waste treatment, recycling, reduction in packaging, energy savings, etc.

Currently, compliance with legislation and policies is probably the most significant reason for the growth of the environmental industry. The manufacturing sector will benefit from legislation regarding air pollution control, such as reduction of NO_x and VOC's, control of green house gases, SO₂ emissions from major point sources, and other toxic emissions. Water pollution control will require equipment and technologies for the implementation of "closed loop" systems, water separation technologies, water filtration, mobile pretreatment of water before final disposal, run-off from parking lots, on-site solvent reclamation in case of spills, UV treatment of water as an alternative to chlorine, water treatment services and membrane separation. Integrated solid waste management will require equipment and technologies for soil remediation, material recovery facilities, composting facilities, and recycling plants. Additional needs will be for computer software and hardware, incineration equipment, solid waste collection, handling and disposal equipment and systems.

Of course the service sector will grow accordingly. Consulting services are expected to grow significantly, especially in the areas of environmental audits, impact assessment, integrated solid waste management master plan development, public consultations and education, emergency response systems, geographic information systems, software development, energy conservation, site remediation studies, and project management.

4. EDUCATIONAL UNIVERSITY-INDUSTRY LINKAGE IN ENVIRONMENTAL ENGINEERING

Education and training programs to serve the environmental industry have increased considerably in the past decade but are still in a developmental stage. Depending on the requirements, the education and training can be obtained at universities, colleges and technical institutes, contract training, and in-house training programs.

4.1 Undergraduate Education

At the undergraduate university level there are four types of programs where environmental expertise

can be obtained; namely, civil and chemical engineering programs, environmental engineering programs, environmental science programs, and course electives found in engineering, physical or biological science programs.

Most traditional civil and chemical engineering programs have environmental options. Civil engineering mostly covered the areas of municipal wastewater treatment, sediment transport, landfill design, and urban water supply. Chemical engineering generally addressed industrial environmental problems, such as air pollution control and industrial wastewater treatment using chemical processes. Many such programs have introduced new environmental electives and minors to broaden the scope of environmental training.

However, in the past few years engineering faculties at the Universities of Guelph, Regina and Windsor developed new environmental engineering programs accredited by the Canadian Engineering Accreditation Board (CEAB). The enrolment at these three institutions in 1995 was 243, 127 and 75, respectively (CCPE, 1996). The objective of these programs is to develop engineers with a scientific appreciation of the ecosystem and a broad understanding of the social-legal-economic environmental framework. In addition to the usual prerequisite courses in mathematics, physical and engineering sciences required by all accredited engineering programs, environmental engineering students are provided with a background in environmental sciences such as biology, microbiology, analytical and/or organic chemistry. In subsequent courses the students concentrate on the conceptualization, model development, and application of engineering solutions to environmental problems. The courses cover such topics as water resource engineering, contaminant and pollution transport in the environment, hazardous waste management, solid waste management, wastewater treatment, hydrogeology and ground water flow management, and municipal engineering. Broader perspectives of environmental management is obtained through courses in environmental impact assessment, environmental law, environmental planning, ecology, ecotoxicology, and environmental resource management.

4.2 Coop and Internship Programs

An important direct educational link with industry is through the placement of students enrolled in Cooperative Educational programs or a variety of Internships. The Coop students spend four to six work terms in engineering jobs, depending on the university's Coop program. A 1993 survey showed that about 20% of the environmental companies participated in cooperative educational programs. Both the Guelph and Regina environmental engineering programs have Cooperative opportunities.

Internship programs work on a similar principle except that the student may be on a work assignment for a summer semester or a full year.

4.3 Graduate Programs

Because the environmental industry is growing rapidly the demand for new employees with new skills is outstripping the supply of people on the short term. Several engineering programs have responded by developing graduate level environmental programs. In addition to the research-based programs

which normally lead to a M.Sc. or Ph.D. in Engineering, there are programs based on coursework which often result in M.Eng. degrees. These programs are particularly popular with practicing engineers and scientists because they allow them to upgrade their environmental engineering knowledge and skills on a part-time basis. The School of Engineering of the University of Guelph has both thesis-based and coursework degrees in environmental engineering.

In many instances the graduate programs are offered in cooperation with university centres or institutes. For example, the Waterloo Centre for Groundwater Research accepts a limited number of students with scientific and engineering background. During their studies they learn to apply hydrogeological principles to the management of groundwater systems.

Another well-known non-thesis graduate program with specialization in environmental engineering is the M.Eng. Pulp and Paper Program offered at the University of British Columbia and McGill University in association with the Pulp and Paper Research Institute of Canada. The institute represents Canada's largest resource-based industry.

4.4 Special Short-Courses and Training Programs

Companies with interest in environmental issues have several other avenues of satisfying their specific training needs, such as association training, on-the-job training, outside trainers, industry seminars and conferences, internally-developed training programs, and equipment supplier/vendor training programs.

Industry associations often offer courses to their members. For example, The Air and Waste Management Association has a Training Institute in Calgary to provide some 32 courses on a broad variety of environmental topics. Similarly, the Environmental Services Association of Alberta has a program to retrain technically-skilled workers from the oil and gas industry for work in the environment.

University engineering and science faculty with special knowledge often contribute as teachers in the associations' initiatives, as outside-trainers or as seminar speakers. They normally provide these services as consultants. An important spin-off of these involvements is that they frequently lead to research projects funded by member companies.

It is expected that distance education through video conferencing or similar methods will play an increasingly important role in making university courses available to industry for on-site training.

5. ENVIRONMENTAL RESEARCH

In considering research linkages between universities and industry it should be kept in mind that the research is often done in traditional engineering programs as well as in the newer environmental engineering program, and increasingly involves interdisciplinary groups. This is particularly true for the environmental research at the University of Guelph where most of the focus is on nonindustrial areas, with the exception of the food processing industry. For example, a one-year pilot project

involving composting of source-separated organic waste from 15,000 Metro Toronto households involved environmental engineering, soil science, and microbiology faculty and staff.

The actual linkages between environmental research at universities and industry can be summarized as being either direct or indirect. In direct cases individual companies provide funding through grants or contracts to individual faculty or group of faculty. Usually this type of involvement is due to the specific expertise of the researcher or the need of a company to find a solution to a specific problem.

In indirect instances a number of companies fund research of general interest to all of them through an association, research institute, Centre, or similar industrial organization. Again, the grant or contract may be with individual faculty or group of faculty. It is also possible for the industrial organization to provide funding to a University Research Centre or Institute. These will in turn fund the work of individual faculty or groups of faculty.

Another indirect linkage is developed through the funding of Research Chairs by, usually with additional funding from government sources. The Chair is usually for a limited duration, normally five years, during which time research is conducted on behalf of the industry. The Natural Science and Engineering Research Council normally funds 50% of industrial chairs.

Figure 1 shows the structure of one industry/university organization - Environmental Science and Technology Alliance Canada (ESTAC). In 1995 ESTAC consisted of the member companies shown, each contributing an annual membership fee ranging from \$25,000 to \$100,000 based on Canadian-Made Sales or Total Sales in Canada, and universities, each contributing \$10,000 per year. Additional funding in the amount of \$5 million over 5 years is provided by Industry Canada to carry out environmental research & development. It is expected that ESTAC will grow to 50 companies and 20 universities by 1999. Research projects are conducted through interactive networks of company personnel and university faculty.

The MEND program (see Table 1) is a cooperative effort financed and administered by the Canadian mining industry, the Canadian government through Energy, Mines and Resources Canada (CANMET), Environment Canada, and Indian and Northern Affairs Canada, and the governments of British Columbia, Manitoba, Ontario, Quebec and New Brunswick. MEND's objective is to develop knowledge and technology that will substantially reduce the concerns and the environmental problems related to acid mine drainage caused by bacterial oxidation and acidification of sulphide minerals contained in copper, nickel, gold and uranium orebodies and tailings. In Ontario alone some 20 out of a possible 2000 sites have been documented to contain 55,000,000 tonnes of reactive sulphide tailings over a surface area of 830 hectares. The cost of stabilizing some sites have been estimated to be as high as \$400,000 per hectare, while the average cost is expected to be \$200,000 per hectare.

In the past two years there has been a significant shift in funding of environmental research. In the past almost all of the environmental engineering research at universities was funded by grants or contracts from federal, provincial and municipal governments. However, governments have either significantly reduced or completely eliminated their direct grant programs. The present situation is

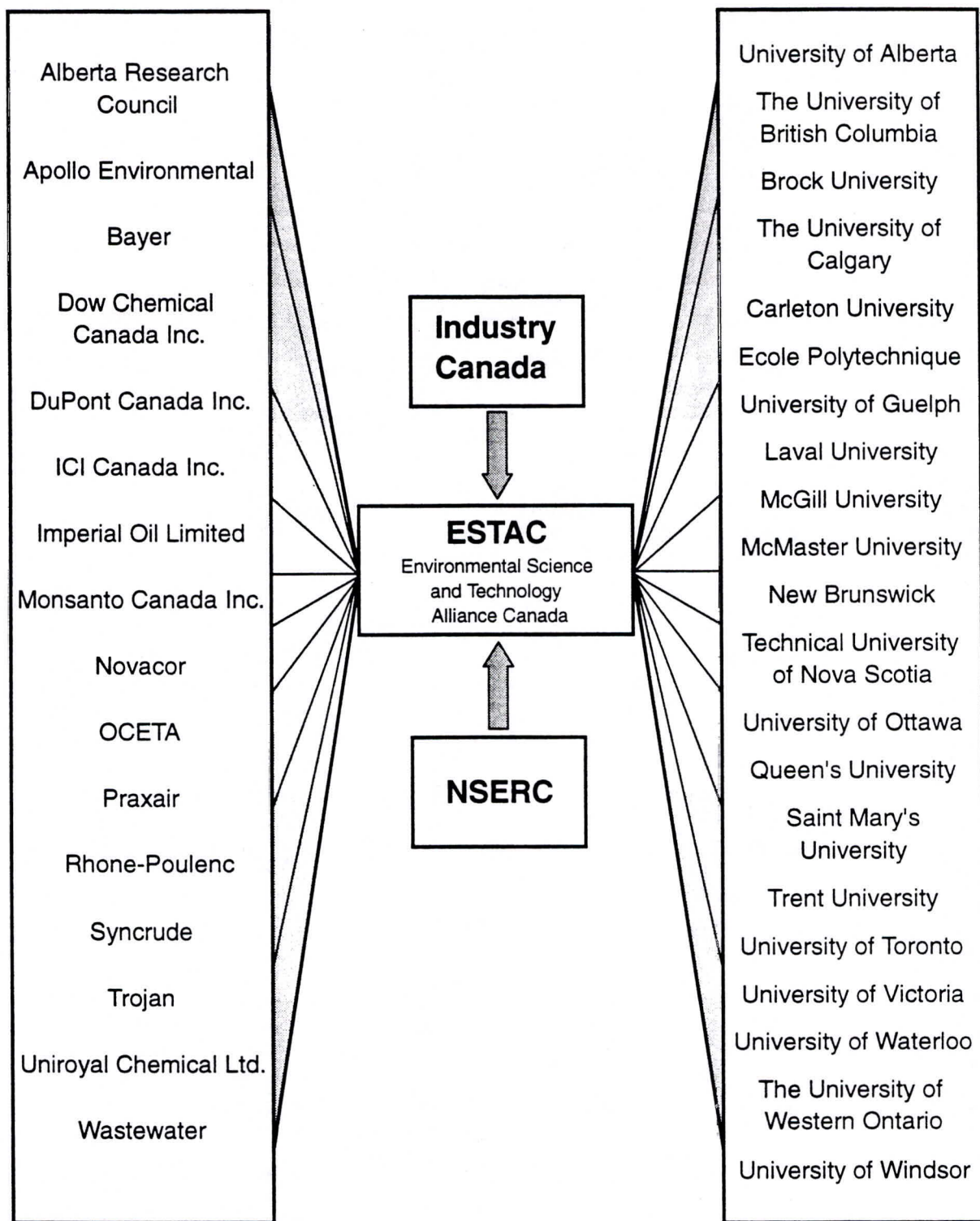


Figure 1. Environmental Science and Technology Alliance Canada

that researchers must have industrial or commercial sponsors before they can apply for matching governments funding. In most cases this still means that government provides most of the funding but the research tends to be more applied and problem oriented. NSERC has a number of special programs, including co-operative research grants, shared equipment and facilities, industrial research chairs, senior and visiting industrial fellowships to promote research.

Table 1. Examples of Industrial Research Funding

INDUSTRIAL RESEARCH FUNDING GROUPS	TYPICAL RESEARCH PROJECTS
Associations Canadian Chemical Producers' Association Petroleum Association for the Conservation of the Conservation of the Canadian Environment (PACE) North American Recycled Rubber Association (NARRA) Alliance of Manufacturers and Exporters of Canada Ontario Restaurant Association Institutes Environmental and Plastics Institute of Canada Pulp and Paper Institute of Canada (PAPRICAN) Other Soft Drink Manufacturers Food and Consumer Products Manufacturers of Canada (FCPMC) Mine Environment Neutral Drainage (MEND)	hazardous waste; air & water pollution; bioremediation plant decommissioning; soil remediation, air & water pollution; hazardous waste, environmental impact of explorations recycling tires; incineration; reclamation; reprocessing; packaging organic waste disposal: land application, composting hazardous waste; packaging; toxicity; recycling; waste disposal; life-cycle analysis; solvent substitution wastewater treatment; biological treatment; sludge management; biodegradation; deinking; recycling; bioconversion; oxygen bleaching; closed cycle technologies recycling, packaging; life-cycle analysis packaging, recycling, waste management; life-cycle analysis land reclamation, acid mine drainage control, groundwater and surface water pollution

The Canadian Pulp & Paper Industry has recently launched a \$88-million closed cycle research drive. The objective of the five-year program is to shift the emphasis from pollution treatment to prevention, while boosting the industry's global competitiveness. The program is a follow up of the \$5-billion investment in new bleaching technology and secondary treatment facilities from 1988-1995, which effectively eliminated dioxins and furans and sharply reduced pollutants in effluent streams. The new

research effort is expected to contribute significantly to the various university pulp and paper centres and other environmental engineering efforts.

Table 2. Examples of University Centres with Environmental Research Interest

UNIVERSITY CENTRES	RESEARCH EFFORTS
Pulp and Paper Centres: University of British Columbia University of Toronto McGill University École Polytechnique McMaster University	deinking, chlorine dioxide production, anaerobic fermentation, composting, biodegradation of resin acids, monitoring of contaminants in pulp mill discharges, treatment of newsprint mill whitewater, dour removal and control, bioprocessing of solid waste residue, wastewater sludge management.
Waterloo Centre for Groundwater Research	groundwater quality; soil remediation; risk assessment; environmental impact assessment

5. EXAMPLES OF RESEARCH LINKAGES

As mentioned before, the scope of environmental research is considerable and involves traditional engineering fields, environmental sciences, chemical and biological sciences, toxicology, sociology, mathematics, computer science, etc. Table 3 was constructed to provide some specific examples of the types of projects funded directly or indirectly by industry in the last few years at the School of Engineering. It does not show the research funded directly by different levels of government, which still accounts for at least 80% of all environmental engineering research funding for the School because of its roots and connections with the agricultural and food sciences.

It is interesting to note that several of the projects involve biological treatment of contaminated sites and waste streams. Biofiltration and composting of organic wastes are major areas of research, only a fraction of which is funded by industry. Nevertheless, industry has provided some \$300,000 for these projects in the past few years.

6. CONCLUSIONS

There has been a rapid growth in the environmental industry, both in equipment production and services sectors, in response to a number of driving forces. The most important one being the need to comply with new environmental laws and standards. Most engineering faculties have responded by either increasing the number of environmental options available to the students or, in a few cases, by introducing accredited environmental engineering programs. A variety of graduate programs have also

Research linkages in environmental engineering between universities and industry are less common than government sponsored research. Furthermore, most projects that are funded by industry also have significant contribution of government funds. It is however expected that industry will play a greater role in research funding as governments are more and more cutting back to reduce their enormous deficits.

Table 3. Examples of Industry Funded Environmental Engineering Research Project at Guelph (1994-1996)

PROJECT TITLE [SPONSOR]
Formation of chlorinated organic compounds by commercial bleach discharges to sewers [Chlorox]
Quality of storm water runoff. [Gamsby and Mannerow Ltd]
Enhanced biofiltration of waste off-gas streams. [Canadian Petroleum Products Institute]
Biofiltration pilot study for CGT's dry laminator emissions. [Canadian General Tower Limited]
Composting of source-separated municipal solid waste. [Procter & Gamble Inc.]
Fate of disposable diapers in composting systems. [Procter & Gamble Inc.]
Biological degradation of slaughterhouse waste. [J.M. Schneider Limited]
Soil remediation using supercritical extraction. [GASRep]
Chemical spill behaviour. [Imperial Oil]
Stripping and volatilization in wastewater facilities. [Water Pollution Control Federation Institute]
VOC emissions from industrial drops and drains. [Dupont Chemicals]
Gasoline volatilization from wet soil. [Imperial Oil]
Biological remediation of diesel fuel contaminated soil. [Bell Canada]
Hydrocarbon flux measurement: method development and application. [Bell Canada]
Infiltration into permeable concrete block pavement. [Unilock Ltd.]
Thermal enrichment of stormwater runoff by paving. [Unilock Ltd.]

7. REFERENCES

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APPENDIX B

**ACTIVITY A 2.26 STUDY TOURS
REPORTS**

A 2.26 57387
REPORTS - FINAL

Mary Jane Curtis
Supervisor, Administration
Ryerson International
Ryerson Polytechnic University
350 Victoria Street
Toronto, Ontario.
M5B 2K3

November 8, 1996

RE: Study Tours for Kontorn Chamniprasart and Rawat Vipia
November 4 - November 8, 1996

Mary Jane;

Kontorn and Rawat arrived on Saturday, November 2, 1996. I contacted them on Sunday to arrange for pick-up and transportation at UW on Monday Morning. Since the missions of these two individuals was somewhat different from each other, there was not a great deal of 'common time' with the two individuals except for lunches, dinners, and some specific activities of mutual interest. Specific individual reports from Dr. Kontorn and Mr. Rawat are attached to this communication.

Kontorn was primarily interested in the laboratory setup and equipment in the Mechanical Engineering department. As such, he was given an overview tour of the facilities and laboratories in Mechanical Engineering on his first day. On subsequent days he explored specific areas of particular interest to him; these included the wind tunnel laboratory, the heat transfer and fluid mechanics laboratory, the robotics laboratory, and the library. He was also provided with an undergraduate laboratory manual for the 3B academic term.

Rawat spent the majority of his formal study time with personnel in the Electrical and Computer Engineering department. His primary interest was in the construction and special considerations needed for a high voltage laboratory, for both undergraduate and graduate study and for research. He had extensive meetings with Prof. J.D. Cross (internationally respected for his research in this area), Prof. Shesha Jayaram, and the technician for the High Voltage Laboratory, Terry Weldon. In addition, he met with the Associate Chair for Graduate Studies and Research for the Department, Prof. A. Vanelli, and with the Chair of the Department, Prof. S. Chaudhuri.

I believe that both individuals enjoyed their stay at Waterloo and that their study tour was successful in achieving the objectives for their respective tours.

Respectfully submitted,



G.E. Schneider
Associate Dean of Engineering
Undergraduate Studies
GES:1251

Attention:

Mary Jane Curtis
Supervisor-Administration
Ryerson International

The Summary Report:

Visiting University of Waterloo Mechanical Engineering Laboratory
By Dr. Kontorn Chamniprasart

We, me and Mr. Rawat, arrived at Toronto International Airport on Saturday, November, 2, 1996 at 6:30 p.m. We got into hotel in Kitterer that night. I received a phone call from Dr. Scheider on Sunday and making arrangements for Monday.

Monday morning Dr. Scheider kindly picked us up at the hotel and brought us to University of Waterloo. Dr. Scheider kindly arrange mechanical engineering laboratory tour for me and I did visit all undergraduate laboratories that I like to see, such as Fluid Mechanics Lab., Heat Transfer Lab., Materials Lab., Wind Tunnel, Machine Shop, etc.

I found out that the Heat Transfer Lab. was very interesting, so on Wednesday Dr. Schneider explained how the apparatus was builded and how to conduct the experiments. He also gave me the experiment direction sheets, which very useful for me.

The Wind Tunnel at University of Waterloo is also very impressive. I had a change to meet Dr. Ewart Brundrett, the designer of this wind tunnel. We had a long meeting and he kindly explained every thing about this Flexible Wall Wind Tunnel. He also gave me all documents and papers related to how to build the wind tunnel and how to conduct experiments in the wind tunnel.

We also have a change to visit the engineering library which is very interesting placed. Most engineering related books, references, journal can be find in this library. Finally, Friday afternoon, we have change to visit graduate and research laboratory.

I find my time at University of Waterloo very interesting and rewarding. I would like to thank all faculties at University of Waterloo for their time and a warm welcome. I also like to thank all staff of SUT-CUTC project for arrange such a convenient trip. Special thank to Dr. Scheider for his time and warmest hospitality.

Kontorn Chamniprasart
Nov, 8, 96

Dr. Kontorn Chamniprasart
Lecturer, Mechanical Engineering School
Institute of Industrial Technology
Suranaree University of Technology

University of Waterloo
November 8, 1996

About: A summary report of visit the High Voltage Lab at
the University of Waterloo from November 1-11, 1996

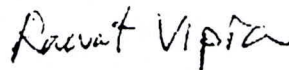
Dear Project Coordinator
Thailand-HRD CUTC-SUT

I have already visited the HV lab, discussed about detailed
equipments needed, required grounding and other safety issues,
possible research collaboration with Prof. Dr. J. D. Cross, Assistant
prof. Dr. Shesha Jayaram and Mr. N. Terry Weldon

And I have a good opportunity to discuss with Prof. Dr. Ewart
Brundret, Prof. Dr. Anthony Vannelli and Prof. Dr. Sujeet K. Chaudhuri.

Thank you very much for the staff that treat me and Dr. Kontorn
very kindly and warmly, especially Prof. Dr. G. E. Schneider that take
care of us everyday.

Your Sincerely



(Rawat Vipia)

Instructor

School of Electrical Engineering

Suranaree University of Technology

THAILAND

APPENDIX C

**ACTIVITY A 2.31A CO-OP PROGRAM
THAI STUDENTS IN CANADA
REPORTS**