

**SURANAREE UNIVERSITY OF
TECHNOLOGY**

**SCHOOL OF TECHNOLOGY OF RESOURCES
Major: Chemical Engineering**

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NOMENCLATURE

<u>Symbol</u>	<u>Definition</u>
A	Interfacial Area
C_i	Concentration of component i
E	Surface Elasticity
$E(S)$	Laplace Transform of Error signal
$e(t)$	The error signal
g	Gravitational acceleration
h	Immersed Depth
i	Component i
K_c	Proportional gain
$M(S)$	Laplace transform of the output from the controller
$m(t)$	The output from the controller
P	Pressure
P_{max}	The maximum pressure inside the bubble
P_s	The pressure inside the bubble
P_h	The hydrostatic head
R	Gas constant
r_1, r_2	Probe radius
T	Temperature

Greek Symbol

Δ	Incremental change of variable
∂	Patial differentiation of variable
ρ	Density
σ	Surface Tension
τ	Rate of Time constant
Γ_i	The amount of Surfactant adsorption

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ABSTRACT

Gas-Liquid Contacting is extensively used for providing the application in the Chemical Industries. The study ⁱⁿ ~~about its process~~ is involved in terms consideration of the characteristics, affecting factors on the transport phenomena by concerning the dynamic surface tension related to the diffusivity, adsorption, interfacial properties, including elasticity.

The measurement of dynamic surface tension of the surfactant, SDS aqueous solution at the different concentration; 2, 5, 10, 20, 50, 100, 200 ppm is presented with the time scale (bubble interval), to determine the relationship between the surface tension and the concentration due to the interfacial properties, elasticity, bubble breakup, coalescence and mass transfer.

As the concentration of the solution is higher, the dynamic surface tension due to the equilibrium values are decreased^a, tending the dispersion process is most occurred during the high concentration of the solution. The dynamic surface tension is rapidly decreased within the short time scale and slidely flatten until the equilibrium value is achieved.

In order to be certain that the standard criteria is met, the way that should be carried during the experimental run to obtain the correct data is an experimental set-up, step-by-step to gain the accuracy. The response is verified by the display data on the software program screen.

software PC900
(Chem-Dyne Research
Corp)

1. INTRODUCTION

As part of this work term, the author has worked for three months, in the position of a research assistant, in Chemical Engineering Department, Technical University of Nova Scotia, involved in experimental measurement dynamics surface tension and chemical engineering activities: group meeting for organizing laboratory setting, seminar and data analysing Liquid-Liquid Dispersion, supervised by Dr. A. M. Al Taweel, Professor of Chemical Engineering Department, Technical University of Nova Scotia.

The Technical University of Nova Scotia (TUNS) has a unique place in Canadian higher education. As an independent Canadian technical university, TUNS is dedicated to professional education and computer science.

TUNS was founded as the Nova Scotia Technical college in 1907. Its mandate was to carry out research and offer degree programs in Engineering with the cooperation of universities and college in Nova Scotia and New Brunswick and to accept students with previous studies at the university level.

The original faculty of six taught courses in mining, metallurgy, civil, electrical and mechanical engineering. Over the years, new department of agriculture, ^{Chemical Engineering} chemistry, food science and industrial engineering were added.

In 1961, the School of Architecture was established. Today, degree in environmental design, architecture, and urban and rural planning are offered through the Faculty of Architecture. Recently, the School of Computer Science has been established. A co-operative degree is offered by the Faculty of Architecture, the School of Computer Science and several engineering departments.

TUNS' commitment to graduate studies and researches is worthy of special note. In the 1950's, graduate studies programs were developed, first at the Master's level and then at the Ph.D. level.

To encourage research activities, TUNS supports or is associated with, several

research institutes and centres: Centre for Water Resources Studies (CWRS); Canadian Institute of Fisheries Technology(CIFT); Centre of Marine Vessel Design and research (CMVDR); Vehicle Safety Research(VSR); Minerals Engineering Centre(MEC); Nova Scotia CAD/CAM Centre; Advanced Materials Engineering Centre(AMEC); Applied Microelectronics Institute(AMI); Atlantic Industrial Research Institute(AIRI).

In addition, an active program in international development is pursued and there is a significant commitment to continuing education. (Academic Calender, 1996)

1.1 Gas-Liquid Mixture

Gas liquid contacting techniques are frequently encountered in petroleum, chemical, biochemical, food processing, and many other industries. In certain operations, mass transfer with or without reaction is involved, and maximizing the mass transfer rate between gases and liquids is usually required. Examples of such applications are gas absorption in bubble columns, chemical or biochemical reactions in agitated tanks, distillation, waste water treatment by ozonization/oxidation, aerobic waste water treatment, selective floatation of constituents, etc.

Industrial streams usually contain a mixture of compounds (e.g. solutes such as alcohol, proteins, organic acids, surfactants, or finely-divided particulars such as catalysts, clays). The presence of these impurities affects interfacial characteristics. However, most published investigations were conducted using pure air-water systems. The most significant difference between the air-water and air-aqueous solution systems is that, in the former, the bubble coalescence rate is high, while in the latter, the rate is low. The impurities reduce the bubble coalescence rate, and hence strongly affect gas-liquid contacting behavior.

Most investigators try to correlate gas-liquid contacting characteristics with the static (or equilibrium) surface tension. However in many processing applications, the gas-liquid contacting time is very short, and the time scale of the process does not allow for impurity

molecules to be in equilibrium at the gas-liquid interface. In these processes, the dynamic surface tension may yield a better insight of what really happens at the interface.

Gas and liquid phases are known to extensively circulate within most constants. Wide residence time distributions are therefore observed when stirred tanks and bubble columns are used for gas-liquid contacting purposes. These results in reduced performance effectiveness and the need to use excessive energy inputs in order to improve contacting efficiencies (Jie, 1996). Another application is involved in enhancing the mass transfer, by generating very small gas bubble, produced by static mixers or motionless mixers, depending on the objectives. Those mixing elements redistribute or direct fluids across the flow channel and thus produce a large interfacial area between the two immiscible fluids (Chen, 1996)

In this report, firstly the detail of an experimental set-up is presented. In the second part, the dynamics surface tension is quantitatively investigated. Using the diffusion controlled dynamic surface tension model to fit the experimental data, the effect of surface tension on the elastic characteristics were considered and determined due to the behavior different concentration. Efforts were made to find the effects of interfacial properties (surfactant) on the gas-liquid contacting characteristics.

1.2 Background

1.2.1 Interfacial Characteristics of Industrial System

Interfacial characteristics are most widely concerned in two phases contacting between gas and liquid. The study involved to the significant factors that are importance and have an effect to the bubble breakage & coalescence rate and the equilibrium bubble size in the gas-liquid contactor.

One of the important factors in the transport phenomena is the effect's factor. In bubble case, the balancing or controlling of the dynamic equilibrium between the opposing process bubble dispersion and bubble coalescence is used to characterize the gas-liquid

no more

the effect's factor
what

effect
factor?

explain
in in
a sentence

contacting.

• Interfacial Properties

Interfacial is a thin layer at an intermediate region or boundary which has the important properties to the bubble dispersion and coalescence.

The Interfacial area in the liquid phase is a region where the imbalance attractive van der Waals occurred between the molecules, the contracting force at the surface is known as the surface tension. The equilibrium or static surface tension is defined thermodynamically as the energy per unit area, while the physical surface tension is defined as the force per unit length (equilibrium's measurement), for reducing the interfacial area of contact. A fresh interface is said to be a zero age which corresponds surface/interfacial tension which is called pure dynamic surface/interfacial tension. The surface/interfacial tension is reduced with the time during the aging of the surface, and its successive values are called intermediate dynamic surface/interfacial tension. The surface pressure (Π) is one of the parameters affecting the dynamic surface tension and is defined as the surface tension of pure solvent minus that of the surfactant solution at the same concentration.

The amount of material absorbed per unit area of the interface is directly calculated from the surface tension measurement. A plot of the surface tension as the function of concentration is used to describe the amount of the surfactant absorbed per unit area of the interface by using of the Gibbs adsorption equation as followed:

$$\Gamma_i = (C_i/RT) * (d\sigma/dC_i) \quad (1)$$

The amount of surfactant adsorption on the interface depends on the directly influence of the bubble dispersion and coalescence, the quantity of $d\sigma/dC$ greatly affects the dynamics of the film and should therefore form a suitable basis for the prediction of the coalescence behavior of a "contaminated" solution.

• Surface elasticity and Surface diffusivity

A gas-liquid film must be somewhat elastic in order to be able to withstand

deformations without rupturing. The Surface-chemical explanation for film elasticity comes from Marangoni and Gibbs (Cluine et al., 1971). In contaminated system, if a film undergoes a sudden expansion, the expanded portions of the film must have a lower degree of surfactant adsorption than the unexpanded portions because the surface area has increased (Figure 1). This expansion causes an increased local surface tension that provides increased resistance to further expansions. The local rise in surface tension produces immediate contraction of the surface, which induces liquid flow from the low tension region to the high-tension region. The transport of bulk liquid due to surface tension gradients is termed the Marangoni effect and provides the resisting force to film thinning. The rate of drainage of thin liquid films is thus hampered, and, is controlled by the transport properties at the surface, which is time dependent. The elasticity from the surface tension ^{varies} variation during the deformation process of liquid lamella. Surface elasticity can be described by the Gibbs equation:

where
is the
Verb

$$E = \partial\sigma/\partial\ln A = -RT(\partial\Gamma/\partial\ln A) \quad (2)$$

where Γ is the surface excess and is a measure of the surfactant concentration at the interface.

• Effect of the Interfacial Properties on the bubble breakup & Coalescence

To characterize the factors affecting to the transport phenomena, dispersion and coalescence processes which are known as the opposing process has been extensively studied for years (Figure 2).

The characteristics of the gas-liquid contacting are controlled by the dynamic equilibrium between the opposing process of bubble dispersion and coalescence (Figure 3).

For a gas-liquid contactor, the total surface area produced increases as the bubble size that is produced decreases. Free-energy increases as well with decreasing bubble size because it is associated with surface area. Energy has to be added to the system to achieve

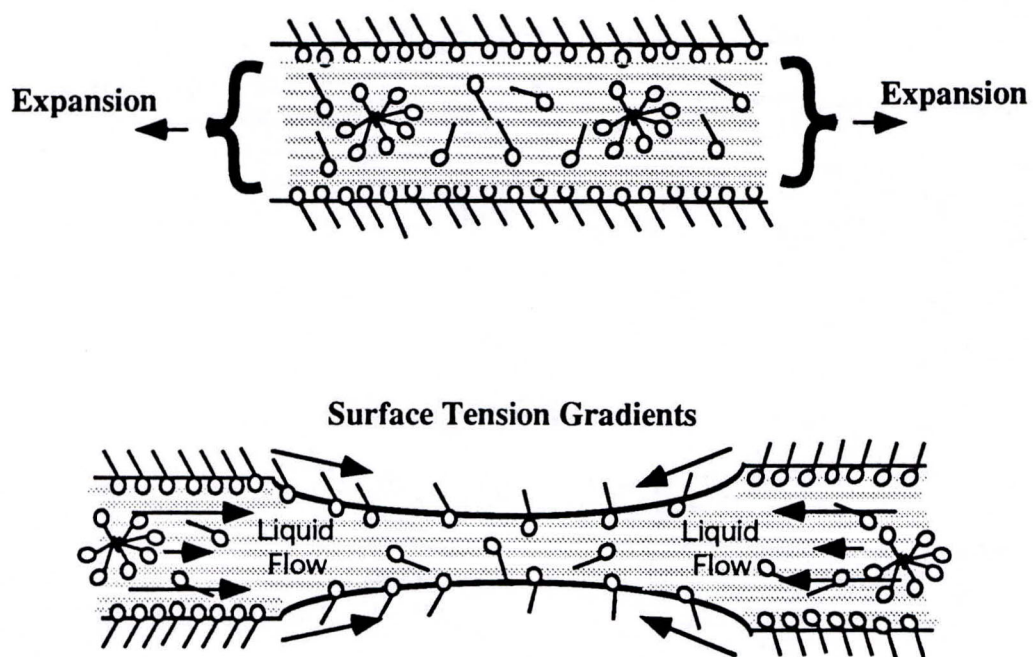


Figure 1: Marangoni effect (Surface Tension) (Schramm, 1994)

the dispersion of small bubbles. If sufficient energy can not be provided though the mechanical energy input, then another alternative is to use surfactant to lower the interfacial free energy, or interfacial tension (Schramm, 1994).

As the bubble grows, the surface expands with time. These results in a surface concentration are different from the equilibrium value, thus producing the surface concentration gradient and the surface tension gradient (Figure 4). To restore the equilibrium surface concentration the surfactant molecules in the bulk diffuse to the expanded surface. This diffusion controlled adsorption process depends upon the time scale of the bubble creation. Therefore, at fix bulk contaminant concentration, the less time is allowed for contaminant molecules to diffuse to the surface, the larger is the difference between the surface and bulk concentration. On the other hand, in the same diffusion time period, system with faster diffusion rate, the small difference exists between the surface concentration and the bulk concentration, which causes the low surface tension. For the same kind of surfactant, increasing bulk surfactant concentration yields a larger concentration gradient and diffusivity which causes the lower surface tension.

The "Dynamic" surface tension can be calculated from the Laplace equation:

$$P_{\max} = P_h + P_s = (2\sigma/r) + \rho gh \quad (3)$$

where P_s is the pressure inside the bubble due to surface forces; P_h is the hydrostatic head; $P_{\max}$ is the maximum pressure inside the bubble when the bubble radius of curvature equals the capillary radius r ; h is an immersed depth; σ is the surface tension; ρ is the density of the liquid; and g is the gravitational acceleration. The differential maximum bubble pressure method involves two capillaries of differing internal radii (r_1, r_2) but with equal immersion depth, thus the effect of hydrostatic forces was cancelled out.

$$\Delta P_{12} = 2\sigma((1/r_1) - (1/r_2)) \quad (4)$$

This measurement can be made for varying gas flow rates (that is, varying bubble

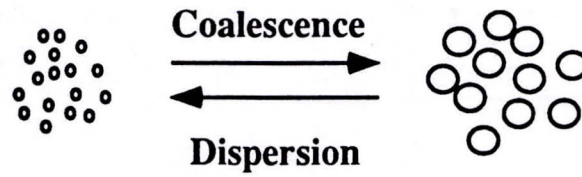


Figure 2 : Dynamic equilibrium between dispersion and coalescence process

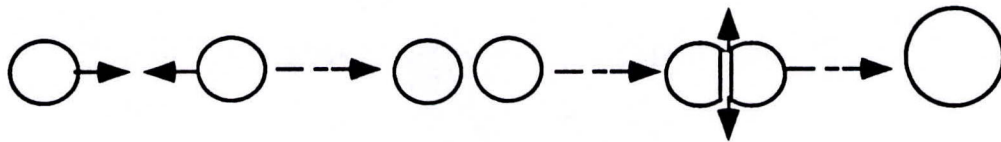


Figure 3: Film drainage in bubble coalescence process

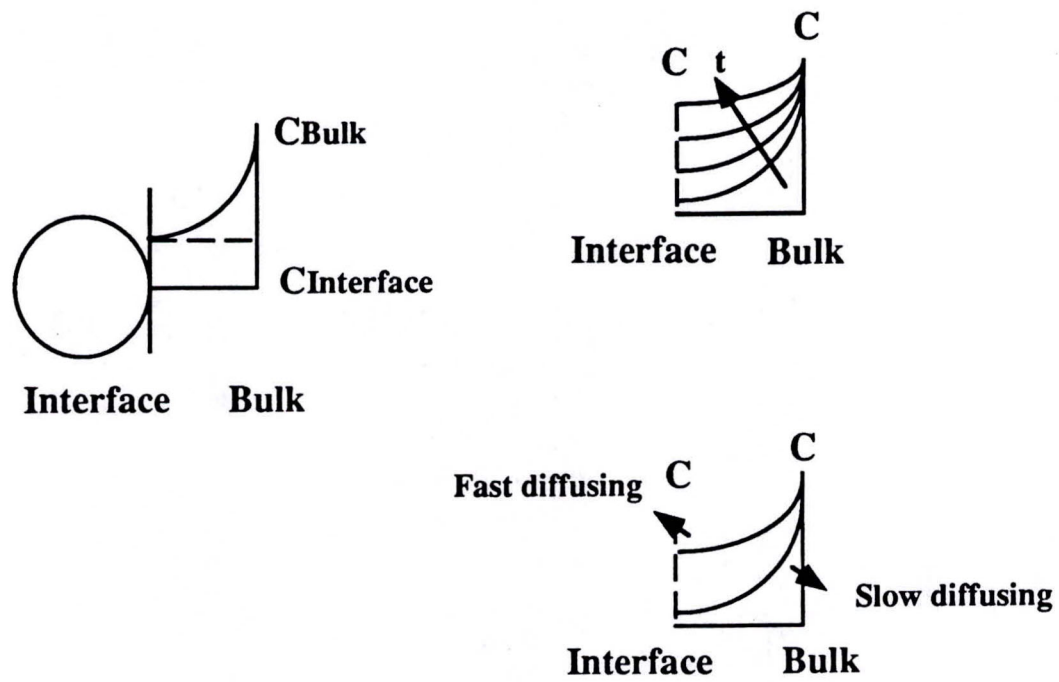


Figure 4: Diffusion controlled interfacial concentration

2. EXPERIMENTAL SET-UP

2.1 Apparatus

1. Probe:

To measure the Dynamic Surface Tension, ^{two} ~~the~~ standard ~~two~~ probes are necessary for calibration; 4.0 mm. ~~&~~ 0.5 mm. These probes should be used to do ~~the~~ initial checkout procedure. ^{an}

Before measuring any required samples, the initial checkout procedure is ^{performed} ~~done~~ by ^{setting} ~~set~~ zero and span that will be discussed in the later section.

The two ~~above~~ probes are used at low bubble frequency adjustment (< 4 bubbles/s). ^{another smaller} ~~The~~ ^{one} that is used at high bubble frequency (> 4 bubbles/s) is 0.25 mm. The selection of the correct probes ^{depend} ~~depend~~ on the particular application.

As the smaller probe approaches the smallest physically possible diameter, the pressure measurement ^{approach} ~~approach~~ ^{more accurately} ~~more~~ the true surface tension value. However, the limitation ^{of the smaller probe} ~~using~~ ^{arises in} ~~in~~ operation because of the physical configurations, like fluids that tend to coagulate or are high in particulates that plug extremely small probes. On the other hand, the larger the probe, the less of signal amplitude, and therefore, decreased accuracy. (Operator Manual)

Any change in probes (even change from one probe to another of the same size and shape) ~~must likely~~ require a new calibration to be performed.

To connect the probes with the probe holder, the correct different position of the probes should be done to obtain the true data. As the connection is achieved, the larger probe have to be ^{placed higher} ~~upper~~ than the smaller probe $2/3 r_1$, where r_1 is the larger probe diameter as shown in Figure 5.

~~The~~ ^{the} Both of the glass and ^{teflon} ~~teflon~~, coated glass probe, are in the Figure 6.

2. Probe holder:

The probe arm may be raised and ^{lowered} ~~lowed~~, or rotated radially about the base by loosening the locking knob (k1). A retaining ring clamp (c1) sets the

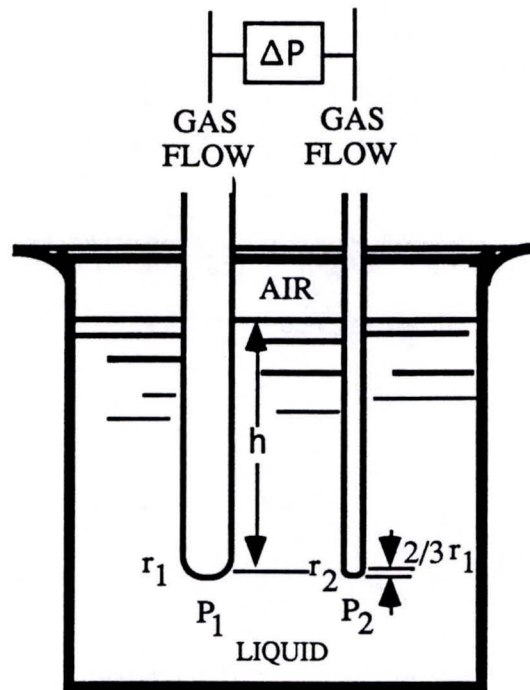
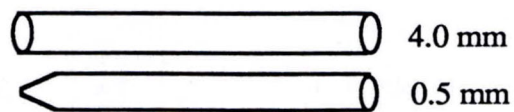


Figure 5: The correct connecting position



Glass Probes



Teflon Probes

Figure 6: Glass and Teflon Probes

bottom-most position of the arm and allows consistent and repeatable depth of probe penetration in fluids when repeat reading are taken. The arm also be extended horizontally, away from the base, using the other lock knob (k2) as shown in the figure 7. (Operator Manual)

3. Temperature Controller:

For the ^lLong time constant process (large capacitance), for example the temperature loop, the ^{ee}temperature controller recommended is Proportional Integral Derivative Controller, PID, ^{with}having three tuning parameters: the gain or proportional band, K_c , the reset time or reset rate, τ_I or τ_{IR} , and the rate time constant, τ_D .

PID controller has the new mode added the derivative action, its purpose is "anticipate" where the process is heading by looking at the time rate of change of the error, the operational equation is followed:

$$m(t) = m_{ave} + K_c e(t) + (K_c / \tau_I) \int e(t) dt + K_c \tau_D (de(t)/dt) \quad (5)$$

Where $m(t)$ is output from the controller, ^{ee} m

$e(t)$ is error signal, mA. This is the difference ⁿbetween the set point and controlled variable.

^{ave} m_{ave} is bias value, or mA. The significance of this value is the out-put ⁺from the controller when the error is zero. This value is usually set during calibration of the controller, at 12 mA.

The derivative action allows the controller "look ^aAhead" by calculating the derivative of the error. The amount of "anticipate" is decided by the value of the tuning parameter, τ_D . By looking at the derivative of the error, the controller knows that how the controlled variable is heading away from the set point, consequently, it uses this fact to help in controlling and the amount of the control correction ^{is} provided by the Proportional and Integral mode. ^{are}(For ~~aware~~ the Noise in the Long time constant process is produced by the noise transmitter.) ~~In this case,~~ before the PID controller is used, the transmitter must be fixed. ^{is}In order to reduce the noises,

The transfer function ^vprovided by

$$M(S)/E(S) = K_c (1 + (1/\tau_I S) + \tau_D S) \quad (6)$$

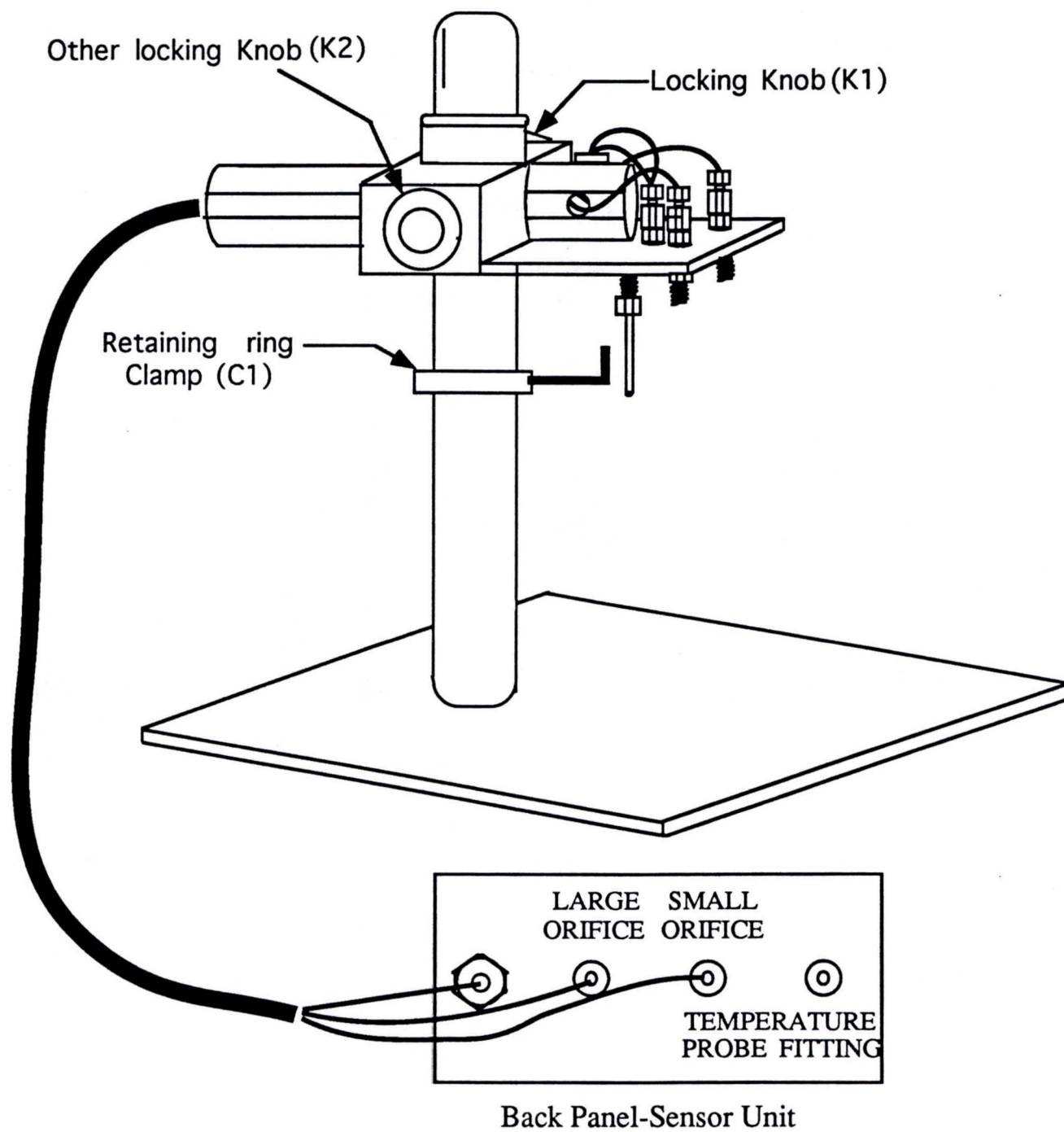


Figure 7 : Probe Holder

This transfer function is called "ideal" because in the real practice the implementation of the derivative calculation is impossible to obtain. The derivative is then approximated by the use of a lead/lag, resulting in the "actual" transfer function as followed:

$$M(S)/E(S) = K_c(1+(1/\tau_i S)(\tau_D S+1))/(\alpha \tau_D S+1) \quad (7)$$

During the experiment, to reject or reduce the ^{error} ~~error~~ the temperature controller acts approach to retain the set ~~point~~ ^{point} by heating up or cooling down the temperature process. The operating controlled variable is obtained depending on the situation. The ^t ~~Temperature~~ controller is shown in figure 8.

4. SensaDyne 6000:

The SensaDyne 6000 is ^{composed of} ~~contained with~~ the electronics system, the Computer/Interface board, SensaDyne circuit board with four important components, ^{namely,} Zero-Span-Temperature-Filter potentiometer, and Peak Detector IC, Pressure Transducer.

The Span and Zero ^t ~~potentiometers~~ are importance in the initial checkout procedure to make ^{certain that} ~~sure~~ the amplitude of the displayed pressure graph starts from the ~~low~~ zero set to the ^{high} ~~high~~ between 3-4 volts as shown in the Figure 9.

To select the correct data at the remained set point temperature and fit the rejection of the noise, the Temperature and Filter potentiometers are ^{performed} ~~done~~ by adjusting on both of them.

The differential pressure is determined and ~~transferred signal~~ ^{which can be measured} achieved by the Pressure transducer, and the capturing the maximum bubble pressure signal (sawtooth peak value), ^{measured and} store ~~it~~ until the next peak occurs including the updated values are allowed by the Peak Detector, as shown in the Figures 10-11.

5. Software PC9000 (version 5.1):

All of the results are transferred and displayed by ^a ~~the~~ software, ~~which~~ ^{called}, PC9000, containing 5 ~~items~~ ^{components} in the main menu; FILE (F2), CALIBRATION (F3), OPTIONS (F4), CHANNEL (F5), and ALARMS (F7), as shown in the figure 12.

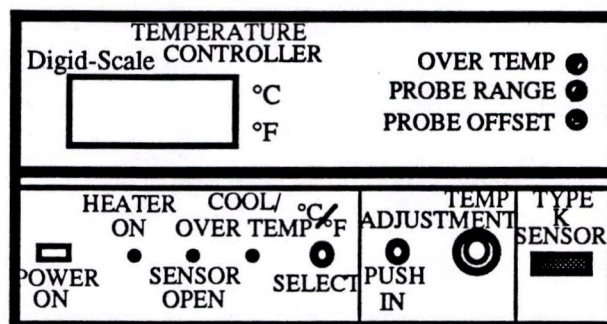


Figure 8: Front view of the Temperature Controller

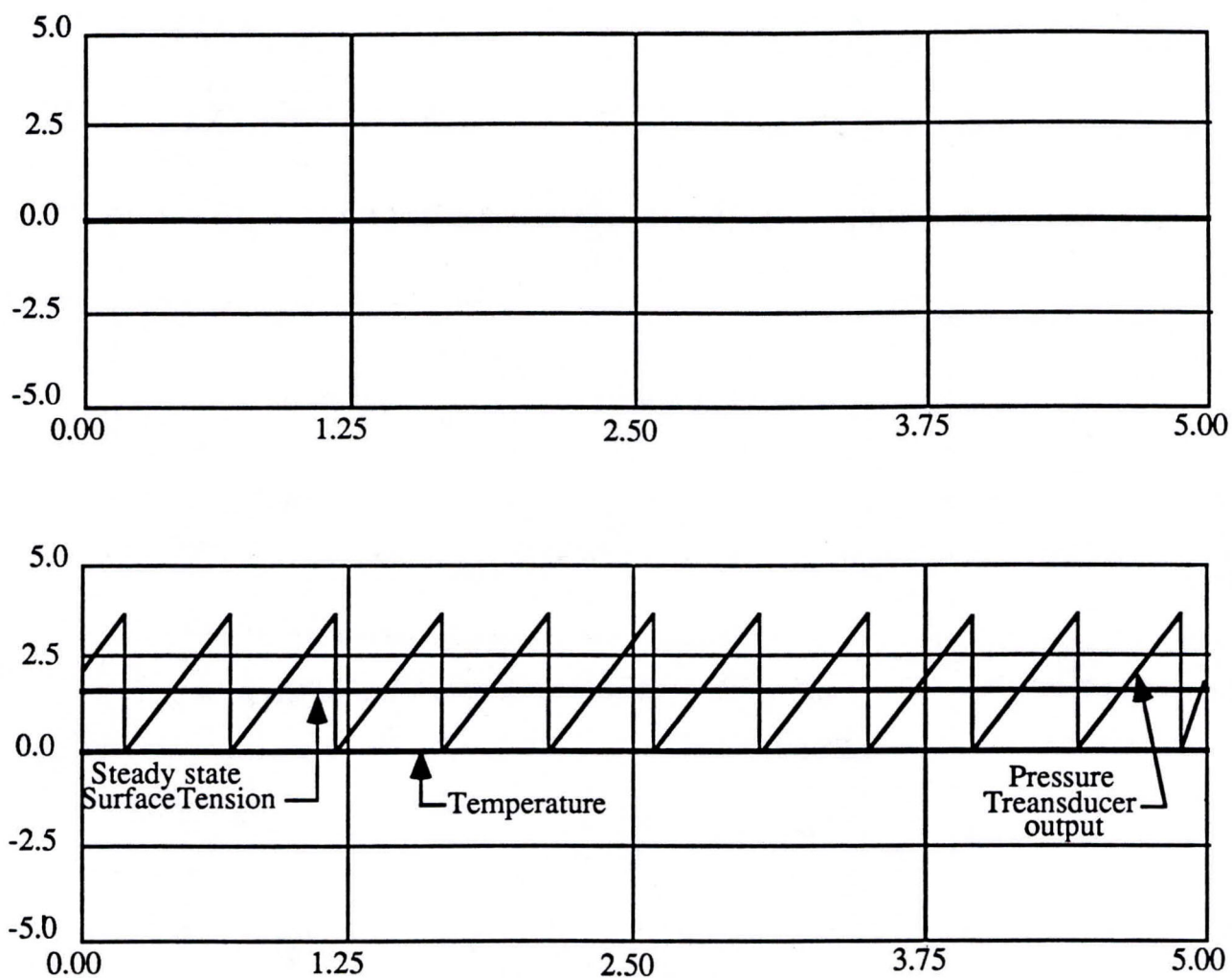


Figure 9: The regular display of the Set Zero and Span

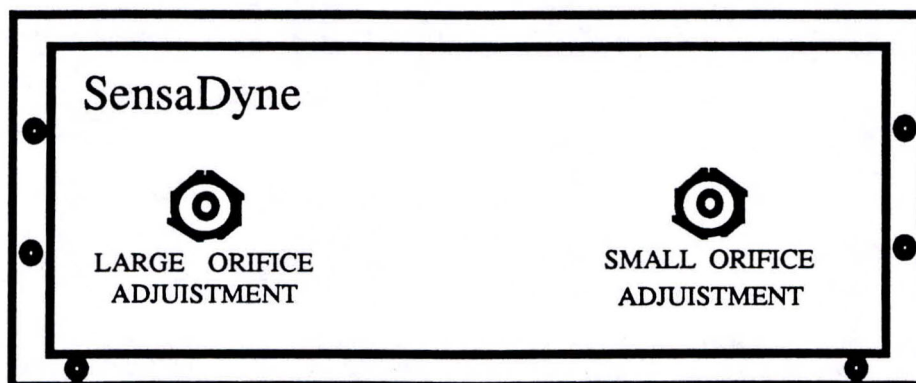


Figure 10: Front view of SensaDyne 6000

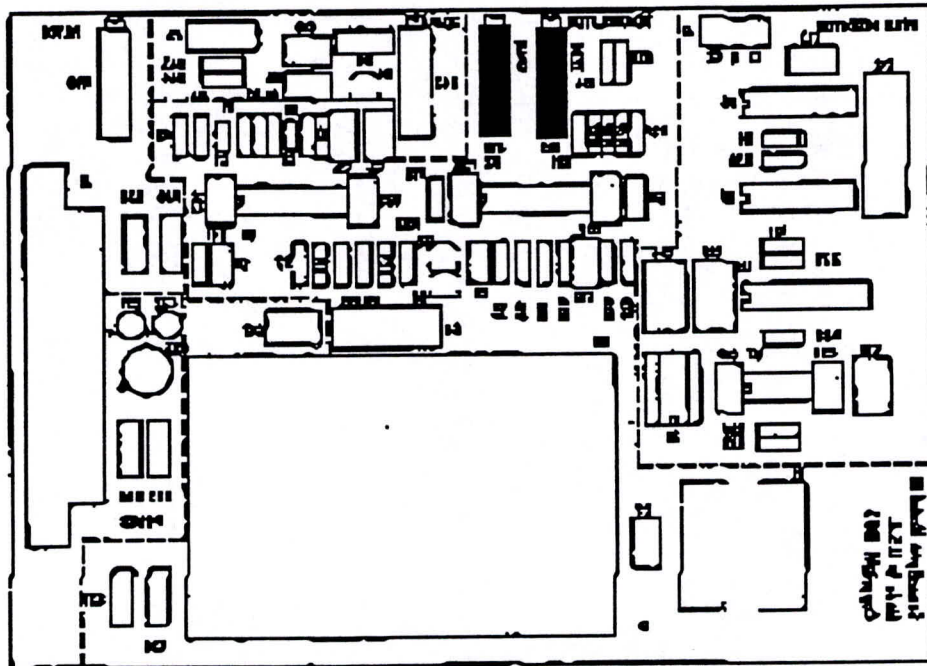


Figure 11: Electrical Circuit contain; Zero, Span, Temp.,and Filter Potentiometer

FILE (F2) CALIBRATION (F3) OPTIONS (F4) CHANNEL (F5) ALARM (F7)

OPTIONS Select HW PD Start Recording Do Quicklog Start Printer Analyze Sample Start Sampling BUBBLE DATA Sampling points B. Frequency Hz B. Interval sec TIME	CHANNEL SELECTION Surface Tension ☐ Temperature ☐ Pressure ☐ Trigger ☐ DATA PLOT <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left; padding: 2px;">Ch. #0</th> <th style="text-align: left; padding: 2px;">Ch. #1</th> <th style="text-align: left; padding: 2px;">Ch. #2</th> <th style="text-align: left; padding: 2px;">Ch. #3</th> </tr> <tr> <td style="text-align: center; padding: 2px;">5.0</td> <td></td> <td></td> <td></td> </tr> <tr> <td style="text-align: center; padding: 2px;">2.5</td> <td></td> <td></td> <td></td> </tr> <tr> <td style="text-align: center; padding: 2px;">0.0</td> <td></td> <td></td> <td></td> </tr> <tr> <td style="text-align: center; padding: 2px;">-2.5</td> <td></td> <td></td> <td></td> </tr> <tr> <td style="text-align: center; padding: 2px;">-5.0</td> <td></td> <td></td> <td></td> </tr> <tr> <td style="text-align: center; padding: 2px;">0.00</td> <td style="text-align: center; padding: 2px;">1.25</td> <td style="text-align: center; padding: 2px;">2.50</td> <td style="text-align: center; padding: 2px;">3.75 5.00</td> </tr> </table> REALTIME RESULTS <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left; padding: 2px;">VALUE</th> <th style="text-align: left; padding: 2px;">UNITS</th> <th style="text-align: left; padding: 2px;">MESSAGE</th> </tr> <tr> <td style="text-align: center; padding: 2px;">0.0</td> <td></td> <td style="text-align: center; padding: 2px;">Peak #</td> </tr> <tr> <td style="text-align: center; padding: 2px;">0.0</td> <td style="text-align: center; padding: 2px;">Dynes/cm</td> <td style="text-align: center; padding: 2px;">Surface Tension</td> </tr> <tr> <td style="text-align: center; padding: 2px;">22.0</td> <td style="text-align: center; padding: 2px;">Deg. C</td> <td style="text-align: center; padding: 2px;">Temperature</td> </tr> </table>	Ch. #0	Ch. #1	Ch. #2	Ch. #3	5.0				2.5				0.0				-2.5				-5.0				0.00	1.25	2.50	3.75 5.00	VALUE	UNITS	MESSAGE	0.0		Peak #	0.0	Dynes/cm	Surface Tension	22.0	Deg. C	Temperature
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Figure 12: Program screen of PC9000

The ~~allowing~~ convenient experimental procedure is provided in the step ~~by step~~ by the PC9000. ~~that will be discussed in the Appendix.~~ A

2.2 Material

1. De ionized water and standard methyl alcohol.
2. The different concentrations of the Surfactant (Sodium Dodecyl Sulfate, SDS); 2, 5, 10, 20, 50, 100, 200 PPM.
3. Extra Dry Nitrogen, is used at 50 psi.
4. Volumetric flashes; 200 ml. x
5. Beagers; 100 ml.
6. Earimeyer flash; 2000 ml. x
7. Water bath x
8. Heater and Magnetic bar x
9. Pipette x
10. Glass termometer

2.3 Procedures

To allow the instrument ^{to analyse} ~~analyze~~ the correct data, the complete step-by-step should be ~~done~~ ^{performed} to keep being ~~familiar~~ ^{familiar} with the previous software version. ^{the error to be minimal}

Step 1 : Starting the program

On the hard disk where ~~where~~ ^{ed} software is install, switch to the program directory. x

PC 9000: Type pc9000

Then the program screen appears. In the lower left corner, the current DOS time being updated every time.

Step 2 : Setting up Data & Quicklog file

On the program screen, click the file item, then the sub-items ~~are~~ ^{ed} appeared, select the "New Data File". The appropriate directory, sub-directory and a file name should be selected as follow: x

PC9000:\pc9000\data, type (? : file name.sdd)

To allow the computer ^{to the input} accept, the OK item is clicked or the ENTER key is pressed, then the setting up data is completed. x

On the program screen, click the file item, then the sub-items ~~are~~ ^{ed} appeared, select the "New Quicklog File". The appropriate directory, sub-directory and the file name ~~should~~ ^{should} be selected as follows: x

should



Figure 13: Quantitative Extra Dry Nitrogen

PC9000:\pc9000\data, type (?: file name.sdq)

To allow the computer accept, the ok item is clicked or the ENTER key is pressed, then the setting quicklog file is completed.

Step 3 : Temperature Calibration

To calibrate the temperature, the standard materials, ~~De-Ionized Water and Alcohol~~ are prepared ^{to} ~~type~~, ^{the main} ~~the methanol is used~~ with the following characteristic

- A hot water bath, temperature 75°C- 90°C

- A cool water bath, temperature 2°C- 10°C

Insert the probe to the hot water bath. Observe the temperature value. As soon as the ~~reading~~ ^{temperature} is constant, the high temperature calibration can be ~~done~~ ^{performed} by:

Selecting the "High Temperature" from the menu, type the current high stable value. To allow the computer accept, the OK item ~~was~~ ^{the input} clicked or the ENTER key ~~was~~ ^{is} pressed.

After a short pause, insert the probe to the cold water bath, observe the temperature reading, as soon as its reading ~~constant~~ ^{constant}, the low temperature calibration can be ~~done~~ ^{performed} by selecting the "Low Temperature" from the calibration menu and then type the current low stable value. To allow the computer accept, the OK item ~~was~~ ^{the input} clicked or the ENTER key ~~was~~ ^{is} pressed.

During Temperature Calibration, the temperature is quickly cool down, this is a sign for the accuracy that was careful protected.

~~it will affect the accuracy of the calibration.~~ The temperature calibration should be repeated if the situation occurs.

Step 4 : Adjusting the bubble frequency for Surface Tension Calibration

Adjust the appropriate bubble frequency by starting from the lower up to the higher value in each time's calibration. To allow the suitable illustration purposes, the ways was done as followed:

From "OPTION" in the main menu and select "Sampling Interval"

Click on the five seconds by the mouse or move by the cursor, and accept by clicking on the OK item or pressing ENTER key.

Step 5 : Select Tolerance Window

To ^{obtain} approach the correct data, from the "OPTION" the "Narrow" was selected in the Detection Tolerance by the mouse ^{clicking the mouse or pressing the cursor} clicked on or move it up or down by the cursor, Pressing ENTER key or clicking OK item by the mouse.

Step 6 : Surface Tension Calibration

Prepare the standard samples for calibration:

A sample of deionized water at ~~the~~ room temperature. ×

A sample of Methyl alcohol at ~~the~~ room temperature. ×

Insert the temperature controller's probe in the sink which contains the water ~~that is used to carrying~~^{at} the stable room temperature. Before inserting the probes to measure the standard samples, the "ZERO Adjustment" was ~~done~~ as followed: ×

Take the temperature probe out of the fluid. From the "OPTION" select the ~~analyze~~^{analyze} sample or click the analyze sample on the program screen by the mouse. After that, when the computer sampling reach 5116 sampling points, the straight blue line pressure is displayed (it should be at the 0.0 Volt, because when the temperature probe is taken out of the fluid ~~in~~^{to} the air, the pressure between ~~both of~~ small orifice and large orifice probes ~~are~~ equal to the air pressure, so the pressure drop or the different pressure is equal to zero).

To make sure that the peak-to-peak and the magnitude of the graph is correct, the "SPAN" is involved to set within the suitable range (3-3.5 volts). ×

From "OPTION" in the main menu select "Analyze sample". After sampling for five second, the sweep graph is displayed, as the narrow tolerance is ~~achieved~~^{achieved}, the sweep graph is reset to clear all previous data ~~as well as~~, then the sampling button is selected off state (green color). The sampling button stays ON (reading "Stop Sampling"), showing that the measurement procedure is in progress. The program now enters the Advanced Peak Detection mode (SensaDyne Software manual version 5.1). ×

As soon as the computer reads the constant surface tension, from the calibration, the "High Software Surface Tension" is selected. The high surface tension is clicked by mouse or can be moved UP or DOWN by the cursor. The high surface tension is ~~input~~^{input} at the current temperature. To accept, the OK item is clicked by the mouse or pressure the ENTER.

AutoCal:

From "CALIBRATION" in the main menu, select "Autocal D.I. Water", then the surface tension is calculated automatically, the high ~~surface~~^{surface} tension calibration is complete, and the current calibration data is written automatically to the setup file. ×

To verify the calibration, let the software sample a little longer, as soon as the peak to peak looks like the sawtooth then the "Stop Sampling" (green color) is clicked by the mouse or selected the "Stop Sampling" from ×

the option. The current display is shown after the software finish the circle running. ×

Now, insert the temperature probe in to the methyl alcohol and allow the software ^{to analyze} analyzes, from the "OPTION", select the "Analyze Sample" by moving the cursor UP or DOWN or click the program screen. When the software starts to ^{analyze} analyze, the state is ON (Red screen). The updated data will display after it finished the reset before the graph is appear. ^{the analysis} During the analysis, none of the other results, including bubble data, is updated. ×

As soon as the reading low surface tension is stable, the low surface tension calibration is done. From the "CALIBRATION", in the main menu, select the "Low Software Surface Tension" by the mouse or move it UP or DOWN by the cursor, enter the correct surface tension of the Methanol. To accept the OK button is clicked by the mouse or ENTER key is pressed. ×

To verify ^{the input} the Surface Tension calibration reading, let the temperature ^{the} analyze little longer. As soon as the value is verified, push the "Stop Sampling" button, or from the "OPTION" in the main menu select the "Stop Sampling". The button is reset to the OFF state (green color), if the system is running, it will stop immediately then the program reach the idle state. ×

Note :

To make sure that all the results are correct, The surface tension calibration should be done every time when the measurement of the samples are required. Before the calibration, the set point temperature should be select at ^{the} the room temperature, including the reading values on the program screen and temperature controller should be equal to each other. ×

Step 7 : Measuring the test sample

Prepare the Samples; 2, 5, 10, 20, 50, 100, 200 ppm, whose surface tension is to be measured, ^{then} and insert the probes in to the samples. ×

Note :

Remember that as the probes are insert in to the samples, the software has to be analyze. To obtain the equal temperature values, the sink of water is ^{analysed} analysed. ×

used to carry the sample beager to acquire the stable value and protect the temperature fluctuation.

Either

From "OPTION" in the main menu select the "Analyze Sample" with the mouse click on the "Analyze Sample" button. *the*

Make sure, the sawtooth fit completely in ~~to~~ graph window. If the peaks are clipped, the signal is out of the range. Let the software select the sampling points long enough. *x*

As a narrow tolerance window is selected, ten peaks are captured *analysis* for ~~analysis~~. As soon as this is achieved, the sweep graph is reset to clear all previous data as well as the ~~analysis~~ *analysis* button set to its OFF state (green color). The sampling button stays ON (reading "Stop sampling"), showing that the measurement procedure is in progress. The program now enters the Advanced Peak Detection mode. *the analysis* During ~~analysis~~, non of the other results, including bubble data, is updated. *x*

All of the results are updated every *time* it is reset, including the real time increases while the analysis is progressing. The surface tension is shown as the surface tension of the sample under the test. *x*

Step 8 : Collecting data to disk

Note:

Before the data is collected, the two specific files should be created. ~~If these two files are not done, the following way~~ as followed: *x*

From the "OPTION" in the main menu, select the "Start Recording" or click at the "Start Recording" button with the mouse.

Data collection to disk is started *at* at the adjusted rate ~~in~~ to the specified data recording file. *x*

At any point, the current data, including the numeric label and an optional comment, can be stored by the quicklog storage as followed:

From "OPTION" in the main menu, select "Do Quicklog" or click on the "Do Quicklog" button with the mouse.

The Quicklog dialog box is displayed. In the first entry box enter the numeric label, that is used later for ~~the graphing~~ *displaying graphs*. Move the cursor DOWN to ~~on~~ the optional comment. This optional comment can be up to 30 characters long. To accept both of them, the OK button is clicked with the mouse or ~~Press on~~ *pressing* the ENTER key.

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During the peak detection process, sampling can be ^estop any time. The program completes data display and ^{stopped}result ^{update results}update for the whole data sample. X

If sampling is stopped during data acquisition (running sampling counter), the acquisition process is stopped immediately. When a new acquisition process is started, the sampling counter is reset, so that no gap is left in the data sample. This function can be used to "freeze" the data display for manual ~~analyzation~~. ^{analysis}. X

Step 9 : Exit the program

To exit the program, it is necessary that the program is in the idle state, by ^{turning}turn off sampling first. Then, from "FILE" in the main menu, select "QUIT". The program is stopped, all files are closed and screen is reset to text mode. X

3.RESULTS AND DISCUSSION

The Dynamic Surface tension for the various SDS ^{concentrations?}~~concentrational~~ aqueous are shown in Figure 14. The surface tension of the various SDS concentrations ^{are significantly}is found ~~that~~ lower than the pure standard compounds or even those of the mixture of the pure compounds. These are responded to reduce the bubble coalescence and hence the mass transfer in the low energy requirement. X

The surface tension was found ^{decreasing}decrease at the bubble generated time. The values of the surface tension decreased very rapidly, ~~at the short period time,~~ the curve ^{is flattened at}is flattened until the equilibrium surface values. The time required ^{to reach}the equilibrium surface tension values depends on ~~the different~~ concentration. The high surface tension has a sooner time to ^{reach}achieve the equilibrium values. X

From the results, ^{in consideration of the diffusion}~~in case diffusional consideration~~, the higher SDS concentration allowed the ~~the~~ high diffusion because there is ~~the~~ more differences between the bulk of the surfactant concentration and the interface causing ^{and a}the larger diffusion driving force. higher interface surfactant concentration due to ^alower surfactant. The effect of the surfactant concentration of SDS on the surface tension is shown in the Figure 15. X

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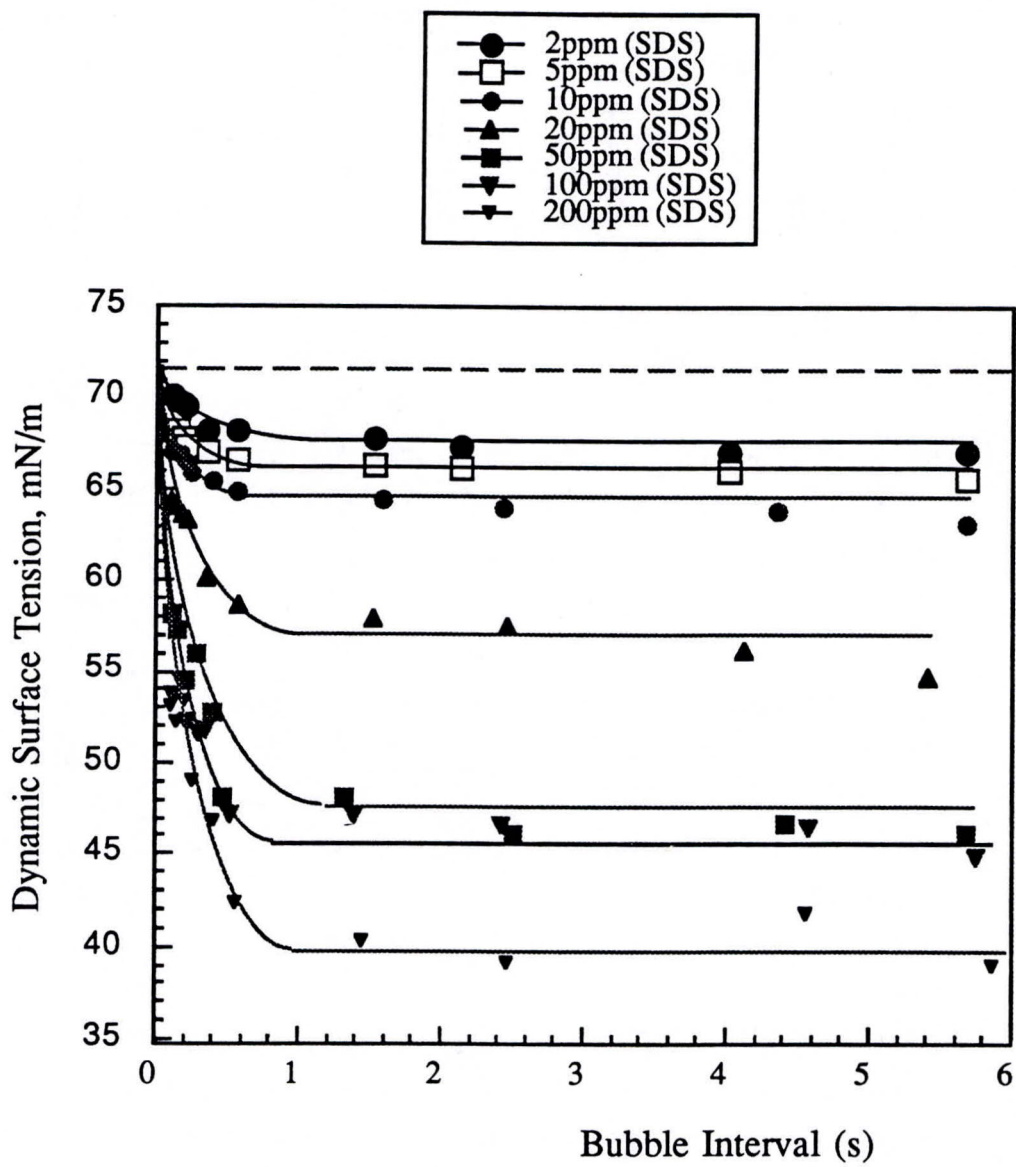


Figure 14 : Effect of SDS concentration on dynamic surface tension of aqueous solution

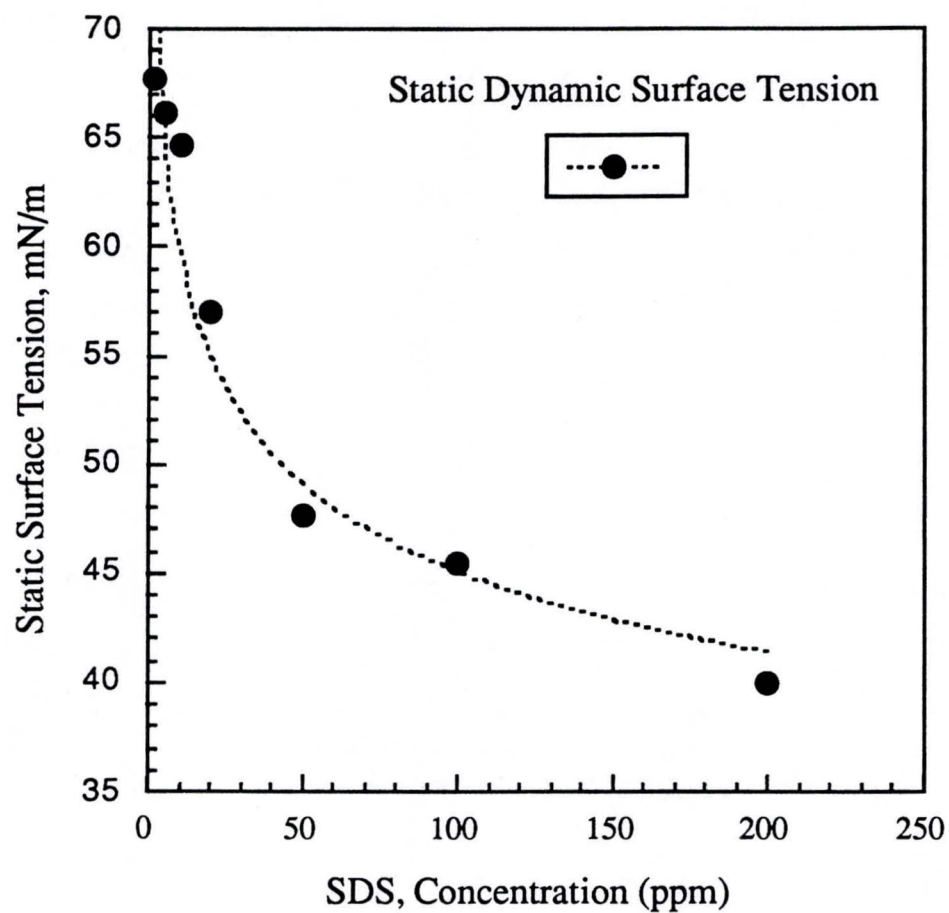


Figure 15: Effect of Various SDS concentration on Static Surface Tension

4. CONCLUSIONS

1. The presence of the different SDS surfactant concentrations affect ~~on~~ the surface tension and ~~hence~~ the gas-liquid contacting behavior, such as bubble break-up, bubble coalescence including ~~the~~ mass transfer rate.

2. The ^{high} increased surfactant concentration causes the bubble breakage as shown ^{in a} ~~that~~ lower dynamic surface tension ~~including to the~~ lower equilibrium values. ^{and a}

3. At the high surfactant concentration, the diffusion ~~is allowed to~~ increase, ~~hence~~ decreasing the low surface tension at the interface. ^{resulting in}

5. RECOMMENDATION

The important ^{procedure of getting results} ~~fitting~~ the correct ^{maintained} ~~data~~ should have been obtained since the initial checkout procedure; the set zero and span, the standard suitable probes at any situation until the appropriate bubble frequency ^{adjustment} ~~adjustment~~, the bubble frequency of the smaller orifice should be slightly faster than the larger one.

The fact that

1 - ^{a for checking} ~~The~~ graph should be looks like the sawtooth, allowing ~~to~~ check the bubble frequency adjustment, is suitable or not. ^{whether it}

The experimental set-up is exactly step-by-step and every ^{ed} ~~thing~~ should be very clean.

Before measuring any samples, the surface tension calibration should be ^{performed} ~~done~~ every requirement with the standard probes, even change ^{in every changes,} ~~in the same~~ size and shape of probes.

To ^{obtain} ~~allow~~ the correct ^{results} ~~data~~, the temperature of the system should be obtain ^{ed} ~~ably~~ more ^{accurately} ~~accuracy~~ and constant by the water bath with magnetic spinding to retain the small fluctuation of the temperature.

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SURFACE TENSIONMETER BLOCK DIAGRAM

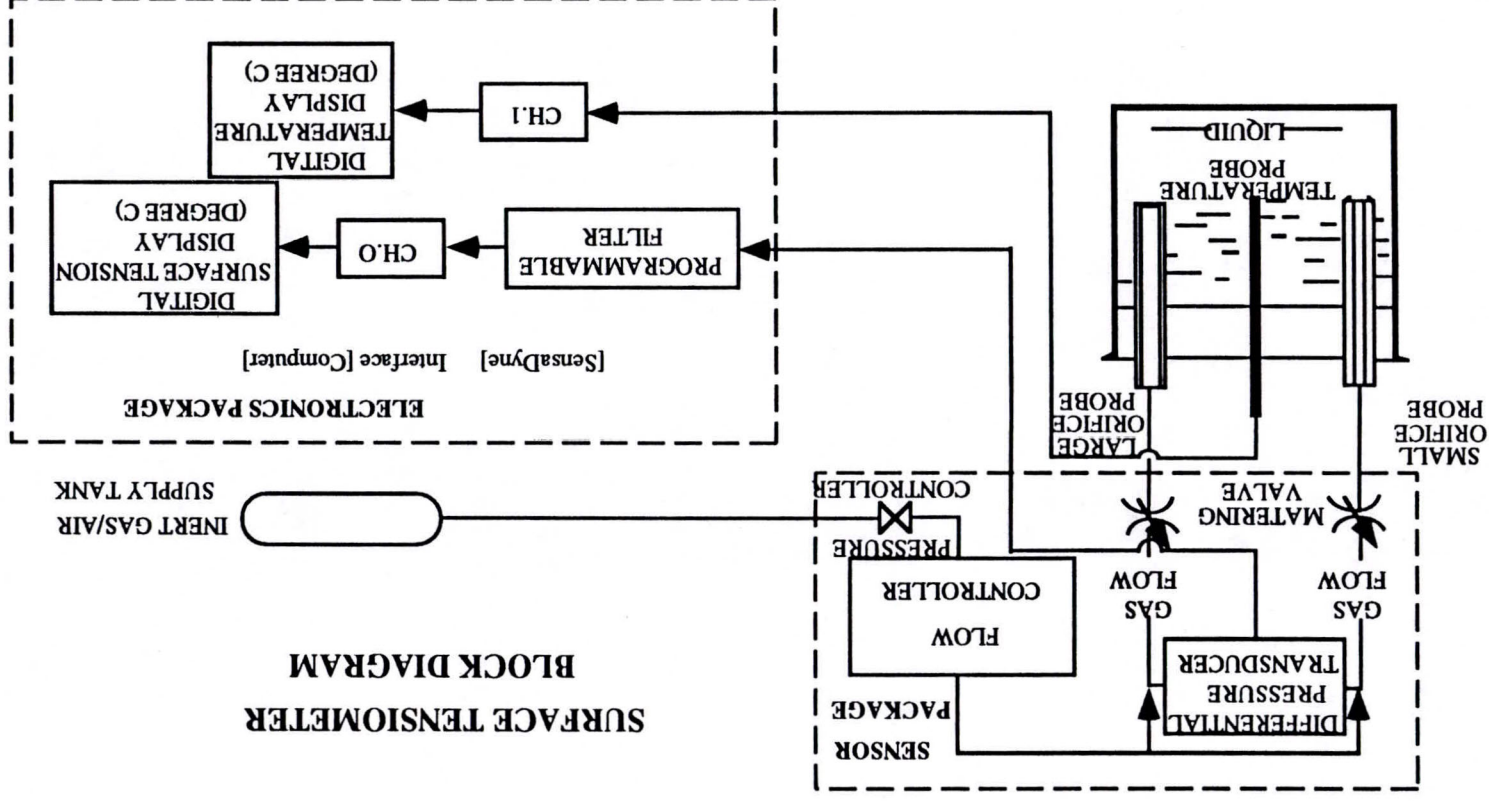


Figure 16: Surface Tensionmeter Block Diagram

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APPENDICES

Appendix A. Glossary PC9000

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Advanced Peak Detection Mode:

Patented algorithm that allows evaluation of each detected peak for its validity. Due to this algorithm, highly accurate measurements independent from any noise are possible, even under pressure.

Alarm(s):

The values of surface tension and temperature are checked against user selected alarm limits. Alarms are audible and are logged to disk. Also, a drastic change in surface tension, which the software can not follow without (-> Analization), causes an alarm.

Analog Input Board:

Interface from the PC to the instrument, which is installed in a free slot in the PC. Analog data from the instrument is collected using this board, and then stored digitally in PC memory (-> Sensor Electronics).

Analyzation Mode:

Mode in which the software works in standard peak detection mode, where every peak is accepted. A filtering algorithm is used to determine the valid peaks and calculate the average. The software enters Analyzation mode, if there is a change in surface tension, either due to a new fluid, or changed instrument parameters (-> Calibration Interval).

Bubble Frequency:

Number of bubbles that release per second. Inverse of (-> Bubble Interval)

Bubble Interval:

Time period between two released bubbles. Inverse of (-> Bubble Frequency)

Calibration:

In order to measure accurately, the instrument has to be calibrated for

temperature and surface tension. Calibration is done at the upper point (High Calibration) and a lower point (Low Calibration) of the calibration curve. (-> Standard Calibration Fluid)

Calibration Interval:

Temperature calibration is recommended every 6-8 months, depending on the drift of the temperature probe.

Surface tension has to be calibrated each time, whenever a parameter of the instrument changed:

- Flow Rate
- Span Potentiometer Adjustment
- Zero Potentiometer Adjustment
- Change of probe Size or Material

CANCEL Button:

Clicking this button with the mouse discards all inputs or changes mode. The dialog box closes. Pressing the ESC key has the same effect.

Channels:

The QC3000 and the QC6000 software each read and display two channels, which are:

- Channel 1: Temperature
- Channel 2: Pressure Transducer Output (-> Sawtooth Signal)

The PC9000 software reads the display four channels, which are:

- Channel 0: Steady State Surface Tension (-> Sensor Electronics)
- Channel 1: Temperature
- Channel 2: Pressure Transducer Output (-> Sawtooth Signal)
- Channel 3: Peak Trigger Signal (-> Sensor Electronics)

The channel display can be turned on and off using the switches and the mouse, or the channel menu.

Configuration File:

The configuration file holds on this data describing the current setting, such as sampling interval, paths, and calibration parameters. Each time a

setting is changed, the configuration file used for the initial setup at program start is updated automatically. The user has possibility to save a setup at any time, allowing the retrieval of calibration setting for specific flow rates.

Data File:

To record data over the period of time, it is stored in the data file (default file extension *.sdd). The data file format is standard ASCII, the data values are stored in the following order (1 data set per point):

- Scan number
- Surface Tension [Dynes/cm]
- Temperature [°C]
- Bubble Frequency [bubbles/s]
- Bubble Interval [s]
- Total Process Time [s]

Dialog Box:

An interface for specific user input. Dialog boxes can consist of one or two input boxes. They all have a (-> OK button) and a (-> CANCEL button). The input focus can be moved with the cursor keys from one input window to the next, or with the TAB key to the buttons, which then appear in dark red, or to another input box.

Hardware Peak Detection:

Only available for the PC9000 instrument and software. The PC9000 (-> Sensor Electronics) sets a digital output each time a peak appears (so-called *trigger*). In Hardware Peak Detection Mode, when this trigger is detected the signal on channel 0 (-> Channels) is read and used to calculate the surface tension. Hardware Peak Detection is more susceptible to noise than (-> Software Peak Detection).

OK Button:

Clicking this button with the mouse accepts all input or changes made. The dialog box closes. The new values are processed. Pressing the ENTER key has the same effect.

Peak #:

The peak # is displayed in the first line of the *REALTIME DATA* window. It is increased on every peak that was detected and accepted as valid in Advanced Peak Detection Mode. In Analyzation Mode, it display the number of peaks detected, until the mode is automatically awitched to advanced Peak Detection.

This indicator is a way to verify the correct measurement procedure, as the number of peaks that are visible in the sweep graph can be compared to this number.

Quicklog:

The Quicklog function is used for data recording on demand. Only one set of values is stored in a Quicklog file (default file extension *.sdq) per call. If more than one set of values is recorded to one Quicklog file, the data sets are appended. The Quicklog file format is standard ASCII, the data values are stored in the following order (1 data per line):

- Surface Tension [Dynes/cm]
- Temperature [°C]
- Bubble Frequency [bubbles/s]
- Bubble Interval [s]
- Numeric Label
- Comment

Sampling Interval:

The sampling interval defines the time period for data collection from the (-> Analog Input Board). The software uses the so-called post-processing method to measure surface tension. Thereby, data is collected in real time, and then evaluated.

Sawtooth Signal:

This signal is display as channel#2. It is the output of the differential pressure transducer, which is used for (-> Software Peak Detection).

Sensor Electronics:

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The electronics located in the instrument enclosure. It conditions the output signal from the temperature probe and the pressure transducer to different voltage levels, making them readable for the (-> Analog Input Board).

PC9000 only: The PC9000 electronics also provides a trigger signal on each peak, and a steady state output signal (-> Channels) proportional to the surface tension, which can be used for process control.

Software Peak Detection:

(-> Advanced Peak Detection)

Standard Calibration Fluids:

Deionized water and Ethyl alcohol are commonly used as standard fluid for calibration, their surface tension is known, and does not change with the flow rate, as they are non-active.

Start Sampling function:

The Start Sampling function starts data collection from the (-> Analog Input Board). The correct installation of the analog input board can be verified by invoking this function and watching the counter in the first panel of the BUBBLE DATA window, which indicate the number of data points that are collected. The time period of this counter running must be equal to the (-> Sampling Interval) value.

Tolerance Window:

For the Advanced Software Peak Detection Mode, a bandwidth around the peak average has to be specified, in which peaks whose values are within this bandwidth are accepted as valid.

The user has the choice of three bandwidths:

- Narrow
- Medium
- Wide

This setting also effects the number of peaks that have to be detected during Analyzation. The wider the Tolerance Window, the more peak have to be detected before a valid average is calculated.

Total Process Time:

Time period beginning and ending with the data recording. Can be used alternatively to the scan numbers to graph recorded data (Operator Manual).

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Appendix B. Experimental Data of Dynamic Surface Tension

Dynamics Surface Tension VS Bubble Interval (SDS 2PPM)

Run	Bubble Interval ; s	Dynamics Surface Tension ; σ mN/m
1	0.12	70.12
2	0.15	69.80
3	0.18	69.68
4	0.21	69.50
5	0.35	68.25
6	0.56	68.12
7	1.52	67.67
8	2.13	67.35
9	4.02	67.02
10	5.67	66.98

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Dynamics Surface Tension VS Bubble Interval (SDS 5PPM)

Run	Bubble Interval ; s	Dynamics Surface Tension ; σ mN/m
1	0.12	68.24
2	0.15	68.13
3	0.18	67.78
4	0.21	67.25
5	0.35	67.02
6	0.56	66.56
7	1.52	66.23
8	2.13	66.14
9	4.02	65.98
10	5.67	65.52

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B

Dynamics Surface Tension VS Bubble Interval (SDS 10PPM)

Run	Bubble Interval ; s	Dynamics Surface Tension ; σ mN/m
1	0.11	67.02
2	0.17	66.83
3	0.20	66.42
4	0.25	65.87
5	0.39	65.46
6	0.57	64.78
7	1.58	64.35
8	2.43	64.03
9	4.35	63.75
10	5.67	63.16

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Dynamics Surface Tension VS Bubble Interval (SDS 20PPM)

Run	Bubble Interval ; s	Dynamics Surface Tension ; σ mN/m
1	0.12	64.28
2	0.16	64.02
3	0.19	63.54
4	0.23	63.20
5	0.36	60.08
6	0.58	58.64
7	1.53	57.92
8	2.48	57.41
9	4.13	56.13
10	5.42	54.72

Dynamics Surface Tension VS Bubble Interval (SDS 50PPM)

Run	Bubble Interval ; s	Dynamics Surface Tension ; σ mN/m
1	0.12	58.17
2	0.16	57.23
3	0.20	54.56
4	0.28	56.02
5	0.40	52.81
6	0.48	48.06
7	1.32	48.13
8	2.51	46.13
9	4.42	46.59
10	5.68	46.01

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LJ

Dynamics Surface Tension VS Bubble Interval (SDS 100PPM)

Run	Bubble Interval ; s	Dynamics Surface Tension ; σ mN/m
1	0.14	53.64
2	0.18	54.32
3	0.22	52.18
4	0.31	51.60
5	0.36	51.76
6	0.52	47.13
7	1.40	47.05
8	2.43	46.48
9	4.58	46.39
10	5.76	44.83

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Dynamics Surface Tension VS Bubble Interval (SDS 200PPM)

Run	Bubble Interval ; s	Dynamics Surface Tension ; σ mN/m
1	0.12	52.98
2	0.16	52.12
3	0.20	53.36
4	0.26	49.02
5	0.42	46.86
6	0.56	42.26
7	1.45	40.19
8	2.48	39.11
9	4.56	41.66
10	5.87	38.98

APPENDIX D

**ACTIVITY A 4.33 MINI-PRC MEETING
THAILAND - SUT, FEBRUARY 12, 1997
DR. STALIN BOCTOR - REPORT**

*Report on
SE Asia Deans of Engineering Conference and Mini-PRC (SUT/CUTC)
February 10-14, 1997*

On arrival in Bangkok, I received a fax from SUT informing me that the mini-PRC on Friday, February 14, 1997 is cancelled due to other commitments, even though this meeting was scheduled and reconfirmed over the past two months. The mini-PRC was finally rescheduled for Wednesday, February 12, 1997 between 5-7 p.m.

The four members of the Canadian CUTC delegation delivered four papers in one session, on Tuesday, February 11, 1997, scheduled for 1:30-3:30 p.m., as originally planned. The conference was reasonably attended (about 35 people, including 4 from Canada and 4 from France).

The mini-PRC was held on February 12, 1997. It was attended by:

- a) Dr. Schneider, Dr. Hamdullahpur, Dr. Bector and Dr. Otten from the CUTC
- b) Dr. Tavee, Dr. Tawachai, Dr. Sarawut, Dr. Umaly, and the new VP Planning.

Both sides exchanged submitted discussion items (see attached appendix). Dr. Bector presented the on-going and agreed upon activities (3rd PRC meeting in Waterloo) and the contracts requiring SUT signature. He also presented SUT with the latest 6 month project report. He then presented some ideas for relevant additional activities to use the remaining funds in the budget. Dr. Tavee and Dr. Umaly informed the CUTC that the Thai Project Committee met last week, presided upon by Dr. Wichit, to examine the project's activities and future collaboration. However, there was a clear indication that:

- a) the IUP (3rd trimester June-Sept. 1997 for the 5 remaining Electrical Engineering students) may be cancelled
- b) all agreed upon activities during the 3rd PRC meeting may be cancelled due to budget cutbacks at SUT
- c) Dr. Wichit has yet to decide upon the anniversary theme and dates and that he will inform Dr. Bector. All that is known at present is that the festivities will be from July 22-27, 1997. Also, no discussion has yet been made regarding speakers or topics.

The CUTC suggested that Dr. Prasart could be included in the Thai SUT delegation to the 4th PRC meeting in Halifax, for the sake of continuity, particularly since the SUT project management has changed considerably.

There was no time for discussions, reflections or exchange of ideas beyond the items referred to above.

During the conference breaks, Dr. Hamdullahpur met with four prospective Ph.D candidates from SUT. Also Dr. Bector met with the remaining 4 (of 5) EE IUP students, with Prof. Barta and Dr. Sarawut in attendance. The students were given RPU advanced-standing application forms for foreign students, and were informed about the final decision to cancel the third trimester (June-Sept. '97). They were also informed that once they successfully completed the present second trimester, they could be admitted to RPU next January 1998 in the second semester of Year I, since they have not completed the year I curriculum. They were also advised that it would be

very beneficial if they came in September 1997 to take intensive ESL for one term. They were informed that they could transfer to SUT's regular Thai Engineering Programs if they so wished. It may even be conceivable that they may want to apply to other Canadian universities on their own.

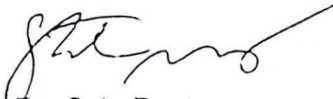
On Thursday, February 13, 1997, just before Dr. Boctor was to meet with the IUP students, Dr. Boctor met briefly with Dr. Tavee. He was informed that:

- a) The SUT's project budget has been severely cut, and that they will not be able to fund their remaining committed share of the project cost. Unless CIDA's funds completely covers the remaining activities, it may not be possible to implement them.
- b) On the basis of (a) above, the IUP will be cancelled for the remaining EE students. Also the visits to help SUT prepare their graduate programs in engineering will be cancelled. The proposed visits by Ph.D advisors from TUNS to promote sustainable future research collaboration were also cancelled.
- c) The following exceptions to the cancelled activities will remain:
 - 1. The proposed visits by Dr. Goff and Dr. Demann in September '97
 - 2. One Ph.D supervisor's (Dr. El Taweel from TUNS) visit, yet to be determined.
(Please note that the relevant contracts which were left with Dr. Tavee are still to be signed!)
 - 3. Since two Canadian co-op students from TUNS have already obtained job offers and placements, one additional Canadian co-op student can be supported.
- d) The Halifax meeting should reflect on "lessons learned", and possible future collaborations/sustainable activities.

No further information regarding the proposed RPU President's visit in July was received.

Conclusion

Since a major change in the project funding agreement has occurred at SUT, and since the majority of the approved and assigned project activities (see 3rd PRC meeting's minutes) will not be funded by SUT as previously agreed to, the CUTC has no other option but to inform the ARA and CIDA about the present circumstances. Except for those activities presently taking place, and those that may be approved by SUT (see item (c) above), the funds allocated for all the cancelled activities in Programs I, II, III, and IV may have to be returned back to CIDA through the ARA. An approximate summary of those funds is attached.



Dr. S.A. Boctor

- c. All CUTC member universities

Funds Remaining in Cancelled Project Activities

	Approximately	() means deficit
Program I	\$17,620	
Program III	(\$2,630)	
A2.11	\$22,000	
A2.12	\$46,000	
A2.21	0	
A2.23	\$5,200	
A2.25	(\$4,700)	
A2.26	\$16,920	
A2.27	\$18,900	
A2.31	0	
A2.32	(\$4,000)	
A4.311	25,500	
A4.33(c)	<u>\$25,000</u>	
Total	\$165,810	

APPENDIX E

PROJECT STATUS UPDATE DR. STALIN BOCTOR, APRIL 22, 1997 LETTER TO ARA



DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
FACULTY OF ENGINEERING AND APPLIED SCIENCE

April 21, 1997

Mr. Roger Griffin, Project Coordinator, Thai-Can. HRD Project
The ARA Consulting Group Inc.
121 Bloor Street East, Suite 405
Toronto, Ontario, Canada, M4W 3M5

**Re: Status of Project L-3004 Deliverables and Project Activities Adjustments
based on resolutions of the 4th PRC meeting (Halifax, April 1997)**

Dear Roger:

The following summary of the status of the project deliverables, and adjustments to projects activities (and hence funding allocations), describe the resolutions reached at the 4th PRC meeting in Halifax, on April 3-4, 1997. The minutes of the 4th PRC meeting and the most up-to-date Project Deliverable Status summary budget (including adjustments) are attached. Details of the completed activities will be provided in the Annual Report (April, 1997).

- A2.11b) Contributions of the CUTC to the S.E. Asia Deans of Engineering meeting at SUT, Feb. 1997, and the mini-PRC: This activity was **completed**. Actual expenditures: \$16,709.
- A2.11c) **Unchanged**. Total expenses budgeted: \$21,681.
- A2.12b) This activity relating to Postgraduate Engineering Program development was **cancelled** by SUT. Unassigned funds: \$19,200. However, the 4th PRC meeting **replaced** this deliverable by the new deliverable A2.4 (see below), with new budget allocation.
- A2.12c) This deliverable was **reduced** to only one assignment for Prof. P. Barta. This assignment is on-going and will be completed in May, 1997. All other assignments were cancelled by SUT. The total expenses budgeted for this activity are reduced to \$4,700. Unassigned funds: \$27,300.
- A2.12d) **Unchanged**. This deliverable will be completed in Dec. 1997. Total expenses budgeted: \$12,800.
- A2.21) All Ph.D. candidates from SUT have now been selected. This activity is now **complete**. Actual expenditures: \$15,835.

- A2.23) **Reduce** this deliverable to only one assignment for Prof. Al Taweel. The budget is changed as follows:

Travel to and in Thailand	\$3,910
Accommodation (7 days)	\$840
Perdiem (7 days)	\$350
Consultant Fees (5 days)	\$1,800
Total Expenses Budgeted	\$6,900

This activity is expected to be completed in October, 1997. Unassigned funds: \$3,500.

- A2.25) **Change** the budget for this deliverable to include **one additional** postdoctoral fellow (Dr. Arjuna to Guelph University). Also adjust funding allocation to reflect actual expenses of the present postdoctoral research fellows:

Travel to Canada	\$3,400		
Living Allowance (18 weeks)	\$5,400		
Research Program Material and Local Travel	\$2,700		
	\$11,500		
Adjustment to line item	\$3,600		
New total expenses budgeted	\$15,100	+ \$44,700	= \$59,800

This deliverable is expected to be completed in Dec, 1997.

- A2.26) **Completed** in Nov. 1996. Two advisors from SUT visited University of Waterloo to facilitate the design of High Voltage and Thermodynamics research laboratories at SUT. Actual expenditures: \$8,073. Unassigned funds: \$4,927.

- A2.31a) **Completed** in Dec. 1996. Actual expenditures: \$16,000.

- A2.31b) **Unchanged.** To be completed in Dec. 1997. Total expenses budgeted: \$16,000.

- A2.32b) **Add** one Canadian Co-op student assignment in Thailand, for a total of 5. This activity is expected to be completed in September, 1997. Total expenses budgeted: \$20,000.

- A3.23) **Unchanged.** Total expenses budgeted: \$19,600. The three additional industrial seminar assignments in Thailand will be completed in March, 1998.

- A4.21d) **Completed.** Actual expenditures: \$34,416.

- A4.21e) Change total expenses budgeted to \$38,002.
- A4.31) **Unchanged.** Total expenses budgeted: \$25,560.
- A4.32) **Completed** in April, 1997 (PRC 3 and PRC 4). Actual expenditures: \$24,491. Unassigned funds: \$3,709.
- A4.33b) **Unchanged.** Total expenses budgeted: \$26,412. To be completed by Dec. 1997.
- A4.33c) **Unchanged.** Total expenses budgeted: \$25,000. To be completed by March, 1998.

Unassigned funds (inflation adjustments) to be allocated by 4th PRC meeting: \$41,964.

List of Completed Activities by April 1997

A2.11b)	\$16,709
A2.21)	\$15,835
A2.26)	\$8,073
A2.31a)	\$16,000
A4.21d)	\$34,416
A4.32)	\$24,491
Total	\$115,524

Funds Available for Reallocation

From	2.12b)	\$19,200	
	2.12c)	\$27,300	
	2.23)	\$3,500	
	2.26)	\$4,927	
	4.32)	\$3,708	
Unassigned		\$41,964	
	4.41)	\$1,101	(Reduction of funds allocated to this line item)
	Total	\$101,700	

Reassigned funds

To	A2.25)	\$15,100
	A2.32b)	\$4,000
	Total	\$19,100

Net funds available for reallocation **\$82,600**

New Approved Activities (RPC4, April 1997)

A2.4) Workshop for Postgraduate Engineering Programs Development and Quality Control:
Seven Canadian Consultants, Nov. 1997.

Travel to and in Thailand	(7 × \$3800)	\$26,600
Accommodation	(7 × 10 × \$120)	\$8,400
Perdiem	(7 × 10 × \$50)	\$3,500
Consultants fees	(7 × 10 × \$360)	\$12,600
Total		\$51,100

A2.5) Academic Research Exchange for Thai Faculty:
5 Thai faculty members, total 10 weeks. To be completed by Dec. 1997.

Travel to and in Canada	(5 × \$3900)	\$19,500
Living Allowance	(10 × \$300)	\$3,000
Program Planning by CUTC partners	(10 × \$900)	\$9,000
		\$31,500
Total Funds Reassigned		\$82,600

The remaining project deliverables will be completed within the 1997/98 fiscal year as indicated above, and the SUT/CUTC project (L-3004) will thus be completed on target as budgeted.

Thank you for your continued help and support.

Sincerely,



Dr. S.A. Bector, P.Eng.
Program Manager

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	

APPENDIX F

SUT CONTRIBUTION TO ANNUAL REPORT FOR THE PERIOD COVERING JULY TO DECEMBER 1996

**THAILAND - CANADA HRD PROJECT
SUT-CUTC INSTITUTIONAL LINKAGE
AND TECHNICAL COOPERATION**

QUARTERLY PROGRESS REPORT NO. 9

1 August 1996 - 31 December 1996

Submitted to :
Ryerson Polytechnic University

Prepared by

SURANAREE UNIVERSITY OF TECHNOLOGY

111 University Avenue

Amphur Muang

Nakhon Ratchasima 30000

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6. Trip report by Mr. Robert Eagle on the industrial seminars.	
7. Minutes of the third PRC Meeting	

SUT-CUTC Biannual Report for July-December 1996

I. REPORT SUMMARY

1. Program and Achievements to Date

Program 1. Institutional Capacity Building Program

Study tour was made in September 1996 by the Director of the Center for International Affairs (2 weeks) and of a Program Officer of the Center (4 weeks) to discuss the administration and management of the SUT-CUTC Project in Canada as well as to acquaint them of the activities of the Centers for International Relations / Affairs of the partner CUTC universities.

All activities of Program 1 have been completed.

Program 2 - International Academic Programs

2.1 International Applied Science and Engineering Undergraduate Programs

Two Canadian professors - Professors David MacKay and Gerry Schneider finished their 7 week assignments of teaching the 1995 IUP students (Mechanical Engineering).

The remaining five 1995 IUP students in the Mechanical Engineering program have been transferred to CUTC universities to start their second year in Canada. Three of them were admitted conditionally to TUNS while the other two were admitted to Conestoga College for remedial English course and would later enroll in the Engineering Program at the University of Waterloo.

There are currently 8 students remaining in the 1996 IUP Electrical Engineering Program.

2.2 Joint Research and Ph.D. Program

Two SUT faculty members have enrolled Ph.D Program at TUNS and two more will start in January and September, 1997 respectively. A fifth candidate is being considered for admission by TUNS. A sixth candidate is expected to start his Ph.D. Program in September of 1997 at the University of Guelph.

Two professors from the Institute of Industrial Technology visited some laboratories for mechanical and Electrical Engineering at the University of Waterloo.

2.3 Co-op Student Exchange Program

Two Thai students who have been working at the University of Guelph since June 1996 would finish their assignments in December 1996. Another two students started their co-op work terms at TUNS in September 1996.

Program 3 - University - Industry Linkage Program

Mr. Robert Eagle from TUNS visited SUT last October to discuss the possibility of additional industry-based workshops and seminars in Korat. It is expected that two or three seminars / workshops for industry will be organized by SUT's Technopolis in

II. PROGRESS REPORT ON PROJECT PROGRAMS, ACTIVITIES AND DELIVERABLES

1. Accomplishments

Program 1 - Institutional Capacity Building Program

1.3 Development of Academic Programs and Curricula at SUT

A1.31 Provision of customized training in Canada for SUT Academic Support Personnel

Visits to Canada of SUT's CIA Director and one program officer took place in September 1996. Prof. Dr. Ruben C. Umaly, CIA Director, visited the partner CUTC universities to discuss plans for the implementation of the remaining SUT-CUTC Project activities and future cooperation and also to examine the administration and management of the CUTC project in Canada. **(Attachment 1)**

Ms. Mantana Thammachoti - a Program Officer from The Center for International Affairs - attended a 4 week training course in September 1996 (during 1-27 September 1996) to familiarize herself with the strategic and operational management of Centers for International Relations/Affairs at each of the CUTC partner universities. **(Attachment 2)**

With these activities, all of Program 1 activities have now been completed.

Program 2 - International Academic Programs

2.1 International Applied Science and Engineering Undergraduate Programs

A2.11 Academic program planning and coordination

Two professors from the CUTC partner universities were at SUT for short-term assignments (7 weeks each) to help teach the International Undergraduate Program in Mechanical Engineering during the third trimester.

Prof. David MacKay from TUNS taught Engineering Practice, Ethics and Technical Communication, and ESL 300 from 1 June-19 July, 1996.

Prof. Gerry Schneider from University of Waterloo taught Engineering Graphics I and Fundamentals of Mechanical Engineering from 17 July-29 August, 1996.

A2.12 Curriculum Implementation of the International Applied Science and Engineering undergraduate programs.

a) Status of the 1995 IUP students (Mechanical Engineering)

After completing their first year in early September, the five remaining IUP mechanical engineering students transferred to Canadian universities. As the students did not meet the English language prerequisites, they were required to take remedial English language courses before being definitely admitted to the CUTC partner universities.

Two students were admitted for their remedial language courses at Conestoga College; one of them - Nattapon POOIPAT, has now completed his English training and will enroll this coming winter term at the University of Waterloo. The second student is still in the English language program. The remaining three students were accepted by TUNS, but they also had to take English classes during October-December. They will be able to register in Engineering at TUNS in January 1997, but will first have to take a number of remedial courses at St. Mary or Dalhousie University before continuing in the engineering program at TUNS.

The sudden and unexpected decision to have the students continue their

second year of studies in Canada caused some disruption and delay in the program.

As the students had not taken any TOEFL examination, the Canadian institutions found it difficult to assess their English language proficiency. As a consequence, one of the students, although qualified in the opinion of his instructors, could not obtain admission to Conestoga College. The students' departure for Canada was further delayed by about 4 weeks (and 8 weeks in one case) because of a lengthy visa application process.

Acceptance letters for 1995 IUP students by CUTC universities are given as

Attachment 3.

b) Status of the 1996 IUP students (Electrical Engineering)

SUT only offered the Electrical Engineering Program for the 1996 academic year. After finishing the intensive courses during June - August 1996, 9 out of 13 students registered for the first trimester beginning September, 1996. Currently, there are 8 students remaining in the program. They were informed by the CIA Co-advisor of the transfer to the CUTC institutions for their second year studies.

2.2 Joint Research and Ph. D. Program

A2.21 Ph. D. Program

The second Ph.D student - Mr Anand Unsivilai from the Institute of Industrial Technology of SUT started his Ph.D program in electrical engineering at TUNS in September 1996. Another two faculty members - Ms. Ganthima Polprasert and Mr. Rangsan Wongsan were also admitted at TUNS for their Ph.D. programs. Ms. Polprasert is expected to start in January and Mr. Wongsan is expected to start in September 1997. A fifth candidate who is presently studying in USA has requested permission to transfer to TUNS.

Acceptance letters for Ph.D students from SUT by CUTC universities are given as **Attachment 4**

One Ph.D. candidate in Food Science anticipates to start his Ph.D. program at the University of Guelph as early as possible in 1997.

A2.25 Post-Doctoral Research Fellowship for Thai scholars

Three post-doctoral research proposals were approved. The recipients are Dr. Chongchin Polprasert, Dr. Sureelak Rodthong and Dr. Somprasong Suttayamully.

Dr. Chongchin Polprasert is expected to undertake his 12 month research in environmental engineering during January-December 1997.

Dr. Sureelak Rodthong has been accepted by the University of Guelph to pursue her research in Biology at the Agrofood Canada Lab for 5 months during 11 February-12 July, 1997.

Dr. Somprasong Suttayamully will undertake research in Transportation Engineering for 5 months at TUNS starting April 1997 and may extend it to one year if the necessary additional budget can be allocated.

Acceptance letters / contracts for post-doctoral research fellowships of SUT professors in CUTC universities are given as **Attachment 5.**

A2.26 Thai Research Advisors

Two SUT professors from The Institute of Industrial Technology visited laboratories at the University of Waterloo to familiarize themselves with research facilities and projects. Dr. Kontorn Chamniprasart of the School of Mechanical Engineering visited Mechanical Engineering laboratories while Mr. Rawat Vipia of the School of Electrical Engineering, visited high voltage laboratories at the University of Waterloo during November 1-7, 1996.

2.3 Co-op Student Exchange Program

A2.31 Provision of work placement and supervision for Thai students in Canada by CUTC institutions

Since June 1996, two Thai students in food science, have been at Guelph University for their 16 week Co-op work terms. They will finish their assignment in December 1996.

Another two Thai students started their one term assignment in Mechanical Engineering and Chemical Engineering at TUNS in September 1996.

A2.32 Provision of work placement and supervision for Canadian students in Thailand by SUT

Four Canadian Co-op students from TUNS carried out their four - month assignment from May-August 1996. A fifth student started in September and finished his assignment in December, 1996.

Program 3 : University - Industry Linkage Program

3.2 Joint University-Industry Cooperation and Training Activities

A3.21 Development of a Framework for Industrial Training Seminars

It was agreed during the 3rd PRC Meeting held in Waterloo (September 26-27, 1996) that the development of a framework for industry-based seminar would be replaced by a planning and follow - up mission by Mr. Robert Eagle from TUNS in October 1996.

Mr. Robert Eagle visited SUT from 6 to 11 October, 1996 and met with SUT administrators and staff involved in the University Industry Linkage Program, and discussed the possibility of training / seminars with industry in Korat. (**Attachment 6**)

At least three seminars are being planned.

Program 4 : Project Management

A4.32 Third PRC Meeting in Canada

The third Project Review Committee Meeting was held in Waterloo during 26-27' September, 1996. Dr. Sam-arng Srinilta led the SUT delegation consisting of Dr. Prasart Suebkha, Dr.Tawit Jitsomboon, Prof. Dr. Ruben C. Umaly and Ms. Mantana Thammachoti.

During the meeting, both parties discussed the programs and issues of project implementation, readjusted some program activities, did a budget revision and discussed possible future cooperation among CUTC institutions after the SUT-CUTC Project termination. (**Attachment 7**)

It was agreed to hold the next meeting in Halifax in April 3-4,1997.

2. PLANNED ACTIVITIES

Program 1 : Development of Institutional Capacity

A1.32 Provision of Technical Services to SUT

Two additional activities were considered by the PRC.

1. Participation by CUTC Institutions in the Regional Colloquium on

Engineering and Technology Education for the 21st Century at SUT during 11-14 February, 1997. Four CUTC representatives will attend the colloquium with support allocated from activities A2.11 and A4.33.

2. The organization of a workshop on Continuing and Distance Education at SUT will be discussed at the next PRC meeting in Halifax.

Program 2 : International Academic Programs

A2.11 Academic Program Planning and Coordination

Dr. Stalin Bector from Ryerson Polytechnic University will be involved in planning, coordination and monitoring of the program during his visit in February, 1997 to SUT. The 1996 IUP students' English competency and academic progress will also be assessed at that time.

A2.12 : Curriculum Implementation of International Engineering Program

Since the first year IUP mechanical engineering students have already been transferred to CUTC partner universities for their second year of study, the assignment of only four CUTC professors to teach the IUP students at SUT will be needed for 1996/1997.

Ryerson Polytechnic University sent the curriculum vitae and contracts of four professors to SUT for approval. Prof. Peter Barta, who will be teaching Electric Circuits I and Lab I in January 1997, has arrived at SUT. The other three professors will teach during the third trimester of 1997 beginning in May. Professor David MacKay from TUNS will come again to teach in the third trimester of 1997.

The remaining funds for CUTC expert assignments will be used to help SUT in the formulation, planning and development of graduate programs in engineering and applied science.

Dr. Goff and Dr. DeMann from the University of Guelph will visit SUT in September of 1997 to help the Institute of Agricultural Technology develop its undergraduate and graduate programs in Food Technology and to give seminar workshop in Food Technology.

A2.21 Selection of Thai Supervisors

A2.22 Provision of Ph.D Courses

A2.23 Jointly Supervised Research Work in Thailand

Some of the activities in this category were readjusted during the last PRC Meeting. Three Canadian professors from TUNS and Ryerson Polytechnic University will lead a 4 - week CUTC mission to SUT in 1997 to discuss and assist in the development of Post-Graduate Engineering Programs. The exact date and time will be announced later.

A2.25 Postdoctoral Research Fellowships

Two SUT faculty members will commence their research in January 1997. Dr. Chongchin Polprasert at TUNS and Dr. Sureelak Rodthong at Guelph. A third faculty member - Dr. Somprasong Sattayamully - will start his research at TUNS in April 1997. Additional post-doctoral research fellowships will be considered at the next PRC meeting.

A2.26 : Thai Research Advisors

The Director of the SUT Scientific and Technological Equipment Center - Assoc. Prof. Dr. Virul Mangalaviraj - will visit the CUTC institutions' laboratories in mid 1997. SUT will send his CV to Ryerson International to facilitate issuance of letters of

invitation.

A2.26, A2.27 : Collaboration and Co-supervision in Canada

Some of the funds remaining from these two activities may be used to support additional postdoctoral fellowships and additional industrial seminar activities. This issue will be discussed at the next PRC meeting.

A2.31 Thai Co-op Students in Canada

Two SUT students will start their co-op terms at TUNS in January, 1997.

A2.32 Canadian Co-op Students in Thailand

TUNS will prepare plans for a final group of Canadian students to be sent to Thailand at the next PRC meeting.

Program 3 : University - Industry Linkage Program

A3.21 Technical Service by Canadian Consultants to provide Training Seminars in Thailand

During his assignment at SUT next September, Dr. Douglas Goff from the University of Guelph will arrange a seminar on Food Technology / Agribusiness.

A3.22 Delivery of Industrial Training Seminars in Thailand

Mr. Robert Eagle from TUNS visited SUT last October for discussions with SUT administrators. After an initial survey, topics for possible workshops were identified. It is expected that in the year 1997, two to three workshops will be organized by SUT's Technopolis in cooperation with CUTC.

Program 4 : Project Management

A4.32 Next PRC Meeting

The fourth PRC meeting is scheduled to be held at the Technical University of Nova Scotia, Halifax, Canada during April 3-4, 1997.

A4.33 Project Management

Dr. Claude Lajuenesse, President of Ryerson Polytechnic University, will visit SUT for discussions in July of 1997. He will also be a speaker at the international conference to be held at SUT in July 1997.

3. Budgetary Report

Budgetary report and requirements are included in the minutes of the PRC meeting.

III. Attachments

1. Report of a study tour of Prof. Dr. Ruben C. Umaly to Canada.
2. Training / study visit programme arranged by CUTC institutions for Ms. Mantana Thammachoti.
3. Acceptance Letters for 1995 IUP students by CUTC universities..
4. Acceptance letters for Ph.D students from SUT by CUTC universities.
5. Acceptance letters/contracts for Post-doctoral research by CUTC universities.
6. Trip report by Mr. Robert Eagle on the industrial seminars
7. Minutes of the third PRC Meeting

Industrial Seminars, Trip Report

*Prepared for
SUT/CUTC Partnership*

*by
Robert Eagle*

December 16, 1996

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Introduction

During the week of October 6, 1996 and until October 17, 1996, Robert Eagle visited the campus of Suranaree University of Technology in Nakhon Ratchasima in order to help establish a program of industrial seminars in which the Canadian Universities Technology Consortium would play a supportive role. The goals of the visit were to identify a process for selecting seminar topics, select a structure to give the seminars and to select the first few areas where CUTC could assist SUT with the seminar packages. The expected outputs of the visit were to be suggestions of specific topics, potential lectures, potential revenue, expected expenses and available resources.

Visit Schedule

The program schedule began in Nakhon Ratchasima on Monday October 7, 1996 and finished in Bangkok with a wrap up meeting on Thursday October 17, 1996. The program included meetings with senior SUT officials, industry representatives, executives of the Federation of Thai Industries, SUT Faculty members, Technopolis staff and Centre of International Affairs staff. The detailed program is attached in Appendix A.

Suranaree University of Technology

SUT has two departments that will be directly involved with organizing the seminar series. These being Technopolis and the Centre for International Affairs.

Technopolis is a science park established for technology innovation and fine tuning, technology transfer, and exhibition. Technopolis, an innovation in Thai higher education, has three directives:

1. Serving the industrial sector in research and development, individually or jointly with the University;
2. Promoting and supporting creative inventors; and
3. Offering service to both government and private sectors, to strengthen ties and cooperation between the University and those sectors for mutual benefit.

More specifically the facilities, resources and services which Technopolis offers are shown in Appendix B. Also in Appendix B is a list of Technopolis' Activities over its first 5 months. These activities included an industrial survey, the results of which are shown.

Under its mandate, Technopolis has been offering a series of seminars to industry and

government. Appendix C shows the seminars which are planned to be offered in the coming year.

Technopolis will be the delivery arm for the industrial seminar series. However, the Centre for International Affairs, which is responsible for all international activity at SUT will plan a key co-ordination role. CIA will be involved for two reasons:

- CUTC is an international contact and the project we are working on is administered by CIA.
- Some of the seminars may wish to draw from an international clientele.

There have been some talks about using the CUTC speakers to help with an extension program which may be offered by the Association of Universities of Asia and the Pacific (AUAP). CIA would lead this initiative.

One further point on SUT participation should be mentioned. The local Thai speakers will in many cases come from the SUT faculty. At the present time the faculty have extremely heavy work loads and thus may not be able to take the time required to fully participate. This may mean that speaker fees will have to be paid to SUT faculty to reimburse them for this added commitment.

North East Region Industry

Until recently the North East sector was the least developed area of Thailand. The Thailand Board of Investment has in recent years targeted the NE for growth and has financial incentives to encourage new, modern and technically advanced industries to the area. This initiative, coupled with an increase in the infrastructure linking Khorat to Bangkok has stimulated considerable growth in the area around Nakhon Ratchasima. The industrial base has been largely agro industry, however in recent years the advanced manufacturing sector (auto parts, telecommunications, electronics, plastics) has been on the increase. In Appendix D is a brief report on the economy of the NE sector.

At this point there is some concern about the absorptive capacity for advanced technology of the local industry. The industry has been relatively small with local family ownership and few technical people on staff. New technology in general has been bought and not developed locally. Few plants have engineering staff and the training of the workforce has largely been done in-house. Little attention has been given to safety or environmental issues.

The newly established industries tend to have more advanced technology, more engineering and technical staff, and in general a higher level of absorptive capacity.

There is a problem in the NE of attracting and keeping skilled labour. Labour has tended to move to the Central and Southern regions where wages are higher. A move to a better work environment with such benefits as affordable housing, good schooling, training, increased wages, etc., could help to reverse this trend.

Some of the training requirements that industry indicated an interest in participating in include:

- industrial safety
- a practical course in quality management
- industrial/environmental management-water related in particular
- management skills - in particular financial management/accounting
- computer management
- precision machinery

No industry specific courses were recognized in either the industry talks or the Technopolis questionnaire. More work needs to be done to identify these topics.

Technopolis is addressing many of the fundamental training requirements in the seminar program they have prepared for the coming year (Appendix C).

Course Criteria

Objective - The objective of the CUTC/SUT Industry Seminars is to assist industry in understanding and transferring new advanced technologies. The focus will be on local industry initially, however, topics for a broader participant base will also be sought.

Organization - Technopolis will be the main vehicle to deliver the courses, assisted by CIA, the SUT faculty and staff, and outside Thai expertise when necessary. CUTC will assist only where expertise is not available in Thailand.

Technopolis will be responsible for the organizing, administration and marketing of the seminars. CIA will assist when there is an international component to either the delivery or the audience.

Delivery - Technopolis will seek out the most appropriate speakers from SUT, CUTC, industry and government. A course director will be appointed to help bring together curriculum or course content, speakers, topics, etc. Each speaker will be asked to have a copy of their address in advance of the seminar. Technopolis will arrange for the translation of papers when necessary. Consideration should be given to having translation at the seminars.

Revenue/Expenses - The seminars will be set up to recover all costs including room rental, food, lodging, speakers fees, marketing costs, copies, supplies, telephone/communications, speakers living and travel costs, and some degree of overhead or profit. The early seminars should try to recover some of the CUTC cost so that they can be used to help bring in speakers for future seminars.

To save on costs, the seminars could be given in more than one location or country. This would allow for better use of resources. Travel cost would thus be written off over a larger number of participants.

Size & Duration - The seminars should try to be industry specific and applied in nature. This means a smaller participation but of more practical use.

Also the length of the seminars should be kept to 2 to 3 days so that industry can attend. Combining weekends or at least Saturday makes it more accessible to industry.

Topics

The topics that have been discussed for potential industry seminars are as follows:

1] Food Prooessing

Dr. Doug Goff from Guelph will be at SUT for the September to December term of 1997. He has agreed to offer one or two seminars in the food science area. The topics suggested are:

a] Food Technology for the Dairy Industry - This will be a 3 day course offered in the 3rd week of September 1997 [the week of the 15th]. It will emphasize advanced food processing processes. Three or four faculty members from SUT will assist in the giving of the material. It may be combined with a course offered by Germantown, an Australian Ice Cream Company that Doug has worked with in the past.

b] Food Quality and Safety - There have been a number of courses offered in this area but the emphasis has always been on the principles. This course will concentrate more on the application, process and documentation of the principles. It will be a two day course given either at the exam break in November 1997 [11th] or on a Friday/Saturday in that month.

Dr. Suwayd is the SUT contact person for these two courses. Robert Eagle has contacted Dr. Goff to express the changes to his program from the one he originally suggested.

2] Integrated Watershed Management of an Industrial Site

In July 1996, CUTC & SUT offered a seminar in water resources management. Although this was well received, there appeared to be a need for a more detailed hands-on workshop. Local industry are also concerned with how to dispose of or treat their industrial waste water. This course would address both of these needs. It would be 2 to 3 days in duration. It will be fit into the Technopolis schedule at a convenient time. The presenter from Canada would likely be Dr. William Hart. He would be assisted by SUT faculty he has already made contact with.

Prof. Manoo and Dr. Hart will exchange thoughts on this project with these two also being responsible for its implementation. Dr. Hart needs more information before he can proceed, thus Eagle to update him.

3] Community Based Environmental Resource Management

In January 1997, Technopolis will begin a series of meeting or workshops to discuss environmental resource based management. The first step would be a workshop in January [20 to 30] for Government, university and private sector organizations, to discuss the concepts surrounding CBERM. The second workshop, which would be held latter in the year , would develop an operational plan for CBERM of the North East Region. The third step would be to select pilot projects, one of which would be the establishment of a center of coordination at Technopolis.

The CUTC/SUT fund would be used to bring in a facilitator for the first workshop. It is likely that the speaker would come from either Guelph or Ryerson. Eagle is to get a name of someone to SUT. Prof. Manoo is to approach the Ministry of Science and Technology for support of this workshop.

The second workshop could be run at the same time as the SUT Anniversary [July 27 and the following week].

It is likely that this series of workshops will help identify other topic areas for technical seminars. Certainly technology gaps will be identified during the process.

4] Computer Technology In Industry

This could be a course aimed at showing the benefits of advanced computer technology to industry. It could address such topics as computer control systems, CAD/CAM, e-mail,

internet, management control systems, robotics, etc. This concept needs more work and a more specific focus.

It will be integrated into the Technopolis program of computer courses. Technopolis already has computer courses planned in:

- 1] introduction to programmable logic controllers;
- 2] basic computer training, and
- 3] training for computer mapping, increased efficiency of library work with internet.

The two areas that SUTC can assist with are:

- 1] Integrated Manufacturing through Dr. Vorapot of Mechanical Engineering, and
- 2] something on computer aided management.

The first of these will take place in August 1997 after the new equipment is in place. Eagle will try to arrange an expert. The second will be explored with CUTC members and Technopolis.

Other Ideas

The remainder of these courses and workshops are ideas that need further exploration. Dr. Hueng is to prepare an industrial questionnaire to get more information about industrial needs. The process will be to interview a select number of industries to get detailed information and send the questionnaire out to the other firms in the area. Eagle to send a copy of the questionnaire TUNS is preparing for our manufacturing program.

- 1] Industrial Safety - This course would be aimed at showing the benefits of increased safety to local industry. The North East is losing its labour force to the more highly industrialized areas of Thailand. A cleaner/safer environment for workers would help to keep skilled labour in the area. The emphasize should be on industrial health and safety. The local regulations lack enforcement.
- 2] Industry Specific Courses - The need exists to develop a series of industry specific course aimed at transferring to industry specific technologies. Technopolis needs to refine there contacts with industry to more clearly identify these opportunities. Some of the areas to be considered include;
 - a] Ceramics - The ceramics industry is made up of a large number of small producers, whose products are largely for the craft sector. Nova Scotia College of Art and Design has done some work with such industries in other countries in increasing the quality of their products with enhanced production techniques, new coatings, etc. Bill Caley has some expertise in this area.

- b] Plastics/Polymers
- c] Other industries - need information
- 3] Quality Assurance - Courses have been given in ISO 9000 and one is being planned in ISO 14000. What appears to be missing is a workshop that is more applied in nature. Again the concepts seem to be known but the process of application is weak.

Industry Trade Mission To Canada

The local branch of The Federation of Thai Industries is interested in taking a trade mission to Canada. This project would be self financing and would be arranged jointly by Technopolis and CUTC, support would be sought in Canada from CIDA. Industry Canada and the provincial economic development departments. Eagle had a meeting with Trade Officers in the Canadian Embassy on Thursday Oct. 17th. They would offer logistical; and administrative support.

Timing would be in the summer of 1997 and would be linked to a major industrial trade show in Canada. CUTC will begin the process by identifying potential shows and communicating with FTI.

Technopolis Training

At the April meeting of PRC in Halifax, a proposal will be put forward to offer training in Canada to two or three Technopolis staff members in the areas of technology transfer, continuing education and industrial outreach. This will include visits to TUNS Continuing Education program, Waterloo Innovation Centre, Waterloo and Guelph's industrial parks, along with other components yet to be identified. The visit would be 3 weeks in length.

Appendix A
Visit Schedule

Tentative Program
Visit SUT of Mr. Robert Eagle

7 October 1996

08.20 Arrival at Nakhon Ratchasima Airport
09.00 Refreshment at hospitality house
11.00 Courtesy call on VR Planning, Dr. Pongchan Na-Lampang, Technopolis
 Coordinator, Dr. Neung Teaum voong, VR Development, Director, and
 Dr. Ruben Umaly, Director, CIA
12.00 Lunch with Director, CIA
13.00 Campus tour
19.00 Dinner with VR Planning, Director CIA, Dr. Prasart, VR Administrative
 Affairs, and Prof. Manoo, Director, Technopolis, O-makwb

8 October 1996

09.30-11.00 Meeting with SUT executives/staff at Saranithas Conference Room,
 Admin. Bldg.
12.00 Lunch
Afternoon Visit Technopolis - Ms. Panpimol (On)

9 October 1996

09.30 Visit Sa-nguanwong Industry Co. Ltd. - Mr. Eakarin Yanubol, Mr. Ded-
 anan, Labour Consultant, Wongkom Chan
11.00 Babcock Plant - Mr. Boontham Phaeprodit & TUNS Co-op Student,
 John Sole
12.00 Lunch
13.30 Visit S.W. Group Co. Ltd., Mr. Chaiya Wongprasert, Dr. Kiltisak, SUT

10 October 1996

14.00 Meeting with executives of the Federation of Thai Industries, Nakhon
 Ratchasima and SUT executives in FTI office. Chair - Mr. Chaiya
 Wongprasert

11 October 1996

09.30 Visit Chao Phraya Crop Co., Ltd. - Chol Anukulkitch, President
12.00 Lunch
13.30 Visit Chao Phraya Marble Co., Ltd. - Wong-A-Mart Amatyakul,
 Suvith Kruawan

12-13 October 1996

Toured local area

14 October 1996

a.m. Prof. Manoo, Director of Technopolis
p.m. Visit Suranaree Industrial Zone - Jimmy Panyarit Lawansirc

15 October 1996

- 09.00 Meeting with Dr. Terce, Dean, Institute of Agricultural Technology and
Chair, Food Technology at Institute of Agricultural Technology, &
Dr. Suwayd
12.00 Lunch
13.00 Final planning of seminars with SUT, Technopolis and CIA

16 October 1996

- 08.00-16.30 Wrote draft report
18.00 Transfer to Nakhon Ratchasima Airport for TG Flight to Bangkok

17 October 1996

- 10.00 Canadian Embassy - Thawee Thaiprasithiporn
18.00 Final Meeting - Dr. Ruben Umaly

Appendix B

Technopolis

SUT BACKGROUND

According to the Fifth National Social and Economic Development Plan prescribed among other things an increased distribution of opportunities for post-secondary education to rural areas as a major higher education development policy. Five new regional colleges were recommend to established by Ministry of University Affairs. Suranaree University of Technology (SUT) in Nakhon Ratchasima is one of those which chosen for serving the trends of national development needs and future direction of higher education management in country. Finally, His Majesty the King signed the Suranaree University of Technology BE 2533 Act on 27 July 1990, to conclude the process. Hence, SUT considers this auspicious date as her founding date.

SUT is a state University of Thailand, neither a government agency nor a government enterprise. It is a juridical body under the supervision of Minister of University Affairs and, hence, a state University supervised by government as defined in the 2533 BE SUT Royal Decree and in the Ministry of University Affairs operating Guidelines Act 2537 BE.

Supervised by the government, SUT has instituted its own administrative structure and system by concentrate in decentralizing authority using full automony. Thus, the University's administrative and management decision making is practically self-contained with the University Council being the highest authority. The organizational structure of SUT is compact as to ensure a high degree of flexibility and efficiency.

MISSION

SUT has a five-fold mission:

1. The training and production of highly qualified sciencetific and technological personels in response to national development needs.
2. Research and development for academic advancement and national development.
3. Adapting and disseminating suitable technologies for increased national and technological self-reliance.
4. Academic service to the public and various, both government and private.
5. National and Regional cultural preservation, especially that of the Northeast.

TECHNOPOLIS

BACKGROUND

Regards to the Eight National Economic and Social Development Plan (1997-2001), the approaches for solving problems concerned with direction of development by science and technology are as follows:

- a. To develop the group of scientist and researcher in both term of quality and quantity.
- b. To fill the gap of linkage between government and private sectors using cooperation in term of research and development.
- c. To follow up the globalization, technology transfer and development of information technology must be adapted.

SUT has been realized that mainly four of five from our mission can be served for these approaches. Since the Technopolis has occupied one tenth of the SUT total area to support the special mandate of technological adaptation and development. However, prior Technopolis will be established for serving these mandate, the site of Technopolis was used for WORLDTECH'95 Thailand, the World Agricultural and Industrial Exhibition, from 4 November to 16 December 1995 which aimed as follow:

1. To exhibit technological progress in agriculture, industry, and the environment of various countries, as well as leading companies from all over the world and from Thailand.
2. To stimulate agricultural and industrial growth through the use of suitable technology.
3. To build business relationships between exhibitions and vistors, as well as to promote information exchange.
4. To provide an academic forum for discussion of issues concerning agriculture, industry, and the environment.
5. To strengthen relations between Thailand and other countries.

From these aims we expected that WORLDTECH'95 Thailand could motivate both government and private sector for increasing recognized the cooperation each other as well as higher education institutions. However, there will not happen without concerted and sustained efforts in research and development by universities, industries, business enterprises and government agencies as well as infomed and concerned general public. These, SUT converted some of the buildings and facilities into TECHNOPOLIS, a science park for technology innovation and fine tuning, technology transfer, and exhibition.

Technopolis, with a total area of 128 hectares, is an innovation in Thai higher education initiated by SUT with 3 directives:

Directive 1: Serving the industrial sector in research and development, individually or jointly with the University.

Directive 2 : Promoting and supporting creative inventors.

Directive 3 : Offering services to both government and private sectors, to strengthen ties and cooperation between the University and those sectors for mutual benefit.

Technopolis was constructed by the Royal Thai Government and assigned to be site of the World Agricultural and Industrial Exhibition 1995 (WORLDTECH'95 Thailand), held from 4 November to 16 December 1995. After the exhibition, the government handed over the land and various buildings of WORLDTECH'95 Thailand to the University. They were 10 permanent buildings, namely, Surapat 1, to house the Technopolis administrative office and incubation units, with 7,138 square meters of usable area; Surapat 2, to house the National Synchrotron Light Source Research Laboratory Center, with 9,907 square meters of usable area; Surapat 3, to house various exhibition, with 9,891 square meters; Surapat 4-5-6, to house various exhibitions and the Butterfly Park, with 5,264 square meters of usable area; Suranitat, a semicircular amphitheater for cultural events with a 3,000 seats capacity and 4,056 square meters of usable area; the Golden Jubilee Building, for Royal project exhibition, with 1,505 square meters; Suranapa Tower, the Technopolis symbolic tower from which SUT's campus may be viewed, 82.30 meters in height; and the Scientific and Technological Equipment Building, with a total of 8,232 square meters of usable area.

The University has also received buildings from exhibitors of WORLDTECH'95 Thailand to use in education, teaching, and research, including Exhibition Buildings 1-4. Exhibition building 1 was given to SUT by the Electrical Generating Authority of Thailand and the Metropolitan Electric Authority, with 5,600 square meters of usable area. Exhibition Building 2 was given by the Ministry of Science, Technology, and Environment, with 3,000 square meters of usable area. Exhibition Building 3 was given by the Laemthong Company,Ltd., with 1,200 square meters of usable area, and Exhibition Building 4 was given by the Charoen Pokapan Company, with 480 square meters of usable areas.

Technopolis serves as a University center for academic support, working as the central unit in the adaptation, transfer, and development of appropriate technology, as well as academic servicing to society. Technopolis and the SUT campus will be refurbished to become;

1. A Technology Incubation Department, a place to generate support for research and development, with Surapat 1 serving as the technology incubation unit, Technopolis management office, and central business center.

2. An Innovation Department, a place for prototype projects under development, or new projects that need testing and fine tuning before being released for marketing, such as the High Tech Thai House.

3. A Technology Extension Department, to promote the transfer and adaptation of technology for maximum production efficiency, with the Scientific

and Technological Equipment Building being the main unit, along with laboratories to enable academic servicing.

4. An Exhibition Division, mainly with Surapat 2-5 and Exhibition Buildings 1-4 and the Butterfly Park.

5. Academic Services Division, to provide academic services to society on the local, national and international levels; such as expert speakers, presentation of project results and academic papers, project assessment and academic documentation expert and organization of meetings/seminars/workshops.

Technopolis's Activities (March - July 1996)

1. Survey of status, problems and needs assessment in term of technology and management from government and private sectors in local area. The concluded data are as follow;

1.1 Government Sectors (106 departments)

Percent of Ministry

Departments from Ministry of Interior	33%
Departments from Ministry of Education	20%
Departments from Ministry of Agriculture and Cooperatives	16%
Departments from Ministry of Public Health	13%
Departments from other Ministries	18%

Education status of officers

- Higher than Bachelor's Degree	7.4%
- Bachelor's Degree	27.4%
- Lower than Bachelor's Degree	26.8%
- Temporary Empolyees	36.4%

Problems and needs assessment

1. Needs technology with related work and want SUT to be the center of technology transfer.
 2. Needs improvement for officers quality.
 3. Needs development of information and communication system.
 4. Needs increasing of efficiency in administration and management system.
 5. Needs more research and development
- (1 = most needed 5 = less needed)

1.2 Private Sector (64 companies)

Status

* Type of industry	
- Engineering Industry	40.3%
- Agricultural Industry	25.6%
- Manpower Industry	19.3%
- Electrical and Machinery Industry	8.1%
- Other industries	9.7%
* Size of capital outlay Expenditure	
- 1-25 million baht	40%
- 26-50 million baht	27.5%
- 51-75 million baht	12.5%
- 76-100 million baht	10%
- more than 100 million baht	10%
* Employees according to work characterization	
- Production	90.5%
- Administration	5.4%
- Quality control	3.3%
- Research and Development	0.8%

Problem and needs assessment

1. Development of products quality
 2. Increasing the efficiency of production
 3. Needs improvement of workers quality
 4. Needs developments of processing system
 5. Improve the quality of raw materials
- (1 = most needs.....5 = less needs)

R&D experiences

- Ever 19.6 %
- Never 80.4%

Problems with R&D establishment

- | | |
|------------------------|-------|
| - not enough experts | 41.7% |
| - not enough equipment | 27.0% |
| - not enough knowledge | 25.2% |
| - other | 6.1% |

2.High Tech Thai House

The High Tech Thai House, powered by solar energy, is a prototype project received by the Invention Unit from Thai Gypsum Products Company,Ltd. It was displayed at WORLDTECH'95 Thailand. The house design considered the environment, used high quality material, saved energy and insulated from heat, as well as brought energy of the sun into daily home use. There was also a water restoration system using natural methods and large numbers of fish.

To adapt, transfer, and develop technology, SUT has a cooperative research project with the private sector to develop the High Tech Thai House further by testing various system such as agricultural systems, water purifying systems, and energy conservation, eventually to form an "Eco-Village" consisting of such houses. Upon completion, this project will be the prototype of environmental care, using resources suitably, and improving the quality of agricultural personel.

3. Butterfly Park

The Butterfly Park is a project to instill into the public consciousness the values of nature conservation and appreciation, along the line of the plant and wild animal preservation used by Her Majesty the Queen. The Butterfly Park provides scientific knowledge about insects, biology, ecology, habits, agricultural and environmental impact, etc.,through exhibitions, creating natural aestheics, as well as providing a place for recreation.

The Butterfly Park is a large netted park in Surapat 6 building. Within the park are waterfalls, brooks, flowering plants, plant species, and plants which are food for the insects, with diverse kinds of butterflies.

4. The National Synchrotron Light Source Research Laboratory Center

The Synchrotron Light Source Generator is a high level instrument of technology useful in research in the fields of Physical Sciences, Material Sciences, Biological Sciences, Medicine and Industry, especially in the production of very small parts and telecommunications components. Industrially development countries such as the United States of America, Japan, South Korea, and China all use the Synchrotron Light Source Generator to support research impacting industrial development. As Thailand does not yet have such a Synchrotron Light Source Generator, the National Research Council appointed a committee of academics to perform a study involving Synchrotron feasibility and suitability for national research. As the study concluded that it was necessary for Thailand to have a synchrotron light source, the National Research Council Office was in the process of drafting a proposal to government showing details for the construction of a synchrotron light source, when it received news from scientists in Japan that the SORTEC Corporation and Japan, Ministry of Industries and Commerce were interested in giving a medium sized synchrotron light source generator (1 GeV in size) to Thailand, since the Corporation had finished their research projects by the end of 1996. A Group of Thai academics traveled to inspect the condition of the generator, and after careful analysis concluded that it was in excellent condition, with no less than twenty years of use remaining. Receiving the generator would

save time and national resources, for building one from scratch take about 5 years and about 4,500 million baht

Since the Synchrotron light Source Generator is a high caliber instrument, and perhaps in the beginning, too advanced for the use of any one unit, the Prime Ministerial Cabinet Meeting on 5 March 1996 resolved to establish the "National Synchrotron light source Research Laboratory Center" under the supervision of the Ministry of Science, Technology, and the Environment, using an administrative system free from the civil service, with a Center Administrative Board to supervise. The Center will be located at Surapat 2, Technopolis, SUT, Nakhon Ratchasima Province, a technological university with a basic structure amenable to the support of the installation of the synchrotron light source generator as well as the operation of the National Synchrotron light Source Research Laboratory Center. Installation is expected to be completed and the Center open for operations in 1998.

The Synchrotron light source generator will be a national instrument, used to conduct scientific and technological research in various fields. Moreover in the research of faculty, researchers, graduate student from universities, institutes of higher education, and in industrial research and development projects both public and private will be further established. Thus Thailand has increased potential to be a leader and center of high level technology and research in the Southeast Asia region.

5. Academic Services

- Organizing conferences/seminars/training session:

- * ISO 9000 and techniques for quality Improvement

- University personnel serve as special lecturers and speakers:

- * Special lecture for science high school teachers
- * Special lecture for science primary school teachers
- * Special lecture for mathematics high school teachers
- * Special English course for industry
- * Special English course for general

- Consultation to project /research for outside units:

- * Conservation of electrical energy for local industries
- * Product development of granite for local industries
- * Iron strength analysis for local industries

TECHNOPOLIS AND OPPORTUNITES

As the results indicated from survey of both government and private sectors problem and their needs assessment, those are correspond to our mission. From the requirement data obtained from government sector, transferring of technology from university is the most wanted item as well as the development of human resources particularly in their units. On the other hand, from industry sectors more technological needs is required rather than government sectors.

Thus, Technopolis has set up four important tools for these requirement and problem from them. First, **technological manpower**, mainly from Institutes (92 doctorate and 45 master's degree level) , center of scientific equipment of SUT (87 staffs) who able to support the technological needs from both biological and physical science as well as social sciences. Second, **science and technology infrastructure**, piece of land, seminar hall ,and building spaces for example with Surapat 1 building serving as the incubation unit and Technopolis administration. Surapat 1 initially can provided 30 small incubator units size ranged from 48 m²-160 m²/ unit) from total usable area 7,138 m². In addition, High Tech Thai House can be the place for innovate new research in term of high quality material for saving energy and insulated from heat, development of solar energy system and various system of agriculture etc. Third, **technological capability**, which mainly served from Scientific and Technological Equipment center and the National Synchrotron Light Source Research Centre in the near future. Fourth, **information technology and knowledge technology**, can be served by SUT's facilities such as satellite communication system, "SUTnet" network of type FDDI with a speed of 100 Mbps. and the subcomponents of the information system which are capable of Integrated Hypermedia information services, consisting of Hypertext, Electronic mail, Internet, Applications, www, FTP, and two-way Teleconference etc.

Hehce, SUT is located in the area where easily conducted to various countries in Indochaina as well as these four tools as mentioned above togetherwith to construct the linkage between Universities, government and private sectors in local. Thus, rendering, Technopolis aims to make use of these opportunities to create strong production relationships among those concerns to open the gateway for business and development of country and the Indochina region. And further more expand economic and commercial which based upon technological development to international level.

Appendix C

Schedule at Technopolis
Academic Services Plans
1996-97

SCHEDULE OF TECHNOPOLIS ACADEMIC SERVICES PLANS (96-97)

TIME	TOPICS	ORGANIZED BY
NOV 96	1. "SCIENTIFIC PLANING FOR PRIMARY SCHOOL TEACHER"	TECHNOPOLIS
	2. "AGRICULTURAL EXCURSION" : ADVANCEMENT FOR ECONOMICAL FLOWERS : ADVANCEMENT FOR ECONOMICAL FRUITS	TECHNOPOLIS
DEC 96	1. "AGRICULTURAL SEMINAR ON" : CUT FLOWERS	TECHNOPOLIS
	2. "AGRICULTURAL TRAINNING FOR" : MANAGEMENT TECHNOLOGY OF AGRICULTURAL MARKETING	TECHNOPOLIS
	3. "INDUSTRIAL TRANNING FOR": INTRODUCTION TO PROGRAMMABLE LOGIC CONTROLLERS (PLC)	TECHNOPOLIS + PRIVATE SECTOR
JAN 97	1. "WORKSHOP ON ALGEBARIC ANALYSIS"	TECHNOPOLIS+CIA(SUT)
	2. "ENVIRONMENTAL SEMINAR FOR": NATURAL RESOURCES MANAGEMENT IN THE NORTH-EASTERN PART OF THAILAND	TECHNOPOLIS
	3. "TRANING FOR EVALUATION TECHNIQUE FOR QUALITY CONTROL IN PROJECT MANAGEMENT	TECHNOPOLIS
FEB 97	1. "AGRICULTURAL SEMINAR ON" : TECHNOLOGY FOR ORCHARDS	TECHNOPOLIS
	2. "AGRICULTURAL TRAINNING FOR" : TECHNOLOGY FOR ECONOMICAL FLOWERS PRODUCTION IN NORTH-EAST	TECHNOPOLIS
MAR 97	1. "INDUSTRIAL EXCURSION": IN TAIWAN	TECHNOPOLIS
	2. "BASIC COMPUTER TRAINNING"	TECHNOPOLIS + SUT - COMP.CENTRE
	3. "TRANING FOR COMPUTER MAPPING"	TECHNOPOLIS

TIME	TOPICS	ORGANIZED BY
APR 97	1. "AGRICULTURAL SEMINAR ON" : FISHERIES TECHNOLOGY 2. "AGRICULTURAL EXCURSION ON" : ADVANCEMENT OF ECONOMICAL CUT FLOWERS	TECHNOPOLIS
APR- MAY 97	1. "TRAINING FOR" : INCREASING EFFICIENCY OF LIBRARY WORK WITH INTERNET 2. "TECHNICAL TRAINING FOR" : BALLROOM DANCE FOR HEALTH	TECHNOPOLIS SUT-LIBRARY CENTRE TECHNOPOLIS+ SUT-SPORT CENTRE
APR- JUN 97	1. "SUT MEETS PEOPLE" (LOCAL SEMINAR, TRAINING, LOCAL PRODUCTS CONTEST)	TECHNOPOLIS+SUT -PR DIVISION
MAY 97	SEMINAR ON "MANDATE OF SCIENTIFIC TEACHER" 1. "AGRICULTURAL TRAINING FOR" : PRODUCTION OFF-SEASON FRUITS	TECHNOPOLIS TECHNOPOLIS
JUN 97	1. "AGRICULTURAL SEMINAR FOR" : AGRICULTURAL MACHINERY	TECHNOPOLIS
JUN- AUG 97	1. "COMPUTER TRAINING PROGRAMMES"	TECHNOPOLIS+SUT- COMP.CENTRE
JUL 97	1. "SCIENTIFIC PROJECT CONTEST" 2. "TRAINING FOR COMPUTER MAPPING" 3. "TRAINING FOR HIGH LEVEL BALLROOM DANCER"	TECHNOPOLIS TECHNOPOLIS TECHNOPOLIS
AUG 97	1. TRAINING FOR SPORT TRAINERS	TECHNOPOLIS+SUT- SPORT CENTRE

- All year round projects are as followed:

- A. Services for scientific analysis equipments
- B. Survey and study of electrical energy saving in industries
- C. Community English language courses
- D. Fitness test
- E. TECHNOLIS Tours

- The projects which have not been indicated the exact time are as followed:

- A. Short-term training (CIA-SUT&Vietnam national Univ. and ICEE)
- B. Industry-based seminar (CIA-SUT&CUTC)
- C. "Green conservation" (School of Biology)

Appendix D

Regional Economic Performance The Northeast

REGIONAL ECONOMIC PERFORMANCE : The Northeast

In 1993, the Northeastern regional economy expanded at a satisfactory rate, somewhat higher than that in the previous year. Price stability, meanwhile, improved, with the inflation rate falling to a very low level. A growth-cum-stability economic situation in this region was in keeping with that of the entire country. Fuelling growth of the economy in the Northeast in 1993 were a number of factors, including principally the following. Manufacturing, construction and local and border trade expanded, while private sector investment recovered, thanks largely to the government policy of strongly promoting investment in zone 3. Consumption was, meanwhile, on the uptrend, driven by an increased purchasing power. Nonetheless, the 1993 pace of economic expansion failed to match that in the late eighties, having been reined in by a slowdown in the rate of growth of agriculture, which was affected by drought.

The Research Department, Bangkok Bank Public Co., Ltd., estimated the growth rate the Northeast's gross regional product (GRP) in 1993 at 6.2-6.5 per cent and the inflation rate at 2.5 per cent.

For 1994, a number of positive factors are at work (some continuing from prior year) to provide the impetus for further growth. Principal ones of these are growth in real estate, construction, personal consumption and border trade; continued recovery of investment; large government expenditure on infrastructure; strengthening prices of farm commodities and world economic recovery. But agriculture in this region continues to face drought, affecting overall economic expansion.

The Research Department expects the rate of increase of the Northeast's GRP to be 6.4-6.7 per cent in 1994. Inflation should hot up slightly, with the consumer price index (CPI) for the region advancing by an estimated 3.0-3.2 per cent.

Agriculture

This sector is the backbone of the Northeast's economy, accounting for an estimated 30 per cent of this region's GRP. Of the figure, production of crops, which are not numerous comprising principally rice, cassava, sugarcane, maize, kenaf and eucalyptus, makes up 20 per cent. The remaining 6 per cent and 4 per cent shares go to

fishery and forestry production and simply agricultural processing respectively.

The Northeast grows more glutinous than the ordinary variety, with the ratio between the former and the latter being about 60 to 40 per cent. This region is famous for its jasmine fragrant high quality rice, which falls under the ordinary rice category and which constitutes a popular export item, commanding a high price. In 1993/94, rice cultivation was affected by a combination of a dry spell at the start of the planting season and the general low rainfall of this particular region. As a result, paddy output dropped 30 per cent to about 7.2 million tons. However, farmers were partially compensated, as they could fetch higher prices due to a 1.87 per cent fall in global paddy production, with China, Japan, South Korea and Taiwan suffering from inclement weather.

In 1992/93, production of cassava in the Northeast amounted 19.8 million tons, a drop of 2.7 per cent from 1991/92 and an equivalent of about 90 per cent of the country's total production of the crop. The price fetched by farmers averaged Baht 0.62 per kilogramme, down 7 per cent, due to

Key Economic Indicators of the Northeast

	1988	1989	1990	1991	1992	1993	1994
Regional economic growth (%)	11.9	8.1	6.7	6.4	5.7	6.3*	6.6*
Agriculture (%)	15.0	8.9	3.5	3.2	2.8	2.7*	2.8*
Non-agriculture (%)	10.6	7.7	8.1	7.8	7.2	7.7*	8.1*
Change in CPI (%)	3.9	3.1	4.4	5.8	6.6	2.5*	3.1*
Border trade with Laos (million baht)	1,896.9	2,872.2	2,976.0	3,496.3	3,982.5	5,897.8*	8,610.8*
- Exports	1,287.3	1,673.1	1,563.3	1,902.9	2,837.9	4,313.6*	6,642.9*
- Imports	609.6	1,199.1	1,412.7	1,593.4	1,144.6	1,584.2*	1,967.9*
Change in bank deposits (%)	13.5	19.0	24.7	18.1	21.9	19.0**	-
Change in bank credits (%)	25.6	25.6	25.7	16.4	23.0	29.2**	-
Change in credits for:							
- Personal consumption (%)	45.4	41.5	22.9	16.0	25.4	35.4**	-
- Construction (%)	18.0	9.2	33.4	14.1	21.2	49.0**	-
- Real estate	3						
business	0.2	48.3	44.6	-2.1	31.8	74.1**	-

Source: Bank of Thailand Northeastern Branch

* Estimated by the Research Department, Bangkok Bank Public Company Limited

** Jan.-Nov.

the impact from the European Union's (EU's) agricultural reform policy implemented since July 1, 1993 and limited domestic usage of cassava. For 1993/94, cassava output of cassava in the Northeast is projected to stagnate at 19.8 million tons. Planted areas are expected to shrink somewhat on account of unattractive prices, which are weakened by exporters'

refraining from buying the crop ahead of time. Thailand's exports of tapioca products, particularly pellets, are expected to continue to decline in the wake of a weakened demand in the EU market, where prices of animal feed fall leading to a drop in the use of tapioca pellets as a substitutes for other feed items. Moreover, the remaining amount of the quota for

tapioca exports to the EU is only 4.3 million tons. However, exports of tapioca flour is foreseen to tend upwards on the heels of decreased competition from Indonesia, with principal markets being Taiwan, Japan and Hong Kong.

Area under sugarcane and output in the Northeast expanded, thanks to the relocating of a number of

sugar mills from the Central Region where land is increasingly expensive and the supply of labour for cane cutting is insufficient. It is expected that sugarcane will be planted more and more in the Northeast as a substitute for cassava, maize and kenaf. (Other crops also gaining in popularity include mulberry, eucalyptus and rubber, while those, the importance of which is on the wane, are cassava, kenaf, cotton and cashew nuts.)

Agro-industries in the Northeast with bright prospects are ready-to-drink milk and modified starch (made from cassava). The former has lately been growing, on an average, by 20 per cent annually. This has been thanks largely to the country's economic expansion, the successful official campaign to promote milk consumption and increased popularity of milk as a nutritious food item among the public. Principal types of ready-to-drink milk are pasteurized milk, sterilized milk, UHT milk and yogurts. Currently, sixty-odd ready-to-drink milk factories are operative throughout the country, the majority of them being located in Nakhon Ratchasima (in the Northeast), Saraburi and Ratchaburi, where the bulk of raw fresh milk is produced. Dairy farms in the Northeast account for 20-30 per cent of the country's total production of ready-to-drink milk, totalling 392,163 tons in 1993. Practically all of the ready-to-drink milk produced in the country is earmarked for domestic consumption, due mainly to the fact that Thailand's production costs of fresh milk are relatively high and domestic demand for dairy products is firm. The local market for ready-to-drink milk is worth about Baht 5,600 million a year, growing at an esti-

mated 13-14 per cent annually. Of the market, UHT milk corners the largest share, followed by pasteurized and sterilized milk.

In regards to modified starch, which is a product made from cassava, a total of about 10 manufacturers with Board of Investment promotion are now operative in the country. Their combined production capacity totals roughly 300,000 tons per annum. Locally made modified starch consists of two grades, one being suitable for use as a feedstock for production of manufactured products, such as, textiles, paper, cosmetics, drugs, forged metals and mining, the other being processed into a raw material for a variety of food product industries. Both local and overseas demand for modified starch has been growing steadily and currently exceeds supply forthcoming from local factories. Thus, prospects for investment in this industry is promising and will help solve the problem of excess cassava production. Exports of modified starch amounted to 318,562 tons, worth Baht 1,840.4 million in 1992, compared to 295,140 tons, worth Baht 1,787.4 million in prior year, up 7.9 per cent and 3.0 per cent. In 1993, these exports are estimated at 200,000 tons, worth Baht 1,100.0 million. Principal markets are Japan, the USA, Australia, the Netherlands and Taiwan.

Manufacturing

The manufacturing sector contributes an estimated 9 per cent to the Northeast's GRP. Investment in industries in this region expanded satisfactorily in 1993, due mainly to the government's policy of giving high priority to the distribution of progress to the outlying provinces.

Industries that continued to grow well in 1993 included certain agro-industries and labour-intensive industries. The latter consisted of factories relocated to this region to take advantage of its abundant, inexpensive, easily trainable and reasonably disciplined labour. These are, for instance, garments, artificial flowers, fishing nets and seines. The former, meanwhile, make use of locally available raw materials to produce goods for both the local and overseas markets, with emphasis being placed increasingly on the latter. These include paper pulp, animal feed, silk canned vegetables and fruit and sugar. Concerning the last-mentioned, two large sugar mills were relocated from the Central Region to Nakhon Ratchasima in the Northeast. This has considerably increased output of sugar in this region and has helped promote sugarcane cultivation in the areas surrounding the factories.

Garments

Garment manufacture in the Northeast used to be a cottage industry, run by family members and supplying the local market. It has, however, expanded rapidly in the past few years, driven particularly by the relocation of the production base by entrepreneurs mainly from the capital area to this region. In the process, many garment factories have been established, with the highest concentration in Nakhon Ratchasima, followed by Udon Thani, Ubon Ratchathani, Maha Sarakham, Khon Kaen, Kalasin and Nong Khai. The vast majority of them are small and medium-sized concerns, with relatively low technology and very labour-intensive. They are, for the most part, subcontractors, taking orders from

large-sized manufacturers in the capital area, who usually supply them with the raw materials needed. Important items produced in the Northeast are, for instance, sports wear, jeans and knitted shirts and blouses. They are destined either for local or overseas consumption, with however the actual marketing of the finished left in the hands of the large-sized firms in the capital area.

At end-1992, garment factories in the Northeast numbered 58, with a total investment of Baht 439.63 million and a combined workforce of 6,423. In the first half of 1993, roughly another 20 factories were set up, being located in Udon Thani, Nakhon Ratchasima and Ubon Ratchathani. The mushrooming of garment factories in the Northeast has lately been thanks to the fact that the Board of

Investment no longer requires that garment production be totally export-oriented to qualify for its promotion given to a garment maker in the provinces. Moreover, Japanese and Taiwanese investors have been attracted by low labour costs and a trainable and sufficiently disciplined workforce to invest in garment manufacture in especially the Suranari Industrial Estate in Nakhon Ratchasima.

Promotion of Investment by Industry

(Million baht)

	1992			1993 (Jan.-Sept.)		
	No. of factories	Investment	Employment	No. of factories	Investment	Employment
Garments	6	128.3	1,875	4	64.1	2,440
Canned food	2	52.7	332	-	-	-
Footwear	-	-	-	-	-	-
Sports equipment	-	-	-	1	130	75
Electronic products	2	239.5	1,570	2	20.0	238
Gems and jewellery	1	45.0	752	-	-	-
Toys	2	30.0	378	1	40.0	396
Spinning and weaving	-	-	-	4	332.3	1,409
Spare parts	2	352.2	359	5	406.8	406
Machinery	-	-	-	2	42.0	278
Glass and ceramic products	-	-	-	-	-	-
Plastic products	1	101.7	280	5	502.3	1,429
Leather products	1	15.0	118	1	40.0	418
Chemical products	1	89.0	104	-	-	-
Animal products	2	10.0	66	1	120.0	97
Agricultural products	2	388.8	286	5	355.7	271
Mining	1	7,514	1,260	5	461.5	611
Paper products	-	-	-	-	-	-
Wood products	-	-	-	-	-	-
Watches and clocks	-	-	-	-	-	-
Hotels and resorts	1	55.0	41	4	693.0	382
Hospitals	2	200.0	324	2	550.0	1,209
Others	2	2003.4	169	9	741.3	831
Total	20	11,254.3	7,914	49	4,107.7	10,490

Source: Board of Investment

From a survey, it was found that garment producers in Nakhon Ratchasima utilized only about a third of their total capacity in 1993, manufacturing only about 3,000 dozens per month. This was due mainly slackened world trade on account economic slowdown in major markets, namely the USA, the EU and Japan. Moreover, competition intensified further by increased sales of low-cost countries like China, Indonesia, Bangladesh and Vietnam. However, it is expected that production in Nakhon Ratchasima will rise to about 6,000 dozens a month in 1994, with prices strengthening and exports tending upwards, as importers' stocks were drawn down substantially in 1993.

Future prospects appear reasonably bright for the garment industry in the Northeast, which should as a base for export-oriented production for many more years to come. As it has turned out, certain garment makers in the Northeast, who moved to Laos, being attracted by the US GSP privileges given to that country, have encountered many grave problems particularly a lack of certain and clear-cut regulations and procedures and high transportation costs.¹ In the meantime, the Northeast has a large supply of labour and the government has been active in training and enhancing the skills of workers in this region. The BOI is giving very generous incentives to investment in zone 3, which takes in all of the Northeast, and grants promotional privileges to R & D on garment manufacture. The garment has a policy of promoting sub-contracting by factories as well as households in the provinces. All these factors should help ensure a continued

bright future of garment manufacture in the Northeast.

Industrial estates

Unfortunately, despite the decision of the Chatichai government set up 5 industrial estates in Nakhon Ratchasima, Khon Kaen, Udon Thani, Nong Khai and Ubon Ratchathani, the Northeast is still not in possession of any industrial estate operated by the public sector. However, the private sector has launched a number of projects to set up industrial estates as follows.

Suranari Industrial Estate. Located in Nakhon Ratchasima, this industrial estate has recorded the most progress. Its location is highly appropriate, as Nakhon Ratchasima serves as the gateway to the Northeast and is well linked up with Bangkok and the Eastern Seaboard through a well developed highway system. The Suranari Industrial Estate has been granted Board of Investment (BOI) promotional privileges and is situated in investment zone 3, which enjoys the most generous promotional privileges from the BOI. It encompasses a total of 2,800 rai. The first portion amounting to 530 rai has been developed and sold to investors. Application has been made to the BOI for its promotion for another 1,500 rai. Currently, a total of 31 factories have been approved for operations in this industrial estate, involving a combined investment of Baht 1.5 billion and hiring a total workforce of 5,000. Investment in the factories in this industrial estate has been mostly by Thais, who have relocated their production bases from Bangkok to this Northeastern province. There is also a number of foreign inves-

tors, the most numerous being Taiwanese, followed Americans, Japanese and Pakistanis. Topping the list of industries established there is agro-processing, followed by engineering industry, computers and parts, metals, plastics, carpets (for cars), household textiles and sports equipment. Most of the industries are small-sized, with investment ranging from Baht 10 to 60 million.

Udon Thani Industrial Estate.

This is the first industrial estate project to be implemented by the private sector in the Upper Northeast. Udon Thani has the advantage of being a major urban centre in the Northeast. It also borders on Nong Khai, which is located on the Mekong River opposite Vientiane, the capital of Laos. A total of 2,000 rai has been set aside for the project. Currently, development of utilities to serve this industrial estate is in progress, with about 80 per cent of the work having been undertaken. It is expected that utility development will be fully carried out by mid-1994.

Needless to say, the establishment of both private and public sector industrial estates in the Northeast should be given high priority by the government, as this region has abundant labour with a high degree of stamina, relatively inexpensive and easily trainable. Moreover, the Northeast possesses considerably potential of being a gateway to Indochina and perhaps also South China.

Investment

Investment in the Northeast, all of which lies in investment zone 3, picked up perceptibly since April

1, the date on which the government zone 3 promotional measure became effective. According to BOI statistics, in the first three quarters of 1993, applications for promotional privileges for projects in the Northeast numbered 110, proposing to invest Baht 11.7 billion, increases of 3.6 times and 1.3 times over the same period of prior year. Roughly half of these projects are in Nakhon Ratchasima. During this period, 49 projects were approved, for promotion, up 1.3 times, with a combined investment of Baht 4.11 billion, up 1.8 times, and a combined workforce of 10,559, up 80 per cent. The majority of these projects were medium-sized. Topping the list were projects to manufacture garments, followed by agro-industrial projects and those to make machinery and parts. Twenty-nine were proposed to be set up in Nakhon Ratchasima, nine in Khon Kaen with the remainder being distributed among several other provinces.

An interview with businessmen in the Northeast revealed that there was still considerably potential for growth in investment there, particularly in medium and small-sized industries. There is strong likelihood that industries will be set up to do sub-contracting work, especially for major manufacturers in the Capital area. Many local entrepreneurs are expected to enter joint-ventures with big-time Thai investors and foreign investors. It is also expected that the Northeast will be as a base for production of goods earmarked for Indochina.

Construction

Public and private sector construction in this region expanded briskly

Investment Indicators

	1991	%±	1992	%±	1993	%±
Private sector investment						
No. of new plants	554	-17.8	138	-75.1	n.a.	n.a.
Expansion	100	35.1	55	-45.0	n.a.	n.a.
Construction area (1,000 sq.ms.)	105.7	-10.6	129.1	21.2	86.7 ^{1/}	22.7
Investment promotion						
No. of applications	63	-24.1	38	-39.7	110 ^{2/}	358
Investment (billion baht)	10	-10.7	8.2	-18.0	11.69 ^{2/}	132
Applications approved	65	22.6	31	-52.3 ¹	49 ^{2/}	178
Investment (billion baht)	8.5	23.5	11.5	35.29	4.11 ^{2/}	-63
Promotion certificate granted	31	-25.0	26	-16.13	27 ^{2/}	35
Investment (billion baht)	3.2	-65.6	3.3	0.31	1.93 ^{2/}	-36
Firms starting operations	9	125.0	17	88.89	8 ^{2/}	-27
Investment (billion baht)	0.9	50.0	1.6	77.78	0.44 ^{2/}	-41
Commercial bank credits (million baht)						
Manufacturing	14,941.2	11.19	17,530.7	17.33	19,512.9 ^{3/}	21.94
Construction	4,359.5	14.36	5,284.0	21.10	6,692.5 ^{3/}	33.32
Real estate business	1,482.3	-1.98	1,953.9	35.71	3,223.5 ^{3/}	86.97

Source: Bank of Thailand Northeast Branch

1. Jan.-Jul.
2. Jan.-Sept.
3. Jan.-Aug.

in the first seven months of 1993. Municipal areas given permission to construct totalled 86,731 sq.m., an increase of 22.7 per cent over the same period of prior year. Areas given permission to build homes and commercial buildings grew at relatively faster rates of 28.6 per cent and 34.4 per cent respectively. This was due to strong demand for low and medium-price housing facilities and stepped up construction of commercial buildings in keeping with high economic growth. By province, Chaiyaphum topped the

rest with the highest percentage growth in the areas given construction permits, followed by Sakon Nakhon and Roi Et. On the public sector front, construction to lay down infrastructure is being undertaken in many parts of the region, for instance, expansion of highway construction in Khon Kaen province.

The real estate business expanded satisfactorily. In the first half of 1993, land transacted in this province was worth Baht 7,675 million, more than doubling

that in the same period in prior year, and the number of transactions was 4,627, an increase of 42.2 per cent. The province with the highest transaction value was Nakhon Ratchasima, followed by Khon Kaen, Surin and Buriram. Credits granted to real estate-related businesses in the Northeast rose by as steeply as 86.9 per cent, with Nakhon Ratchasima being provinces with the highest amounts of this type of credit.

Factors fuelling growth in the real estate business included strong housing demand and land speculation on the expectation that the Northeast will become a gateway to Indochina.

Consumption

Consumption expenditure particularly in urban centres in this region expanded at a rather high rate. This was thanks to continued economic expansion, which became more evident in 1993. The situation is reflected particularly by the fact that in the first eleven months of 1993 commercial bank credits for consumption purposes grew by slightly over 35 per cent over the corresponding period in prior year. Another factor driving consumption was the sales promotional campaigns by department stores and shopping centres, which have mushroomed throughout the region. Remittances by overseas workers moreover put more money in the pockets of consumers, who spent more as a consequence.

In 1994, it is expected that consumption expenditure in the Northeast will continue on the uptrend as the positive factors will continue to be at play. In addition, the

value of agricultural production in this region will rebound in 1994.

Car sales

The car market in the Northeast is the Kingdom's second largest after Bangkok, with car sales in this region accounting for roughly 15 per cent of the country's total. Pick-up trucks dominate the market, with a ratio between their sales and those of passenger cars being roughly 85:15 per cent. In 1993, car sales rose by about 17 per cent on the back of overall economic growth, expansion of commerce and border trade and strengthened purchasing power of those who had become suddenly wealthy due to their sales of real estate especially land.

Broken down, sales of commercial vehicles in 1993 rose 15 per cent, a slight drop from the rate of increase in 1992. This was due largely to weak prices of cassava and affected crop production in drought-stricken areas. Moreover, the market for large trucks and buses had become saturated, due to a sharp rise in their sales in 1990-1992.

In contrast, sales of passenger cars soared by about 40 per cent. This was thanks to strong demand by consumers in the non-agricultural sector. Furthermore, distributors waged strong campaigns to promote car sales, which proved very enticing and effective. Hire-purchases accounted for an estimated 60 per cent of passenger car sales, 70 per cent of the sales of pick-ups and 85-90 per cent of the sales of large trucks and buses.

It is expected that a similar pattern of car sales will prevail in 1994,

i.e., a smaller growth in sales of commercial vehicles compared to that in sales of passenger cars. This is due to the fact that a similar set of factors remains to affect the car market in 1994.

Tourism

In 1993, tourism in the Northeast was much affected by the collapse of a hotel building in Nakhon Ratchasima. The building mishap, which occurred in August, nudged the tourism sector into the doldrums in the three subsequent months. This, it is estimated that visitors to the six major tourism provinces (namely, Nakhon Ratchasima, Khon Kaen, Udon Thani, Ubon Ratchathani, Buriram and Nakhon Phanom) in 1993 numbered 4,651.5 thousand, up 3.7 per cent on 4,486.4 thousand in the preceding year. Of the total, 97.5 per cent or 4,535.0 thousand were Thais and the remaining 2.5 per cent or 116.5 thousand foreigners. Most popular provinces were, in order of importance, Nakhon Ratchasima (with a 33.1 per cent share), Khon Kaen (21.7 per cent), Udon Thani (18.3 per cent), Ubon Ratchathani (14.8 per cent), Buriram (6.3 per cent) and Nakhon Phanom (5.8 per cent). Hotel occupancy was satisfactory, averaging 70-90 per cent.

In terms of spending in 1992, Udon Thani and Ubon Ratchathani, with their numerous entertainment places, headed the list, recording an average tourist expenditure of Baht 897.51 and Baht 886.26 per person per day, followed by Khon Kaen (Baht 816.15), Nakhon Ratchasima (Baht 797.89), Nakhon Phanom (Baht 711.32) and Buriram (Baht 443.05). For 1993, the average tourist expenditure is estimated to increase by

about 20 per cent. The average tourist spending is kept low by the fact that many Thai vacationers stay in the homes of their relatives while sojourning in the region.

It is expected that the number of tourists visiting the Northeast will rise by 6.1 per cent in 1994. Future prospects for tourism in the Northeast are promising as the region holds considerable potential as the gateway to Indochina. Moreover, its transportation and telecommunication systems are pretty well developed.

Thai-Lao trade

Total bilateral Thai-Lao trade, comprising border trade and transshipments from third countries through Thailand to Laos, should exceed the milestone Baht 10 billion for the first time in 1996. Available statistics show that in the first eight months of 1996, the total bilateral trade grew dramatically by 52.1 per cent over the same period of prior year to Baht 6,980.7 million. Of the amount, border trade accounted for Baht 3,576.4 million, up 41.8 per cent, and transshipments through Thailand to

Laos another Baht 3,404.3 million, up 64.8 per cent.

Border trade between Thailand and Laos is being undertaken through six check points, namely those at Nong Khai, Mukdahan, Nakhon Phanom, Phiboonmungsaharn and Khemmarat in Ubon Ratchathani and Loey. Of these, Nong Khai is the most important, with the lion's share or 63 per cent of total border trade, followed by Mukdahan with an 18 per cent share. Major export goods in the Thai-Lao border trade include cars, motorcycles and parts and electrical appliances. Rice, which used to be a leading Thai export to Laos, has lately declined in importance, with Laos becoming more self-sufficient in the staple. Capital goods and raw materials accounted for 14.4 per cent and 2.6 per cent of exports to Laos. In particular, construction materials shipped to Laos have grown satisfactorily, with Laos expanding its utilities and enjoying brisk economic expansion. On the import front, sawn wood is the most important import commodity from Laos, making up 90.1 per cent of imports from that country, and metal scrap, making up another 1.3 per cent.

In regards to goods in transit through Thailand to Laos, machinery and parts account for a major portion, originating from Singapore, Hong Kong and Japan. They are followed by textiles from Singapore and Hong Kong, and oil products from Singapore. Leading products in transit from Laos through Thailand to third countries and garments to France, Italy, Canada, the USA and Holland and sawn wood to Japan, Hong Kong and Taiwan.

The Structure of Thai-Lao Trade (Jan.-Aug. 93)

	Share (%)	Value (million baht)
Total exports	100	2,518.6
<i>Consumer goods</i>	29.1	732.8
- Rice	0	0.4
- Vehicles and parts	6.3	157.7
- Electrical appliances	6.4	161.2
- Others	16.4	413.5
<i>Raw materials</i>	2.6	64.2
<i>Capital goods</i>	14.4	362.3
- Construction materials	8.8	221.3
- Machinery and parts	2.5	63.9
- Others	3.1	77.1
<i>Others</i>	12.1	305.7
<i>Unclassified goods</i>	41.8	1,053.6
Total imports	100	1,057.8
Timber	90.1	953.0
Metal scraps	1.3	13.7
Others	8.6	90.9

Source: Bank of Thailand Northeastern Branch

Thai-Lao Trade

(Million baht)

	1992	+-%	1993 ^a	+-%	1994 ^a	+-%
Border trade	3,982.5	13.9	5,897.8	48.1	8,610.8	46.0
Exports	2,837.9	49.1	4,313.6	52.0	6,642.9	54.0
Imports	1,14.6	-28.2	1,584.2	38.4	1,967.9	24.2
Balance	1,693.3	447.1	2,729.4	61.2	4,675.0	71.2
Goods in transit	3,418.0	18.3	5,800.0	69.7	8,004.0	48.2
From Laos	1,153.3	31.1	2,133.0	85.0	3,071.5	44.0
To Laos	2,264.7	12.8	3,667.0	61.9	4,932.5	34.5
Total	7,400.5	15.9	11,697.8	58.0	16,614.8	42.0

Source: Bank of Thailand Northeastern Branch

^a Estimated by the Research Department, Bangkok Bank Public Company Limited

Throughout 1993, border trade is estimated at Baht 5,897.8 million, up 48.1 per cent. Exports amounted to Baht 4,313.6 million and imports Baht 1,584.2 million, with the surplus being Baht 2,729.4 million in Thailand's favour.

In 1994, prospects for growth in Thai-Lao bilateral trade are promising, as the Thai-Lao Friendship Bridge are open to traffic further facilitating trade between the two countries. It is expected that the bilateral trade will total Baht 16,614.8 million, up 42 per cent. Of the figure, border trade amounts to an estimated Baht 8,610.8 million and transshipments of goods through Thailand another Baht 8,004 million.

Banking and finance

Deposits outstanding at end-August 1993 at commercial banks and the Government Savings in the Northeast amounted to Baht 143,865.4 million, an increase of 18.7 per cent or Baht 22,680.2

million over end-August 1992. Commercial banks accounted for 91.2 per cent or Baht 131,216.7 million and the Government Savings Bank the remaining 8.8 per cent or Baht 12,648.7 million.

At end-August 1993, commercial bank branches in this region numbered 402 (of which 23 were sub-branches), an increase of 17 branches. A total of 132 ATMs were installed, up 16 machines. Deposits at commercial banks in the Northeast rose 19.8 per cent, compared to 21.8 per cent in prior year and the country's average growth figure of 17.7 per cent. Nakhon Ratchasima, Khon Kaen, Udon Thani and Ubon Ratchathani topped the list as the provinces with the largest amount of deposits, with shares of respectively 21.3 per cent, 15.1 per cent, 12.1 per cent and 9.8 per cent.

At end-August 1993, the Government Savings Bank operated 122 branches in the Northeast, up 6 branches. Its outstanding depo-

sits stood at Baht 12,648.8 million, up 8.1 per cent.

Outstanding credits at commercial banks and the Bank for Agriculture and Agricultural Cooperatives in the Northeast totalled Baht 148,682.1 million, an increase of 32.3 per cent or Baht 36,268.3 million over end-August 1992. Commercial banks accounted for 82.2 per cent of the total and the Bank for Agriculture and Agricultural Cooperatives the remaining 17.8 per cent.

Commercial bank credits in the Northeast rose 30.7 per cent to Baht 122,193.2 million at end-August 1993, compared to 18.2 per cent in prior year and the country's average figure of 21.1 per cent. Similarly, Nakhon Ratchasima, Khon Kaen, Udon Thani and Ubon Ratchathani were provinces with the largest amount of credits, boasting percentage share figures of respectively 20.2 per cent, 16.6 per cent, 11.8 per cent and 9.8 per cent.

At end-August, the Bank for Agriculture and Agricultural Cooperatives' outstanding credits amounted to Baht 21,848.3 million, up 41.6 per cent.

At end-1993, the number of securities trading offices in the Northeast was 33, up 7 over prior year. Securities turnover at these offices amounted to Baht 37,198.4 million, down 10.6 per cent.

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APPENDIX G

ACTIVITY A 4.32

PRC MEETING, HALIFAX, APRIL 1997 - MINUTES

THAI-HRD CUTC-SUT PROJECT
Fourth PRC Meeting, April 3, 4, 1997
Dalhousie University Polytechnic (formerly TUNS)
MINUTES

CUTC: Dr. Stalin Boctor, Ms. Mary Jane Curtis, Dr. Gerry Schneider, Dr. Feridun Hamdullahpur, Dr. William Caley, Mr. Robert Eagle, Dr. James Shute

SUT: Dr. Tavee Lertpanyavit, Dr. Pongchan Na-Lampang, Ms Mantana Thammachoti

1. *Welcome, Introductory Remarks*

Bill Caley welcomed SUT partners. Dr. Tavee thanked hosts and hoped for fruitful discussions.

2. *Selection of Chair for the Fourth PRC Meeting*

Motion: Bill Caley and Dr. Tavee as co-chairs. Moved by Stalin. Seconded by J. Shute. Carried.

Approval of agenda: Dr. Tavee noted additional items for #8 from SUT.
R. Eagle - spelling correction to INNOVACorp

3. *Review and Approval of Third PRC and Mini-PRC Meetings' Minutes (September 1996, University of Waterloo and Thailand, February 1997)*

- correction A2.26, under action Prof. Virul

Motion to approve minutes of PRC Meeting, September 26-27. Moved by: J. Shute; Seconded by: F. Hamdullahpur. Carried.

Motion to approve Mini-PRC Feb'97: Moved by: J. Shute seconded by: S. Boctor. carried

- spelling correction to DeMan, and 'Al' Taweel

Review of completed/ongoing activities since the 3rd PRC meeting:

- a) *A 2.11: CUTC representatives' contribution to the S.E. Asia Deans of Engineering Conference at SUT, February 1997/Mini-PRC report*

Stalin summarized activities since October 97:

- Eng. Conference Feb'97 + Mini PRC
- IUP Program: third trimester cancelled, 4 teaching assignments in EE cancelled.

The above assignments were approved in 3rd PRC and are now cancelled.

- R. Eagle requested discussion and review of the Mini-PRC February to clarify what happened at SUT from the 3rd PRC leading to the cancellation of a number of key project activities. Dr. Tavee explained that SUT did not retain sufficient numbers of students in the IUP Program in the third trimester for its continuation. Because Ponsiri is staying in Canada, there is no need for her Canadian Supervisor to come to Thailand. Graduate students and Post-Doctoral programs will continue as planned. Budget constraints at SUT - government has made general cutbacks; a 15% cutback was made for the current fiscal year ; Dr. Tavee hopes that in the next year the financial situation will improve.

- b) *A2.12: IUP Electrical Engineering, Prof. P. Barta's assignment, and status of the remaining students. Availability of study program at Ryerson and transferability of eligible students.*

- 2 SUT students have requested transfer to Ryerson (Mr. Gal Samanmoo, Ms. Oei Chantarasombat). Stalin made enquires about available courses in Summer'97. English Dept. at Ryerson running intensive English courses commencing June'97 June 23-Aug 14'97 Condensed program 9 am-3 pm and an evening program in Oral Communication from 6:30 pm-9:30 pm. Other make up courses will be offered in Fall'97 (language, liberal arts, 2nd yr. math). By January 1998 students will be enrolled in regular stream program, 2nd semester. Require official transcripts (after conclusion of second trimester) and other documentation from SUT as soon as possible in order to enrol students in Summer'97 programs. SUT students also must obtain visa and medical clearance. Robert Eagle noted that there are changes soon to be made to the system which will shorten the visa/medical clearance.

- c) *A 2.21: Selection of Ph.D. candidates. Status of present and expected candidates at TUNS. Activity Completed*

Status report from F. Hamdullahpur: 3 students currently registered (Ms. Pornsiri Jongkol, Mr. Anand Unsivilai, Ms. Kanthima Polprasert) 4th candidate will arrive in September 1997, Mr. Rangsan Wongsan, Electrical Engineering. Dr.

Chongchin requested another candidate in environmental engineering (TBA) but no fellowships received to date. Post Doctoral fellow Dr. Chongchin and all Ph.D. candidates are making excellent progress.

- d) *A 2.25: Two-term assignments in Environmental Engineering started January 1997 at TUNS. One single-term assignment in Biology started February 1997 at Guelph. One term Assignment in Transportation Engineering will start in June 1997 at TUNS.*

2 started: one at TUNS- environmental engineering, in January'97. (Dr. Chongchin Polprasert). Dr. Sureelak Rodthong started at Guelph in February, 1 at TUNS in Transportation Engineering: start date has been revised and confirmed to June '97. (Dr. Somprasong Sattayamully)

- e) *A 2.31: Co-op work placements. Canadian students completed 5 assignments, one on-going and three assignments (1 TUNS, 2 Guelph) to start in April/May 1997. Thai students completed 4 assignments, two on-going at TUNS and two to start in May at Guelph, thus completing the program.*

Canadian Co-op students:

- five completed as of December. One ongoing from Guelph. 3 more assignments - 2 Guelph, 1 TUNS commencing May. Total 9 Co-op (Canadian) students to Thailand. Activity will be completed.

Thai Co-op students:

4 completed, 2 at TUNS, 2 expected at Guelph TBA

A total of 8 Thai students to Canada when program completed

5. *Status of the planned project activities:*

A 2.12: Cancellation of the third trimester of the IUP Electrical Engineering, and the four Canadian professors' assignments planned for June 1997.

- *Status of the two assignments in "Food Technology" planned for September 1997;*
- *Latest developments regarding the new IUP student intake for June 1997;*
- *Cancellation of the three Canadian Consultants' assignments at SUT to develop post-graduate degree programs in Engineering, planned for June 1997.*

4 Cdn. professors planned for June, cancelled due to lack of students; 2 prof. from Guelph (DeMan, Goff) contracts were left at Mini-PRC Feb'97 for SUT to sign. Dr. Tavee will have the contracts signed (informally approved by Dr. Terd) and returned to Ryerson. Guelph conducting briefing and orientation for Co-op students and professor Goff and wife.

IUP intake: Program may not run if less than 30 students/program are registered. Need to wait until end of April to determine status of each programs SUT has created a Task Force to promote program. Stalin enquired about what CUTC could do to assist. SUT want 30 students each in Mechanical, Electrical, Chemical and Food Technology programs. Tutition structure compared with Thammasat: SUT slightly more expensive.

Stalin asked what the status is at SUT to plan graduate programming. Some engineering post-graduate programs have been postponed for one year. The graduate Program in Chemical Engineering will start next year, June 1998. Stalin proposed a one or two week workshop at SUT, by CUTC professors, to discussion planning and administration of graduate programs in engineering.

A 2.23: Ph.D collaboration: Assignment for Professor Al Taweel regarding the Chemical Engineering Ph.D. candidate, to be determined.

Planned activity :

Prof. Al Taweel will travel to SUT in October 1997. (to be confirmed)
(Co-supervisors: Dr. Kasem and Dr. Chaiyot)

A 3.23: Plans for the proposed new additional Industrial Seminars requested by SUT in Construction Management (September 1997), Watershed Management and Industrial Safety and Health.

Increased project funding was allocated to support SUT request for this activity. Three consultants to go to SUT. SUT will choose which seminars will be offered. Bill Hart, TUNS is available re: Watershed Mgmt.; Construction Management - maximum 2 persons (Ryerson/Waterloo) but requires more input from SUT (topics, structure, dates etc.) Robert Eagle and Bill Hart will be in touch with Mr. Manu and directly organize the seminar. Construction Management: Robert Eagle will follow through. Topics will be confirmed by SUT. Seminar to be organized by SUT. Project funding will support 3 Canadian participants in total. Activities must be confirmed by December 1997 and completed by March 31, 1998.

6. *Project sustainability after the completion of CIDA funding:*

- *Areas to explore: IUP, Ph.D. and Research collaboration, Industrial Seminars, etc.*
- *Lessons learned from the project's implementation to date*

a) Dr. Tavee stated that the Ministry of University Affairs will support the following in the field of engineering :

- One-term student exchanges for academic credit, fees waiver requested.
- 6 months to one year research assignments: funding for transportation , per diems and living allowance for Thai faculty to Canada

- Short term assignments for Canadian professionals to Thailand: The Ministry will support transportation, accommodation and fees for professional services. (lecture/seminars).
- b) SUT is interest in exploring other exchanges such as Co-op.
- c) IUP Program: Question raised about further exploration of admitting undergraduate Thai students in Canadian universities as this was a focal point in the development of the project. SUT indicated recruiting students is a challenge and CUTC should give students more incentive to come to Canada. The tuition fees, TOEFL level, documentation (visa) and admission requirements for foreign students present some problem. TUNS and other CUTC partners have reduced the level of TOEFL requirement for SUT students to ease the difficulty. Additional English support at no additional cost (tutorials) has been offered by TUNS. SUT faculty at TUNS have shown great improvement in English (written/oral). Students must have English language certification before they can be accepted into programs. A testing method could be instituted at SUT acceptable to the CUTC member institutions, such as CANTEST. CUTC want students to succeed in programs - without acceptable English standards the potential to fail is great and would be damaging to the success of the project.

7. *Status of Project Funding and Budget Review*

A March 27, 1997 budget summary was attached to Agenda package. Stalin Boctor and Sam Mikhail met with ARA to review status of the project budget. Other ARA-administered Thai projects have experienced similar challenges in not being able to deliver on some of the program areas. ARA has agreed to be flexible on the funding allocation. The project can put additional funds towards key activities jointly approved.

Funds remaining after the cancelled activities are approximately \$130,000.

8. *Other requested activities and their relationship to the project's goals:*

a) *One additional post-doctoral assignment (Dr. Arjuna Chaiyasena, SUT).*

This has been approved by CUTC ; dates to be confirmed by Dr. Langford/Guelph. Funds can cover a 4 month assignment.

b) *Two new assignments in Multimedia (Dr. Krich and Dr. Umaly from SUT)*

CUTC cannot approve funding for these activities (Mass Communications and Multi-Media) as they are beyond the scope of the project and do not meet the sustainability objectives.

c) Visit in Nuclear Engineering (Prof. Virul from SUT)

The request was reviewed. Nuclear Eng. is not available within CUTC group. Dr. Tavee would like Prof. Virul to review graduate and teaching lab equipment. CUTC require a more specific proposal. The request is pending.

*d) Visit to explore technology transfer and industry outreach
(Dr. Neung and Mr. Manu from Technopolis at SUT)*

A 2-week visit can be supported by U. of Waterloo, Guelph and TUNS. Approve 2 assignments: one week at TUNS and a couple of days at each of Waterloo and Guelph. Robert Eagle will prepare the proposed program and sent to SUT.

e) Additional CUTC Proposal:

A three-day workshop in planning/administration of post-graduate programs was proposed. Dr. Tavee wanted as well to address the issue of accreditation/quality assurance and the participation of other universities. Approval was given but the content is to be negotiated with SUT based on proposal from CUTC.
Possible date: November 10-12/97

*f) SUT additional requests:
Chair of Mathematics, Dr. Pairote Sattayatham, 2 weeks at Waterloo, Faculty of Mathematics*

Pending review by U. of Waterloo, Gerry Schneider. Dr. Boctor will advise Dr. Tavee.

Assistant Rector Academic, Dr. Tasanee Sukosol: 3 weeks at U of Guelph, Depts. of Food Science and Veterinary Microbiology

Pending: Jim Shute will review with Doug Goff. Dates requested: May-June 2-3 weeks
Stalin Boctor to confirm program with Dr. Tavee

9. *Status of proposed visit to SUT by Dr. Claude Lajeunesse, President, Ryerson Polytechnic University, July 1997.*

Date confirmed Thursday, July 24, 1997. Dr. Lajeunesse will give an address at the 7th Anniversary of SUT and attend an evening formal reception. CUTC would like the President to make mention of the CUTC-SUT project and its accomplishments. Speech topic is open.

10. *Need for 5th PRC meeting in Thailand? If yes, when?
(originally proposed for Dec. '97) Agenda items to be included.*

CUTC and SUT confirmed the need for the meeting in order to ensure continuity and sustainability. Dates: January 12-13, 1998 arrival in Korat 11th evening.

11. *Review of the draft of the minutes - 4th PRC meeting*

Dr. Boctor moved to approve the revised draft of the minutes.
Seconded by Robert Eagle. Carried.

12. *Closing Remarks*

Bill Caley thanked the CUTC-SUT group for their contribution to the 4th PRC.
Acknowledgement and thanks were given to Mary Jane Curtis for handling the minutes .
Dr. Tavee thanked the partners and indicated that SUT would be looking forward to seeing everyone at the 5th PRC meeting to be held at SUT in January, 1998.

CUTC-SUT offered their gratitude and thanks for all the arrangements for the 4th PRC.

13. *Adjournment*