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REPORT ON THE THAILAND TEXTILE INDUSTRY

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I. EXECUTIVE SUMMARY

During this two week technical assistance project, the two United Nations Industry and Development Organization (UNIDO) textile industry experts met with the Director and staff of the Federation of Thai Industries (FTI) Industrial Environmental Management Program (IEMP) and the Textile Industry Club (TIC). Meetings were also held with officials from the United States and United Nations organizations involved in the project, such as the United States Agency for International Development (USAID), the World Environment Center (WEC), United Nations Development Programme (UNDP), the United Nations International Development Organization (UNIDO), and the Textile Industry Department (TID) of the Ministry of Industry (MOI). Seven textile dyeing and printing factories were visited.

The factories visited represent a range of technical levels and were generally using state-of-the-art manufacturing processes. During this project assignment, medium and small size factories were not visited.

Several of the factories visited could benefit from direct technical assistance programs (e.g., foreign textile industry experts providing in-plant assistance for several weeks or months) in terms of pollution reduction. However, most of the plants visited already operate at a fairly high level, and several have ongoing technical assistance cooperation agreements with European companies. The main problem area from an environmental perspective is that of the smaller dyeing and printing units. It is recommended that future technical assistance efforts need to be concentrated with respect to the medium and small size factories.

There is a need to strengthen the technical capabilities of the industry through increased training. Within the FTI and Ministry of Industry cooperative environmental program the issue of the textile education as well as that of a strong textile research and training institution supported by the industry itself, should be addressed. In order to efficiently help the industry, particularly the smaller companies, a professional textile education network should be extended, and a strong textile center established. Options for the establishment of a training institution would include a strengthened Textile Industry Department (TID) or the establishment of a new institution.

As a follow up training project, it is proposed that 2 seminars (dyehouse automation and colour matching) be presented. These seminars should be well organized in advance to ensure their efficiency. Plant visits to small dyeing and printing factories should be scheduled. In order to increase the efficiency of the experts' activities it is recommended to organize their return mission for after the return of the Thai delegation from their study tour.

II. FINDINGS

A. Discussions with FTI-IEMP and the Textile Industry Club

During the textile industry experts' May - June 1993 trip to Thailand, meetings took place with staff from the FTI Industrial Environment Management Program (IEMP) and Textile Industry Club representatives. From these discussions and visits to 7 textile factories, the following major points emerged:

1. The main environmental problem area for the textile industry is the large number of small factories which do not have waste water treatment systems. On the whole, these smaller factories tend to be polluting more heavily than the larger plants.
2. The seven factories visited by the UNIDO team were among the more technologically advanced factories in the Thai textile industry. To varying degrees, these factories were larger, well organized companies already conscious of the need to reduce effluent discharges and to increase efficiencies. From among the 7 factories visited, several were operating at such a level (not necessarily in terms of equipment, but in controlling their processes and general plant practices) that further improvements could only be achieved by either very meticulous analysis (e.g. Nan Yang Knitting Factory) or by changing the whole production structure (e.g. Thong Thye Chiang R.O.P.).

At other factories (e.g. Union Textile Industry Corp., Siam Knitware and Garment Co., Thong Thai Textile Co.) a relatively short (i.e. 3-8 weeks) in-plant internship by a process engineer, concentration on process analysis and optimization may bring measurable results.

3. The efficiency of both a pollution prevention as well as end-of-pipe pollution control approach could be further adopted by the Thai textile industry if incentives were provided. Incentives could include the provision of technical assistance and training to those mills that implemented process optimization, automation and colour matching into their operations. This "stick and carrot" policy is being adopted by the Government.
4. The technical area of most need in the Thai textile industry pertains to industrial training. Within the cooperative environmental program the issue of the textile education as well as that of a strong textile research and training institution supported by the industry itself, should be addressed.
5. The experiences gained in other countries at a similar level of development could prove very useful. In Brazil, for example, a unique system of industrial training both in textile technology, effluent treatment, and optimal industrial

management practices has been implemented. A study tour to Brazil by Thai textile industry technicians and plant managers, as well as further co-operation between the FTI Textile Industry Club and the SENAI system in Brazil, is recommended. The proposed program is attached in Appendix 3.

6. Nine individual, but related, subprojects have been identified for the textile dyeing, printing and finishing industry in Thailand:

- optimization of chemical recipes in dyeing, printing and finishing;
- computerized colour matching (CCM) in dyeing and printing;
- clean production dyehouses, printing shops;
- automation of dyehouses, printing shops and fabric preparation ranges;
- polyvinyl alcohol (PVA) recovery;
- powdered activated carbon technology (PACT) colour removal;
- colour removal at small textile plants;
- dyestuff and printpaste toxicity; and
- whole effluent toxicity testing.

These subprojects have briefly been discussed in a concept paper prepared by the IEMP (see Appendix I). Components of this concept paper have been incorporated into the cooperative environmental program between the FTI Textile Industry Club and the Ministry of Industry. Details of how and in what way the United Nations Industry Development Organization (UNIDO) could support these projects should be further explored.

B. Ministry of Industry's Textile Industry Division

The Ministry of Industry's Textile Industry Division (TID) is currently one of the primary sources of technical assistance for the industry. TID has a well stocked library, complete with most of the standard handbooks and monographs as well as the major professional journals for the textile industry. However, with respect to laboratory equipment, additional equipment could be beneficial. For example, research

and development projects would be assisted by equipment such as dyeing machines and computerized colour matching systems. For purposes of quality control, up-to-date material testing instruments are needed.

One of the major strengths of TID is its group of highly qualified professionals, which should be regarded as a major asset. Textile education in Thailand is much below the required level, and the 20 or so technicians trained yearly provide only a fraction of what is really needed. Most of the environmental and process concerns encountered during the factory visits and reported during discussions relate to the general lack of adequately trained textile professionals. The smaller factories are in particular need of training assistance in the small plants. The important role of a textile center, such as TID, to provide this training service cannot be over-emphasized.

TID at present is hindered in meeting its objectives due to operational flexibility and financial resources constraints. These constraints impact upon TID's ability to provide the high level of services demanded by the textile industry. Consequently, the industry is not entirely supportive of TID. TID, which is located within the Ministry of Industry (MOI) is also associated with the regulatory function of MOI. During the team's visits, discussions were being held between MOI and FTI-TIC, and other concerned parties, to determine how an optimal level of technical services for the industry may best be provided.

During discussions at TID, it was evident that future programs in textile pollution control, waste prevention, and process optimization would greatly profit from utilizing the knowledge, experience and good factory-level connections of TID.

C. One day seminar on "Pollution Prevention and Control in the Textile Dyeing Printing Industry".

A one day program was organized to discuss the main issues with representatives of FTI, MOI and a wide audience from industry. The program was the following:

- | | |
|------|---|
| 8:30 | Registration |
| 9:00 | Welcome |
| - | Welcoming address, Khun Kasen Narongdej, Chairman, FTI's Subcommittee on Environment |
| - | Opening remarks, Khun Veera Susungkornkarn, Deputy Minister, Ministry of Industry |
| - | Opening remarks, Khun Phongsak Assakul, Chairman, FTI's Textile Industry Club |
| 9:30 | Overview: Current Problems of Pollution Control in the Textile Industry
Director General, Department of Industrial Works |

10:30 Coffee Break

11:00 Pollution Prevention: Source Control
Dr. James Gallup, USAID

12:00 Lunch Break

13:00 Panel Discussion: Pollution Prevention and Control
Measures in the Textile Industry

Khun Phongsak Assakul, Chairman, FTI's Textile Industry Club

Prof. Surin Sethamanit, Chulalongkorn University

Dr. John-Peter Moll and Dr. Robert Hirschler, UNIDO

Dr. James Gallup, USAID

Mr. Tienchai Mahasiri
Representative Textile Dyeing and Printing Industry

Dr. Sarawoot Chayovan, Director, FTI's Industrial
Environmental Management Program

15:00 Coffee Break

15:30 Open Floor for Discussion

16:30 Summary

After the program summary, the Minister for Industry was briefed on the proceedings, and then delivered a short speech summarizing the Ministry's opinions and intentions with respect to regulating the textile industry. The abstract of Dr. Hirschler's presentation on the Brazilian Experience has been reproduced in Appendix 4.

D. Factory Visits

1. Union Textile Industry Co., Ltd.

Large company with 7,000 employees. The plant has a dyeing and finishing production of 6-7 million yards/month:

20 % cotton

70 % polyester/cotton

10 % nylon, rayon etc.

Approximately 600-700 employees work in dyeing and finishing. Normal processing route: singe - desize - scour - bleach - mercerize - heat set - dye - finish.

Desizing: Na-persulphate
Bleaching: mainly NaOCl₂, some H₂O₂
Dyeing: reactive, vat, some direct, sulphur and disperse
Finishing: calender - sanforize
Water consumption: 8000 m³/day with 10-15 % evaporation

Most of the machinery is 20 years old, mainly Japanese (Toyo Menha, Kyoto). Processes are manually controlled. Chemicals in mixing tanks, dosage with rotameters. Pilot plant is dated.

Colour matching: ICS MM 2000 with DEC PDP-11 computer.

Dye dispensing in the laboratory:

GAIN Dye-Master + GAIN Dispenser
(Approx. price: CCM system 4-5 million Baht
Dispensing 2-3 million Baht)

The factory uses approximately 200 dyestuffs, and prepares about 150 dyeings/day, out of which 50 are usually acceptable.

The colour kitchen is reasonably tidy, having electronic balances with printout for control. Dyestuff identification: smearing on the recipe sheet. The working method: dyes are taken from barrels to balances in plastic bags.

In the dyehouse: washing off in open jiggers with hot overflow, no heat recovery. Hisaka circular jets (1970's) with cam controllers. Stork 11-colour rotary printing machine.

Effluent treatment appears to have reasonable results. Data for September 1991, is as follows:

	Before Treatment	After Treatment
pH	8.3	7.6
BOD	393	9.4
COD	923	288
SS	26	7
Colour	dark blue	slightly violet
Temp (Celsius)	48	38
Turbidity	20	1.8
TDS	-	2.119

Remarks: large factory with rather aged machinery. The maintenance level, tidiness, housekeeping may be improved, by changing some of the practices. For example, hot overflow washing to fill-empty washing and economizing with marking the pieces nearer to the end immediate results could be expected.

2. Thong Thye Chiang R.O.P

Small factory with old machinery, approximately 100 employees. Main production 100% cotton canvas for sports shoes. Dyeing with reactive, vat, sulphur and some direct dyes.

Main problem: matching of colours, frequent re-dyeings. Approximate dyestuff costs: 15 million baht/year for a production of about 700,000 yards/month (7.5-8.0 million meter/year), with average width 36"-48". Energy costs about 0.5-0.55 Baht/yd.

Only open jiggers for most of the wet processes: 3-4 hrs white, about 5 hrs for black. For dyeing often pad-batch. Plans for the near future: semi-continuous preparation (cold pad-batch) and more P-B dyeing.

There are approximately 60 dyestuffs in stock, they make 2 to 3 new recipes (colours) /day, the laboratory is in the Bangkok office. Storage of dyestuffs in the original boxes, often not closed (danger of hygroscopicity).

Simple effluent treatment before entering the reservoir control loop for neutralizing. Considering modernization of effluent treatment (activated sludge) primarily to save land area.

Remarks: in spite of the very old machinery park, outdated processes and very simple plant facilities, the factory is well organized. Lacking in space, but tidy, and all machines working (showing good production planning). Savings or improvements could be achieved but would require a major investment in machinery and process changes.

3. Thai Textile Printing (1980) Co., Ltd.

Fairly large dyeing and printing factory with a production of about 4 million yd/month:

30 % dyed
50 % printed
20 % yarn dyed

The production is mainly (80%) for export, so the quality is comparatively high, but as yet there is no automation. For visual colour control a VeriVide standard light-booth is used. Some of the machinery is 20 years old (preparation for printing on 1972 St. James Farmer Norton machines), printing itself is done on two more recent 12-colour rotary screen printing machines (Stork). Average number of colours is 5.

The effluent treatment plant consists of an aerated lagoon following pH adjustment, treating about 3500 m³ water/day. The treatment does not remove the colour. At present the factory does not have plans for improving colour removal.

Remarks: due to time constraints only 50 minutes were available for the visit, thus there was no chance to go into any detail. It was agreed that at the next possible visit would be repeated together with a visit to another factory of TTP where colour matching would by then be implemented.

4. The Thai Printers and Finishers Co., Ltd.

The factory works for the highest market segment and are suppliers to Jim Thompson's. In order to improve working methods and also to enter European markets the company has established a joint venture with Taunus Druck, a leading German printing company.

The production is small and exclusive, producing about 100.000 yards/months, with minimum lot sizes of 40 yards (for silk). There are 260 employees that work in 2 shifts.

The bulk of the production is cotton (which arrives mainly already prepared, sometimes it is scoured at the plant) and silk (which normally arrives degummed). For printing reactive and vat dyes for silk, and for yarn dyeing reactive and metal complex dyes are used.

) The factory has no computerized colour matching as yet, in future plans it is second to dispensing in the colour kitchen. The present colour kitchen is small and crowded, but very clean and tidy.

Machinery is relatively old, but in good condition: second hand Famatex and Bruckner stenters; hand printing tables; 10-colour J. Zimmer printing machine. The processes used are sometimes unusual but efficient, e.g. cold Pad-Batch preparation on jiggers:

cold impregnate NaOH + H₂O₂ 2 mins
rotate on jig or batch unit 4-5 hrs
wash-scour on jig

The designs for printing come from customers. The factory prepares the colour separations, screens and recipes. From the arrival of the design to the screen 3-4 weeks are needed: computer aided design would therefore assist the factory to reduce this time. The number of new designs is relatively low: 1 design/day with average 6 max (????) 10 colours. The majority of the designs are only flat tones and half tone. Quadrichromie printing is just beginning.

Effluents are treated in a relatively simple manner, the main problem being colour removal.

) Remarks: not modernly equipped but a well-run company. Most of the outside technical assistance needs are being provided by the joint venture partner. Detailed recommendations would be required for more efficient effluent treatment, with particular reference to colour removal, taking the physical constraints, particularly space limits, into consideration.

5. Siam Knitwear and Garment Co., Ltd.

) A large batch dyehouse with production of about 20,000 kg/day of mainly cotton (95%), some PES/CO (5%) knitwear, employing about 3,000 people. The machinery consists of 9 HT and c. 50 atmospheric jet and overflow machines, typically Fong's. The plant operates 7 days a week, with two 12 hour shifts. Lot sizes vary from 5 to 2,000-3,000 kg on 20 to 600 kg machines. Typical dye cycle time is 12 hours, with reactive dyes, of which the dyehouse uses 80-100.

The company has started to modernize its laboratory and has recently installed a DATACOLOR TEXFLASH spectrophotometer linked to an AST Bravo 486/25 computer running Applied Color Systems (ACS) quality control software, but no colour matching yet. The system is connected to a CASSAD lab dispenser with DC LACOS software.

) The company has not acquired colour matching software yet as they want to introduce the new techniques stepwise. Mr. Ng, technical director, explained that the

general level of education in the Thai textile industry is rather low and it is difficult to find qualified technicians. Several companies have already installed computerized colour matching systems, but cannot use them properly because of problems with operating them.

Remarks: the plant has a large potential for improvement. Tidiness with regard to storage of goods throughout the plant would lead to waste reduction. Water and energy savings could be achieved by keeping tighter controls. The factory would benefit from a detailed analysis of production methods, processes and plant practices. A very quick check of the DATACOLOR TEXFLASH spectrophotometer revealed some discrepancies regarding the white calibration of the instrument. Consequently, the accuracy expressed in colour differences measured on BCRA-NPL Ceramic Colour Standards is not quite as high as usual with this generation of instruments. The rather unusual combination of spectrophotometer from DATACOLOR run by software from ACS makes data evaluation somewhat complicated.

6. Nan Yang Knitting Factory Co., Ltd.

The factory was founded 20 years ago and was the largest and most impressive of the plants visited. It has undergone 3 major development phases since its foundation: 10 years ago a yarn dyehouse was added, 7 years ago a piece dyehouse was opened, and the latest extension has just been finished (what was it?).

The yarn dyehouse produces 15 tons/day of cotton and polyester/cotton (package) and acrylic yarn (hank). In the older piece dyehouse FONG's winches and jets, with ATYC process controllers, in the new dyehouse FONG's jets with BARCO SEDO PC 3000 and 3100 controllers and PC 5100 central controller, for a production of 40% cotton and 60 % polyester/cotton.

The laboratory is equipped with Kurabo AUPET and 2 AUKITCHEN laboratory dosing/weighing systems, and for visual control a Shirley SDL Colormatch booth with D65/A/TL85/UV light sources. There is an ICS-TEXICON colour matching system, which is being used mainly for recipe prediction, but also for some quality control work.

Remarks: All parts of the factory show a very high level of control, and the results of well planned development work. This factory would be regarded as at a high-level of operation, well-run dyehouse anywhere in the world. The new effluent treatment plant has not started full operation yet, but appears to be at as high a level as the rest of the factory. Improvements in this factory could only be recommended after a very detailed, in-depth process analysis.

The colour matching equipment is run efficiently but calibration procedures - using the BCRA Ceramic Colour Standards provided by the supplier - could be made more

regular. Evaluation of the systems performance based on an abridged test will be provided to the factory during the return mission of the consultants.

7. Thong Thai Textile Co., Ltd.

Medium size dyehouse for 150 tons piece dyed knitwear/month: 80% of it cotton and c. 20% polyester/cotton and polyester/viscose.

The 20 jet/overflow machines are not in faultless condition, some of the latches are not fastened and there is excess foaming in some machines. The machines work in two 12-hours shifts 6 days a week, the total work force is somewhat over 200 people. The dyehouse uses 35-40 reactive, direct and disperse dyestuffs from all the major suppliers (ICI, Bayer, Sandoz, Hoechst) and chemicals also from BASF and Ciba-Geigy.

In the finishing there is a new 5-field Bruckner stenter (1989) in good condition, but e.g. the moisture controller was out of operation during our visit. For visual control there is an ICS-TEXICON Multilight cabinet.

The relative amount of water and effluent (about 150 l/kg) appears to be reasonable.

Remarks: the lack of rigorous controls is reflected in the rather high value of shading additions (3 correction/colour) and the relatively low production (2-3 lots/machines/day). The management is fully aware of the problems, and plans to invest in new machines with process controllers, computerized colour matching and a new colour kitchen in the new building.

III. RECOMMENDATIONS AND CONCLUSIONS

In general, short missions (such as the two-week missions of the textile industry experts) are generally only enough to identify the main areas of further actions. Contrary to some preliminary expectations, enough time is not provided to make it possible to solve factory problems "on the spot". To attempt to do so would be a vast underestimation of the level of the visited factories of the Thai textile industry which is quite highly developed.

It is therefore recommended that:

1. During a follow-up return mission the textile industry experts concentrate their time and effort on the preparation of a draft proposal for further larger scale projects.
2. Within the framework of the new projects based on the FTI-IEMP concept paper longer missions (3-4 weeks or rather some months) for one or two process optimization experts should be scheduled to provide direct assistance to small and large plants. At the same time providing on-the-job training for their counterparts from the designated textile institution.
3. From among the factories visited Union Textile Industry Co., Siam Knitwear and Garment Co. and Thong Thai Textile Co. would benefit the most from a process/plant practice optimization technical assistance program, while for the others consultancy in effluent treatment may be more beneficial.
4. To assess the level of small dyeing and printing factories in Thailand, visits to these type of units should be organized for the return mission of the experts.
5. Two 1.5 - 2 hours seminars (one in colour matching and one in dyehouse automation) should be organized during the return mission of the experts following the recommended topics.
6. A 1-week visit to study the SENAI system in Brazil should be considered as part of the study tour being organized by FTI and WEC.
7. It is recommended that the FTI Textile Industry Club and the Ministry of Industry decide as soon as possible on the best course to establish a strong textile training and R&D center. In this decision the values accumulated at TID should be given due consideration.

8. The return mission of the textile industry experts should be better prepared than the first one. It would greatly enhance the efficiency of their work if the return mission only took place after the study tour of the Thai delegation to Brazil. Expectations could thus be better discussed, the exact topic and scope of the seminars determined and seminar papers could be prepared and translated in advance.

APPENDIX 1 Cooperative Environmental Program Between The Textile Industry Club of the Federation of Thai Industries And The Ministry of Industry

SUMMARY

The Textile Industry Club of the Federation of Thai Industries (FTI) is concerned about the appropriateness of the new environmental standards for the textile dyeing, finishing and printing industry. FTI does not disagree with the intent of Ministry of Industry (MOI) standards nor the critical need for environmental protection in Thailand. However, FTI believes the new environmental standards must be revised and we request that you defer implementation of these standards until new data and information is developed to support an effective and equitable environmental control program for all textile mills in Thailand. The FTI cooperative program includes the following:

1. FTI offers a collaborative program to assist MOI establish interim requirements that will help bring all textile plants to a common level of environmental protection. This program will emphasize pollution prevention, waste minimization and dyehouse optimization and automation as well as effluent treatment.
2. FTI wishes MOI to impose comparable environmental standards on all industries to promote equitable industrial environmental standards. If critical geographic areas must be protected, all industries should be treated fairly.
3. FTI proposes to address color and toxicity problems from textile dyeing, finishing and printing processes through improved dye house operation, computerized color matching and control of problem dyestuffs.
4. FTI plans to use seminars, study tours and technical assistance programs to promote pollution prevention, industrial auditing and training for independent third party organization.

The proposed FTI Textile Industry Club collaborative program with the Ministry of Industry includes the following components, studies and activities:

1. Pollution Prevention
2. Dyestuff Toxicity
3. Color Removal
4. Environmental Seminars
5. Technical Assistance
6. Environmental Fund

7. Effluent Treatment
8. Effluent Toxicity
9. Monitoring
10. Industrial Estates

ENVIRONMENTAL STANDARDS

The Textile Industry Club of FTI offers to collaborate with the Ministry of Industry (MOI) to develop environmental information and data needed to develop more specific environmental standards for the textile dyeing, finishing and printing industry in Thailand. Current environmental standards applicable to the textile industry include:

BOD	20-60 ppm
Suspended Solids	30-150 ppm
Heavy Metals	.02-5 ppm
pH	5-9

The Ministry of Industry has recently issued new performance standards for textile dyeing, finishing and printing mills:

BOD	Removal by biological treatment (activated sludge, aerated lagoons, trickling filters or stabilization ponds);
Color	Color removal by chemical coagulation electrolysis, activated carbon adsorption or bleaching;
Toxicity	Fish pond at the final point of treatment to allow fish harvesting for tissue analysis for uptake of hazardous or toxic substances.
Public Water Resource	Textile dyeing, finishing and printing plant located in the vicinity of a public water resource will essentially need to achieve zero discharge.

The existing standard for BOD is not currently met by most of Thailand's small and medium scale textile dyeing, finishing and printing plants. The new information which will be developed through FTI will assist MOI bring all textile mills to a common level of environmental control. The Textile Industry Club proposes to conduct the studies described below and work with textile dyeing, finishing and printing members of FTI to achieve interim step-by-step requirements that are developed to help the industry meet the existing environmental standards.

The new environmental standards are also not complied with. The new standard for color is very difficult even for Thailand's largest, most modern mills and virtually impossible to achieve at small and medium scale textile mills. The zero discharge for mills near public water resources is not technically achievable and thus will prohibit expansion at any mill affected by the standard. The FTI proposed program will assist MOI establish new environmental standards and an implementation program to promote compliance with all environmental standards.

FTI is concerned about the toxicity of their discharges and the apparent relationship between color and toxicity. However, color by itself is not toxic, nor does color have any significant harmful effect on the environment. Other countries have addressed the environmental problems associated with dyestuffs by restricting or banning use or manufacture of problem dyestuffs (such as benzidine-based dyes and chromium-dyes). FTI's new initiative includes collection of information MOI can use to control problem dyestuffs and to reduce textile discharges of color and prevention, waste minimization and clean production in the textile dyeing, finishing and printing industry, especially emphasizing dyehouse optimization including improving dye and chemical recipes, computerized color matching and dyehouse automation.

Textile mills in other countries have realized the benefits of pollution prevention - improved production efficiency and reduced pollutant emissions and environmental improvement. Color, for example, can be significantly reduced through improvements and automation of the textile dyehouse. FTI proposes to work with member companies and MOI to create and implement a pollution prevention program to reduce discharges of dyes and chemicals. In addition to industry improvement, this program will help develop the skills and expertise of staff in FTI's Industrial Environmental Management Program (IEM) Program. The results of this program can be used by IEM and MOI to establish similar programs in other industries. FTI proposes to assist MOI to apply the results of the cooperative FTI- < MOI program described below to promote environmental control of all textile mills in Thailand.

FTI's PROPOSED COOPERATIVE PROGRAM

The principal components of the FTI Textile Industry Club collaborative environmental program and Action Plan with MOI are as follows:

1. **POLLUTION PREVENTION:** The FTI Textile Industry Club, through the IEM Program, proposes to conduct analyses of current water usage and pollutant discharges (principally BOD and COD) by industry subcategory (based on product, process, age, size, location, etc). Existing MOI information and data on current waste loads from mills in other countries will be supplemented with FTI wasteload studies at five of Thailand's most modern mills to establish the best practicable technology prior to effluent treatment. FTI's study will focus on in-plant pollution

prevention, water conservation and dyehouse optimization.

2. **DYESTUFF TOXICITY:** The FTI Textile Industry Club proposes to develop information on the toxicity of different dyestuffs. FTI will identify dyestuffs that are banned in other countries and prepare safety data sheets for proper handling of dyestuffs and printpastes. Information will be shared with MOI in order to determine if additional standards or controls on dyestuffs are appropriate for the industry.
3. **COLOR REMOVAL:** In order to assess the cost effectiveness of additional treatment for color removal, the industry proposes to conduct a demonstration project using powered activated carbon in biological effluent treatment plants to determine the dosage needed, the cost and the effluent benefits. FTI will also determine the approximate costs associated with other color removal treatment methods. This information will be shared with MOI to determine if more specific color standards are appropriate for the industry.
4. **ENVIRONMENTAL SEMINARS:** FTI will conduct seminars to encourage all FTI textile mills to implement pollution prevention, waste minimization and clean production techniques and technologies. FTI will support an initial technical assistance program aimed at dyehouse optimization, including (a) optimizing dyes and chemicals recipes to reduce chemicals and auxiliaries, (b) dyehouse computerized color matching to reduce dye usage and re-dyeing and to allow print paste and dye bath reuse, and (c) dyehouse automation to permit equipment to operate at optimum performance of each different fabric and product. Additional topics at the seminars will include information on new dyeing processes and design and operation of effluent treatment plants. The first seminar is being scheduled for mid-January 1992 in Bangkok. FTI, MOI and members of the Textile Industry Club will be requested to participate.
5. **TECHNICAL ASSISTANCE:** The World Environment Center (WEC) will be requested to provide textile industry experts to work with mills that request help to improve the performance of dyeing, finishing and printing operations within mills and/or their treatment plants. The WEC technical assistance will begin in November-December 1991 and will be conducted with FTI and MOI staff and in coordination with an FTI-hired local consultant who would assist FTI to become a Thai center of pollution prevention expertise. WEC will also be asked to assist with workshops/seminars to transfer the know-how to additional textile mills and to conduct specialized study tours (March-April 1992) in the USA to help build a Thailand corps of textile industry pollution prevention experts. Other donors will also be asked to help including UNEP and

UNIDO.

6. **ENVIRONMENT FUND:** The Government has established the Environmental Fund and contributed 500 Million Bht. Other funds are being sought from the Asian Development Bank and other international organizations. The Fund is still being set up, but applications can be submitted to the Office of the National Environment Board (ONEB) after October 1, 1992. FTI is interested in using the fund to help finance pollution prevention and clean production equipment. FTI suggests to MOI that they request pollution prevention and clean production equipment be eligible for loans under the Environmental Fund.
7. **EFFLUENT TREATMENT:** The FTI Textile Industry Club proposes to conduct a study of the current effectiveness of industry effluent treatment plants. FTI and MOI will establish textile effluent performance targets for different technologies and industry categories.
8. **EFFLUENT TOXICITY:** FTI proposes to conduct a study of current techniques to identify effluent toxicity. FTI will arrange for acute and chronic toxicity testing using state-of-the-art methods to identify effluent toxicity problems.
9. **MONITORING:** Mills should monitor their existing wastewater discharges regularly and utilize independent third party labs to periodically verify analytical results. Independent third party organizations can also help conduct environmental audits of the entire mill. Analytical results and audit reports should periodically be sent to FTI. FTI proposes to prepare a quarterly monitoring and environmental progress report indicating the industry's environmental improvements. The report will be shared with MOI.
10. **INDUSTRIAL ESTATES:** MOI should conduct an analysis of textile mills discharging into industrial estates to determine whether special problems exist and whether specific effluent pretreatment requirements are needed to insure effective treatment plant performance. FTI will assist as needed.

FTI ACTION PLAN

- o November - December, 1991 -- On-site, direct technical assistance to Thai textile mills on industrial pollution prevention, especially optimization of dye and chemical recipes, dyehouse automation and computerized color matching.
- o January, 1992 -- Follow-up technical assistance to textile mills and a textile

industry environmental seminar to help transfer and implement dyehouse improvements; pollution prevention, waste minimization and clean production processes; and improved effluent treatment design and operation.

- o February, 1992 -- FTI initiates environmental study of current water usage and pollutant discharge by industry subcategory, current effectiveness of industrial effluent treatment plants and toxicity of problem dyestuffs. It is proposed that FTI contract for services of Chulalongkorn University to assist with information collection.
- o March - April, 1992 -- Study tour of textile dyeing, finishing and printing industry leaders and experts from MOI and FTI to visit the USA, Europe and Brazil to participate in a study tour of exemplary textile mills, textile research institutes, textile training centers, universities and other organizations.
- o May, 1992 -- Thai textile experts return from the USA and begin to conduct on-site Thai-to-Thai technical assistance on pollution prevention techniques and technologies to Thai textile mills, especially methods appropriate for small dyeing, finishing and printing mills.
- o June, 1992 -- Environmental standards workshop of FTI and MOI to develop interim step-by-step requirements to bring all textile mills to a common level of environmental control. Workshop will also address color and toxicity, identify control strategies for problem dyestuffs and design additional FTI and MOI studies, demonstrations, training and technical assistance activities.

APPENDIX 2 **Recommended program for the study tour in Switzerland, Germany and Brazil (Duration 1 week each)**

AUSTRIA

- | | |
|------------------------------|---|
| Ciba-Geigy
Sandoz | Latest developments in process optimization, low liquor ratio dyeing, high exhaustion dyes, low energy consumption dyeing (cold pad batch) dyebath + printpaste reutilization, etc. |
| KBC, Lorrach
Lauffenmuhle | Necessary adjustments in technology and work methods to work in concurrence with environmental laws. |
| Benninger/Zell | New slashing (sizing) technologies to reduce energy consumption and to minimize polluting effects of desizing. |
| Datacolor | New technologies in computerized colour and shade matching and their effect on process optimization. |
| Herberlein | Same as KBC above |

BRAZIL Arrival to Rio de Janeiro, Brazil

MONDAY

- a.m./p.m. Visit to SENAI/CETIQT, the Textile and Chemical Industry Technology Center: integrated range of laboratories (Applied Colorimetry - Dyeing, Printing and Finishing - Effluents - Quality Control).
- evening: Fly to Porto Allegre

TUESDAY

- a.m./p.m. Visit the tannery effluent treatment pilot plant and a mobile effluent laboratory unit of SENAI, Factory visit: textile effluent treatment
- evening: Fly to Santa Catarina

WEDNESDAY

- a.m./p.m. Visit to 3 textile dyeing and printing factories

THURSDAY effluent treatment plants

- a.m./p.m. Drive to Curitiba

FRIDAY

- a.m./p.m. SENAI Effluent Treatment/Sanitation School, Fly to Rio de Janeiro

SATURDAY Leaving Rio de Janeiro

APPENDIX 3 Recommended program for Future Seminars

1.5-2 hour seminar on Computerized Colour Matching

1. What is Colour Matching?

2. The advantages: visual vs. instrumental colour matching

- reduction of time (quick response)
- savings in dyestuffs and chemicals
- improved quality

3. The process of colour matching:

- dyeing: preparation of calibration samples, building the databank, laboratory dyeing and printing machines
- measurement: the state of the art and trends in colour instrumentation, colour measuring spectrophotometers, colour matching systems
- computation: the state of the art and trends in colour matching software

4. Discussion.

1.5-2 hour seminar on Dyehouse Automation

1. The reasons: why automation?

- savings in dyestuffs, chemicals, water, energy and labour
- increased productivity: shorter processing times, elimination of dye additions, reduction in off-shade rejects
- better quality: reduction in unlevelness, improved reproducibility

2. The preconditions: are you up to it?

- place and ambient conditions
- engineering: machinery, water-, steam- and electricity supply
- technology and recipes: accuracy, repeatability, reproducibility

3. The possibilities: which way and how far to go?

- process control of production machines
- central colour kitchen
- computer-controlled weighing
- dyehouse management system
- integrated dyehouse automation, full production control

4. The source: who will deliver?

Look for:

- a total system
- full documentation
- thorough training
- reliable after sales service at a reasonable price

5. The human factor: who runs the show?

6. Discussion

APPENDIX 4 Pollution Prevention and Control in the Textile Dyeing and Printing Industry - The Brazilian Experience

This is a summary of the presentation at the "Pollution Prevention" Seminar in Thailand, November 27, 1991

In 1987 UNIDO has started a technical cooperation project in Brazil in (among other fields) computerized colour matching, dyehouse automation and textile effluent treatment. The main reason for selecting these particular topics has been the realization of the need for a dual approach: it is not enough to treat the effluents at the end of the pipe, greater efficiency is achieved through the reduction of the effluent load by optimization of the production processes.

Computerized colour matching (CCM) provides optimization of dyeing and printing recipes resulting in significant savings in dyestuff costs as well as better recipes with less corrections in the dyehouse thus savings in water, chemicals and energy.

Dyehouse automation means (in addition to CCM)

- process controllers on the dyeing, printing and finishing machines;
- computer controlled weighing resp. dispensing of dyestuffs and chemicals;
- central colour kitchen;
- central computer resp. network for the programming of and data collection/analysis from the process controllers, production planning etc.

By these means the repeatability of the production processes is increased leading to savings in water, energy, dyestuffs and chemicals (by a minimum of 5-15%, often 20-30%). Process controllers also make it possible to divide effluents into coloured and colourless, thus enabling specific colour-removal treatment for lower volumes; and/or to separate hot (e.g. above 70 C) and cold effluents for eventual heat recovery.

The project started initially with a rather modest budget of US\$ 360,000 and included short-term (1-1.5 month) missions of UNIDO consultants as well as equipment for the effluent treatment laboratory. The project has from the beginning relied heavily on the existing facilities of the counterpart organization (SENAI) and its textile center, Centro de Tecnologia da Industria Quimica e Textil.

SENAI (Servico Nacional de Aprendizagem Industrial - National Industrial Training Service) is a nationwide organization maintained by the national confederation of the industry. For its regular budget each industrial unit (company, factory) has to pay 1% of the total amount of its payroll, + 0.25% (i.e. a total of 1.25%) for companies with more than 500 employees. For this contribution SENAI maintains a network of schools and technology centers, and provides training at technician (secondary school) level

in all industrial professions.

CETIQT (Centro de Tecnologia da Indústria Química e Têxtil - Technology Center for the Chemical and Textile Industry) has been established over 40 years ago, and annually trains 1,200 students in regular courses and nearly 4,000 in special (mainly evening) courses in all fields of textile manufacturing, from spinning through weaving, knitting, dyeing-printing-finishing to garment making, fashion and marketing.

The UNIDO project has been aimed at strengthening the SENAI/CETIQT Applied research Unit by training its textile professionals and also providing direct assistance to industry. By the second year of the project (1989) it became clear that the efficiency of the short-term visits of UNIDO consultants was not high enough and more concentrated efforts were needed to make a measurable impact. Based on the information gained in the first year, a parallel Special Industrial Services (SIS) project was launched in one selected field: computerized colour matching. At that time several Brazilian textile companies had already installed CCM systems, but their utilization was far from the required level, due primarily to lack of special training and technical assistance in this field.

Under the SIS project the SENAI/CETIQT Applied Colorimetry Laboratory (ACL) has been established with the following aims:

- to serve as a reference laboratory;
- to provide technical assistance for the industry;
- to provide colour matching (recipe optimization) services for the industry;
- to increase the level of education in applied colorimetry;
- to conduct applied research in colorimetry and computerized colour matching.

A DATACOLOR CCM system has been purchased for the ACL to which two other systems (MATHIS-OPTRONIK and BYK-GARDNER) have been added through donation by the manufacturers. Also the laboratories for colour matching, dyeing-printing-finishing and effluent analysis have been integrated, with addition of electronic balances and microprocessor controlled laboratory dyeing machines. In 1990 the new Applied Colorimetry Laboratory began to provide services, and the industry has realized the benefits:

- savings in dyestuff costs (through recipe optimization) up to 30-40%;
- reduction in the number of laboratory dyeings necessary to match new colours from 3-4 to 1-2, with improvement in quality;
- reduction in dyestuff stocks by incorporating surplus dyes (which in many cases would have been discarded) into current recipes,

resulting in better housekeeping.

The obvious advantages and good practical results in CCM have led to the acceptance of and increased demands for the services of the project. The International Technical Assistance Unit of SENAI/CETIQT has therefore been established, which is supported (professionally) by UNIDO and maintained (financially) through the newly created International Technical Assistance Fund which draws its resources from industry contributions as well as the SENAI/CETIQT budget. In addition to the CCM services, textile companies are now requesting consultancy in dyehouse automation and process optimization.

The originally modest project budget was expanded in 1990 by US\$ 55,000, and in 1991 by more than US\$ 350,000: 40% of which has been private industry contribution to the Fund for specific services rendered, the rest coming from the SENAI/CETIQT budget.

This project is going to be closed in February 1992 with the result of:

- having established an integrated range of laboratories;
- having trained 3 chemical engineers, 1 technician and 2 laboratory assistants in CCM, and 3 chemists in textile effluent analysis and treatment;
- the International Technical Assistance Unit of CETIQT being able to provide regular services for the industry in colour matching, and technical assistance in dyehouse automation and process optimization;
- giving training courses in CCM, dyehouse automation and effluent treatment.

The most important result, however, is the general acceptance by the Brazilian textile industry of the SENAI/CETIQT International Technical Assistance Unit as a genuine source of information and assistance of real practical value for small and large companies alike. Based on the success of this project a new phase is under preparation for 1992/1993 continuing the activities in all the above fields, and also extending them into new areas such as total quality management and computer aided design.

APPENDIX 5 Biographical Sketch of the Authors

Dr. Robert Hirschler graduated at the Technical University of Budapest in Chemical Engineering (1967), and following two years post-graduate work in Textile Chemistry received his PhD from the same institution. He was research engineer, then chief technologist of the DUNASILK Dyeing and Finishing factory, Hungary's largest dyehouse (1967-73); senior officer responsible for the textile dyeing, printing and finishing industry in the Ministry for Industry, Textile Department (1973-1981); technical director of the DUNASILK factory (1982-1989).

He has worked as short term consultant for UNIDO since 1981 in colour matching, dyehouse automation, process optimization and CAD/CAM in a number of projects (Egypt, India, China and Brazil) and, since 1989 has been working as Chief Technical Adviser for UNIDO projects in Brazil.

In addition to his work with UNIDO, international activities include a 6 months visit to the Rensselaer Polytechnic Institute (Troy, N.Y.) as visiting scholar in the field of colour science (1977), lecturing at a 3-week post-graduate course in the National Research Center (Dokki, Cairo -1978), presentation of papers at a number of international congresses including plenary papers at the 1981, 1984 and 1987 Congresses of the International Federation of the Associations of Textile Chemists and Colourists.

John-Peter Moll graduated at the University of Kiel in textile engineering from 1976-1978. Project engineer at a German trading house designing turnkey plants (Sudan, Philippines and South Korea).

From 1978-82 Management Consultant to various Hungarian textile companies for the Ministry of Light Industry. 1982-1983 Management Consultant to assist the modernization and rehabilitation of the nationalized Turkish textile industry, and to prepare training schemes for a textile project in Pakistan. Both projects were funded by the World Bank.

From 1983-1985 start up and management of a German owned garment factory with 1500 employees in Sri Lanka, 1985-1986 rehabilitation of a vertical textile mill in Guyana.

Joined UNIDO 1987 as Industrial Development Officer responsible for technical assistance projects in the textile and garment industry sector.

APPENDIX 6 Organizations and Persons Consulted

1. **FTI Industrial Environmental Management Program**
 Dr. Sarawoot Chayovan, Director
 Ms. Dominica Dacera, Environmental Engineer

2. **FTI Textile Industry Club**
 Mr. Phongsak Assakul, Executive Director of FTI,
 President of the Thai Textile Manufacturing Association

3. **UNDP Bangkok Office**
 Mr. Dhannanjaya V. Sunoto, Assistant Regional Representative
 Ms. Ricarda Rieger, Programme Officer

4. **UNIDO Bangkok Office**
 Mr. Nils Ram-Ericson, UCD
 Mr. Johan Nelis, Programme Officer

5. **US AID / Thailand**
 Mr. Will Knowland, Advisor

6. **US AID, BST**
 Dr. James Gallup

7. **WEC / Thailand**
 Mr. Chalot Sripicharn, Country Director

8. **Ministry of Industry, TID, DIP**
 Ms. Prani Obhasanond, Director
 Dr. Satit Sirirangkamanont, Head of Unit
 Dr. Nantaya Yanumet, Senior Scientist
 Ms. Pissamai Likitbanakorn, Scientist
 Mr. Suthep Watchararuangwit, Engineer

9. **Union Textile Industry Corp., Ltd., Finishing Mill**
 Mr. Precha Niltawornkul, Q.C. Division Chief
 Mr. Tawee Watanavitaya, Finishing Mill Manager

10. **Thong Thye Chiang R. O. P.**
 Mr. Pilan Dhammongkol, Factory Manager

11. **Thai Textile Printing (1980) Co., Ltd.**
 Mr. Charoen Laohathai, Vice Chairman
 Mr. Yingchit Sikarinkul, Executive Director

12. The Thai Printers & Finishers Co., Ltd.
Mr. Tamrong Sawatwarakul, Factory Manager
13. Siam Knitwear and Garment Co., Ltd.
Mr. Vikit Dhanasarnsombat, President
Mr. Wiroj Gruntarutana, Dyehouse Manager
Mr. Simon Ng, Technical Director
14. Nan Yang Knitting Factory Co., Ltd.
Mr. Udomchai Chalermarpanan, Factory Manager
Mr. Seantad Chareyalerpongsa, Deputy Factory Manager
15. Thong Thai Textile Co., Ltd.
Mr. Pichai Uttamapinant, Managing Director
Mr. Tongchai Threenuchakorn, Dyehouse Manager

Appendix 7 Project Schedule

16/11 91	Arrive Bangkok
18/11 91	Factory visits - Union Textile Industry Corp. Ltd., Finishing Mill - Thong Thye Chiang R.O.P. - Thai Textile Printing (1980) Co., Ltd.
19/11/91	FTI Textile Industry Club meeting
20/11 91	Factory visits - The Thai Printers and Finisher Co., Ltd. - Siam Knitwear and Garment Co.
21/11.91	Factory visits - Nan Yang knitting - Thong Thai
22/11/91	Discussion at FTI-IEMP
25/11.91	FTI Textile Industry Club meeting
26/11.91	Discussion at FTI-IEMP Preparation of meeting material
27/11:91	Visit to TID, FTI
28/11/91	Production Prevention and Control meeting
29/11/91	Meeting UNDP office
29/11/91	Leaving Bangkok (RH)
30/11/91	Leaving Bangkok (JPM)