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*for a sustainable future*

## OCCASION

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**Nineteenth UNIDO In-Plant Group Training Programme  
in the Field of Plastics Technology**

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Organized by the United Nations Industrial Development  
Organization (UNIDO) in co-operation with the Government  
of Austria

to be held

from 26 September to 11 November 1988 in Vienna, Austria

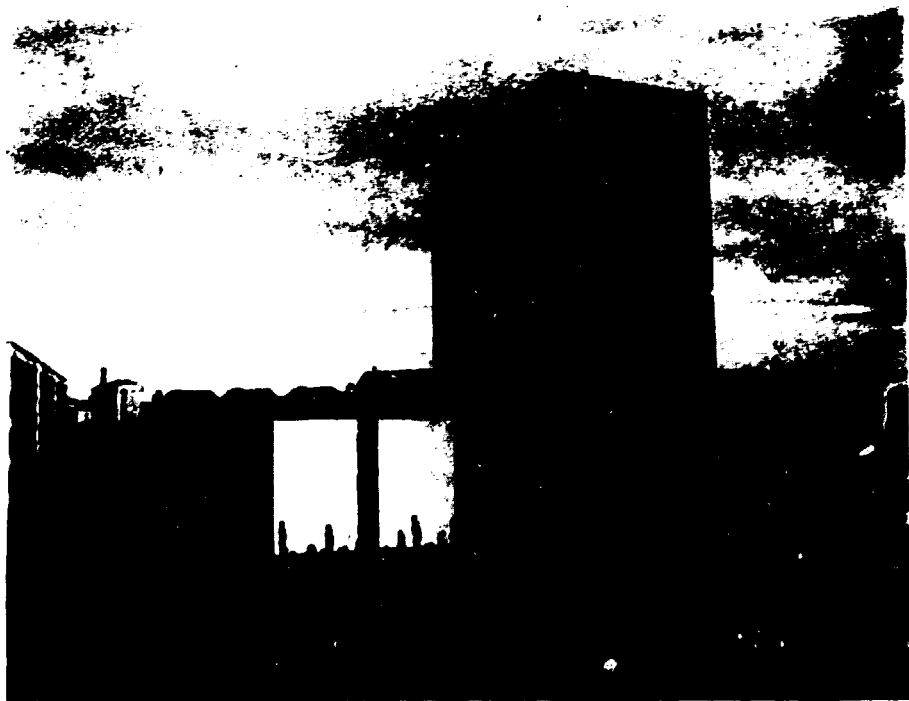
**F I N A L     R E P O R T**

by

**H. HUBENY**  
Programme Director

Z1.2T 159/Hu/Dö, 11. November 1988

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**TECHNOLOGISCHES GEWERBEMUSEUM**

## 1. ACKNOWLEDGEMENT

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Lungauer Liedertafel, Hans und Sepp

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## Background and Objectives

1. The programme in the field of plastics technology is one of a series of the United Nations Industrial Development Organisation (UNIDO) activities on specific sectors of industry which is being organized for the developing countries through the Chemical Industries Branch. This "In-Plant Group Training Programme" has been implemented annually since 1970 through a special contribution of the Government of Austria to UNIDO. The implementation of the 1986 programme as well as the previous ones has been successfully conducted by the Laboratorium für Kunststofftechnik LKT-TGM (Laboratory for Plastics Technology).
2. The trend of training activities in the field of plastics technology is characterized by the increasing sophisticated nature of the programme requiring high level experts, consultants and specialized equipment for the workshop. There is also an increasing demand for visits to plants, companies and institutes which are advanced in their field of specialisation. Group discussion to deal with specific technological problems in manufacturing and application is also an important feature of current training activities .
3. Plastics are already one of the world's main groups of industrial materials. World plastic consumption is now greater than that of all non-ferrous metals in terms of weight and of steel in terms of volume. The numerous uses and applications of plastics which are still increasing, have caused this industry generally to grow at a faster rate than most branches of manufacturing industries and to contribute in growing proportion economy.
4. The demand for plastics materials is steadily growing at a very high rate and this situation is expected to continue in the future. Engineering plastics will find many new applications and replace traditional materials. Important factors in the research and development activities will be the drive to save energy and feedstocks. Plastics allow for a large potential of energy saving, partly by replacing traditional heavier materials and partly by reducing the use of energy in the various production processes.
5. Through the acquisition of technological know-how and skills in the field of mould design and mould making, the plastics industry could achieve further development. The lack of experienced personnel in this field in the developing countries and the need to acquire and exchange experience, are the main reasons for the organization of this programme. Its aim is also to bring together a group of selected persons whose work is expected to benefit from a concentrated training programme which otherwise could require a long period of training, research and development work. This assistance to the developing countries in the development of their plastic industry and the development of manpower is in accordance with items i, ii and k of Article 58 of Lima Declaration and Plan of Action as well as in line with the New Delhi Declaration and Plan of Action and the Fourth General Conference of UNIDO on development of human resources.

6. The programme is designed as a group training course covering the whole field of modern plastics technology at an industrial - not academic - level including

Introduction:

- Theory (Plenary Session)
- Practice (Small Group Work)

Seminar:

- Special Small Group Discussion
- Special Practical Experiments (Small Group Work)

Group Moderation:

- Selection of Priorities (Programme Design)
- Methods of Problem Solving (Case Study)

7. The programme has received the support of the Austrian Federal Ministry for Foreign Affairs, the Austrian Federal Ministry of Education and Fine Arts, the Austrian Federal Economic Chamber and Association and Industrialists. The Laboratorium für Kunststofftechnik LKT-TGM (Laboratory for Plastics Technology), a leading technological institute, will conduct, utilizing its facilities, the theoretical and practical training in plastics technology. The institute has a staff of highly qualified specialists.

Since 1970 LKT-TGM held seventeen programmes with a total of 341 participants from 79 countries. The regional distribution was the following:

Far East (FE)	114	33%
Middle East/ North Africa (ME)	75	22%
Latin America (LA)	75	22%
Africa (AF)	54	17%
Europe (EU)	23	6%

70% of the participants came from privat and public companies, 30% from institutes and non-profit government organizations.

Place	Region	Programme 1,--18.	Programme 19,Programme	Total
Afghanistan	NE	1	1	2
Algeria	NE	2	2	4
Angola	AF	1	1	2
Argentina	LA	9	9	18
Bangladesh	FE	6	6	12
Benin	AF	2	2	4
Bhutan	FE	3	3	6
Bolivia	LA	7	7	14
Bulgaria	EU	1	1	2
Brazil	LA	6	6	12
Burma	FE	5	5	10
Chile	LA	4	4	8
China	LA	15	15	30
Colombia	LA	4	4	8
Costa Rica	LA	4	4	8
Cuba	LA	4	4	8
Cyprus	EU	3	3	6
Dominican Republic	LA	2	2	4
Ecuador	LA	3	3	6
Egypt	NE	15	15	30
El Salvador	LA	2	2	4
Ethiopia	AF	5	5	10
Ghana	AF	3	3	6
Guatemala	LA	2	2	4
Guinea	AF	1	1	2
Guinea-Bissau	AF	1	1	2
Haiti	LA	1	1	2
Hongkong	FE	1	1	2
Hungary	EU	3	3	6
India	FE	12	12	24
Indonesia	FE	11	11	22
Iraq	NE	18	18	36
Israel	NE	10	10	20
Jamaica	FE	3	3	6
Jordan	LA	4	4	8
	NE	3	3	6

Place	Region	Programme 1,--18.	Programme 19,Programme	Total
Korea DPR	FE	1	1	2
Lebanon	NE	4	4	8
Madagascar	AF	2	2	4
Mali	AF	1	1	2
Malta	FE	1	1	2
Mexico	EU	4	4	8
Morocco	AF	2	2	4
Nepal	FE	1	1	2
Nicaragua	LA	1	1	2
Nigeria	AF	4	4	8
Pakistan	FE	7	7	14
Panama	LA	1	1	2
Paraguay	LA	2	2	4
Peru	LA	4	4	8
Philippines	FE	5	5	10
Poland	EU	6	6	12
Romania	EU	2	2	4
Rwanda	AF	1	1	2
Saudi Arabia	NE	3	3	6
Senegal	AF	7	7	14
Singapore	FE	1	1	2
Somalia	AF	3	3	6
Sri Lanka	FE	5	5	10
Sudan	AF	2	2	4
Switzerland	EU	6	6	12
Taiwan	FE	2	2	4
Tanzania	AF	7	7	14
Thailand	FE	10	10	20
Trinidad Tobago	LA	2	2	4
Turkey	EU	5	5	10
Uganda	AF	1	1	2
Uruguay	LA	6	6	12
Venezuela	LA	2	2	4
Vietnam	FE	2	2	4
Yemen PDR	NE	2	2	4
Yugoslavia	EU	2	2	4
Zambia	AF	3	3	6
Zimbabwe	AF	1	1	2
	FE	79	79	158
	EU	15	15	30
	LA	326	326	652
	AF	15	15	30
	FE	15	15	30
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	EU	15	15	30





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## 5. SUBJECT LIST

## 5.1. INTRODUCTION

## 5.1.1. THEORY (Plenary Session) Hours

Technology Transfer and Development	2
Trends in Polymer Engineering	12
Trends in Polymer Science	10
Principles of Mould Design	10
Principles of Control Engineering	4
Plastics Application Engineering	6

## 5.1.2. PRACTICE (Small Group Work)

Compounding	6
Computation	10
Controlling	8
Extrusion	10
Finishing	4
Foaming	6
Injection and Compression Moulding	10
Machining and Forming	6
Computer Aided Mould Design	4
Polymer Chemical Analysis	2
Polymer Physical Analysis	10
Quality Control	6
Reinforced Plastics	4
Trouble Shooting	2

## 5.2. SEMINAR

## 5.2.1. SPECIAL SMALL GROUP DISCUSSION

Quality Control	8
Polymer Science	8
Injection Moulding	8
Extrusion	8

## 5.2.2. SPECIAL PRACTICAL EXPERIMENTS (Small group work)

Quality Control	8
Polymer Engineering	8
Injection Moulding	8
Extrusion	8

## 5.3. GROUP MODERATION

Selection of Priorities	4
Methods of Problem Solving	4

Total: 172 hours

\*\*\*\*\*

## 6. LECTURE NOTES

### 6.1. DESIGN OF LECTURE NOTES

The lecture notes have been adapted and developed in accordance with UNIDO, with the participants and with the experience of seventeen programmes since 1970.

To meet the general, practical and theoretical needs of the participants three levels of comprehensive information are offered at 1344 pages in form of

- general lecture notes  
    Saechtling (International Plastics Handbook)
- special lecture notes      and
- research papers

For this programme some lecture notes have been reprinted.



## 6.2. GENERAL LECTURE NOTES (Theoretical Introduction)

### TECHNOLOGY TRANSFER AND DEVELOPMENT

E. Rubeny

The Global Situation (selected Indicators):

World Development Report - Population - Non-Renewable Resources - Energy - Education - Income

Principles of Development:

Historical Models - Development Analysis

Technology Transfer:

Assumptions- Definitions - Concepts - Cost of Technology Transfer - Characteristic Stimuli and Barriers - Effects

Documents:

Code of Conduct - OECD Classification - National Paper of Austria

Models of Execution:

Macro-Level Conditions - Micro-Level Conditions - Plastics Technology - Plastics Development Activities

Personal questions

### PLASTICS CHEMICAL TECHNOLOGY

E. Wogroly

Classification of Plastic Materials

Formation Reactions

Functionality

Polymerization Reactions:

Addition Polymerization (Free radical mechanism - Ionic mechanism) - Condensation Polymerization - Copolymerization - Auxiliary Materials for Polymerization

Physical behaviour of Plastics

Secondary bonds:

Dispersion Forces - Dipolar-orientation Forces - Glass Transition - Brittle Point - Elastomeric State

Thermoplastics:

Polyolefines, Polyethylenes and Copolymers - Degradation of Polyethylene-Polypropylene (PP)-Modified Polypropylene-Copolymers with Ethylene (EPM and EPDM) - Polybutene -1 (PB) - Polyisobutylene (PIB) - Poly -4-methylpentene -1 (PMP) - Unsaturated Polyolefines - Trends in Research and Development

**Polyvinylchloride (PVC) and Copolymers - Plasticized PVC - Modified PVC - Compounds (Blends)**

**Polystyrene (PS) and Copolymers - Expanded Polystyrene (EPS)**

**Acrylics - Polyacrylonitrile (Barrier Plastics) - Polyacrylates - Polymethylmethacrylates (PMMA) - Polymethacrylimides**

**Polyethers - Polyoxymethylene (POM) - Polyethylenoxide (PEO)**

**F-Polymers - Polytetrafluorethylene (PTFE) - Polytrifluorchloroethylene (PCTFE) - Copolymers**

**Silicones - Methylpolysiloxanes-Phenylpolysiloxanes (PSI)**

**Polyamides (PA)**

**Polycarbonates (PC) - Polyterephthalates (PET, PBT) - Polyphenyleneoxides (PPO) - Polysulfones (PSU) - Polyphenylenesulfides (PPS) - Polyethersulfones (PES)**

**Thermosets:**

**Phenol/Formaldehyde Resins (PF) - Urea/Formaldehyde Resins (UF) - Melamine/Formaldehyde Resins (MF) - Unsaturated Polyesters (UP)**

**Polyepoxides (EP)**

**Polyurethanes (PUR) - Diisocyanates-PU Elastomers-Relations between Structure and Properties of PUR-Manufacture and Properties of PUR-Foams**

**High Temperature Resistant Polymers:**

**Polyimides (PI) - Polybenzimidazole - Polyimidazopyrolone (Pyron) - Polycyclobutadiene**

**Flame Retardancy of Polymeric Materials**

**Auxiliary Chemicals**

**Health Hazards and Toxicity**

**Degradation and Stabilization**

**Environmental Behaviour of Plastics Materials**

**Plastics Waste Management**

**Reclamation, Recycling and Reuse of Plastics Waste**





## **PLASTICS PHYSICAL TECHNOLOGY**

**H. Hubeny**

### **Plastics Technology:**

**Polymers - Cycle Process - Model Matrix - Quality - Technological States - Conversion Processes**

### **Molecular Structure:**

**Description - Linear Macromolecules - Cross-linked Macromolecules - Thermodynamics of Molecules - Degradation of Molecules**

### **Supramolecular Structure:**

**Molecular Arrangement - Amorphous Structure - Mesomorphic Structure - Crystalline Structure**

### **Rheology:**

**Definition - Elasticity - Viscosity - Viscoelasticity**

### **Polymers:**

**Classification - Designation - Survey - Standard Thermoplastics - Engineering Thermoplastics - Specialty Thermoplastics - Thermoplastics - Thermosets - High Temperature resistant Polymers**

**Additives:**

**Compatibility and Efficiency - Antioxidants - Light Stabilizers - Heat Stabilizers - Enhancer - Colorants - Flame Retardants - Antistatic Agents - Biostabilizers - Blowing Agents - Nucleiating Agents - Activators - Plasticizers - Lubricants**

**Compounding:**

**Terms - Particle Size Reduction - Mixing - Pelletizing - Compounding Parameters**

**Continuous Processing:**

**Classification - Continuous Casting and Laminating - Calendering - Extrusion**

**Discontinuous Processing (Moulding):**

**Classification - Liquid Phase Moulding - Compression Moulding - Transfer Moulding - Injection Moulding - Blow Moulding**

**Fabricating of Semi-finished Goods:**

**Technical Terms - Machining - Forming - Assembly - Separating**

**Finishing:**

**Painting - Printing - Metallizing - Hot Stamping - Embossing - Irradiation**

**Application:**

**Systematic Development of Application - Standards**

**Waste****Recycling:**

**Equipment - Cutting mills - Reprocessing Lines - Extruder Screen Changers - Incineration - Outlook**

**PLASTICS MECHANICAL ENGINEERING**

**R.Hillisch, H.Revesz**

**Extrusion:**

**Extruder Plants and -Dies - Pre-set Elements - Elements of the Extruder - Annexed Equipments - Principles of Extruder Die Design - Plants and Moulds for Blow Moulding**

**Moulding of Thermosets:**

**Processing Techniques - Machines - Additional Equipment - Moulds - Design of Compression Moulded Parts**

**Injection Moulding:**

**Techniques - Machines - Additional Equipments - Moulds**

**MOULD DESIGN****R.Hillisch****General:**

Injection Mould - Classification of Injection Moulds - Methodical Mould Design - Size of Mould - Flow Path/Wall Thickness Rate - Number of Cavities - Arrangement of Cavities

**Feeding:**

Sprue Design - Runner Design - Gating - Pin Gate - Edge Gate - Sprue Gate - Film Gate - Diaphragm Gate - Ring Gate - Tunnel Gate - Sprue Puller Pin Gate - Ante-Chamber Type Pin Gate - Sprueless Moulding - Insulated Runner - Hot Runner

**POLYMER PHYSICS****H.Dragaun, H.Maschik****Morphological Structure:**

Structure and Morphology - Models of Crystalline Structure - Expressions of Crystallinity - Experimental Methods

**Differential Thermal Analysis:**

Introduction - Application of DTA - Principles of DTA  
 Evaluation of DTA Curves - Caloric Informations - Thermometric Information Applications - Physical Transitions - Chemical Reactions  
 Concluding Remarks

**PLASTICS APPLICATION ENGINEERING****W.R.Jessenig****Plastics Survey****Shear modulus Temperature Function:**

Plastics, Materials for Constructions - Thermoplastics - Thermosets - Composites - Hybrid systems

**Long-time Behaviour (Static)**

Stress-strain Behaviour Depending on Temperature - Test Speed and Moisture

**Economic Aspects****Plastic Points, Tolerances****Construction of Models and Prototypes****Basic Principles for Mechanical Calculation:**

Temporary Variable Deformations - Characteristic Dimensional Functions

**Reactive Resin Systems****Design of Constructional Parts:**

Friction and Wear - Snap-fit Joints - Press-fit Joints

**Ultrasonic Plastic Assembly****Outsert Technik****Screw-fit Joints****Plastic Screws****Adhesive Joints****CONTROL ENGINEERING****G. Minarovich****Open-Loop-Control:****Voltage Supply:**

Supply for Power-Unit - Supply for Control-Unit

**Standardized Connection-Diagrams and Symbols:**

Connection-Diagrams - Wiring Symbols

**The Use of Instruments for Measuring the Current, Voltage and Resistance:**

Test Lamp - Multimeter

Functional Description of a Reversing Contactor Combination

**Automatic-Control:****Definitions**

Automatic Control-System and Block-Diagram

Transient Response of a Controlled Member

Temperature Behaviour of a Barrel-Zone, Controlled by Two-Step Action Controller, without Feedback

Temperature behaviour of a Controlled Member with Two-Step Action Controller and Feedback:

Feedback - Optimization of the Feedback

**Electrical Methods for Measuring the Temperature:**

Measuring by Means of a Thermocouple - Resistance-Thermometer

**Controllers:**

Continuous Controllers - Two-Position Controllers - Electronic Controllers - Thermocouple as Detecting-Element - Resistance-Thermometer as Detecting Element.

### 6.3. GENERAL LECTURE NOTES (Practical Introduction)

#### COMPOUNDING

H.Wolanek

##### Compounding Methods

##### Additives and Formulations:

PVC Stabilizers - Action of Heat Stabilizers - Groups of PVC Stabilizers - Lubricants - Processing Aids - Impact Modifiers - Fillers

##### Compounding Machinery

##### Mixing Procedure:

Sintering of PVC - Agglomerating of PE-chips - Coloration - Drying

##### Test Methods:

Bulk Density - Heat Stability Tests - Static Tests - Dynamic Tests - Plastograph - Mixing Rolls - Rheometer

#### COMPRESSION MOULDING

R.Hillisch

##### Toggle Lever Press

##### Up-Stroke Press:

Tabletting - Preheating

##### 100 ton-Laboratory-Press:

Compression Mould for Testing-Cups - Determination of Closing-Time (Closing Force) - Determination of Curing Time (Stiffness)

##### 160 ton Down-Stroke Press:

Boiling Test

#### COMPUTATION

F.Mayer, P.Freisler

##### General Facts

##### Structure of a Computer

##### Programming Operations

##### How the Computer Counts

##### Description of the Z80 Microprocessor System:

Memory Allocation - Floppy Diskettes - Data Files - System Start-up - Warm Start and Drive Selection - Directory

**The Programming Language BASIC:**

Introduction - Operators - Important Instructions and Commands

**Example:**

The Problem - Flowchart - Solution of the Problem

**EXTRUSION**

H.Revesz

Production of Tubular (Blow) Film

Extrusion of Blown Double-Layer Films

Production of Flooring

Blow Moulding

Production of Rigid PVC Pipes

Production of Pipes

**FINISHING**

W. T.

Electroless Metal Coating

Vacuum Metallizing:

Base Coating - Vacuum Metallizing - Top Coating - Test-methods

Electroplating:

Molding - Part Design - Preliminary Treatment - Cleaning - Sensitizing - Nucleiation - Electroless Plating Initial Electroplating - Final Electroplating - Applications - Test Methods

Appendix:

Process Sequence for Plating ABS-Plastics - Formulations

**FOAMING**

H.Hubeny

Classification of Plastic Foams:

Material - Stiffness - Cell Morphology - Density - Density Distribution - Fabrication Process

Properties

**Processing:**

Expandable Bead Methods - Reactive Foam Moulding - Thermoplastic Foam Moulding - Foam Extrusion

**Polyurethane Technology:**

Polyurethanes - Mould Materials - Practical Exercises

**INJECTION MOULDING**

**H.Graf**

**Adjustment of Processing Parameters:**

Box Mould - Processing Temperature Mould Temperature - Adjustment of Pressure - Internal Pressure Clamping Pressure - Loss Factor - Cooling Time - Machine Protocol

**Orientation - Mechanical Properties:**

Test Bars - Injection Moulding Machine - Processing Conditions - Interpretation of Test Results

**Foamed Thermoplastics:**

Introduction - Production of Mixtures - Test Panels - Physical Properties - Possibilities in Design of Machine and Equipment - Production of Panels - Machine Protocol

**The Principles of Process Control in Injection Moulding:**

General - Internal Pressure - Influences on Internal Pressure - Influences of Internal Pressure on the Quality of Products - Computerprogramme for the Calculation of cooling time - Location of the Pressure sensors in the Testbar - PVT-Diagram for Polystyrene - Machine Protocol - Surveyor's Protocol  
Simulating Diagram

**MACHINING AND FORMING**

**E.Strohmayer**

**Machining:**

Cutting - Guillotine Shears - Drilling - Screwing - Turning - Planing - Milling - Filing - Grinding - Polishing

**Welding:**

Press-Welding - Heat-Impulsive Welding - High Frequency Welding - Hot-Gas Welding

**Forming:**

Bending - Whirl-Sintering - Vacuum Forming

Workshop - Drawings - Work instructions





**POLYMER PHYSICAL ANALYSIS**

H.Dragann, H.Muschik, M.Radax, H.Braunsteiner

Density Measurement

Measurement of Melt Viscosity

Measurement of K-Value

Measurement of Viscosity - Number and Determination of Intrinsic Viscosity

Optical Microscopy and Preparation

Electron Microscopy and Preparation

Thermal Analysis:

DSC-Differential Scanning Calorimeter - TMS-2 Thermomechanical Analyzer - TGS-2 Thermogravimetric Analyzer

**QUALITY CONTROL**

M.Radax

Statistical Evaluation - Preparation of Specimen - Tensile Test - Determination of the E-Modulus - Flexural Test - Modulus of Elasticity (Flexural Test) - Tensile Impact Test - Impact Flexural Test - Hardness - Shore Hardness - Vicat Softening Temperature - ISO / R 75 - Martens Temperature - Oszillating Twisting Test - Environmental Stress Cracking - Pipe Testing

**REINFORCED PLASTICS**

W.R.Jessenig

Theory

Resins

Reinforcements:

Fibrous and Wire Reinforcements - Fibre Constructions - Nonwove Constructions

Fillers:

Filler to Resin Bonding

Manufacturing Processes:

Contact Moulding (Hand Lay-up, Spray-up) - Bag Moulding - Vacuum Bag - Pressure Bag - Autoclave Moulding - Resin Injection System - Matched Die Moulding, Compression Moulding - Centrifugal Casting Process - Continuous-Pultrusion Process - Continuous-Laminating Process - Filament Winding Process (cont.and discont.) - Injection Moulding

Aspects to Practical Processing:

Surfacing - Subcoat - Topcoat - Moulds - Moulds - Release Agents

Transportation and Handling

Prepreg and Sheet Moulding Compounds

Precautions and First Aid

Dimensional Fundamentals

Constructional Fundamentals

Economic Aspects and Future Outlook

#### **6.4. SPECIAL LECTURE NOTES**

##### **DATA CONVERSION IN INJECTION MOULDING**

**H.Graf, F.Mayer**

General Remarks

Measuring Pressure:

Piezoelectric Transducer - Charge Amplifier

Measuring Temperature:

Fluctuation Compensation - Temperature Sensors - Preheatable Thermocouples - Plotter System

Measuring Front Flow

Measuring Distances:

Inductive Measuring Sensors - Carrier Frequency Amplifier

Computerised Measuring:

Digital Voltmeter - Interface - RS 232 Interface - System Computer

**QUALITY CONTROL OF GRP-PIPES**  
**W.R.Jessenig**

**Designation**

**Company Control:**

Control of Goods Received - Resin Control - Textile-Glass Rest - Filler Control - Reactant Control - Production Control - Regular Production Control - Random Production Control - Acceptance Control

**External Control:**

Test Volume - Recording - Designation - Condition at Delivery - Measurements - Pipe Stiffness - Longitudinal Tensile Force - Circular Tensile Force - Choice of Specimens - Expertise and Test Report

**NEW RURAL APPLICATIONS OF PLASTICS**  
**H.Muschik**

**Introduction**

Protection of Plants by Nets.

Foils in Agriculture: Introduction - Flat Foils - "Mulch-Foils" - Plastic-Covered Tunnels - Foils for Sealing - Recycling of Foils - Greenhouses.

Containers for Plants.

Non Wovens for Mulch-Technique.

Irrigation: Introduction - Spray Tube - Sprinkler Irrigation Plants.

Waste Water and Drainage: Waste Water - Drainage.

Heating of Greenhouses.

Storage of Agricultural Products: Storage of Wood - Storage of Fruit and Vegetables in Foils - Storage of Fruits and Vegetables in Sacks - Storage of Liquids and Food.

Coating.

Technological Transfer.

**QUALITY CONTROL AND DAMAGE ANALYSIS BY MORPHOLOGICAL METHODS****H.Dragau****Introduction:**

Definition of Quality - Increase in Quality - Technological Problem - Continuous Melt Viscosimetry - Polypropylene Pressure Pipes - Morphology

**Morphological Methods:**

Optical Microscopy - Electron Microscopy - X-ray Diffraction - Wide-Angle X-ray Scattering (WAXS) - Small-Angle X-ray Scattering (SAXS) - Thermoanalytical Methods - Calorimetric Methods - Dilatometric Methods - Spectroscopy - Infrared Absorption (IR) - Electron Spin Resonance (ESR) - Nuclear Magnetic Resonance (NMR)

**Practical Application in Damage Analysis:**

Crack Formation in Polyethylene (PE)-Pipe - Irregular Characteristic of Polyethylene (PE) Sheets during Finishing - Different Abrasion Characteristics of a Polypropylene (PP) Drive-Component - Differentiation of Polyblends in various Polyethylene (PE) Types - Different Fracture Behaviour of Polypropylene/Polyethylene Copolymer - Fracture in a Moulded Part (Fitting) of Rigid Polyvinylchlorid (PVC)

**ENVIRONMENTAL ASPECTS OF PLASTICS TECHNOLOGY****E.Wogroly****Introduction**

U.S.-Activities in the Field of Environmental Protection

**The Environmental Impact of Plastics:**

Air Pollution - The Properties and Effect of Pollutants - Ozone, its possible biological Effects and Reduction in the Atmosphere - MAK-Values - Formaldehyde Odor and Health Problems within Residences - Toxicity of Formaldehyde - The Vinyl Chloride Problem - Waste Water Treatment - Some Aspects of Waste Disposal - Plastics Wastes in the Solid Wastes Stream - Reclaim, Recycling and Reuse of Plastics - Recycling Mixtures of Plastics - Separation of Plastics from mixed Refuse - Biodegradation - The Technology of Biodegradable Fillers

The Competiveness of Plastics with traditional Materials after the 1973 Oil Crisis

## 6.5. RESEARCH PAPERS

### DATA CONVERSION IN TECHNOLOGY AND MORPHOLOGY

#### Extrusion:

New Possibilities of a Cascade Control of Extruders by Means of a Torsion-Sensitive Screw Tip - Continuous Measurement and Control of Viscosity throughout the Extrusion Process - Novel Systems for Viscosimetry of Polymer Melts and Solutions

#### Injection Moulding:

The Principles of Process Control in Injection Moulding - Degassing of Plastics Materials on Injection Moulding Machines

#### Morphology:

A Comparison of Critical Elongation as Determined by the Ball Indentation Method and by Creep Test on Injection Moulded Rigid PVC Test Specimens - The Technology and Morphology of Polypropylene Pressure Pipes - Microfibrils in Brittle-Fracture-Surfaces on Isotactic Polypropylene at 4.2 K - Shear-Induced -form Crystallization in Isotactic Polypropylene - Determination of the Avrami Exponent of Partially Crystallized Polymers by DSC-(DTA)-Analysis - Qualitative Analysis of Molecular Structure of Polypropylene Fibres on the basis of X-ray Diffraction Patterns

### POLYURETHAN STRUCTURAL FOAMS

Non-Destructive Determination of the Density Profile in Polyurethane Structural Foams - Measuring and Influencing of the Density Distribution in Polyurethane Structural Foams - Statistic Examination of Cell Size Distribution in Polyurethane Structural Foams

### RECYCLING

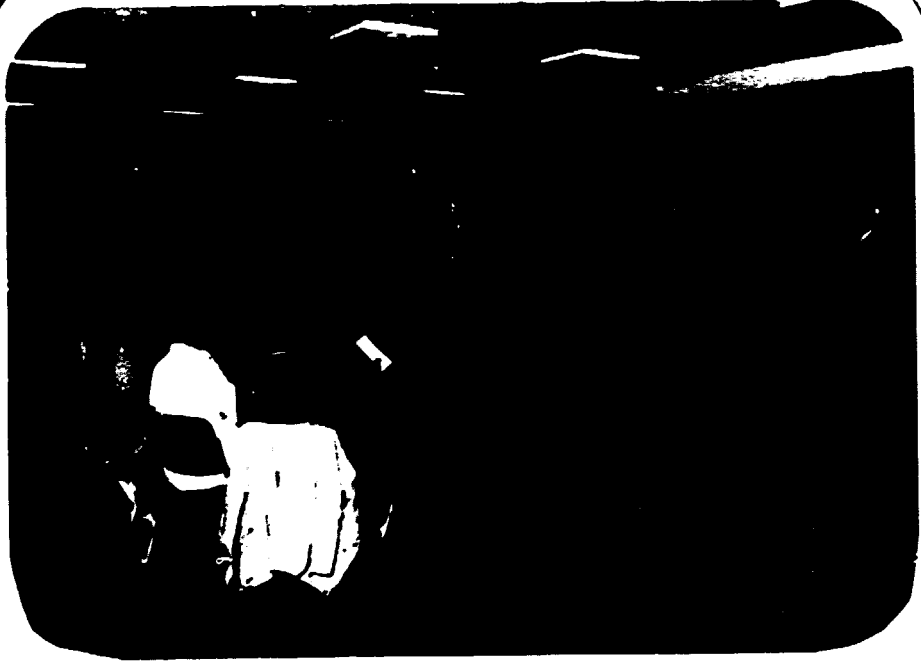
The Behaviour of Household Refuse containing PVC in Incinerators.



### Pm Board Method: Selection of Priorities :

warming up	problem collection practice	Quality Contr. or Polym. Sci. 8h	problem collection theory	Quality Control 4h
visibility of expectations	problem valuation practice	Inj. Moulding or Extrusion 8h	problem valuation theory	Polymer Science 4h
	group selection practice		group selection theory	Injection Moulding 4h
				Extrusion 4h

feed  
back



## 7. PLANT VISITS

To the special interest of the participants 18 plant visits during the seven-week course in Austria has been organized by LKT-TGM.

The selection of the plants according to the interest of the participants gives a regional and technical survey on the Austrian plastic industry:



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**actual**

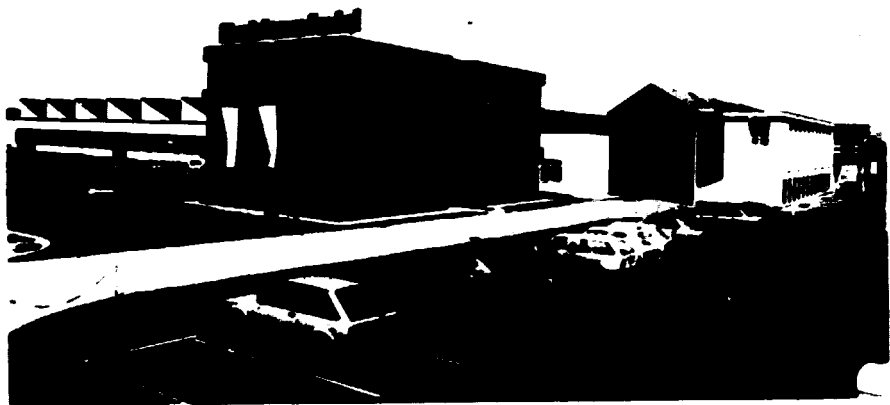
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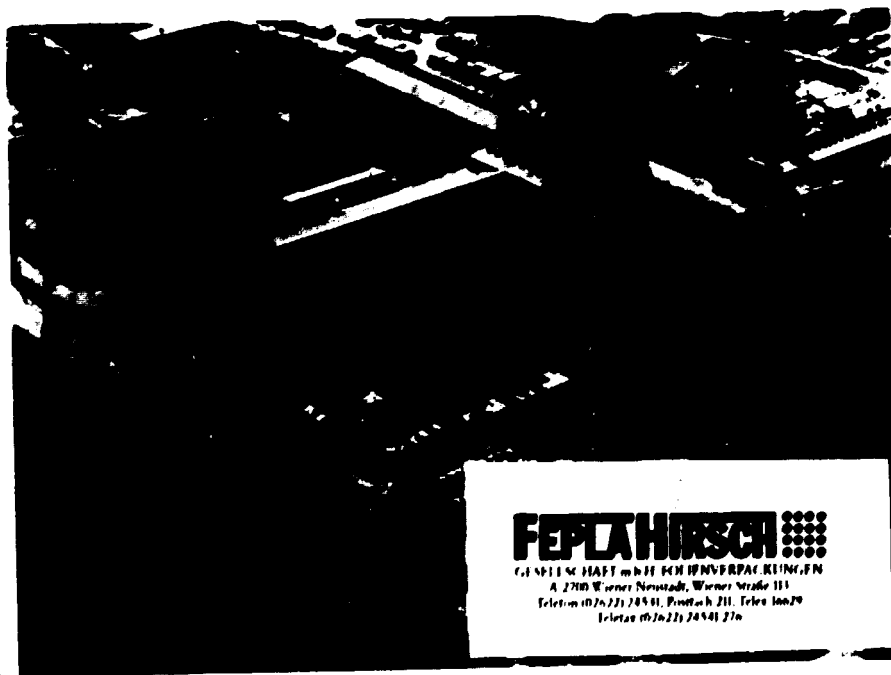
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Telex 02 17452  
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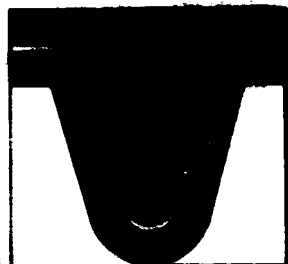
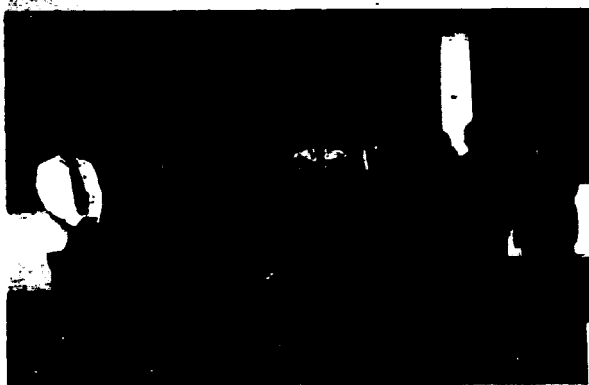
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# FORM-TECHNIK



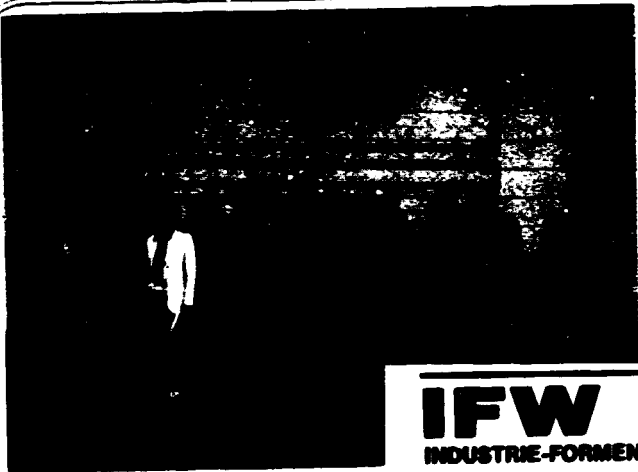
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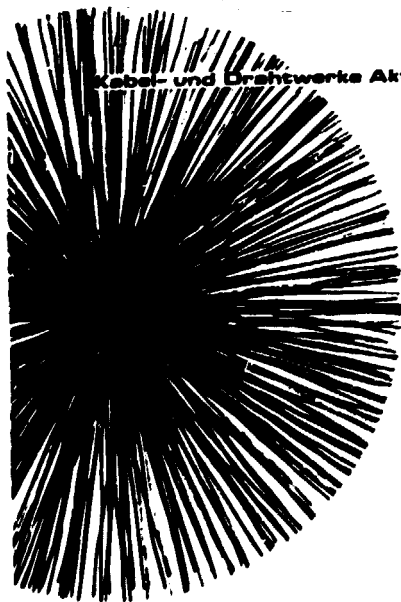
**Manfred Otto**

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# Lenzing AG

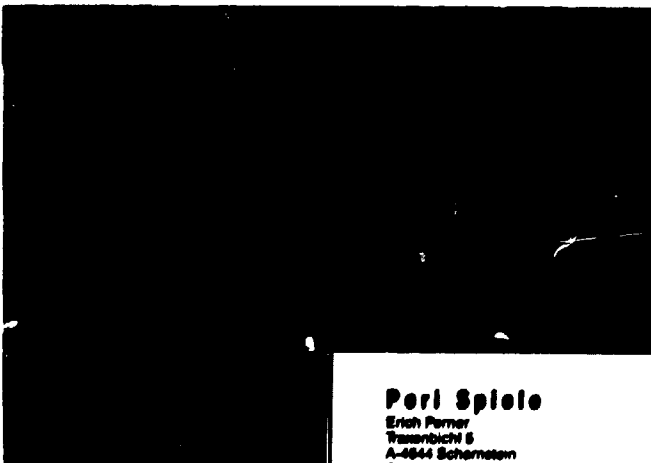
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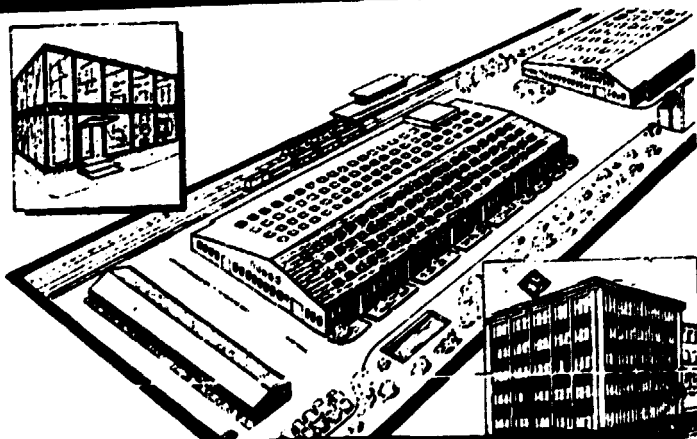




 **poloplast** 

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Laboratory for Plastics Technology

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Im Rahmen des  
19<sup>th</sup> UNIDO Training Programme in  
Plastic Technology findet am

Montag, den 24. Oktober 1988  
um 16.00 Uhr, im Exnersaal des  
TGM eine

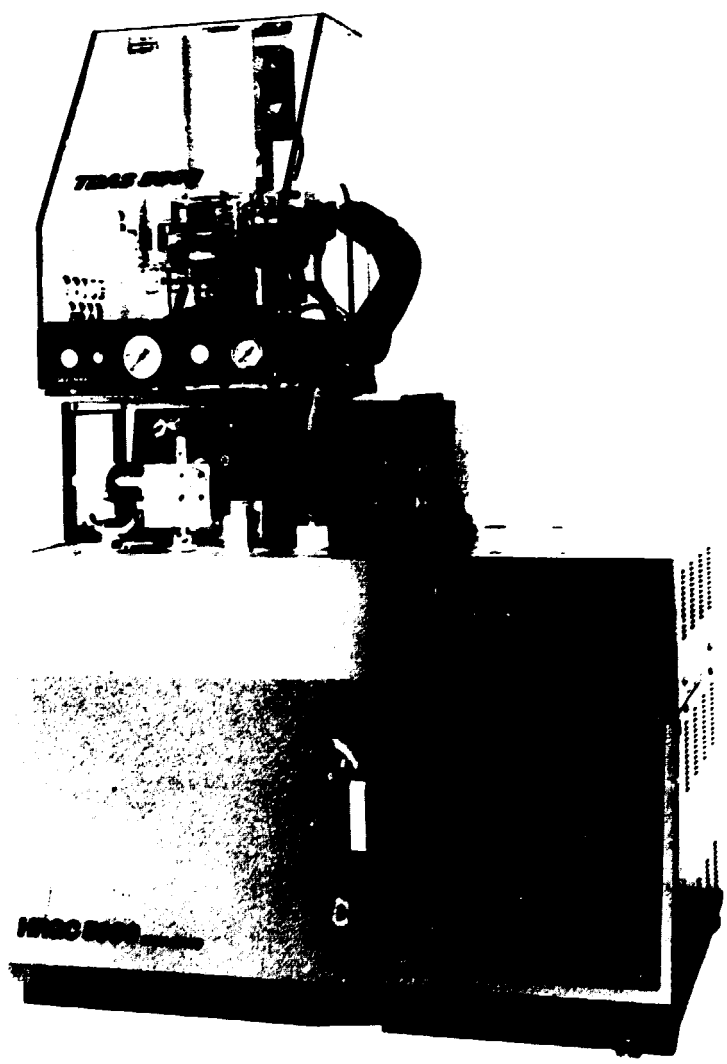
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Computergestützter Literatur-  
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durch Techninform statt.

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## 8. IN-DEPTH-EVALUATION OF THE PROGRAMME 1970 - 1988

### Improvement of Cost Efficiency

- increase of cost efficiency of the programme: 21,8 participants in the last five years
- increase of cost efficiency by continued reduction of government contribution by selffinanced participants
- government support is basic help also for middle income countries, it stimulates private participation (help to self-help)

### Regional Orientation to Africa and Far East

- changes in the regional distribution following to the Austrian development policy
- highest increase in lowest and low income countries in AF and FZ

### Priority to Lowest and Low Income Countries

- successful technology transfer of participants in middle income countries up to 1978
- successful introduction of lowest and low income countries to the programme
- motivation for selffinanced participants from middle income countries

### Direct Structural Orientation to Industry

- government contribution oriented to public and private companies
- priorities of public companies in Far East and Middle East, priorities of private companies in Latin America, balanced in Africa
- participants of institutes are increasingly financed by UNIDO and other development organizations
- the government contribution stimulates direct industrial development in lowest and low income countries and activates industry in middle income countries to vocational training

### Excellent Programme Design

- UNIDO's international Know How and facilities
- LKT international is a leading European institute in training, testing, research
- excellent feed back of participants
- permanent improvement and adaption to the collective and individual needs of the participants

### International Follow Up

- direct continued co-operation with 18 countries
- vocational training in companies
- establishment of national training courses by programme participants
- regional seminars, interregional co-operation
- independent industrial activities
- training/cost relation

### Technology Export of Austria

- Exports of injection moulding machines, extruders, moulds and other equipment 1978-1987 in the regions covered by the programme from visited companies
- exports of materials and additives 1978-1987 as above

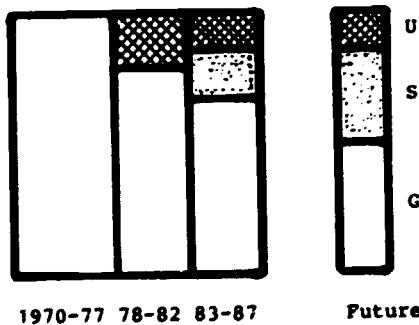


Fig 1: Structure of Contributions

U: UNIDO Projects, S: Selfsupport, G: Government

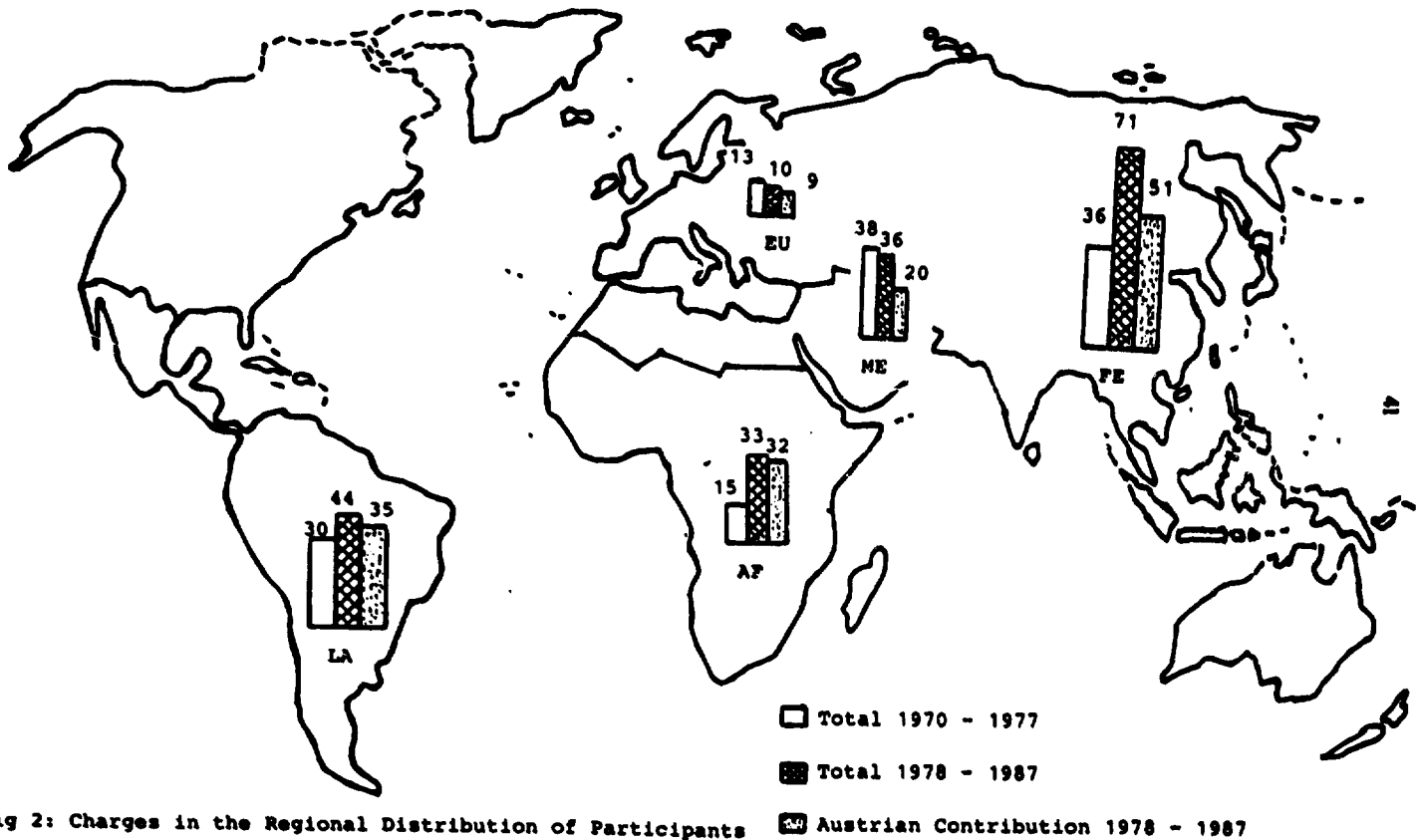


Fig 2: Changes in the Regional Distribution of Participants

Legend: □ Total 1970 - 1977, ▨ Total 1978 - 1987, ▩ Austrian Contribution 1978 - 1987

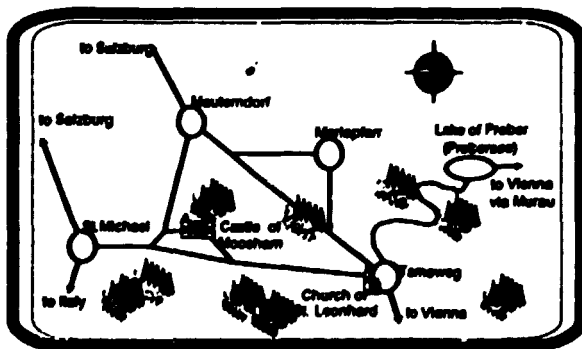
## 9. SPECIAL EQUIPMENT FOR THE TRAINING PROGRAMME

**ALPINE, FRG:** Extruders  
**AVL, Graz:** Electronic Control Systems  
**BATTENFELD, FRG:** Injection Moulding and Blow Moulding Machines  
**BATTENFELD-FISCHER, FRG:** Blow Moulding  
**BATTENFELD Kunststoffmaschinen GmbH., Xottingbrunn:** Injection Moulding Machines  
**BAUER, Switzerland:** Measuring Instruments  
**BECKMANN, USA:** IR-Equipment  
**BIZERBA, Vienna:** Silo-Installation  
**BRABENDER, FRG:** Testing Equipment  
**BRANSON, USA:** Ultrasonic Welding  
**BROSA, FRG:** Control Instruments  
**BUCHER-GUYER, Switzerland:** Presses  
**BULL, USA:** EDV-Equipment  
**CADMOLD, FRG:** Expert System for Molding  
**CEAST, Italy:** Testing Equipment  
**CHURCHILL, England:** Water and Oil Circulating Controllers  
**CINCINNATI MILACRON, Vienna:** Extruders, Injection Moulding Machines  
**COUDENHOVE UND HÜBNER, Vienna:** Spray-Up Machines  
**DEMES, FRG:** Pre-Treatment Instruments  
**DIETACHMAYER, PUR-Mixing and Dispensing Machines**  
**ENGEL, Schwertberg:** Injection Moulding Machines  
**EPSON, Japan:** EDV-Equipment  
**ERBA, Italy:** Gaschromatography  
**FBW, Vienna:** Process Control Systems  
**FRANX, FRG:** Testing Equipment  
**FUCHS, Vienna:** Mills  
**GOERZ Electro, Vienna:** Instruments  
**GÖTTPERT, FRG:** Rheological Equipment  
**HAACK, Vienna:** Laboratory Equipment  
**HAGEDORN & BAILLY, FRG:** Water and Oil Circulating Controllers  
**HARTMANN & BRAUN, FRG:** Control Systems  
**HASCO, Vienna:** Moulds  
**HENSCHEL, FRG:** Mixers  
**HOTTINGER, Vienna:** Torque Measurement Equipment  
**JEOL, Japan:** Electron Microscopic Equipment  
**JOZNS, FRG:** Control Systems and Recorders  
**JUMO, n.K.Juchheim, FRG:** Control Instruments  
**ILLIG, FRG:** Vacuum Forming Machines  
**KIEFEL, FRG:** Film-Extruder  
**KISTLER, Switzerland:** Piezo-Quarz Sensors  
**KRAUSS-MAFFEI, FRG:** Foaming, Extrusion, Recycling  
**KRAUTKRAMER, FRG:** Ultrasonic Equipments  
**K-TRON SODER, Switzerland:** Dosage-Systems, Dosage-Computer  
**LINK, G8:** X-Ray Analytical Equipment  
**LÜDIGE, FRG:** Mixer  
**MEDEX & SCHÖRNER, Vienna:** Signator (Marker)  
**METRAWATT, FRG:** Control Systems  
**METTLER, Switzerland:** Analytical Instruments, Balance  
**MIKRONIX, Pulkau:** Electronic Equipment and Computer  
**MOLDFLOW, Australia:** Expert System for Molding  
**NETSTAL, Switzerland:** Injection Moulding Machines

**OMYA, FRG: Ultrasonic Measuring Systems**  
**PAAR, Austria: Electron Microscopic Preparation**  
**PERKIN-ELMER, USA: Analytical Instruments**  
**PHILIPS, Vienna: Control Systems and Recorders**  
**PRODISTRIBUTION, Switzerland, Dosage Equipment**  
**PVL, Waldbreitbach (Austria): Electronic Equipment**  
**RAPL, Austria: EDV-Measuring Equipment**  
**REICHERT-JUNG, Vienna: Microscopic Equipment**  
**SATORIUS, FRG: Analytical Instruments**  
**SCHLUMBERGER, Vienna: Electronic Equipments**  
**SINGLE, FRG: Water and Oil Circulating Controllers**  
**STAIGER & HOHLO, FRG: Instruments**  
**STOUGAARD, Denmark: Instruments**  
**TESATRONIC, Switzerland: Measuring Equipment**  
**TAC CONCEPT, Italy: Expert System for Molding**  
**TIEDERAND, FRG: Optical Instruments**  
**TROESTER, FRG: Calanders, Roll Mills**  
**UNILABOR, Vienna: Electronic Equipment**  
**UNITEX, Vienna, Extruder Heads for Cables, Digital Processing Control Systems**  
**WITHOFF, FRG: Control Systems**  
**WITTMANN, Vienna: Water Flow Regulator**  
**ZWICK, FRG: Testing Equipment**

# Tamsweg

## Prebersee



Salzburger Land

21 - 23 October 1988

1988 In-Peak Group Training Program  
at Devils Postpile

Weekend at Tammog

Program  
Friday, 21 October

Time Where

WYLN

Arrived at hotel  
Rooming in



1200  
2000

Keller  
Oathtaking

Dinner  
Felt: muck, felt, deeking and felt-earng  
with the Stakeholder Spokesman, the Volkskammer  
grupper Meesterder, the Langauer Lieberhabel,  
Hans und Supp. Arranged by Mr. Karl Metelheid

7777

Saturday, 22 October

Breakfast

0720 - 0800  
8020

Keller

Hitting to the most famous Gothic Church of St.  
Lorenz and on a hill thirty meters from the hotel  
guided by Hans Christ Prober. There we saw the  
-Ochters Windows as it is called and other  
colored windows in a church built in the 15th  
century.  
Afterwards we will meet the Mayor of Tammog,  
Mr. Hans Rastacher, in the yard in front of the  
church.

Back to Tammog for lunch at the -Oathtaking-  
restaurant

Immediately after lunch we will start for a slight  
outing: view by bus through the Langau.

We will visit the old Castle of Mauthausen with its  
relics of the Middle Ages -- bridges, castles,  
fountains, gardens, vineyards and more besides.  
Coffee break at the restauar bar in the castle.

1200  
1320  
1500  
1600

Oathtaking

Mauthausen

21 - 23 October 1988

1988 In-Peak Group Training Program  
at Devils Postpile

Weekend at Tammog

Program  
Saturday, 22 October, cont.

Time Where

WYLN

Back to hotel

Lunch: also

1700  
2000

Tammog  
Keller

Dinner  
Pried waffles in Langau-ayla.  
In restaurant the sheep are in the high noon.  
also eating beautiful herbs. In autumn they come  
back to the stable. In these days it's a good tradi-  
tion to fry waffles and potatoes in wide pans and  
to gather one's friends for lunch a feast. The most  
is dished out from the pan together with the pre-  
vious, although cold and homemade.  
After dinner we will see a "Polymer"-illness  
presented by Prof. M. Oswald.

7777

Sunday, 23 October

Breakfast

0730 - 0800  
8020

Keller

After breakfast we will clear the rooms, get the  
bags up into the bus and start for a trip to the  
-Prebensen -- a little lake high in the alps. There  
we will walk around the lake seven circum-  
ferences.

Going to Maria, a small town in Tyrol, by bus.  
There we will have lunch at the restaurant.

Back to Vienna -- sorry, the weekend in Langau  
was too short.



1120  
1400







**LKT-TGM** international  
Austrian Laboratory for Plastics Technology

The LKT-staff members  
invite

all UNIDO-Seminar participants



for a

**PRATER-  
BUMMEL**

and a

**DINNER**

on

Saturday

1<sup>st</sup> of Oct. '88

at 4.30 p.m.

Meeting point:

Entrance to Riesenrad

Dinner: 7 p.m. in

Wieselburger Bierinsel

All further information:

Robert Hillisch

LKT-Mitarbeiter:

Teilnahme wie gewohnt,  
mit Frau und Kindern!

95 07 26 / 90 / 112

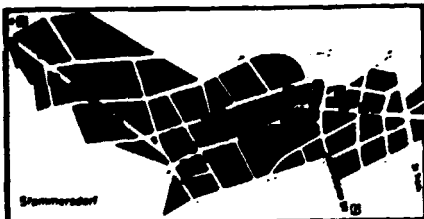
## Ausg'steckt



## ROBERT und MIMI HELM

### Weinbau und Buschenschank

1210 Wien, Stammersdorfer Straße 121,  
Tel. (0 22 2) 39 12 44



## Stammersdorf

Stammersdorf, at the foot of Bisamberg, a long low hill to the north of the city, is Vienna's largest wine-growing district. There are more than 100 wine growers here who produce around 30% of all Viennese wine. More than 40 of them are open at any one time during the summer months. It is well worth visiting the comfortable wine taverns with attractive heuriger gardens in Stammersdorfer Strasse and the romantic lane with wine cellars on either side where the wine is served in small rooms adjacent to the cellars.

## Vienna and Wine are inseparable

The »heuriger« is an unusual form of wine tavern in Vienna due to the close proximity of vineyards to the city. The genuine »heuriger« can be recognised by the sprig of pine hung up above the door and a small plaque informing the passer-by that the wine grower serves wine on the premises.

The sale of wine in Vienna is governed by a special law — the so-called »Buschenschankgesetz« — which stipulates that only establishments that grow their wine entirely in Vienna or the surrounding rural districts may call themselves »heurigers«. The wine growers are strictly forbidden to purchase grapes or wine, and are only allowed to sell their wine in the wine-growing districts for a maximum of 300 days a year. Apart from wine, they also serve various kinds of food. In Vienna it is usual for guests to fetch their food from the buffet themselves, whilst the wine is served in glass mugs by a waitress.

The wine which you buy at a »heuriger« is also known as »heuriger« if it is wine from the last vintage. After Martinmas (11th November) the following year, the »heuriger« becomes an »alter« (old) wine.

The wine is usually a »mixed batch«, a blend of several different varieties of good wines which gives these wines their characteristic flavour, making them refreshing, fruity, sparkling and palatable. You can drink several »viertels« (1/4 litres) of wine without feeling the effect of the alcohol particularly. Of course pure unmixed wines are also sold in 1/4 litre glasses or filled into 0,7 litre bottles. These are full-bodied, heavier wines which people often like to drink at the end of a heuriger evening.

Today there are 700 families in Vienna growing wine over an area of about 1,800 acres. The majority of these vineyards — about 1,000 acres — are on the slopes of Kahlenberg and Nussberg, where you will also find the better known wine-growing districts such as Nussdorf, Heiligenstadt, Grinzing, Sievering and Neustift. There are about 600 acres of vineyards at the foot of Bisamberg on the left bank of the Danube in the wine-growing districts of Stammersdorf, Strebendorf and Jedlersdorf, and the rest of the vineyards are in the south of the city in the wine-growing districts of Mauer and Oberlaa. The annual grape harvest in Vienna produces around 30,000 hectolitres of wine — about 12 million »viertels«!

No matter whether you decide to drink your wine in a secluded country lane with wine cellars on either side or at a fashionable heuriger, at a tavern specially recommended by your friends or in world famous Grinzing, you will enjoy Vienna and its wines. Cheers!



## ID-Programme

(Standard 1987)

### Industrial Development Programme in Polymer Engineering and Plastics Technology

#### Description:

The ID-programme is an individually arranged top-level programme for experienced candidates to help them solve their specific problems in polymer engineering and plastics technology. It is designed as an individual tuition course through project work in a specific field of polymer processing, engineering, application and recycling including theoretical introduction, practical work, educational training methods, computer-aided skills, publications, and membership to the Austrian Society for Polymer Engineering (ÖPFT).

#### Content:

The project work is selected from the following fields of study:

Plastics processing and control engineering: injection moulding, extrusion, blow moulding, foaming, compounding, machining, forming, welding, bonding, finishing, mould design, reinforced materials — application engineering: mechanical engineering, electrical engineering, electronics, ecotechnology, energy conversion, pipe and fitting systems, transport and packaging composites — quality control: polymer physics (X-ray diffraction, electron microscopy, thermal analysis), polymer chemistry (analysis, IR-spectroscopy, chromatography), testing (mechanical, thermal, optical, electrical behaviour, ageing, stability and flammability) — environmental technology: waste management (collection, transportation, disposal, composting, combustion, refuse derived fuel), reclamation (secondary usage and recycling of polymeric materials), hazardous waste — automation and computation: programming, microprocessors, robots — control engineering — quality assurance.

#### Services:

Permanent individual tuition by senior lectures — individual lectures — planning, review and evaluation of project work — permanent assistance — operators services — preparation and use of equipment and materials — introduction to computer aided literature and patent services — documentation — basic administrative facilities — computer aided skills.

#### Organization:

Austrian Laboratory for Plastics Technology LKT-TGM, (Laboratorium für Kunststofftechnik), Werrstraße 19-23, A-1200 Vienna, Austria, Tel (0)222 35 21 06-0 and (0)222 35 35 11-478, Telex: 13 18 24 in co-operation with UNIDO Headquarters, Chemical Industries Branch, Division of Industrial Operations, Vienna International Centre, PO Box 300, A-1400 Vienna, Telefon (0)222 26 31-0, Telex 13 66 12

#### Qualifications:

Graduation and experience in industry

#### Language:

English, German



**VIENNA INTERNATIONAL CENTRE (UNO-CITY)**

## Training

Technologisches Gewerbemuseum TGM, Top-Level Secondary Industrial School

### Division of Plastics Technology

Five-year course in German after completion of school grade 8 or equivalent

Three-year course in German after completion of a technical school or equivalent

### College of Plastics Technology

Post-secondary four-semester course in German after immatriculation examination or equivalent

Foreign applicants must have an adequate command of German

Certificates in foreign languages must provide certified translations into German and have to be recognized by the Federal Ministry of Education and Arts

The courses lead to a qualification for university studies and for civil service and after three years in profession to the right to use the professional title "Ingenieur"

### Vocational Training Courses

Training courses for foremen and technicians in German in co-operation with the Industrial Promotion Institute (WIFI)

### International Programmes

UNIDO training programmes and Special Industrial Development (SID) programmes in English  
Interpreters for other languages can be arranged by request

## Testing

Staatliche autorisierte Versuchsanstalt für Kunststofftechnik am TGM

### Federal Centre of Testing Materials for Plastics Technology

Certification and licenses according to UN, IMCO, ADR, ISO, DIN, ASTM, ONORM, AUSTRIA Quality Regulation, GRIS and other national and international standards in physical and chemical plastics technology

Certificates of the Federal Centre of Testing Materials are official Austrian documents

### Fields of Authorization:

Investigation and examination of polymer materials (thermoplastic, thermosetting and elastomeric materials) including processing and application engineering, analysis, structure, mechanics, thermal, optical and chemical behaviour, compounding, stability, ageing, flammability, general properties and recycling. Examination of plastics in engineering, agriculture, medical applications, packaging, household and factory.

Investigation and examination of raw materials for plastics processing and applications, including compounds, additives and auxiliaries.

Corrosion and protection including galvanizing, varnishes and coatings. Examination of environmental problems related to polymers, environment protection and recycling.

## Research

Forschungsinstitut der Gesellschaft zur Förderung der Kunststofftechnik GFKT

### Research Institute of the Austrian Society for Polymer Engineering

200 national and international projects of applied research and development exist in the following fields:

Plastics processing — compounding — control engineering — mould design — application engineering — quality control polymer physics polymer chemistry, testing — environmental technology — automation and computation

Major equipment for training, testing and research includes 5 injection moulding machines, 6 extruders with down stream equipment, 2 blow moulding machines, 1 foaming machine, 2 rolling mills, 3 presses, 4 mixers, various machine tools, 1 spray-up machine, 6 microprocessors, 3 electronic universal testing machines up to 200 kN, walk-in climatic chamber ( $-25 / +80^{\circ}\text{C}$ ), 3 weathering testers, cold check tester, endurance testing beds, optical tension tester, scanning electron microscope, gas chromatograph, 2 spectrometers, differential scanning thermoanalysis systems, 5 torque and capillary viscosimeters. Testing equipment for gas and water pipes, fittings, containers, roofing materials, thermal isolation elements, windows, doors, low temperature heating systems, solar energy systems