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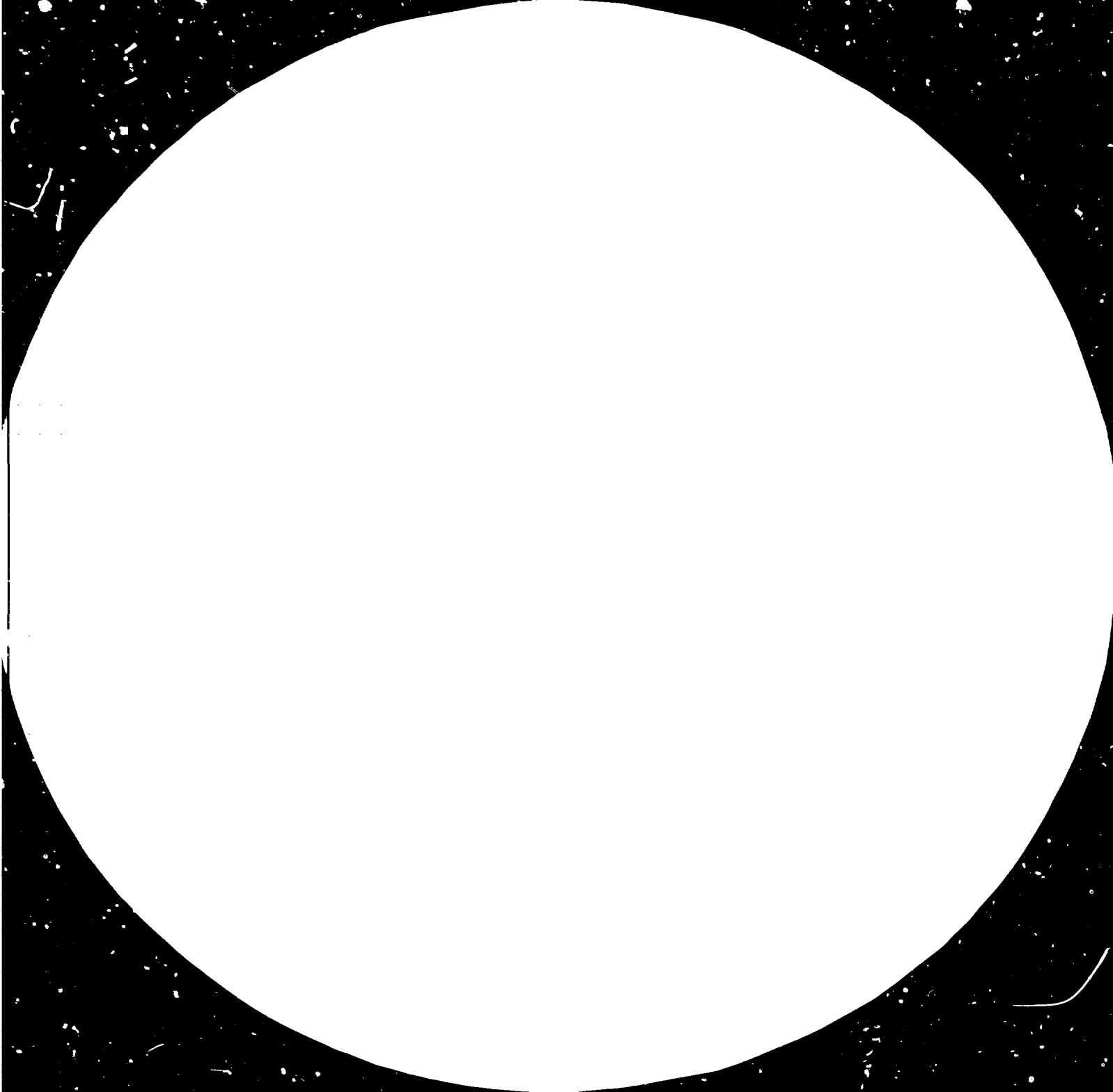
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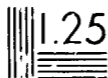
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5.0



Resolution Test Chart (ANSI #2) - 100% Contrast - 100% Modulation Transfer Function

Resolution Test Chart (ANSI #2) - 100% Contrast - 100% Modulation Transfer Function

# LKT-TGM



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Laboratorium für Kunststofftechnik am TGM  
INSTITUT ZUM AUSBILDEN PRÜFEN UND FORSCHEN  
Wexstraße 19-23, A-1200 Wien, Tel.: 35 35 11, 35 28 01, Telex: 131824

11059

## FINAL REPORT

002246

**12<sup>th</sup> UNIDO In-Plant  
Group Training Programme  
in the Field of  
Plastics Technology  
and Mould Design**

**AUSTRIA 1981**



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Laboratorium für Kunststofftechnik am TGM  
INSTITUT ZUM AUSBILDEN PRÜFEN UND FORSCHEN  
Wexstraße 19-23, A-1200 Wien, Tel.: 35 35 11, 35 26 01, Telex: 131824

Twelfth UNIDO Austria Group Training Programme  
in Plastics Technology and Mould Design

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

to be held

from 29 September to 12 November 1981 in Vienna, Austria

Final Report

by  
H. HUBENY  
Programme Director

ZI.ZT 112/Hu/Dö, 12. Nov. 1981

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Mr. Raimund Geyer

We have of course, also appreciated any contribution towards the programme, in form of free materials, lectures, invitation and visits presented to us by companies and individual persons in Austria and abroad.

## 2. History of the UNIDO/AUSTRIA Training Programme in Plastics Technology

Group Training Programmes for engineers and advanced technical personnel from developing countries are organized by UNIDO in co-operation with the Governments and Industries of countries having the specialized know-how and experience in the field in which the training is carried out. It is being increasingly recognized that intensive, systematic and closely controlled training in a suitable industrial environment is one of the most effective ways of acquiring industrial experience in a relatively short time. Through these programmes a means has been found of providing an experience that might not otherwise be possible in developing countries.

The programmes help to bridge the gap between the specific requirements of industry and the theoretical knowledge the participants have acquired through their studies. They also provide an opportunity for an exchange of ideas and experience both among senior personnel of industry and research institutes in industrialized and developing countries and among those from the developing countries themselves.

Austria and LKT-TGM are responsible in the field of plastics technology since 1970, in mould making and mould design since 1975.

Since 1970 LKT-TGM held twelve programmes with a total of 197 participants from 56 countries.

The regional distribution was the following:

Far East (FE)	60	31 %
Middle East/ North Africa (ME)	56	28 %
Latin America (LA)	41	21 %
Central Africa (CA)	20	10 %
Eastern Europe (EE)	20	10 %

55 % of the participants came from companies, 40 % from institutes and 5 % from government authorities.



	Region	Programme	1.-10.	11.	12.	Total
Afghanistan	ME	-	-	1	1	
Algeria	ME	2	-	-	2	
Argentina	LA	2	1	-	3	
Bangladesh	FE	3	-	-	3	
Bolivia	LA	3	-	1	4	
Bulgaria	EE	1	-	-	1	
Brazil	LA	3	-	-	3	
Burma	FE	1	-	-	1	
Chile	LA	2	-	-	2	
China	FE	5	1	5	11	
Colombia	LA	4	-	-	4	
Costa Rica	LA	3	-	-	3	
Cuba	LA	4	-	-	4	
Cyprus	EE	3	-	-	3	
Egypt	ME	8	-	4	12	
El Salvador	LA	2	-	-	2	
Ethiopia	CA	-	-	1	1	
Ghana	CA	3	-	-	3	
Guyana	LA	1	-	-	1	
Honduras	LA	1	-	-	1	
Hongkong	FE	1	-	-	1	
Hungary	EE	3	-	-	3	
India	FE	6	-	-	6	
Indonesia	FE	6	2	1	9	
Iran	ME	18	-	-	18	
Iraq	ME	8	-	-	8	
Israel	ME	3	-	-	3	
Jamaica	LA	1	-	-	1	
Jordan	ME	1	-	1	2	
Korea	FE	1	-	-	1	
Lebanon	ME	1	1	-	2	
Madagascar	CA	1	-	-	1	
Malawi	CA	-	1	-	1	
Malaysia	FE	1	-	1	2	
Nicaragua	LA	1	-	-	1	
Nigeria	CA	4	-	-	4	
Pakistan	FE	6	-	-	6	
Paraguay	LA	2	-	-	2	
Peru	LA	3	1	1	5	
Philippines	FE	3	-	1	4	
Poland	EE	6	-	-	6	
Romania	EE	2	-	-	2	
Singapore	FE	3	-	1	4	
Somalia	CA	1	-	1	2	
Sri Lanka	FE	1	-	1	2	
Sudan	CA	2	-	-	2	
Syria	ME	5	-	1	6	
Taiwan	FE	2	-	-	2	
Tanzania	CA	4	1	-	5	
Thailand	FE	6	-	-	6	
Trinidad Tobago	LA	1	-	-	1	
Turkey	EE	4	-	-	4	
Uruguay	LA	6	-	-	6	
Vietnam	FE	-	1	-	1	
Yemen P.D.R.	ME	-	-	1	1	
Yugoslavia	EE	2	-	-	2	

(56)

166

9

22

197

### 3. Background and Objectives

The programme, organized by the United Nations Industrial Development Organization (UNIDO), in co-operation with the Government of Austria, is one of the series of UNIDO training programmes on specific sectors of industry for engineers from developing countries. The programme will be carried out by the Laboratorium für Kunststofftechnik (LKT-TGM). This programme, the twelfth in succession, has been implemented annually since 1970.

The rapid increase in the use and application of plastics in industry, agriculture and homes in recent years has placed plastics among the leading basic materials used for economic development of the developing countries. Parallel to this increase in the demand for plastics products, the developing countries have embarked on the establishment and development of a plastics industry to meet their own demands and even export to other countries. However, besides the financial difficulties, they are also encountering technological difficulties in processing and in acquiring raw materials.

The principal objective of the programme is to bring together a group of selected persons whose work is expected to benefit from a concentrated programme in modern plastics technology which otherwise would require a long period of training, research and development work. The programme is designed mainly to emphasize plastics fabrication technology, including the use and selection of modern processing equipment, quality control and testing, as well as various applications of plastics.

The programme has received the support of the Austrian Federal Ministry of Foreign Affairs, the Austrian Federal Ministry of Education and Fine Arts, the Austrian Federal Chamber of Commerce and the Association of Austrian Industrialists (VOI). The Laboratorium für Kunststofftechnik (LKT-TGM), a leading technological institute has promised full co-operation in running the theoretical and practical course in plastics technology in its premises, utilizing its laboratories and equipment for this purpose. The institute has a staff of highly qualified specialists.

The programme will consist of theoretical and laboratory training, study visits and an evaluation session.

The theoretical part of the training will cover a general introduction to the plastics industry, the chemical and mechanical technology of plastics, raw materials, utilization of plastics equipment and tools, etc.

The practical training will be implemented in laboratories of LKT-TGM in Austria. The participants will be assigned to small groups according to their field of specialization and training needs as much as possible.

4. The Training Programme4.1. Subject List

Abbreviation	Subject	Plastics Technology Hours	Mould Design Hours
TTD	Technology Transfer and Development	4	4
PCT	Plastics Chemical Technology	8	4
PPT	Plastics Physical Technology	14	4
MEM	Mechanical Engineering and Mould Design	18	18
PEN	Plastics Engineering	6	6
PPH	Polymer Physics	4	-
CEN	Control Engineering	4	4
TME	Training Methods	2	2
TAN	Trouble Analysis	4	-
Subtotal Theory		64	42
CC	Compounding and Calandring	10	3
CE	Computation Engineering	4	-
CT	Control Techniques	12	-
EX	Extrusion	16	16
FI	Finishing	6	6
FO	Foaming	6	-
IC	Injection and Compression Moulding	18	18
MF	Machining and Forming	6	-
ME	Mould Making	2	84
PC	Polymer Chemical Analysis	4	-
PP	Polymer Physical Analysis	10	-
QC	Quality Control	6	-
RF	Reinforced Plastics	6	-
TS	Trouble Shooting	4	-
Subtotal Practice		110	132
Grand Total		174	174

## 4.2. Content of Lectures and Lecture Notes

### 4.2.1. Design of Lecture Notes

The lectures notes have been adapted and developed in accordance with UNIDO, with the participants and with the experience of eleven programmes since 1970. To meet the general, practical and theoretical needs of the participants three levels of comprehensive information are offered in form of

- general lecture notes (380 pages)
- special lecture notes (270 pages) and
- research papers (60 pages).

### 4.2.2. General Lecture Notes (Theory)

#### TECHNOLOGY TRANSFER AND DEVELOPMENT (TTD)

H. Hubeny

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 - Role 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:

References:

PLASTICS CHEMICAL TECHNOLOGY (PCT)

E. Wogrolly

Classification of plastic materials

Formation reactions

Functionality

Polymerization reactions: Addition polymerization (free radical mechanism - ionic mechanism) - Condensation polymerization - Copolymerization - Auxiliary materials for polymerization.

Physical Behavior of Plastics

Secondary Bonds: Dispersion Forces - Dipolar-orientation forces - Induction forces - Hydrogen bridges.

Transition States: Hard-elastic state - Setting or Softening range - Glass transition - Brittle Point - Elastomeric state.

Polymers: POM - PVAL - PVAC - PVC (Plasticizers, Stabilizers, Fillers, Lubricants, Pigments) - PVDC - PMMA - PS (Expanded, High Impact) - Polyvinyl - Carazol - Polyvinylpyrrolidone - PE (LD, MD, HD) - PP - Fluoric Polymers - other Polymers.

Polycondensation and Polyaddition Products

Classic condensation reaction: Phenoplasts - Aminoplasts..

Thioplasts

Polymeric Esters and Ethers: CN - CA - CAB - Cellulose ethers.

Polyesters: UP - PETP - PC.

Polyamides: PA6 - PA66.

Polyimides

Epoxy Resins

Polyurethanes: Isocyanate manufacture - PUR Elastomers.-

Relation between structure and properties of PUR-

Manufacture and properties of flexible foam - Rigid foam -

Combustion properties - Health hazards of isocyanates.

Silicones: Oils - Resins - Rubbers.

Inorganic Polymers.

PLASTICS PHYSICAL TECHNOLOGY (PPT)

H. Hubeny

Plastics Technology

Introduction

Cycle Process

Model Matrix

Quality and Polymer Processing: Materials - Processes - characteristic functions

Technological States: Basic Material - Intermediate Material - Resin - Additives - Moulding Material - Moulded Material - Semi-finished Product - Finished Product - Waste.  
 Conersion Processes: Refining - Syntheses - Compounding - Fabrication - Machining and Forming - Finishing - Application - Recycling

#### Molecular Structure

Linear Macromolecules: Molecular Models - Molecular weight - Helical Conformation - Polarity

#### Crosslinked Macromolecules

Thermodynamics of Molecules: Potentials - Molecular Motion

Morphological Structure: Amorphous - Mesomorphous - Crystalline Structure

Additives: Stabilizers - Fillers and Reinforcement Materials - Plasticizers - Colorants - Flame Retardants - Antistatic Agents - Blowing Agents - Antimykotika (Biozides) - Lubricants - Activators - Nucleating Agents

#### Rheology

Elasticity: Crystalline Elasticity - Rubber Elasticity

Viscosity: Newtonian Fluids - Non - Newtonian Fluids - Flow Theory - Morphological Interpretation

#### Properties of Plastics

Classification: Oscillation Twisting Test - Definitions (Thermoplastics, Thermosets, Elastomers, Thermoelastics)

#### Abbreviations

#### Price

#### Statistical Data

#### Thermoplastics Moulding Materials

Bulk Polymers: Polyolefines (PE, PP, PB, PMP Ionomers)

- Styrene Polymers (PS, BS, ABS, SAN) - Vinylchloride Polymers (PVC + Cop).

Engineering Thermoplastics: PA - PUR - PETP - PBTB -

PC - Phenoxy - POM - PPO - PPS - Polysulfones - Polyarylsulfones.

General Thermoplastics: CA, CAB - Chlorinated Polyethers

- Fusible Polyfluoro-carbons (PCTFE, PFEF, PVDF)

#### Thermosetting Moulding Materials:

PF - UF - MF - UP - EP - FUR

#### Thermoelastic Moulding Materials (PMMA)

#### High Temperature Resistant Moulding Materials:

PTFE - PI - PBI - PBT - Developing Products.

#### Selection of Materials

#### Compounding

#### Discontinuous Processing of Moulding Materials

Compression Moulding: Operations - Fluidity - Temperature - Time Preheating - Shrinkage.  
 Transfer Moulding: Pot-Type, Transfer Moulding, Plunger-Moulding, Operations, Comparison.  
 Injection Moulding: Operations - Pressure - Speed, Frozen Strains - Mould Design - Injection Stamping - Injection Blow Moulding - Flow Moulding - Reactive Moulding.  
 Casting: Hollow Moulds - Embedding - Dip Moulding - Filament Winding.

#### Continuous Processing of Moulding Materials

Extrusion: Classification - Single-Screw Extruder - Design and Theory - Twin Screw Extruder - Characteristic Lines - Working Diagrams - Quality Theory - Tube, Sheet, Film, Profile-Extrusion - Coating - Laminating - Blowing - Winding - Internal Stresses - Orientations.  
 Calendering  
 Drawing

#### Moulding Expanded Plastics

##### Fabrication of Semi-Finished Goods

Technical Therms - Machining - Vacuum Forming - Blow Moulding - Hot-Forming - Plug- and Ring Forming - Friction Welding - Hot-Gas Welding - Heated Tool Welding - HF-Welding - Ultrasonic Welding - Banding.

##### Finishing and Decorating

Printing - Metallizing - Stamping - Embossing - Irradiation.

##### Coating Methods

##### Quality Control

Molecular Tests - Structural Tests - Mechanical, Thermal, Acoustic, Optical, Electrical, Stability Behavior.

##### Fields of Application

Mechanical and Electrical Engineering - Transport - Apparatus Construction - Packaging Industry - Building and Architecture - Medicine - Electronics - Precision Mechanics and Optics - Agriculture - Household and Living - Recreation.

#### MECHANICAL ENGINEERING AND MOULD DESIGN (MEM)

R.Hillisch, H.Revesz

##### Extrusion

Extruder Plants and -Dies: Pipe Manufacturing - Blown Film - Flat Film - Sheet Extrusion - Lamination - Wire - Covering - Pelletizing Plants - Monofilaments - Profile Extrusion Plants.

Pre-Set Elements: Silos - Transporting Systems - Compounding and Reworking Machines - Mixers - Kneaders - Mills - Preheating- and Drying Equipments - Vent Systems.

Elements of the Extruder: Classification - Function of Screws - Feeding - Designs of Barrels and Screws - Drives - Bearings - Heating and Cooling - Temperature Control - Melt Pressure Gauges - Die Adapters.

Annexed Equipment: Sizing Dies - Cooling - Take off - Control Devices - Signators - Preliminary Treatment - Separating Equipment - Post Forming Equipment.

Principles of Extruder Die Design

Plants and Molds for Blow Molding  
Accumulators - Tubing Dies - Orifices - Closing Units - Blowing Equipment - Severing Equipment - Ejection Equipment - Transporting - Blow Molds.

Molding of Thermosets.

Processing Techniques: Compression Molding - Transfer Molding - Injection Molding

Machines: Semi-automatic Presses - Automatic Presses - Mechanical - Hydraulic Presses - Compression- and Transfer Molding Machines - Plungers - Screw Plungers

Additional Equipment: Dosing - Preforming - Preheating - Finishing

Molds: Open Flash Mold - Positive Molds - Split Molds - Transfer Molds - Runners and Gates - Transfer Pot and Plunger Leaders - Ejector Pins - Mold Heating - Types of Steel - Special Machining Molds.

Design of Compression Molded Parts

Requirements - Draft of Surface - Wall-Thickness - Roundings and Ribs - Undercuts - Holes - Slots - Design of Threads - Metal Inserts.

Injection Molding

Techniques: Injection Molding - Injection Stamping - Flow Molding - Molding of Expanded Materials - Injection Blow Molding - Two Color Molding.

Machines: Classification - Technical Data - Injection Units - Screw Plunger - Nozzles - Closing Units - Safety Devices.



Additional Equipment: Material Storage - Transport - Preheating - Drying - Mixing - Dyeing - Cooling Equipments - Cutting Equipments.

Molds: Elements - Design of Sprue, Runner and Gate - Types of Molds: Single Cavity, Multiple Cavity, Three Plate, Four Plate, Split, Side Full, Hot Runner, Calculation - Design of Molds.

### PLASTICS ENGINEERING (PEN)

W.R.Jessenig

Survey on the mechano-thermal behaviour of plastics: Structure - Flow behaviour - melting point - glass transition point - dependence of properties on the temperature - definitions.

Mechanical short- and longtime behaviour: Creep - relaxation - temperature dependence.

Structure: crystallinity - microscopy - intrinsic viscosity.

Discussion: Interference to the practical work and to Chemistry, Plastics Chemical Technology and Plastics Mechanical Technology.

### POLYMER PHYSICS (PPH)

Morphological Structure

H.Dragaun

Structure and Morphology

Models of Crystalline Structure: Fringed - Micelle Model - Folded - Chain Model

Expressions of Crystallinity: X-ray Crystallinity - Mass Crystallinity - Calorimetric Crystallinity

Experimental Methods: Optical Microscopy - Electron Microscopy - X-ray Diffraction - Density Measurement - DTA

## Differential Thermal Analysis

H. Muschik

Introduction

Application of DTA

Principles of DTA

Evaluation of DTA Curves

Caloric Informations

Thermometric Informations

Applications

Physical Transition: Crystallinity - Melting - Glass -  
Transition - PretreatmentChemical Reactions: Crosslinking - Vulcanization -  
radiation

Concluding Remarks

CONTROL ENGINEERING (CEN)

F. Gregori

Control Loop

Controlled System: Time-Behaviour - Heating-zone as  
Controlled System

Temperature Measurement

Resistance Thermometer: Cross-Coil Instrument - Moving  
Coil Instrument in Bridge Circuit (Deflection Method).

Thermocouples

Controllers

Continuous Controllers

Two-Position Controllers: Galvanometric Controller -  
Chopper bar Controller - Controller with inductive Pick-Up  
- Controller with Photoelectric Scanning - Electronic Con-  
trollers - Thermocouple as Detecting Element - Resistance  
Thermometer as Detecting Element.

Temperature Control

Hunting

Two Position Control with Feedback: PD-Control Behaviour  
- Thermal Feedback - Electronic Feedback - PID-Control  
Behaviour - Thermal Feedback - Electronic Feedback.

### 4.2.3. General Lecture Notes (Practice)

#### COMPOUNDING AND CALANDRING (CC)

H.Wolanek

The Production of FVC-Compounds by Heater-Mixing

Testing Methods for PVC-Compounds

#### COMPUTATION ENGINEERING (CE)

F.Mayer

General Facts

Structure of an Computer

Programming Operations

Connection with an EDV-Plant

Computation of a problem in Connecting with Testing of  
Plastics Materials

Practical execution of a Programme at the Computer

Other Possibilities of Application in Plastics Engineering.

#### CONTROL TECHNIQUES (CT)

G.Minarovich

Open-Loop-Control

Voltage supply

Standardized connection diagrams and symbols

The Use of Instruments for measuring the Current,  
Voltage and Resistance

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 Controlling Member with  
Two-Step Action Controller and Feedback

Electrical Methods for Measuring the Temperature

EXTRUSION (EX)

H.Revesz

Production of Tubular (Blown) Films  
 Extrusion of Blown Double - Layer Films  
 Production of Sheets  
 Production of Rigid PVC-Pipes  
 Blow Moulding  
 Production of Polyethylene Pipes

FINISHING (FI)

J.Smelik

Electroplating  
 Materials  
 Part Design  
 Moulding Factors  
 Chemical Pretreatment

FOAMING (FO)

H.Huber

Classification of Plastic Foams: Material - Stiffness  
 - Cell Morphology - Density - Density Distribution -  
 Fabrication Process

Properties

Processing: Expandable Bead Methods - Reactive Foam  
 Moulding (Low Pressure - High Pressure - Mould Carrier -  
 Foaming Plant - Slab Stock Foaming) - Thermoplastic  
 Foam Moulding - Foam Extrusion

Polyurethane Technology:

Polyurethanes (Isocyanates - Polyethers - Polyesters)  
 - Mould Materials - Practical Exercises.

INJECTION AND COMPRESSION MOULDING (IC)

H.Graf, R.Hillisch

Introduction

Testing of Influence of Mass Temperature on the Per-  
 formance Qualities of a Moulded Article.

Influence of the Mass Temperature and Injection Pressure  
 on Shrinkage and Mechanical Strength of Polystyrene Test  
 Bars.

Testing of Performance Properties of Standardized Panels  
 made of Expanded Thermoplastics with a varied Injection  
 Capacity.

## Selection of Injection Moulding Equipment

Survey of European Injection Machine Manufacturers  
 Compression Moulding. Toggle lever press - up-stroke press  
 - 100 ton laboratory press - 160 ton down-stroke-press

## MACHINING AND FORMING (MF)

E. Strohmayr

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.

## TESTING (PC, PP, QC)

W.R. Jessenig, H.J. Fischer, H. Hubeny

### Part I

#### Molecular Investigations

Viscometry - Viscosity number - Intrinsic viscosity -  
 k-value - Distribution of Molecular Weight - Density  
 and specific Volume.

#### Structural Investigations

Oscillating twisting test - Thermoplastics - Elastomers -  
 Thermosetting Materials - Glass Temperature - Dynamic  
 Glass Transition Temperature (according to DIN standards) -  
 Melting Temperature - Decomposition Temperature - Melt  
 Viscosity and Flow - Flow - Rheology - Terminology -  
 Definitional Equations - Viscoelastic Behaviour - Measur-  
 ing of viscosity in the capillary-tube rheometer.

#### Stability Behaviour

Permeation of Gases and Vapours - Mechanism of a Solution  
 Diffusion - Gas Permeability.

#### Mechanical Behaviour

Short-Time Behaviour - Tensile Test - Measuring of Force  
 with the Pendulum Force System - Electronic System for  
 Measuring the Force - Electronic Force Measuring Head  
 (Inductive) - Electric Force Measuring Sockets - Measuring  
 of Elongation with the Mechanical Elongation Measuring -  
 Electronic Elongation Measuring - Evaluation of the Tensile  
 Test - Temperature Dependence - Dependence of characteristic  
 values on strain rate in the Tensile Test - Compression  
 Test - Bending Test - Impact Strength Test - Impact Tensile  
 Test - Hardness Testing - Dropping Test - Friction and Wear,  
 Burst Test - Internal Pressure Pipe Testing - Fundamental  
 Principles - Wall Thickness Measuring - Conventional System  
 - System DURAPIPE (ANGER) - Specimen End Fittings - Long-Time  
 Behaviour - Creeping Test.

## Optical Behaviour

## Photoelasticity

## Thermal Behaviour

Determination of characteristic physical values - Dimensional stability under heat - Dimensional stability under heat according to Martens - Vicat Softening Point VSP - Dimensional Stability under Heat according to ISO - Brittleness Temperature Tests according to DIN and according to ASTM - Shrinkage behaviour - Proof of Orientation in Moulded Parts - Classification of High Building Materials according to their Combustion Behaviour - General Facts - Executing of Test I - Evaluation - General Facts Test II - Execution of Test II - Evaluation.

## Heat - and Sound Technology

Thermal Conductivity - Steam Permeability - Thermal Insulation - Step Sound Insulation - Air Sound Insulation - Degree of Acoustic Absorption - Dynamic Elasticity Modulus and Loss Factor.

## Electrical Properties

Volume- and Surface Resistance - Tracking Resistance - Polarization and Dielectric Constant - The polarization of an insulating material - The dielectric constant is a criterion for the amount of polarization of an insulating material - Dielectric Loss Factor.

Part II

Hardness Testing by the Indentation Test

Dimensional Stability after Heat Storage (Shrinkage Test)

Testing of Homogeneity

Testing of Flammability

Compression Test

Tensile Test

Part III

Ultrasonics in Processing and Testing Materials

Ultrasonics in the Processing of Semi-Finished Goods  
General Facts - Method - Sound Sources - Ultrasonic Rivetting - Ultrasonic Embedding.

REINFORCED PLASTICS (RF)

H.Hubacek, W.R.Jessenig

Technology

Reinforcing Materials

Types of Plastics

Practical Hints of Processing

#### 4.2.4. Special Lecture Notes

The objective of the special lecture notes is to inform on new developments in processing, application, recycling and quality control of plastics technology at a higher comprehensive level.

##### 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 Distance: Inductive Measuring Sensors - Carrier Frequency Amplifier

Computerised Measuring: Digital Voltmeter - Interface - RS 232 Interface - System Computer

##### QUALITY CONTROL AND DAMAGE ANALYSIS BY MORPHOLOGICAL METHODS

H.Dragaun

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 characteristics 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).

QUALITY CONTROL OF GRP PIPES

W. P. Jessenig

Designation

Company Control: Resin Control (Purity - Viscosity - Solid Body Content - Gel-Time - Reactivity - Thermal Stability)

Textile-Glass Test (Fineness of Strand - Humidity - Rod Bending Test)

Filler Control (Resin Absorption - Sieve Analysis)

Reactant Control

Production Control: Regular Production Control - Choice of Specimens and Test Frequency - Requirements - Test Procedure - Gel-time - Wall thickness

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 Fruit and Vegetables in Sacks - Storage of Liquids and Food.

Coating.

Technological Transfer.



## ENVIRONMENTAL ASPECTS OF PLASTICS TECHNOLOGY

E. Wogrolly

Introduction.

UN-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.

### 4.2.5. Research Papers

The objective of research papers is to offer information in  
the field of polymer science and technology of LKT-TGM at  
applied research level.

## 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  $\beta$ -form Crystallization in Isotactic  
Polypropylene.

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.

#### 4.3. Special Lectures

- 30.Sept.1981 Univ.Prof.Dr.A.M.Semsarzadeh, Polymer Technology Centre, Tehran Polytechnic, Tehran, Iran: Foundation and Activities of the Polymer Technology Centre
- 1.Oct. 1981 Mr.D.Clarke, UNIDO Expert, UK: Plastics in Agriculture
- 7.Oct. 1981 Univ.Prof.Dipl.Ing.Dr.techn.E.Fitzer, UNIDO Expert, FRG: Fibre Reinforced Composites
- 8.Oct. 1981 Prof.J.Pattfort, UNIDO Expert, Belgium: Application of Plastics in Housing for Developing Countries
- 9.Oct. 1981 Dir.Ing.H.Perera. CITIP-INTI, Technological Research Centre for the Plastics Industry, Buenos Aires, Argentina: Foundation and Activities of the Research Centre
- 12.Oct.1981 Prof.Dipl.Ing.Dr.techn.H.Muschik,LKT-TGM Vienna: New Rural Applications of Plastics
- 20.Oct. 1981 Ing.B.Kozlik, ADC, Vienna  
Ing.R.Zelenka, HB-Plastic, Korneuburg, Austria: Trickle Irrigation Systems  
Irrigation of Desert Plants
- 30.Oct. 1981 Dkfm.G.A.Rubitschka, INPADOC, Vienna: Transfer of Technology with the Help of the International Patent Documentation Centre
- 2.Nov. 1981 Ing.P.Sousek, J.Coudenhove, Vienna: Equipment for Glassfibre Reinforced Plastics
- 4.Nov. 1981 Dr.N.Apendino, CEAST, Milano, Italy  
Kurt Bartelt GmbH, Vienna: Equipment for Testing and Different Testing Methods
- 10.Nov. 1981 DiplChem,Ing.M.Cart, Ing.W.Witzany, Ciba-Geigy, Vienna/Basel: Stabilization of Polyolefines for Agriculture

5. ParticipantsAFGHANISTAN:

MAHMOOD

Technical Designer and  
Mould DesignerJangalak Factory  
KabulBOLIVIA:

ZUBIETA MELO Felix

Plant Manager

Plastix Boliviana S.A.  
La PazCHINA:

LI Zheng Zhong

Plastics Engineer

Plastics Processing and  
Application Centre  
Baizhuizi, Fucheng Menwai  
Beijing

LIU Ji-Chen

M.Sc., Engineer

ditto

PEI Lin

Engineer

ditto

WEI Hua

Engineer

ditto

ZHANG Shi Lin

Engineer

ditto

EGYPT:

FARAG Magdy

Electrical Engineer

Plastic Development Centre  
Egyplastic  
Alexandria

HALIME Mohammad

Prof. Instrument

ditto

KAMAL Mohammad

Electrical Engineer

ditto

EL-MANAWI Nagwa

Chemical Engineer

ditto

ETHIOPIA:

MULUGETA Haile Georgis

Ethioplasic

DME, Superintendant

Addis Ababa

INDONESIA:

WIIRYAADINATA Ena Sutisna

Pertamina

Technical Service Engineer

Jakarta

JORDAN:

EL-RISHEQ Adnan

Ministry of Industrie  
and Trade

Chemical Engineer

Amman

MALAYSIA:

MOHAMMAD Mazlan

Metal Industrie Research  
Development Centre  
Shah Alam, Selangor

Research Officer

PERU:

MENDEZ Francisco Flavio

Sociedad Paramonga

Chief of Research and  
Development

Lima

PHILIPPINES:

YADAO Alfonso V.

BOI Ministry of Industrie  
and Trade and Investments

Investments Analyst 1

Makati, Metro Manila

SINGAPORE:

ONG Thye Pheng

Ngee Ann Technical College  
Singapore

Lecturer

SOMALIA:

ABDULHAMID Abdulhamid Sh. Abdi Faq

Snai-Biasa Jowhar

Plastic Technologist

Mogadishu

SRI LANKA:

PERERA Payagala Vidana  
Arachiga Gnanatilake  
Development Officer

Industrial Development  
Board of Sri Lanka  
Katubedde, Moratuwa

SYRIA:

HAKKI Tamador  
Head of Chemical & Textile  
Division

Industrial Testing &  
Research Centre  
Damaskus

P. D. R. YEMEN:

OBADI Eptessam  
Laboratory Supervisor in  
Quality Control

Ministry of Industrie  
Aden

6. LKT Facts6.1. Staff for the Training Programme

Director of LKT-FGM: Reg.-Rat Prof.Dipl.-Chem.E.Schmitz  
 Programme Director: Prof.Dipl.-Ing.Dr.techn.H.Hubeny  
 Deputy Programme Director: Ing.R.Hillisch  
 Course Attendant: Ing.W.Michel, Ing.F.Mennerstorfer  
 Secretary: B.Dörr, Th.Parzer

Lectures:  
 FOL F.Beran  
 Prof.Dipl.-Ing.Dr.techn.H.Dragaun  
 Prof.Ing.Dkfm.H.Graf  
 Ing.R.Hillisch  
 Prof.Dipl.-Ing.Dr.techn.H.Hubeny  
 Prof.Dipl.-Ing.Dr.techn.W.R.Jessenig  
 StR.Ing.R.Jirsa  
 Prof.Dipl.-Ing.Dr.techn.F.Mayer  
 Prof.Dipl.-Ing.Dr.techn.H.Muschik  
 FOL Ing.G.Minarovich  
 Prof.Dipl.-Ing.Dr.techn.H.Revesz  
 Prof.Dipl.-Ing.Dr.techn.J.Smelik  
 FOL Ing.E.Strohmayer  
 Ing.E.Weiß  
 Prof.Dipl.-Ing.Dr.techn.E.Wogrollly  
 VL Ing.Mag.H.Wolanek

Assistance and Preparation:

Ass.Ch.Armann  
 FOL h.Bitschnauer  
 FOL K.Blazek  
 H.Braunsteiner  
 B.Dörr  
 Ass.P.Freisler  
 FL G.Freyer  
 W.Fussenegger  
 FL E.Jahn  
 Wiss.Ass.Ing.E.Herbinger  
 H.Lahner  
 F.Lorenz  
 Ing.F.Mennerstorfer  
 Ing.W.Michel  
 Ch.Neustifter  
 Th.Parzer  
 Ass.M.Radax  
 Ass.A.Revesz  
 Ing.H.Schermann  
 FL H.Seifert  
 Ing.E.Zehetner

6.2. Equipment for the Training Programme

ALPINE, BRD; Extruders  
 AVL, Graz; Electronic Control Systems  
 BATTENFELD, BRD; Injection Moulding and Blow Moulding Machines  
 BATTENFELD-KUHNE, BRD; Extruders (actually: Kuhne GmbH, BRD)  
 BAUER, Schweiz; Measuring Instruments  
 BOY, BRD; Injection Moulding Machines  
 BRABENDER, BRD; Plastograph  
 BRENSON, USA; Ultrasonic Welding  
 BROSA, BRD; Control Instruments  
 BRUELL & KJAER; Acoustical Instruments  
 BUCHER-GUYER, Schweiz; Presses  
 CHURCHILL, England; Water and Oil Circulating Controllers  
 CINCINNATI MILACRON, Wien; Extruders  
 COUDENHOVE Poly-Spray, Wien; Spray-Up Machines  
 DEMES, BRD; Pre-Treatment Instruments  
 ENGEL, Schwertberg; Injection Molding Machines  
 FRANK, BRD; Testing Equipment  
 FUCHS, Wien; Mills  
 GOERZ Electro, Wien; Instruments  
 HAGEDORN & BAILLY, BRD; Water and Oil Circulating Controllers  
 HARTMANN & BRAUN, BRD; Control Systems  
 HASCO, Wien; Moulds  
 HENSCHEL, BRD; Mixers  
 HONEYWELL Bull, Wien; Time Sharing  
 HOTTINGER, Wien; Torque Measurement Equipment  
 JOENS, BRD; Control Systems and Recorders  
 JUMO, M.K. Juchheim, BRD; Control Instruments  
 ILLIG, BRD; Vacuum Forming Machines  
 KIEPEL, BRD; Film-Extruder  
 KRAUSS-MAPPEI, Injection Moulding, Foaming, Extrusion,  
 Recycling  
 LÖDIGE, BRD; Mixer  
 BATTENFELD Kunststoffmaschinen GmbH., Kottlingbrunn;  
 Injection Molding  
 MEDEK & SCHÖRNER, Wien; Signator (Marker)  
 METRAWATT, BRD; Control Systems  
 NETSTAL, Schweiz; Injection Molding Machines  
 PERKIN-ELMER, USA; Analytical Instruments  
 PHILIPS, Wien; Control Systems and Recorders  
 POLYROLL, BRD; Foaming Machines  
 PVL, Waldbreitbach (Austria); Electronic Equipment  
 PWF, DDR; Presses  
 SCHLUMBERGER, Wien; Electronic Equipments  
 STAIGER & MOHILO, BRD; Instruments  
 STOUGAARD, Dänemark; Instruments  
 TIEDEMANN, BRD; Optical Instruments  
 TROESTER, BRD; Calanders, Roll Mills  
 UNILABOR, Wien; Electronic Equipment  
 VEB Werkstoffprüfmaschinen, DDR; Testing Equipment  
 VIKING, UK; PUR-Foaming Machines  
 WITHOP, BRD; Control Systems  
 ZWICK, BRD; Testing Equipment



## 7. Plant visits

To the special interest of the participants 20 plant visits during the six-week course in Austria were organized by LFT-TGM. The selection of the plant according to the interest of the participants gave a regional and technical survey on the Austrian plastics industry:

### BLEIBERGER BERGWERKSUNION AG

4501 Arnoldstein

Stabilizers, Additives

### CHEMIE LINZ AG

St. Peter-Straße 25  
4021 Linz

PE, PP-Compounds,  
Staple Fibres, Films,  
Plastics-Processings

### CINCINNATI MILACRON AUSTRIA

Laxenburger Straße 276  
1232 Wien

Twin Screw Extruder,  
Dies, Down-Stream-Equipm.

### CO-OP

Steinergasse 36  
1230 Wien

Blow Moulding,  
Injection Moulding

### LUDWIG ENGEL KG

4311 Schwertberg

Injection Moulding  
Machines, Mould Making

### ELIN AG

Shuttleworthstraße  
1210 Wien

Mould Making,  
Tool Machinery

### GABRIEL CHEMIE

Stipckgasse 6  
1234 Wien

Additives for processing  
of plastic materials,  
Colour Concentrates,  
Thermoplastic Rubber-Comp.

### HASENCLEVER

Industriestraße 21  
2353 Neu Guntramsdorf

Standard Moulds

### P. HINTEREGGER KG

Industriezentrum  
2351 Wr. Neudorf

Thermoforming,  
Solar-collector

### IFW-MANFRED OTTE

4563 Micheldorf

Mould and Die-Making

INTERNORM

Janngutstraße 161  
4091 Oedt

PVC-Profiles,  
Window Frame Extrusion,  
Window-Plants

INTERPLASTIC GmbH

Franz Fritschstraße 11  
4600 Wels

Calandering, Films

JUMO

Wolfholzgasse 14-16  
2345 Brunn/Geb.

Injection Moulding,  
Mould Making

ÖSWAG-Österr.Schiffswerfte AG

Derfflingerstraße 15  
4027 Linz

Processing Equipment,  
Extruders, Down-Stream  
Equipment, Recycling

POLOPLAST

Poloplaststraße 1  
4060 Leonding

Pipe Extrusion,  
Injection Moulding,  
Pipe and Fittings Systems

ROGAL-PLASTIC

Cothmannstraße 5-7  
1120 Wien

Finishing

SCHRACK Elektronik

Pottendorfer Straße 25-27  
1121 Wien

Thermosetting and  
Thermoplastics

SIEMENS AG

Apostelgasse 12  
1030 Wien

Mould and Die-Making

KARL WESS OHG

Wieser Straße 54-56  
2640 Gloggnitz

Special Work-shop in  
Mould- and Die-Making

Plant visit in the CSSR, organized by UNIDOINTERPLAS

Nitra, CSSR

Pipe Extrusion, Films

## 8. Applied R & L Programme in Plastics Technology

### 8.1. Objectives

To increase the efficiency of the 12th Training Programme it will be useful to continue the contacts between participants, institutions, companies and authorities. One facility besides contracts between institutions is a tailor-made research programme for candidates to help them solve their problems in plastics technology.

LKT-TGM have had considerable experience in conducting post-graduate research programmes in the German language, especially for students from various institutions in Austria. We are now interested in extending this experience to include post-graduate research programmes conducted in the English and French language for foreign students. The success of the first tentative arrangements encourage us to take on more research students on a similar basis together with UNIDO.

The programme is planned as an academic-practical (professional) tuition in a 12 week-course by applied research work in a specific field of plastics technology including theoretical introduction, project work, plant visits, individual contacts with national and international organizations, companies and other institutes, educational training, publications, membership of the Austrian Association for the Promotion of Plastics Technology (GFKT).

### 8.2. Research Programme in Brief

Subject: Industrial Post-Graduate Research Programme  
in Plastics Technology

Detailed fields

of study 170 Applied Research Projects in Procedur Engineering and Control Engineering (Injection Moulding, Extrusion, Foaming, Compounding, Forming, Casting)

Plastics Application (Mechanical Engineering, Electrical Engineering, Agriculture, Eco-technology, Marine Technology, Transformation and Storage of Energy, Biomedical Application), Testing (Quality Control), Polymer Physics (I-Ray diffraction, Electron Microscopy, DSC), Polymer Chemistry (Analysis), Environmental Technology (Recycling, Re-use of Waste and Litter, Combustion, Protection), Training Technology, Research Management.

**Conducted by:** Laboratorium für Kunststofftechnik LKT-TGM  
Vienna

**Address:** A-1200 Vienna, Wexstraße 19-23, Austria

**Admissions requirements:** M.Sc. or PhD. or equivalent in a scientific faculty and research experience

**Language:** English, German (French, Spanish partly)

**Location:** Vienna

**Tuition fee:** UNIDO

**Commencing date:** January, April, July, October

**Duration:** 12 weeks

**Deadline for enrolment:** September, December, March, June

This Industrial Post-Graduate Research Programme is organized by Laboratorium für Kunststofftechnik LKT-TGM of the Association for the Promotion of Plastics Technology (GPKT) in co-operation with the United Nations Industrial Development Organization (UNIDO), the Federal Government of Austria, Federal Chamber of Commerce and Verband Österreichischer Industrieller (VÖI).



