Charts to support the presentation at the

EIRMA SPECIAL CONFERENCE

TOWARDS A NEW TECHNOLOGICAL BASE FOR INDUSTRY IN THE '90s

PARIS, 17- 19 October 1984

NTB 1

PROBLEM STATEMENT

BASIC TRENDS

- TECHNICAL CHANGE SEEMS TO BE ACCELERATING.
- THE PRODUCTS AND PRODUCTION PROCESSES OF ENTIRE SECTORS HAVE CHANGED BEYOND RECOGNITION IN A SHORT PERIOD.
- NEW MATERIALS, NEW TECHNOLOGIES FOR SHAPING MATERIALS AND FOR ASSEMBLING THE FINAL PRODUCT COEXIST WITH THE OLD ONES.
- INORMATION TECHNOLOGIES TRANSFORM OUR WAYS OF LIVING AND OF WORKING.
- BIOTECHNOLOGIES MAY HOLD SOME OF THE KEYS FOR MASTERING THE FUTURE.

QUESTIONS

- ARE WE UNDERGOING A FUNDAMENTAL TRANSITION?
- TO A NEW "TECHNICAL SYSTEM", CHARACTERIZED BY A NEW "TECHNOLOGICAL BASE"

PURPOSE OF THE CONFERENCE

- TO LOOK AT THE KEY SECTORS WHICH ARE LEADING TECHN. CHANGE;
- EXAMINE THEI'R LIKELY HORIZONTAL IMPACT ON OTHER SECTORS,
- TEST THE HYPOTHESIS OF THE EMERGENCE OF A NEW TECHNOLOGICAL BASE.

NTB 2

A CYCLICAL PATTERN MODEL FOR THE DYNAMICS OF OPEN SYSTEMS

- A PERIOD OF STABILITY WITH PREDICTABLE EVOLUTION EXPLOITING SYSTEM'S POTENTIALITIES,
- A PERIOD OF TRANSITION WHEN LARGE FLUCTUATIONS APPEAR AND ARE SUSTAINED,
- PASSING THROUGH A CATASTROPHY WHERE THE SYSTEM STRUCTURE CHANGES,
- A NEW PERIOD OF STABILITY WITH PREDICTABLE EVOLUTION WITH A NEW SYSTEM STRUCTURE.

NTB 3

THE TECHNICAL SYSTEM (TS) – AN OPEN COMPLEX SYSTEM

TS = THE SET OF TECHNIQUES, ENSEMBLE OF TECHNIQUES, FILIERES, PRODUCTS, THEIR USE.

- THE HYSTORY OF TECHNIQUES HAS SHOWN THAT TS FOLLOWS THE DYNAMICAL PATTERN TYPICAL OF COMPLEX OPEN SYSITEM:
  - THERE ARE PERIODS IN HYSTORY CHARACTERIZED BY A GIVEN **TS**
  - FOLLOWED BY A PERIOD OF TRANSITION;
  - TO A NEW TS.
- HOW MANY DIFFERENT TS IN HYSTORY
  - ~10 OF WHICH 5 IN THE LAST 200 YEARS.
- THE TS FAR FROM TRANSITION IS NOT STATIC

  BUT
  - INNOVATION CHANGES SHOULD BE COMPATIBLE WITH THE TS STRUCTURE;
  - RADICAL INNOVATION CAN BE BLOCKED.

NTB 4

THE SIGNALS FROM THE TRANSITION STATE

A) INCREASED DIFFICULTIES TO MATCH ENVIRONMENTAL CHANGES$

B) SATURATION OF SYSTEM GROWTH POTENTIALITIES "COMPLEXIFICATIONS" / REDUCED EFFICIENCY,

C) POSITIVE FEEDBACKS OF FLUCTUATION PRODUCING IRREVERSIBLE CHANGES.

D) VISIBLE CHANGES IN SUBSYSTEMS WITH LONGER TIME CONSTANT,

NTB 5

IS TODAY THE TECHNICAL SYSTEM UNDER TRANSITION?

- DRASTIC TECHNOLOGICAL CHANGES IN HORIZONTAL TECHNOLOGIES:
  - MATERIALS (COMPOSITES),
  - PROCESSING UNITS (LASER, ROBOT),
  - PRODUCTION SYSTEM (FMS),
  - INFORMATION PROCESSING (VLSI, AI)
- IN IMPORTANT INDUSTRY NEW TECHNOLOGIES HAVE DEEPLY DIFFUSED:
  - E.G.- NEW MATERIALS IN AEROSPACE,
  - E.G.: CIM (COMP, INTEGRATED MANUFACTURING) FOR FABRICATION OF COMPUTERS
- ENVIRONMENTAL CHALIENGES TO PRODUCTS & PROCESSES HAVE STARTED A DE-MATURITY PROCESS IN MASS-PRODUCING INDUSTRIES (E.G. AUTOMOTIVE)
- RADICAL NEW TECHNOLOGIES (E.G., GENETIC ENGINEERING.) STRONGLY PUSH FOR RADICAL INNOVATIONS IN IMPORTANT INDUSTRIES (E.G., BIOTECHNOLOGY)

NTB 6

HOW TO IDENTIFY THE TECHNOLOGICAL BASE

- FROM THE STUDY OF LONG TERM ECONOMIC WAVES
  - THEY CORRELATE WITH CHANGES IN
    - PRIMARY ENERGY SOURCES,
    - BASE MATERIALS;
    - TRANSPORT TECHNOLOGIES;
    - COMMUNICATION TECHNOLOGIES.
- FROM' THE STUDY OF DIFFUSION OF INNOVATIONS IN TECHNICAL FILIERES
  - IT IS IMPORTANT THE ROLE PLAYED BY CERTAIN "ENSEMBLE OF TECHNIQUES" WHICH ACT AS INTERMEDIARIES FOR THE DIFFUSION OF BASE TECHNOLOGIES (ENERGY, MATERIALS, ETC.)

GENERIQUE TECHNIQUES

  - E.G., INSTRUMENTATION & CONTROL GOVERNORS.
  - HYDRO/PNEUMO/ELECTRO-DRIVES
- ALL ABOVE TECHNOLOGIES + PRODUCTION PROCESSES PUT LONG-TERM CONSTRAINTS ON THE **TS** BECAUSE OF RELATED HIGH INVESTMENT.

NTB 7

THE CONFERENCE CHOICE OF COMPONENTS OF THE TECHNOLOGICAL BASE

- BASE MATERIALS X
- ENERGY
- TRANSPORTATION TECHNOLOGY (INDIRECTLY) (INDIRECTLY)
- INFORMATION/COMMUNICATION TECHNOLOGY X
- GENERIQUE TECHNIQUES (INDIRECTLY)
- PRODUCTION PROCESSES X

WHY ADDING BIOTECHNOLOGY?

- IT 15 NOT AN "HORIZONTAL" TECHNOLOGY

BUT

- IT IS PERVADED BY RADICAL INNOVATIONS THAT MIGHT PLAY THE ROLE OF LARGE FLUCTUATIONS NOT WRITTEN-OFF IF THE SYSTEM IS IN A STATE OF TRANSITION.

  IT MIGHT HELP THE TECHNICAL SYSTEM TO ACCELERATE THE TRANSITION,

NTB 8

TOPICS & DISCUSSION GROUPS

TOPICS	PAPERS	DISC. GR.
NEW MATE-RIALS	BALAZARD* Aerospace LARSSON * Cars DIMMOCK * Vehicle components	GÜNTHER
MATERIAL SHAPING	HUART * New processes KUNSMANN* Automob. parts MOSCA * Electro. products	GESSINGER
PRODUC-TION SYSTEM	SKOOG * Robots GILLET * Flexible mnftrng system HEIZINGER*Computer mnftrng	NICOLO'
INFOR-MATION TECHNO-LOGY	STOTKO * Impact of I.T. CATANIA * Telecomm. HEINTZ * Cars WOOD * Instrum.& control	BOSMA
BIOTECH-NOLOGY	STRIJKERT*New tools SCHÖNE * Pharmac. industry SCHELL * Genetic. Eng.in agricult.	NIELSEN
KREDELL - LEPETIT - PARNABY -		SCHMIDT/ KASTNER

NTB 9

A RECIPE TO ANALYSE TECHNOLOGICAL CHANGE DURING TRANSITION

- 1st STEP
  - IDENTIFY THE TECHNOLOGICAL CHANGES AND THEIR POTENTIAL FOR DIFFUSION TO RENEW TODAY PRODUCTS PROCESSES.
- 2nd STEP
  - ANALYSE THE SECTORS WHERE THE CHANGES HAVE TAKEN PLACE, AS CASE HISTORIES FOR OTHER SECTORS.
    ASK THE QUESTIONS
    - WAS THE CHANGE PRECEDED BY "TECHNOLOGICAL CONFUSION?
    - HAS THE R D ROLE CHANGED?
- 3rd STEP
  - ANALYSE THE NEEDS OF CHANGE (ENVIRONMENT, “TECHNOLOGICAL CONFUSION" R&D INEFFICIENCY) FOR MATURE SECTORS.
  - ANY SIGNALS OF DE-MATURITY?
- 4th STEP
- ANALYSE WHETHER NEW TECHNOLOGIES COULD BE
  - BLOCKED BY
    - SOCIAL/ECONOMIC CONSTRAINTS
    - NON SATURATION OF EXISTING TECHNOL.,
    - ETC.

OR

  - ACCELERATED BY
    - SOCIETY NEEDS
    - CULTURAL ATTITUDES
    - ETC.

NTB 10

NEW MATERIALS

- A LOT OF CHANGE BUT NO “REVOLUTION".
- TECHNOLOGY: CAN LIVE WITH THE EXISTING WIDE RANGE OF MATERIALS.
- C.OMPOSITES: NEED FOR BETTER PRODUCTION PROCESSES,
- POTENTIALITY FOR FURTHER SOPHISTICATION OF EXISTING MATERIALS.
- INTRODUCTION OF NEW MATERIALS ONLY FOR ECONOMIC REASONS.
- CONTINUING COMPETITION BETWEEN CONVENTIONAL AND NEW MATERIALS.
- INCREASE OF MATERIAL ALTERNATIVES.
- CLOSER COOPERATION BETWEEN MATERIAL SUPPLIER AND USER.
- CHAGES IN THE STRUCTURE OF INDUSTRY (INTEGRATION OF MATERIAL - COMPONENTS).

ADAPTIVE CHANGES - NO TRANSITION

NTB 11

MATERIAL SHAPING

- INCREASING IMPORTANCE OF SUBSTITUTION OF METALS PROCESSING BY PLASTICS COMPOSITES PROCESSING.
- NEW LOW VOLUME, COST-EFFICIENT PROCESSING TECHNIQUE.
- DIRECT (CONTINUOUS) PROCESSING.
- A DRIVE TOWARDS MINIATURIZATION.
- SUB$TITUTION OF MATERIALS PROCESSING BY SOLID STATE FUNCTIONS (ELECTRONIC VS MECHANICAL PUNCTIONS).
- INTEGRATION OF MATERIALS AND PROCESSING INTO PRODUCT DESIGN (CANGE IN COMPANY STRUCTURE).
- ACCELERATED PRODUCT LIFE CYCLES.

ADAPTIVE CHANGES - NO TRANSITION
(UNLESS SPECIFIC SECTORS LAG IN ADAPTATIONS)

NTB 12

PRODUCTION SYSTEM

- FOR DISCRETE MANUFACTURING PROCESS
  - A SCENARIO OF THE FACTORY OF THE FUTURE IS POSSIBLE;
  - FMS FOR A MIX OF COMPLETELY DIFFERENT PRODUCTS.
- FMS WILL MODIFY THE DESIGN OF PRODUCTS.
- THE DYNAMIC OF CHANGE WILL DEPEND ON THE POSSIBILITY TO INTRODUCE FMS STEP-WISE OR FOR ENTIRELY NEW DESIGNED PLANTS.
- IT IS POSSIBLE TO RECOGNIZE THAT WE ARE IN A TRANSITION.
- IT IS NOT POSSIBLE TO PREDICT WHERE THIS TRANSITION WILL LEAD, BUT SOME OF THE TRENDS ARE CLEAR.
  - FOR EXAMPLE
    - MORE AUTOMATION;
    - MORE FLEXIBILITY;
    - MORE INTEGRATED OPERATIONS;
    - SHIFT OF HUMAN INVOLVEMENT TOWARD HIGHER LEVELS OF ABSTRACTION,
- INFORMATION TECHNOLOGY WILL HELP TO MOVE ALONG THESE LINES, BUT THE GREATEST EFFORT STILL IS WITH MANUFACTURING TECHNOLOGY.

NTB 13

INFORMATION TECHNOLOGY

- TRANSITION? YES, BUT THE PROCESS IS AT DIFFERENT PHASES (FROM INCUBATION TO SATURATION) IN DIFFERENT FIELDS OF APPLICATION,
- THE CHANGING TECHNOLOGY IS PERVASIVE.
- THERE ARE DELAYING FACTORS:
    - INVESTMENT /LACK OF UNDERSTANGING / SOCIAL THREAT.
- PROBLEM AREAS: TO ENGINEER THE NEEDED SOFTWARE / TO DEVELOP NFW ARCHITECTURES.
- AREA OF NEED:
    - EDUCATION AT ALL LEVELS FOR ALL DISCIPLINES,
    - UNDERSTANDING THE POTENTIAL OF **IT** AND NOT ONLY HOW TO APPLY IT.
- **IT**:
    - ENABLE US TO INTEGRATE OUR OPERATIONS;
    - IS A SHIPT TOWARD HIGHER LEVEL OF ABSTRACTION,

NTB 14

BIOTECHNOLOGY

- BIOTECHNOLOGY: A MULTIDISCIPLINARY FIELD
  (FROM MICROBIOLOGY TO PROCESS ENGINEERING).
- TRANSITION? VES.
  - A DRAMATIC INCREASE IN R&D EXPENDITURES;
  - INCREASED EFFICIENCY IN R&D
    (NOW, AND MORE IN THE FUTURE).
- INCREASING NEED OF R&D
  - NOT ONLY IN "RECOMBINANT DNA" BUT ALSO IN ALL FIELDS OF BIOTECH. (E.G. APPLYING COMPUTERS TO FERMENTATION AND RECOVERY TECHNIQUE)
- NEW DEVELOPMENTS
  - BIOCATALYSIS;
  - NEW DRUGS;
  - MEDICAL DIAGNOSTICS;
  - TREATMENT OF AUTO-IMMUNE DISEASE;
  - GENETIC ENGINEERING IN AGRICULTURE
    (E.G. HERBICIDE RESISTANT PLANT).
- NEED OF UNIVERSITY/INDUSTRY COOPERATION:
  - BASIC EDUCATION / POST-GRADUATE TRAINING /SCREENING OF NEW MICROORGANISM / PLANT SCIENCE.

NTB 15

PANEL DISCUSSION

- **MATERIALS**: CUSTOM MATERIAL DEVELOPMENT (E.G. SEMI-CONDUCTORS, ENGINEERING PLASTICS).
- **PRODUCTION TECHNOLOGY**: FMS TREND TOWARDS SMALL PRODUCTION SHOP.
- **IT**: TO BE CONSIDERED THE NEW BASE TECHNOLOGY (AS IN THE PAST TERMODYNAMIC, OPTICS, ELE£TRICITY);
    - SELF REPAIRING OF MACHINERY POSSIBLE IN THE FUTURE;
    - DOUBTS ABOUT ARTIFICIAL INTELLIGENCE / BUT IMPORTANT EFFECT OF APPLYING EXPERT SYSTEMS.
- **BIOTECHNOLOGY**: COULD PRODUCE REAL MAJOR CHANGES
    - SHORT TERM:
      SCALE UP OF GENE TECHNOLOGY / BIOCATALYSIS / INSTEAD OF HIGH PRESSURE, HIGH TEMPERATURE PROCESSES;
    - LONG TERM:
      ”SOLIDIFICATION” OF IDEA (GENE OF NEURONAL /PEPTIDE PRODUCTION INPLANTED IN BACTERIA).
- NEEDED CHANGE IN OUR **METHODOLOGICAL APPROACH**
    - SYSTEM ENGINEERING (IN PRODUCTION WE ARE USED TO YEAR 1950 SYSTEM CONCEPT);
    - INTEGRATING R&D WITH THE OTHER COMPANY FUNCTIONS;
    - INCREASE IN ENGINEERING PRODUCTIVITY,

NTB 16

TRANSITION OR NOT?

- THE CONFERENCE DID NOT AGREE THAT THE QUESTION IS RELEVANT.
- TRE CHANGE MIGHT BE SLOW OR FAST:
  THERE WAS A TENDENCY TO IDENTIFY REVOLUTIONARY CHANGES WITH FAST CHANGES.
- THERE WAS NO DEBATE ON THE MEANING OF A STRUCTURAL CHANGE IN THE TECHNICAL SYSTEM.
- GENERAL AGREEMENT:
  TO COPE WITH THE CHANGE, WE NEED A DIFFERENT MANAGEMENT APPROACH (MORE SYSTEM AND INTEGRATION ORIENTED).

NTB 17

A SCENARIO FOR THE FUTURE TECIINICAL SYSTEM

- **MATERIALS**
  - NEW AND OLD MATERIALS COEXISTING,
  - INCRASED COMPLEXITY OF DESIGN AND MANUFACTURING, MANAGED BY INCREASED KNOWLEDGE.
- **MATERIAL SHAPING**
  - DIFFUSION OF NEW PROCESS WITH INTRINSIC FEEDBACK INFORMATION ON THE QUALITY OF THE WORK BEING DONE;
  - INCREASED SCIENTIFIC KNOWLEDGE NEEDED TO MANAGE THE NEW PROCESSES IN THE DESIGN AND SHOP FLOOR;
  - INTEGRATION OF MULTIPLE FUNCTIONS IN SINGLE COMPONENTS.
- **PRODUCTION SYSTEM**
  - DIFFUSION OF ROBOT AND FMS WILL PRODUCE DRAMATIC CHANGE.
- **INFORMATION TECHNOLOGY**
  - DRASTIC CHANGES IN PRODUCT CONCEPTION AND PRODUCTION;
  - MORE TO BE SEEN BY THE DIFFUSION OF **IT** IN THE REALM OF "MECHANICAL" PRODUCTS.
- **BIOTECHNOLOGY**
  - SECTORIAL IMPORTANT CHANGES IN SHORT TERM SCALE;
  - INTERSECTORIAL LARGE IMPACT ON LONGER TERM SCALE.