INTERNATIONAL ATOMIC ENERGY AGENCY
UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS
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SCHOOL ON PHYSIC IN INDUSTRY

27 January - 14 February 1986

" COOPERATIVE UNIVERSITY - INDUSTRY "

presented by

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These are preliminary lecture notes, intended for internal distribution to participants only.

Institute for Experimental physics IV
(solid state)

at present

1 Head of institute
2 assoc. professors
15 scientists, guests, PhD-students
20 Diploma students
15 Technical staff

produced in 17 years

~ 120 physicists
90 → industry
20 → engineering departments
5 → professors

Finances:

90 000 DM from state
300 000 DM from DFG, federal government
industrie
200 000 Sonderforschungsbereich
„Magnetic and structural
phase transitions"

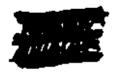
our Fields of Interest.

physics of disordered systems

magnetism in the melt
— " — in the glassy state

Magnetic and structural phase transitions
(SFB 166)

Metallic sandwiches



Free Atom clusters (Matrix-Isolation)

Magnetism under high pressure

Moessbauer Spectroscopy

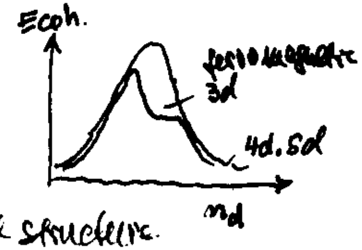
Surface physics

Crystal preparation and Analysis.

Magnetism for Industry
FeSi for electrical machines
Fe Nd B - for permanent magnets
Analyses for ecology. (dying forests)
with developing countries also

Magnetic + Structural Phase Transitions.

$E_{total} = E_{coul} + E_{spin}$



classical Approaches:

Magnetic Structure

$E_{coul} = const (ST)$

$T = 0$

Crystal structure

$E_{spin} = 0$

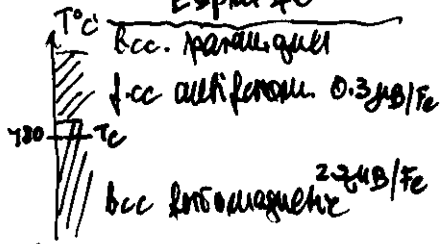
Advanced Magnetism

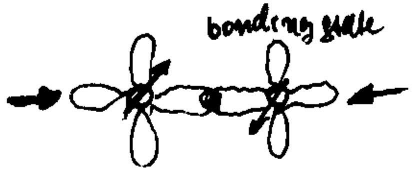
$T > C$

e+s+q – interactions

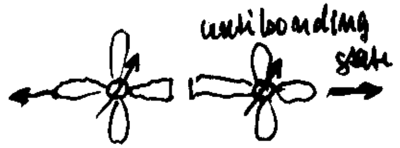
phase transformation

$E_{spin} \neq 0$



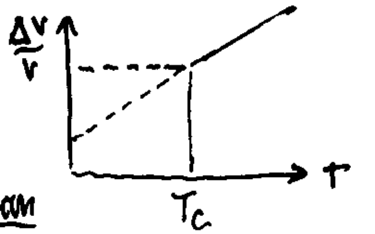


small fcc Fe.

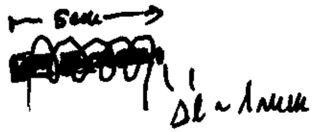


large bcc Fe

„Invar" – Effect.



large magnetostriction



$\frac{\Delta V}{V}$ (magn) $\sim 6\%$

The ideal physicist for Industry.

He has a broad fundamental knowledge in physics, mathematics, chemistry etc

He has a deep and creative understanding of his special field

He has good contact with other fields (e.g. Engineering, Economy, Medizin)

He visited 1-2 years a foreign university

He has a well balanced personality with creative hobbies

He engages himself in social responsibilities

His best age : 24-25 years

absolute maximum: 33-35 years.

Optimal curriculum vitae of german physicists

yrs. of age:	Training:	Degree:
00		born
	childhood (kindergarten)	
06		
	4 yrs. primary School	
10		→ Hauptschule → Realschule → Gymnasium
	6 yrs Secondary School I.	
16		→ Technical School
	3 yrs. Secondary School II.	
19		Abitur ↓ University
	18 month Military Service	
21		
	2 yrs Introductory lectures	
23		Vordiplom
	2 yrs Special Lectures + other fields	
25		
	1 yr Diploma Thesis work 1 yr preparation for Examinations	
27		Dipl. phys. (→ univers. / → industr.)
	3-4 yrs. Thesis work	
31		Dr. rer. nat
	6 yrs. Indep. Research + Lecturing	
37		Dozent
	Ambitious Research + Lecturing	
~45		professor
	Head of an Institute	
65		Retirement.

25 yrs of Learning (ages 06–31)

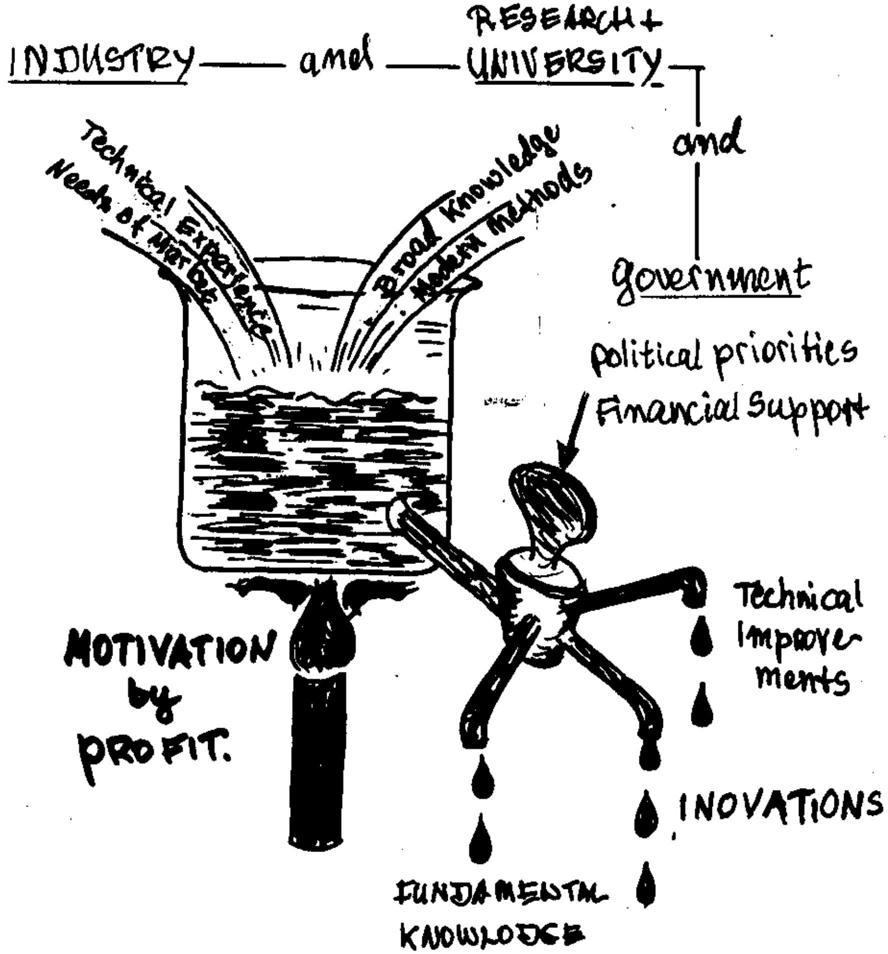
~34 yrs working (ages 31–65)

THE
RANDOM HOUSE
DICTIONARY
of the
ENGLISH
LANGUAGE

in·no·vate (in′ə vāt′), *v.*, -vat·ed, -vat·ing. —*v.i.* 1. to introduce something new; make changes in anything established (often fol. by *on* or *in*): *to innovate on another's creation.* —*v.t.* 2. to introduce (something new) for or as if for the first time: *to innovate a computer system.* 3. *Obs.* to alter. [< L *innovātus*) renewed, altered (ptp. of *innovāre*), equiv. to *in-* IN-[2] + *novātus* (*novā(re)* (to) renew + *-tus* ptp. suffix)] —in′no·va′tive, in·no·va·to·ry (in′ə və tôr′ē, -tōr′ē, -vā′tə rē), *adj.* —in′no·va′tor, *n.*

in·no·va·tion (in′ə vā′shən), *n.* 1. something new or different introduced: *numerous innovations in the high-school curriculum.* 2. act of innovating; introduction of new things or methods. [< L *innovātiōn-* (s. of *innovātiō*). See INNOVATE, -ION] —in′no·va′tion·al, *adj.*

HOW TO PRODUCE INNOVATIONS BY INTERACTION BETWEEN



The Total Research Expenditure in germany

~ 40 x 10^9 DM/yr come (~2.3% of BSP)
- 40% from Local governments
- 37% from Industries
- 23% from Federal government (~6% of their budget)

Distribution of the cake:

→ Industrial Research 44%

60 Universities 39% < 2/3 for Teaching, 1/3 for Research

The Universities Research Money comes from:

- 50% Deutsche Forschunggemeinschaft
- 30% Federal government programs
- 10% Foundations with special purposes
- 10% Industrie

Characteristics of University Research

oriented mainly on fundamentae problems
collaboration international
small teams – large variety of goals
hard to coordinate into larger projects
connected to teaching (student's thesis)
→ TO GET FAMOUS

Characteristics of Industrial Research

oriented mainly on technical applications
collaboration restricted by competition
narrow goals dictated by the market
hard to get interested in fundamentae problems
connected to engineering and economy
→ TO GET RICH!

Nature collaboration:

in special problems requiring
broader knowledge or speciae equipment

in training students in applied research

in joint research projects in potential fields
of future production.

How to handle uncommitted scientists?

Research projects proceed usually in 3 steps:

A. Search for a rewarding problem:

He reads scientific journals,
visits conferences
discusses with other scientists

Tell him about your problems also:
(consultation, workshops etc)

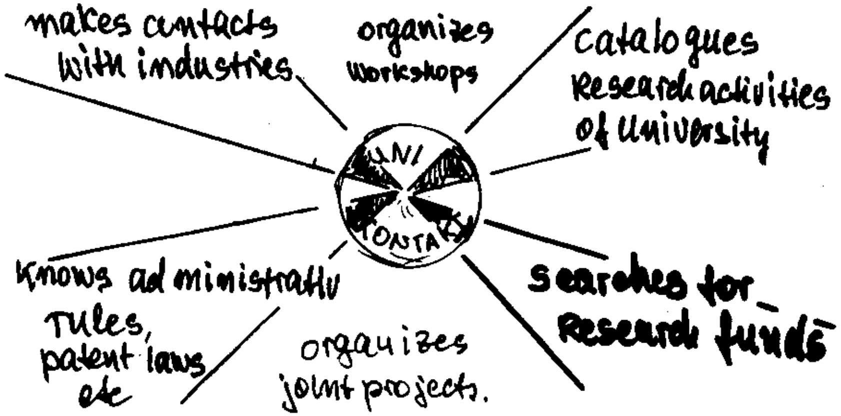
B. Methodical scientific work on the problem

He knows best his resources and abilities
and how to be faster and better than others.
Give him the apparatus he needs, but leave him alone.

C. Utilization of the results.

He is mainly interested to publish in
leading international journals or conferences

Stimulate him by your interest to
inform you earlier than others.



Industrial research projects increased from << 1Mio to > 10 Mio DM.
35 German Universities have now contact offices!

UNIKONTAKT

- is integrated into the University administration
- it provides an easily accessable „Adress"
- it informs scientists about new technical developments in neighbor industrie
- it organizes topical seminars and „workshops"
- it organizes exhibition in industrial fairs.
- it translates industrial problems into projects to be handled by scientists
- it arranges and administers joint projects
- it suggests fair prices for laboratory services
- it helps to find public money
- it should have catalytic, not steering function
- it should not compete with private consultants

<u>Rate of success</u>: per year ~ 500 contacts
30% drafted as proposals
20% made ready for signature
15-10% executed in the laboratory after ~ 1yr preparation

Should university scientists write patents?

In principle „yes"

In praxis: ??

important — patents — not important

↓

you must defend it in court against „infringement"

value for industry ≈ 10 Mio DM

fee for your lawyer ~6% ≈ 600000 DM

patents only meaningful,

if you plan your own factory

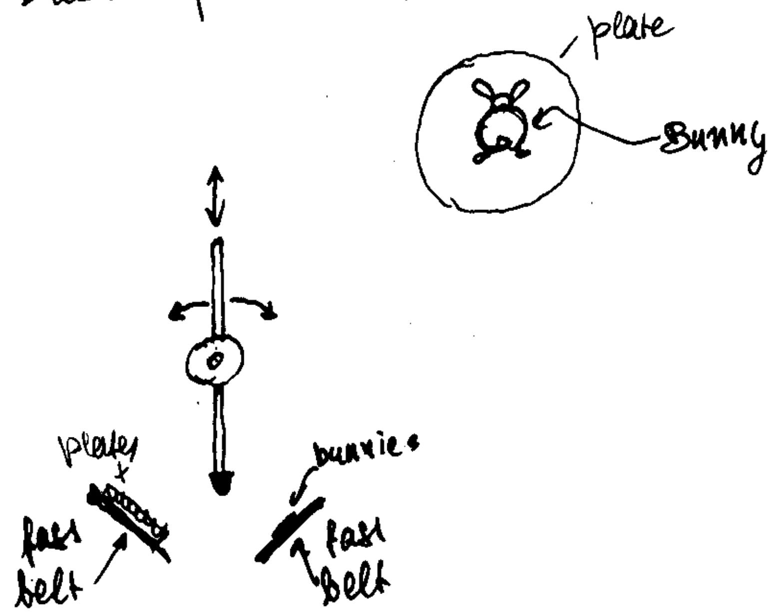
otherwise:

cooperate with industry

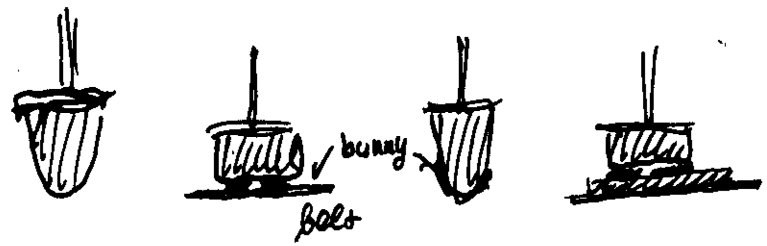
or let university defend your interests

Example of Universities Flexibility

Easter problem 1985



The problem:



WORKSHOPS UNIVERSITY–INDUSTRY

Topics: High-Tech. problems which need collaboration

participants: ~20 from Industry, ~20 from University } by Invitation only

programm: 2 days

90 min sessions:

- introducting review: 30 min
- free discussion: 60 min

all other contributions by posters only.

proceedings: None

purpose: bring people together and let them talk to one another

organisation: to find the right topic and the right people

How physicists from Industry and University may find one another.

Select a field you may contribute somewhat.

Which companies and other university people are interested?

Organize a small workshop.
→ people get acquainted

Report about your potential
→ people get interested

Offer some of your services for free
⇒ industry gives you test cases

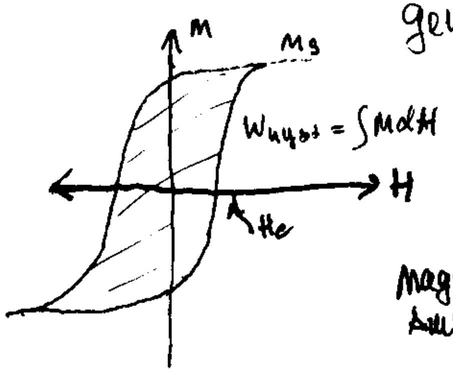
Demonstrate your competence and reliability.
⇒ you get more complicated questions.

You arrange student work on industrial problems.
→ you become trusted friends.

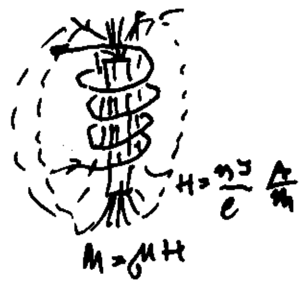
Arrange a joined project on applied topics of mutual interest.
→ get 50-50 public finances.

Core material for Transformers, generators, motors etc.

Fe: 4% Si + 1% Al.



Magnetic Field Amplification.



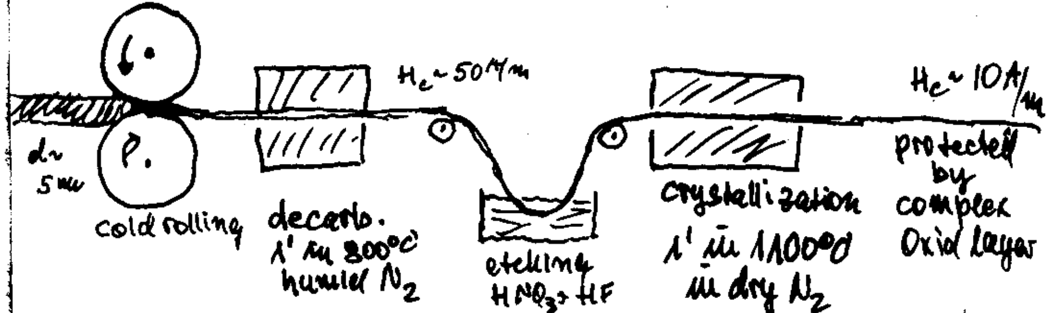
Total energy losses / cycle

$W_{tot} = W_{hyst} + W_{eddy current} (\rho)$

	M_s (A/m)	H_c (A/m)	μ	$\rho \cdot 10^{-8}$ Ω·m	W_{hyst} J/kg
techn Fe	1.7	50	5000	10	0.03
Fe + 4% Si	1.5	10	30000	55	0.005

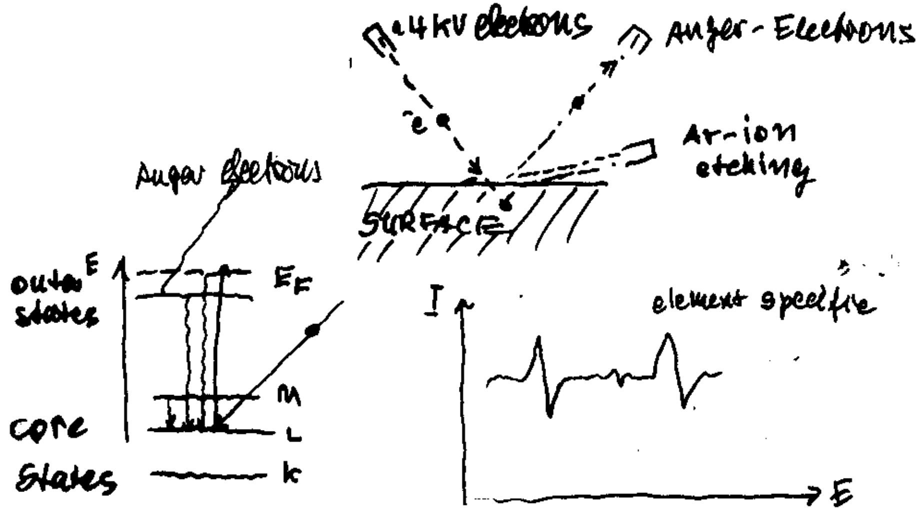
Al, Si lower magnetic hardness
increase electrical resistivity ρ
suppress martensitic α-γ transition

production of electrical steel in principle.



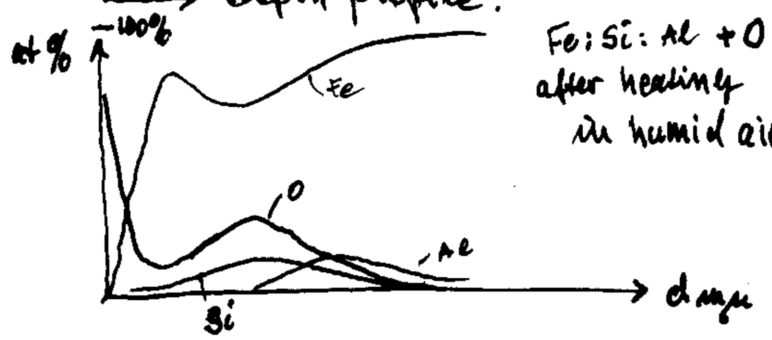
Cutting, Bending etc requires another heating!

SURFACE ANALYSIS by Auger-Electron-Spectroscopy



Computer controlled ion etching
measuring
calculating
etching again ----

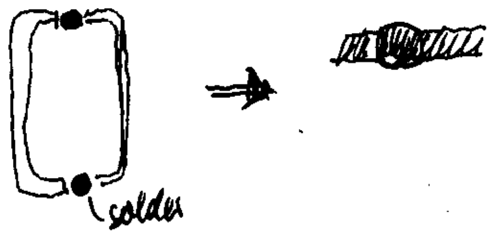
→ Depth profile.



Fe: Si: Al + O
after heating
in humid air.

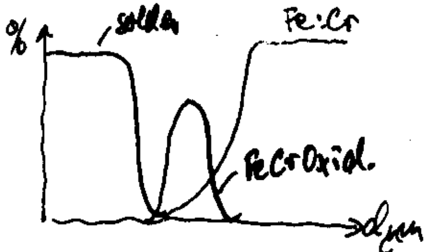
Another project:

Soldering stainless steel

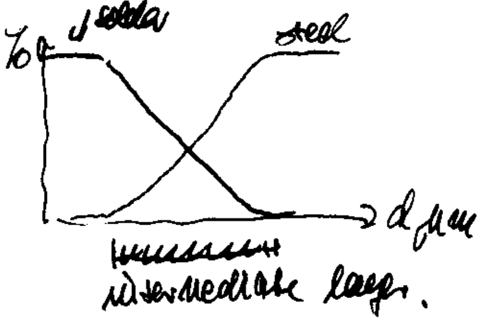


The problem of soldering

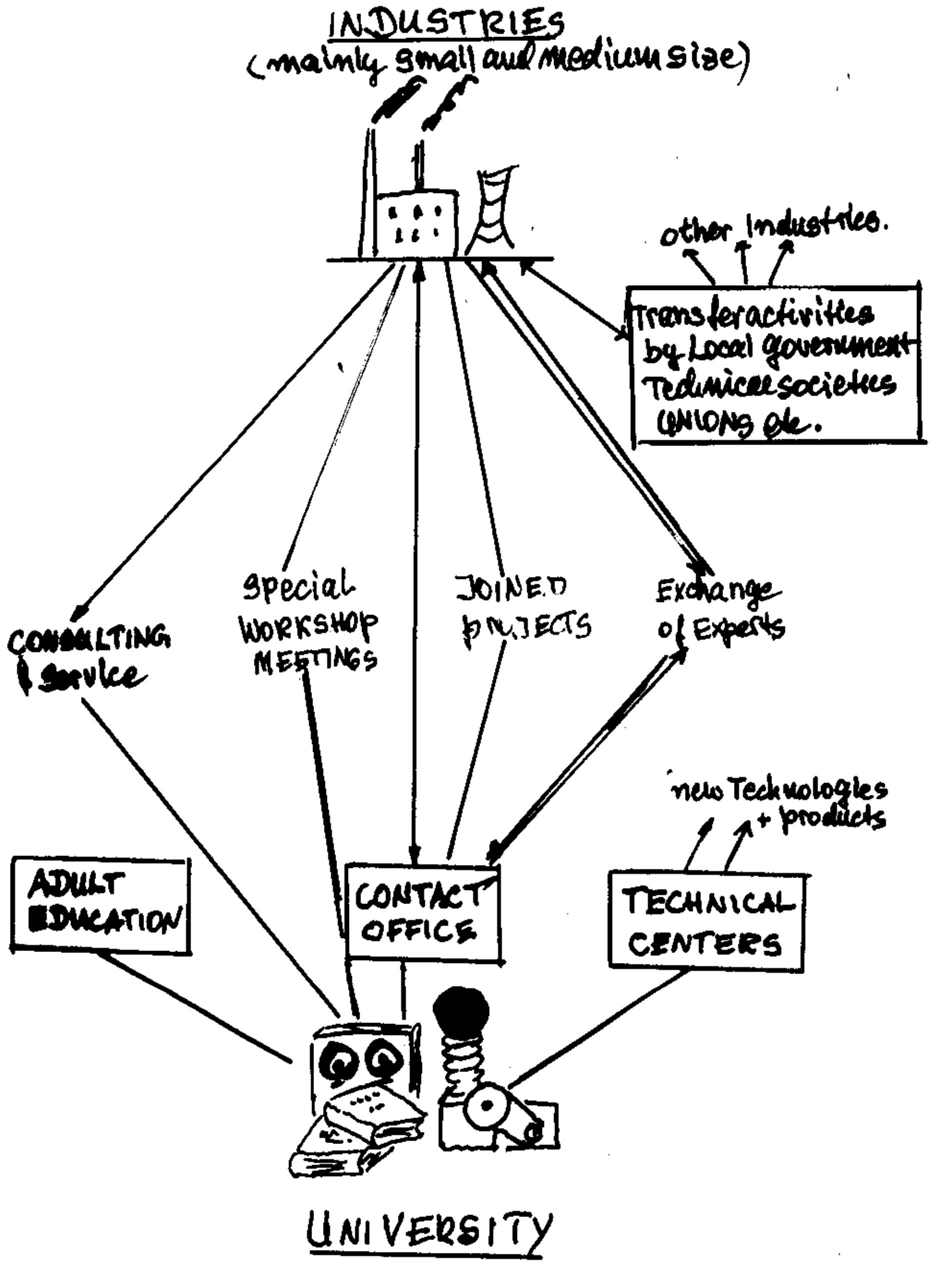
bevor:



after:



WAYS of TECHNOLOGY TRANSFER in GERMANY



Technology Centers (US-example)

now at more than 50 german Universities.

Purpose: Administrative and financial support to scientists for marketing new products.

Conditions: ~ 1 Mio DM from government
+ low interest credits from banks
+ support from some industries

Support by neighbor university giving cheap rooms, sabbatical leaves etc.

problems: scientists have no training or experience in industrial management

scientist makes profit from products he developed using tax payers money.

labor force is very expensive.

Advantage: Flexibility and ability to take high risks.

Summary

Cooperation Industrie - University is not simple because of

- old traditions
- different language
- different style of working
- different goals

it has to develop over years

University Institutes should reserve for cooperation with Industry about 10% of their potential,

because it provides for the University

- practical teaching for students
- interesting research problems
- additional funds.

and for the Industry

- flexible access to a wide scale of consultation and analytical methods
- contact to future employees
- scientific fresh-up of people
- delegation of difficult or expensive tasks.