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16. Abstract

The CAD Report '78 outlines the developments in all programs being developed as well as those which are already in use in the field of CAD (CAD = Computer Aided Design, which here also includes CAM = Computer Aided Manufacturing) granted by the German Federal Government.

Section 1 describes the structure of CAD-programs and contents requirements to the conception as a basis for the program-developments in past and future. Sections 2 to 6 describe the actual standard and the future aims of CAD-programs and give a short view of the developed programs in:

Civil Engineering (2)
Mechanical Engineering (3)
Chemical Engineering/Shipbuilding (4)
Electrical Engineering (5)
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Project Computer-assisted Development, Design and Manufacture

KfK - CAD 50

The CAD Support Project, Situation in July 1978

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CAD Project Manager

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51 figures

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The Nuclear Research Center, Karlsruhe, Inc., coordinates and supervises the Project Computer-Aided Design (CAD), which is sponsored by the Department for Research and Technology within the scope of the 3. DP-Program of the Federal Government. There is close cooperation between the Center, private industrial enterprises and public installations. As project manager it publishes series of papers, CAD-Bulletins, CAD-Reports and CAD development notes. They furnish bases for development, which are to promote faster and more widespread applications of Data Processing in the field of computer-assisted development, construction and manufacture.

The present report documents knowledge and results which were gained in Project CAD.

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Summary

~~The CAD report '78 provides an outline of all developments~~

The CAD Report '78 outlines the developments in all programs being developed as well as those which are already in use in the field of CAD (CAD = Computer Aided Design, which here also includes CAM = Computer Aided Manufacturing) granted by the German Federal Government.

Section 1 describes the structure of CAD-programs and contents requirements to the conception as a basis for the program-developments in past and future. Sections 2 to 6 describe the actual standard and the future aims of CAD-programs and give a short view of the developed programs in:

Building Technology (2)	(KfK-CAD 51)
Mechanical Engineering (3)	(KfK-CAD 52)
Chemical Engineering/Shipbuilding (4)	(KfK-CAD 53)
Electrical Engineering (5)	(KfK-CAD 54)
General Cross-Section Problems (6)	(KfK-CAD 51...54)

Introduction

Within the scope of the 3. DP-program of the Federal Government the development of DP is sponsored with the aim to increase the productivity of German industry and to improve the services offered. A significant part of the sponsorship involves the development of methods and processes as well as the generation of programs for application of "computer-aided development, design and manufacture"--(CAD/CAM) in the fields of building technology, electrical engineering and mechanical engineering, where small and medium-sized companies are predominant. (So far about 30% of the companies cooperating with CAD are small companies, about 40% are of medium size.)

In this project report, which appears in its second edition KfK-CAD 50--the first edition appeared in 1977 as KfK 34--the sponsored project CAD/CAM is described. It includes all development going on or completed in 1978. Additional activities may be added in subsequent years--even activities that may possibly not fall into the areas presented here.

The presentation of the professional background (Section 1) contains statements about the concept on which all prior and future development work will be based.

In the individual sections on Building Technology (2), Mechanical Engineering (3), Chemical Engineering and Shipbuilding (4), Electrical Engineering (5), and Cross-section Problems (6), statements are made with regard to the state and the goals of additional development work. The program developments are arranged in synoptic tables. Certain objectives were included because of their area affiliation, though not among those sponsored within the scope of the project.

A detailed description of all development work (status 1978) can be obtained from the project reports

--Building Technology (KfK-CAD 51)
--Mechanical Engineering (KfK-CAD 52)
--Chemical Engineering/Shipbuilding (KfK-CAD 53)
--Electrical Engineering (KfK-CAD 54)
--Cross-section Problems (in KfK-CAD 51-54) .

Karlsruhe, July 1978 The Project Management

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1. Professional Scope for Carrying Out the Sponsored Project "Computor-assisted Development, Design and Manufacture" /3

1.1 CAD-Concept of Flexible Program Chains

The activity of the user, i.e., of the engineer, is decisive in determining the capacity scope of a CAD program. This field of activity is shown, as an example, in Fig. 1.

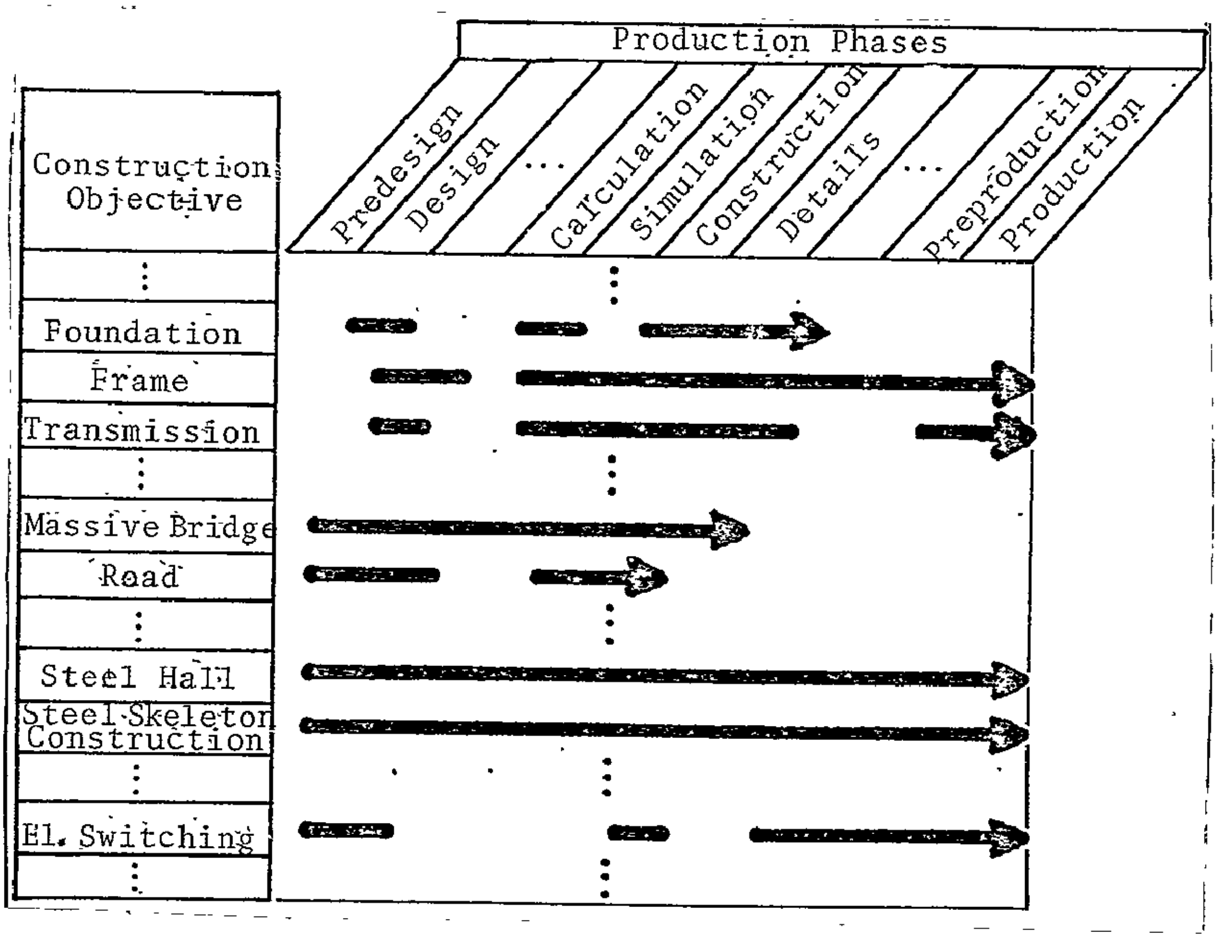

Fig. 1. Schematic arrangement of construction and manufacturing problems within the CAD/CAM-scope of solutions.

The vertical axis contains typical objectives to be realized; in horizontal direction the required activities from design or functional determination to manufacture and use of the object are listed in approximate chronological order. The activities actually required for realization of an object are shown as horizontally drawn lines in this schematic sketch.

The activities profile of presently avoidable programs for users can be seen in Fig. 2. /4

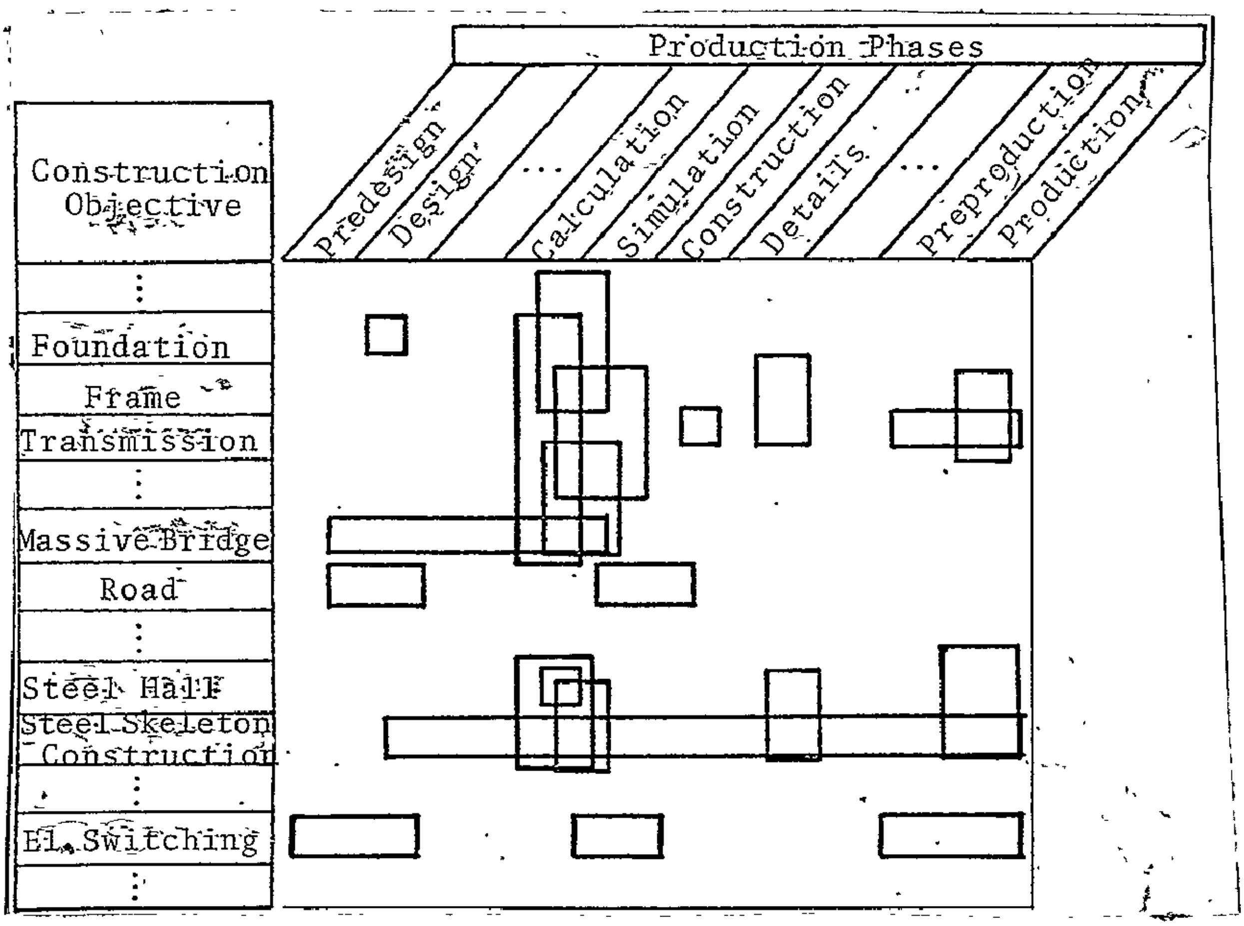

Fig. 2. Arrangement of activities profiles of existing user programs within the scope of CAD/CAM solutions.

Of significance for the present situation are, as always, the numerous individual programs to be considered as "islands," particularly in the area of calculation and simulation.

In addition there are several larger, vertically-oriented, areas representing generally applicable programs, as well as individual object-oriented programs that appear as horizontal beams. Many of the presently existing difficulties in the application of CAD are based on the discrepancy between Figs. 1 and 2, i.e., that engineering tasks and available user programs can rarely be matched up.

In reality only the programs oriented horizontally fulfill tasks required by the user satisfactorily. Only those programs provide more or less complete support to the user and do not scare him off at the start because of unnecessary data outputs and inputs (perhaps even according to varying I/O conventions). /5

The goal of future program development is also the increased generation of such programs which are user-oriented. It has become usual to speak of "program chains" in this connection (see /10/, /11/ for instance). That allows for the fact that a program chain consists of several links (modular), each of which represents a separate unit delineated by clear interfaces. The development of program chains becomes cheaper the more all purpose chain links (modules) can be applied. Differentiation must be made then between modules that are specific to objectives or companies and standard modules, which can and should be used generally, i.e., linked to other program chains. (Particular emphasis must be on sponsoring the development of just such standard modules, because of the achievable multiplication effect.)

Typical examples of standard modules are equation solvers or entire finite-element programs, NC-processors, I/O processors, geometry programs, databank programs, and others. When enough such programs are available it becomes relatively easy to set up program chains for specific objectives or to adapt existing ones to new objectives. Such easily adaptable program chains can also be designated as "flexible program chains."

1.2 Realization of Flexible Program Chains

Realization of a flexible program chain takes place according to the concept of "database oriented program development" shown in Fig. 3 (see also /12/,/13/,/14/), with the example sketched being a program chain for the objective "Steel Frame Construction."

The central function of the interface between the individual program links is assumed by a database, which is interrogated via an appropriate standard module. In the case of the flexible program chain "Steel Frame Construction," for instance, a database in the form of three data files has proved to be practical. /15/: /7

--Data file 1: Standard data, as for instance profiles commonly in use in this branch, or similar ones.

--Data file 2: Company-specific data, as for instance, profiles stocked by the company, company rules, or similar data.

--Data file 3: Data that are functions of the project.

One could probably set up additional data files but this may burden the end user with questions of data administration, like

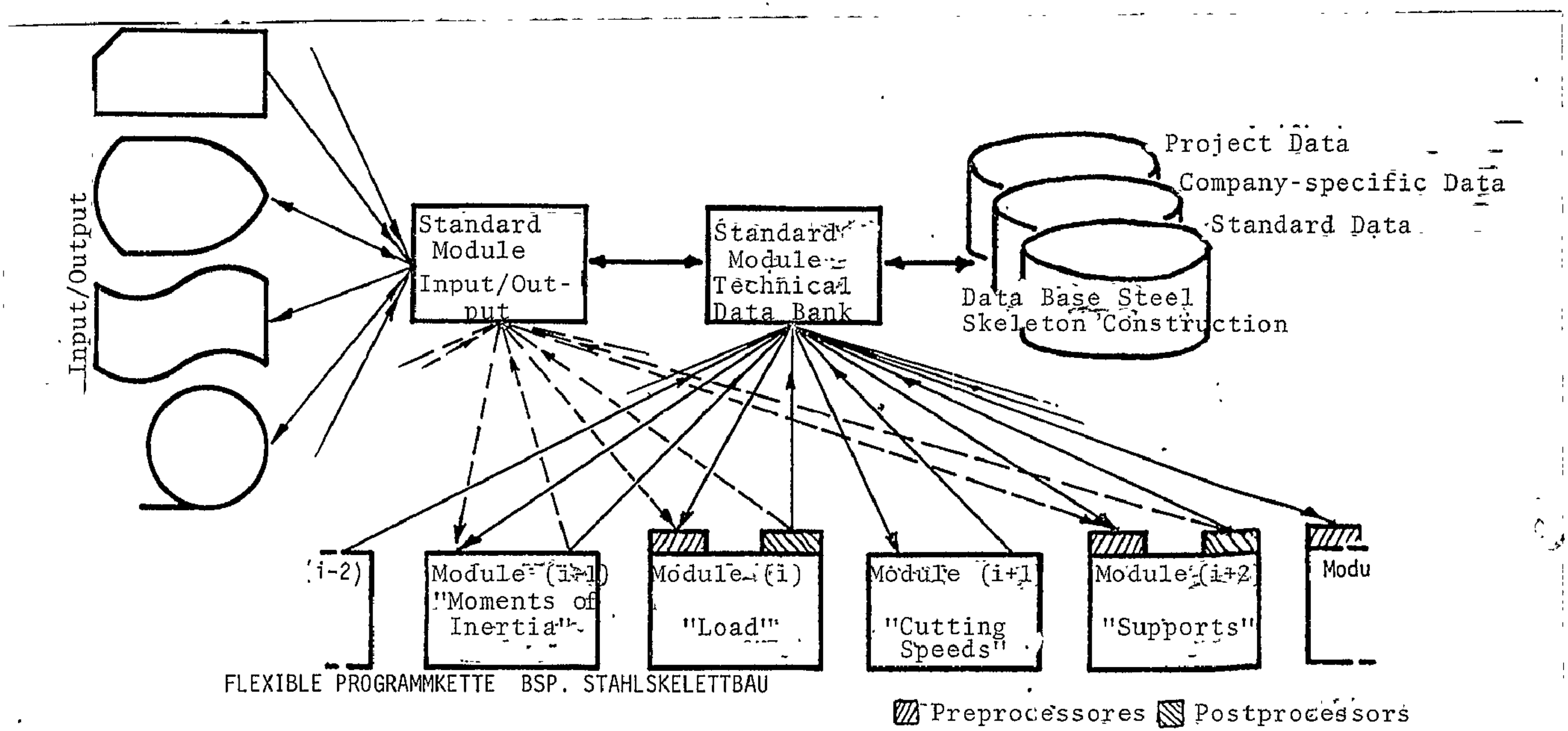

Figure 3. Development of Database-oriented flexible program chains.

what to do in case of an overrun of certain data files. In addition, there are standard models available--though not always satisfactory--for data administration (compare /3/,/16/,/17/, and others) which should be used. One will probably not be able to get by without a "technical databank" (compare /18/) in complex tasks, be it through new development or through modification of an existing system.

As shown in Fig. 3, the problem-oriented modules of the program chain read the input data only from the data base and enter the results into this database. The total data flow goes, therefore, through the database to which individual modules can be attached when needed. Newly to be created modules can thus tap the database directly while existing modules, which so far have seen only isolated applications for their "island" solutions, require small header and follow-up programs, so-called pre- and postprocessors (obliquely shaded) that take over the adaptation, i.e., reformatting.

Reasons of efficiency would call for replacement of the /8
available I/O modules through standard modules; but experience has shown that most programs are far from having as neat a modular arrangement as descriptions would have one believe, so that separation of individual program parts is generally not possible or only with great effort. The simplest and safest path is then the use of the existing user interface without even touching the existing program.

The attribute "flexible" expresses, in the example of the "Steel Frame Construction," shown here, that the program chain can be changed only through exchange of individual modules, and the eventually required changes in individual data fields of the data base, into a program chain for calculations of "Steel Halls," for instance, (the subject of investigation now underway is the question of how much a general but still practical database, "Steel Construction", can be realized).

Employment of the program chain by the user is also more practical via the database, the user corresponding with the database via the uniform I/O module and feeding data directly into the programs or receiving them (dashed lines) only in special cases. The latter possibility must be left open on principle so as not to overload the database too much with ballast. For the sake of uniformity of the I/O interface at least the I/O standard module /19/ should be employed, however. This makes possible input processing with or without format, thus preserving complete freedom in the type of processing (batch/ interactive processing) as well as in the choice of media (punched card, keyboard, etc.)

The advantage of the concept sketched here consists of the existence of clear interfaces once the database has been defined. Individual program developers can work rather independently, departing from the data base. This puts even more emphasis on the database which is to be determined within the scope of the program parameters (compare /3/). As the example shown here indicates, that is more of a task specific to the respective field than specific to DP. The actual program development can be started only when the program chain to be established by the user has been completely specified and when the data flow is clear. /9

There is still another interface, not mentioned so far: the interface with hardware.

Since hardware (in contrast to software) has gone through tremendous development in recent years, increasing value is being attached to program independence, i.e., their portability.

That can be achieved to a large extent through use of standardized higher level program languages. Standard-FORTRAN /20/--though not the best of all possibilities--has become predominant in the technical area. In the sponsored CAD project Standard-FORTRAN is generally used for the sake of portability. Program parts that do not conform with this standard are concentrated in appropriate subroutines and thus clearly separated, while assembler parts that are required for efficiency reasons are written only in addition to Fortran-subroutines.

Most of the CAD-programs now available run in batch operations on medium and large installations (see /5/ to /9/). Much greater application in practice will be achieved once it becomes possible to penetrate to the user's place of work so that he can correspond with the DP interactively or in multiple record conversation. Such a CAD-operator's position has one Mini-computer with sufficient peripheral equipment (screen, keyboard or table, printout, plate, reel, and operational software).

For the CAD program chains this means that individual modules must be programmable on a Mini(computer); in most cases it will be desirable, however, to store the data file of the data-basis, maintain and receive it centrally, according to the user's form of organization. This clarifies the requirement that the CAD-terminal on-line or off-line must have connections to a higher order computer. Such a goal may only be realized for general use, however, after additional decreases in the price of hardware will take place. Development work is going on in this direction (/21/ to /26/). /10

1.3 Forecast, Setting of Objectives for Future Work

The number of program chains existing, or being developed, in the individual areas varies greatly (see also project reports /5/ to /9/). Present CAD-applications are necessarily based on the available "island" solutions, with all the accruing disadvantages. About 20 program developments are presently underway, which aim at the creation of flexible program chains. Additional developments will have to be started to meet the CAD goals (see /1/,/2/).

The following criteria must be considered:

a. Database Concept

Data administration plays a big role in database-oriented program development. Present standard modules are limited to making data groups available in the form of continuous tables /3/, chains /16/ or data trees /17/.

Based on user requirements, the specification and availability of a standard module "Technical Databank" is required, similar to commercial databanks (see /30/ for instance).

b. Standard Modules /11

Increased emphasis must be placed in the future on creating generally applicable, problem-oriented Standard-Modules which are to be afforded within the scope of a generally accessible method bank. A typical example, as required for each program chain, is the Standard-Module "Geometry" /27/ to /29/, which takes over the storage and manipulation of geometric objects and their attributes inside the computer, so that sketches or NC-strips can easily be generated as results.

c. User Proximity

Users wrote the most successful CAD-programs in the past. In the future permanent professional direction is to be assured of development work, which may prevent development of theoretically more interesting but in practice perhaps less sought after programs in favor of actual satisfaction of user requirements.

d. Programming as Craft

Programming should be viewed less as an art or even as research than as a craft (which must nevertheless be mastered!). For that reason the "product" to be developed must in advance be accurately specified within the scope of the program requirements /3/, and be documented in detail during the development period. Included in this are exhausting tests of the product and pilot applications.

e. Maintenance, Operation

Maintenance (= error removal and realization) and operation of the program must already be assured during devel- /12
opment of the program. This is of particular urgency for programs developed at universities.

f. Standardization

Standardizing of the various interfaces (I/O, database calls, graphics, Fortran '77(?), geometry, etc.) must be insisted upon. On the other hand, enough freedom must remain for the developer to make his own decisions to respond, for instance, to given hardware situations, available software files or company-specific requirements.

g. Hardware Development

The more the structure of a program becomes modularized, the easier is it to adopt it to new situations (for instance to realization into hardware of items that have herefofore been programmed). The requirement for portability will, therefore, remain in the future as well but with a different meaning.

h. Collaboration: Information Theory Branch

Research results from information theory must be considered for activities in the various specialized areas, for instance for definition of data structures for a data base, determination of interfaces, and others.

i. Training

It follows that DP-education in the various branches, as well as training of users, must be intensified.

1.4 Fields of Application

In accordance with the overall goal of "modernization of technology" (compare /1/) the sponsorship is aimed at the industrial branches of

--Building Technology /13
--Electrical Engineering
--Mechanical Engineering

At this time the Sponsored Project CAD includes the topical high- points shown in Fig. 4; this arrangement is also a "table of contents" for the individual parts of the project report presented here.

COMPUTER-ASSISTED DEVELOPMENT DESIGN AND MANUFACTURE

BUILDING TECHNOLOGY

- City planning; restoration of old housing, traffic planning
- Construction planning/architecture
- Technical development
- General reinforced concrete technology
- Prefab reinforced concrete parts technology
- Steel construction
- Massive bridge construction
- Foundation engineering
- Roadbuilding
- Hydraulic engineering
- Cross-section problems specific to building technology

MECHANICAL ENGINEERING

- Machines and machine elements
  - Standard machine units
  - Nonuniformly transmitting drives
  - Machine tool units
  - Electr. and Hydr. systems
  - Mech. components and systems
  - Power sources
- Chemical engineering
- Shipbuilding
- Production data
  - Plotting of drawings
  - Plotting work schedule
- Auxiliary implements
  - Datafiles catalogs
  - Guidelines

ELECTRICAL ENGINEERING

- Energy supply and distribution
  - Electrical machines transformers
  - Distribution nets
  - Installation
  - Power electronics
- Equipment electronics
- Components

CROSS-SECTION PROBLEMS

- Finite element methods
- Geometry
- Technical databanks
- CAD/CAM-operator's terminal
- System cores
- Input connections
- Miscellaneous

Fig. 5. Arrangement of project "Computer-assisted Development, Design and Manufacture" status July 1978.

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2. Building Technology Branch

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The state of development of CAD varies considerably in the different specialties of building technology. Electronic data processing has only made a start in the daily practice of architects and consulting engineers while larger building contractors and public institutions are usually equipped with adequate computer centers. The bottleneck is here represented by the missing or nonuniform software, which prevents broad CAD-application.

Analysis of the present software supply reveals that programs which are entirely practice-oriented exist and are applied for certain tasks; for instance, for:

- --problems of statistical analysis (determination of cutting force from the theory of elasticity)
- --problems of street design
- --problems of text processing (proposal, award, accounting).

Reasonably complete program chains, which support the engineer from design to calculation, are only now being developed. Very few programs exist in the specialty construction planning/architecture, as well as in the areas where changing or expansion of regulations dictate new rules of computation which do not always correspond to DP-computation rules.

The development of CAD-programs is also made more difficult by the enormous flood of information that has to be handled in a building project with insufficient knowledge about its mathematical interrelation. Problems of organization, which originate in the permanent dialog between customer and contractor, also play a special role here. Further actions must concentrate on the solution of the following problem complexes, therefore:

a. Generation of organizational premises for CAD applications.

b. Program development.

c. Making programs available for broad application.

Activities within the scope of the sponsor project CAD are naturally only of a supporting character with regard to complexes (a) and (c); the bulk of CAD activities deals with development of programs and program chains. /20

The criterion "portability" and user-friendliness must receive high priorities if application of the programs is to be made possible for the many small consulting bureaus and building contractors. This also requires that the programs be applicable to minicomputers in interactive operation.

Prerequisites for the generation of complete and use-oriented program chains are quite favorable in building technology since--in contrast to other technical application fields--general development of its technology is not so fast that today's customary computing techniques would already be antiquated tomorrow. Up-to-date processes and methods (for instance contour changing procedures, finite element method) will, of course, also be considered.

Program developments in the Building Technology Branch can be assigned to the following subspecialties in which they are concentrated:

City planning; restoration of old housing, traffic planning
Construction, planning/architecture
Technical development

General reinforced concrete technology
Prefabricated reinforced concrete parts technology
Steel construction
Massive bridge construction
Foundation engineering
Roadbuilding
Hydraulic engineering
Cross-section problems specific to building technology

2.1 City Planning: Restoration of Old Housing, Traffic Planning /21

Development Status

The field of city planning is based mainly on the law encouraging urban construction (St. Bau FG) which has two goals:

--Improvement of the housing and employment situation, and
--Improvement of functionality.

When converting the goals of the above mentioned law into reality, the overriding aim becomes rehabilitation, which is to prevent further decay of neighborhoods by counteracting the accumulation of negative structural indications and by communal direction of restructuring processes. Experience with rehabilitations already carried out has perforce added another goal, that the changes also be socioeconomically acceptable to those affected by them.

Data processing already made its entry into this specialized area of building technology in the 60s, where the accumulation, turnover and analysis of large masses of data is concerned. This holds true for buildings and the people living or working in them as well as for the traffic. As soon as city planning goes into /22 the detailed objective-planning phase the application for DP becomes very small. The most important reasons for that are:

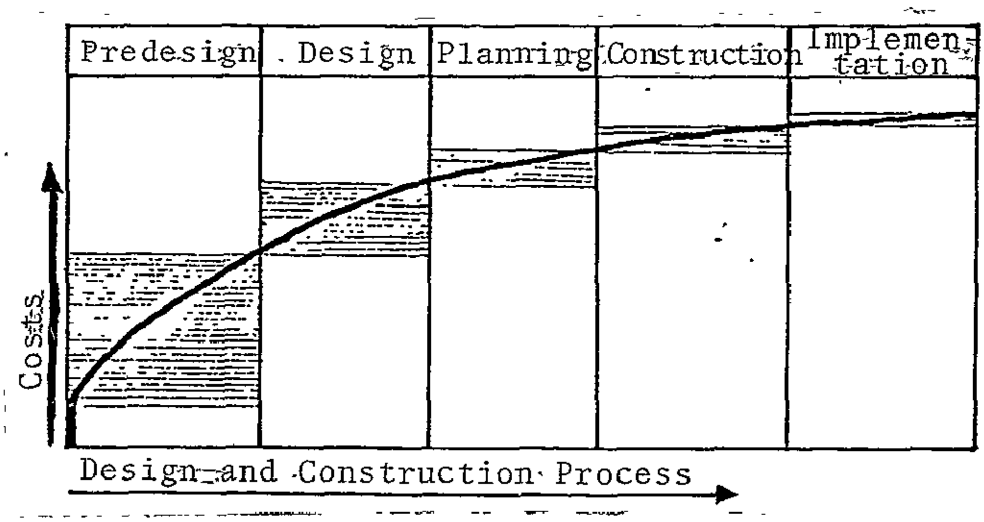
--the range of tasks is too manifold and heterogeneous.

--it is difficult or impossible to turn the tasks into algorithms (social level, rentability and personal financing!)

--the effort for data collection is highly work-intensive and cost-intensive.

Setting of Objectives

The most significant and most cost-intensive measures for rehabilitation of old housing, as well as for traffic planning, fall into the phases of establishment of basic conditions--preplanning--planning of design. Those decisions can, by means of DP, be put on a secure basis. DP can be used here for collection and storage of information on the one hand and as technical aid in design and planning.



Routine operations such as proposal writing, tender offers, price breakdowns, letting of contracts and accounting should be reinforced by means of DP so as to leave the architect free for tasks that cannot be carried out by machine. /23

Points of Emphasis of Development

Buildings in the special area of rehabilitation of old housing are to be identified in a way suitable for DP; a plan of the new construction is placed over an internal computer model of the existing structure. Planning of the rebuilding can be carried out subsequently with computer support.

A special program is developed, attuned to the special requirements of rehabilitation of old buildings, to support the carrying out of required steps. By means of a system simulating the function of a power economy, existing conditions and eventual alternate rebuilding possibilities can be examined. These examinations refer to the use of different building materials, heating systems, energy supplies, etc., with investment and maintenance costs always being accounted for.

A memory is established for storage and retrieval of data, providing interfaces to existing CAD programs (AVA, plotting of building contours, statics, technical development).

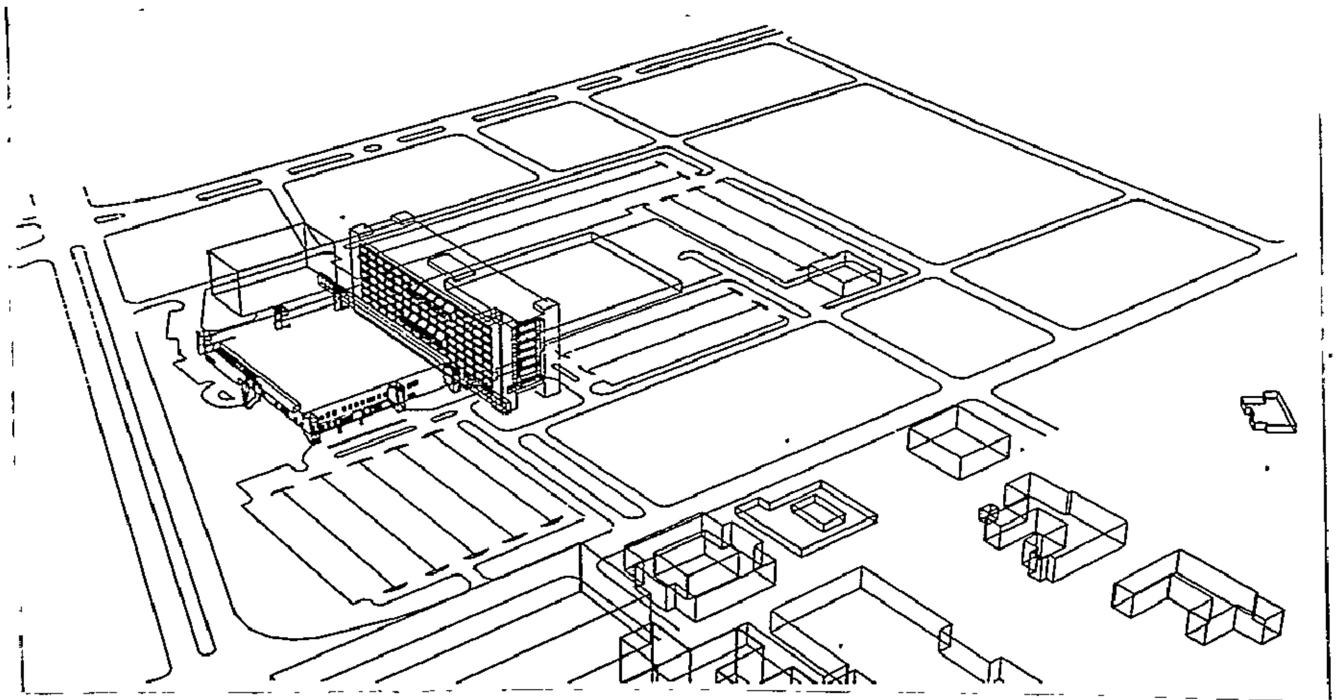
A simulating model will examine and evaluate behavior in traffic, of the total population, for the special area of traffic planning. The simulator model includes the following steps:

--traffic generation /24
--traffic distribution
and
--choice of means of conveyance,

and is far easier to understand in general and far more cost-effective than traditional simulator models for traffic planning, because of the strongly reduced collection effort. This is an important point, particularly for small communities which were so far unable to afford traffic planning with the appropriate instrumentation.

List of Program Developments

Report Page	Author of Program	Topic	Name of Program	Notes
		Restoration of Old Housing		
51/26	RIB e.V.	-Building inventory	78-80	BESTAND
51/28		-Interactive conversion planning	79-81	UMBAU
51/30		-Planning oper. sequence	78-79	ABLAUF
51/32	RIB/BAM Stuttgart	-Space information storage	78-79	RAUM
51/34		Examination of the economy of power	79-80	ENERGIE
		Traffic planning		
51/36	Kocks Consult. Inc. Koblenz	Simulation, local passenger traffic	1978	SIMPNV



Drawing generated automatically by Perry Dean and Steward, Architects, Boston

State of Development

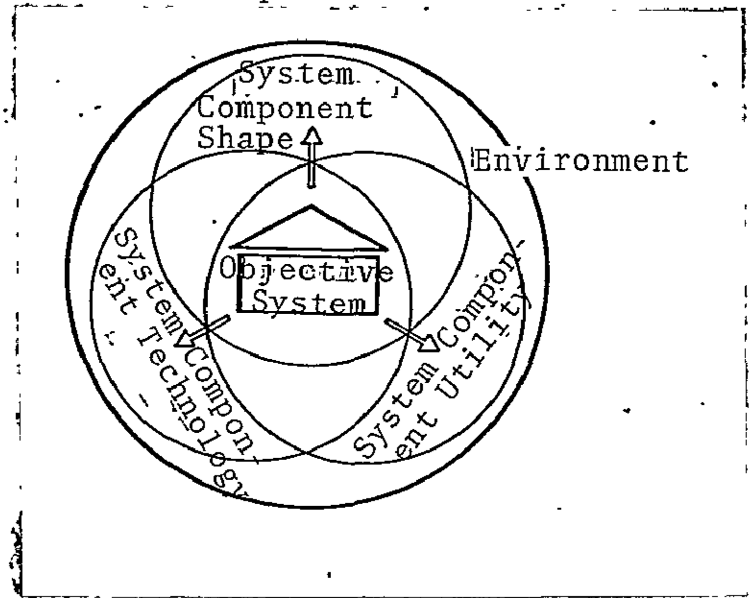
The use of DP in the field of architecture is extraordinarily small when compared to the other specialties of the building industry. There are various reasons for that, some of them are:

--The task spectrum of architects is too manifold and heterogeneous.
--The problems are difficult to state in algorithms.
--Individuality of the user.
--There are no large architectural firms in Germany, which might carry out CAD-developments.
--CAD-uses heretofore have proved to be too expensive.

Setting of Objectives /26

Similar to the special areas of rehabilitation of old housing and traffic planning, the most important and potentially most expensive decisions in building construction planning also fall into the preliminary design and design planning phases.

The complex objective being planned must be integrated into the environment surrounding it. The objective itself is composed of the system components of shape, utility and technology, which must be compatible and attuned to one another.



DP can be employed here for <u>short-term acquisition</u>, for <u>administration</u> and for <u>information exchange</u>, but also as <u>technical aid in design and planning</u>.

DP-beginnings, which have been modest so far, are also to be amplified in the area of <u>subcontracting</u> to release architects from routine operations for more important tasks.

The development of DP into an effective aid for the planner /27
is predicated, however, on the simplification and standardization of the conventions customary in the field of architecture. This

includes the formulation of standards, in suitable form for DP, agreement on uniform coding, systems of building, rasters, etc.

It also requires readiness by those affected, to proceed methodically along this path.

Points of Emphasis of Development

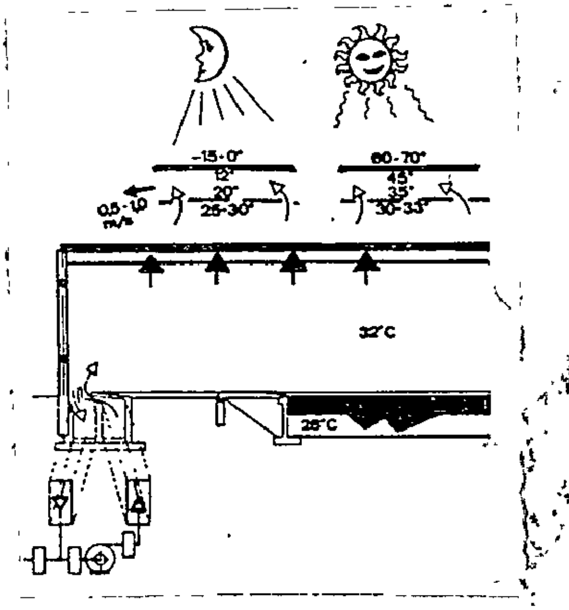
The CAD-proposals of the specialized field of building construction/architecture are primarily in the nature of studies. The proposal "Database building construction" (Professor Schwarz/TH Darmstadt) serves for investigation of the dataflow between employer and employee and has as its aim the increase of the use of DP as means of rationalization (simplification of, data transfer, of documentation, etc., employment of new storage techniques, like microfilming for instance, and similar ones).

The proposal GEAKON by Professor Emde/TH Darmstadt deals with the use of DP in the design process. To guarantee the relevance of this proposal to the practice the architectural firm Straub will install the GEAKON-system as pilot user.

Reports/ Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/41	Tech.U.Darmstadt Prof. Schwarz	Database building construction	76-78		Study
51/42	Tech.U.Darmstadt Prof. Emde	Interactive construction system	75-78	GEAKON	
51/44	Architect's Office Straub, Nidda	Pilot application GEAKON	78-80	GEAKON PRAXIS	
51/45	University Kassel Prof. Keller	Databank "standard costs"	74-78		Study

2.3 Technical Implementation

State of Development



Only very recently have physical problems that occur in the building industry (heat insulation, sound proofing and protection against humidity) gained attention.

Within the scope of CAD there are individual programs for the solution of problems in temperature regulation (heating, ventilating and air conditioning) of rooms. The algorithms are generally based on highly simplified procedures.

The requirement for more accurate methods of computation is combined with one for increased support through DP. The available supply of programs for it is insufficient.

Setting of Objectives

The technical implementation is a part of building construction; for that reason it cannot be isolated from the other requirements for building construction. First we will clarify the individual connections between building construction and technical implementation. That will provide our answer to the question of whether the generation of program chains to include the entire field of building construction makes sense from the user's point of view or not.

Program developments are initiated and accelerated for instant satisfaction of demand; independent of a potential overall concept. Since the potential users are predominantly smaller offices or companies, such programs should also be applicable for the minicomputers available to them.

Points of Emphasis of Development /29

Program developments for the special field of technical implementation deal with the topic "heating, ventilating, air conditioning,cooling (HVAC)."

Developments which have been pushed forward since 1973 with the cooperation of the National Association of Industry Groups for Heating, Airconditioning and Sanitation Engineering, Düsseldorf, have set as their goal the availability of a comprehensive system of programs, which is being realized within the scope of the IST (Information System Technology).

The following program building blocks are ready:

--Loads and outputs
--Costs

Recently completed, resp. being developed, are:

--Networks for fluids
--Air channels
--Instruments

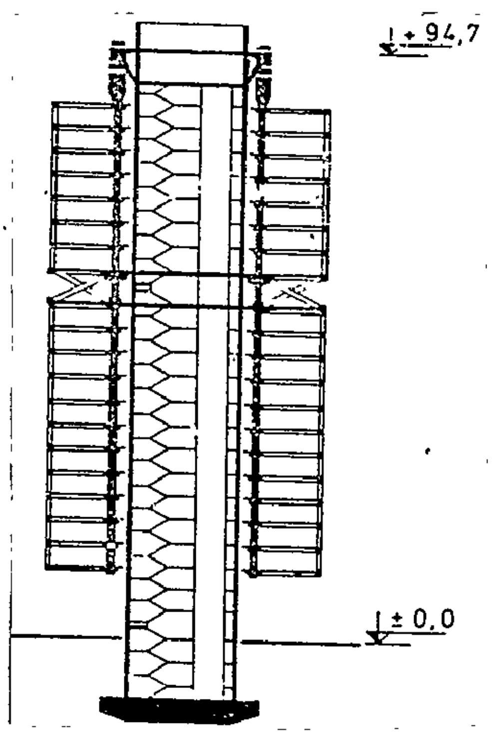
In parallel to the above, Prof. Pahl of the Tech. Univ., Berlin, is providing the graphic building blocks for the individual building blocks.

The proposal by BBC, Mannheim, which deals with the dimensioning of solar installations as replacement, resp. auxiliary heating facility, for one-family and multi-family housing, also belongs to this program system.

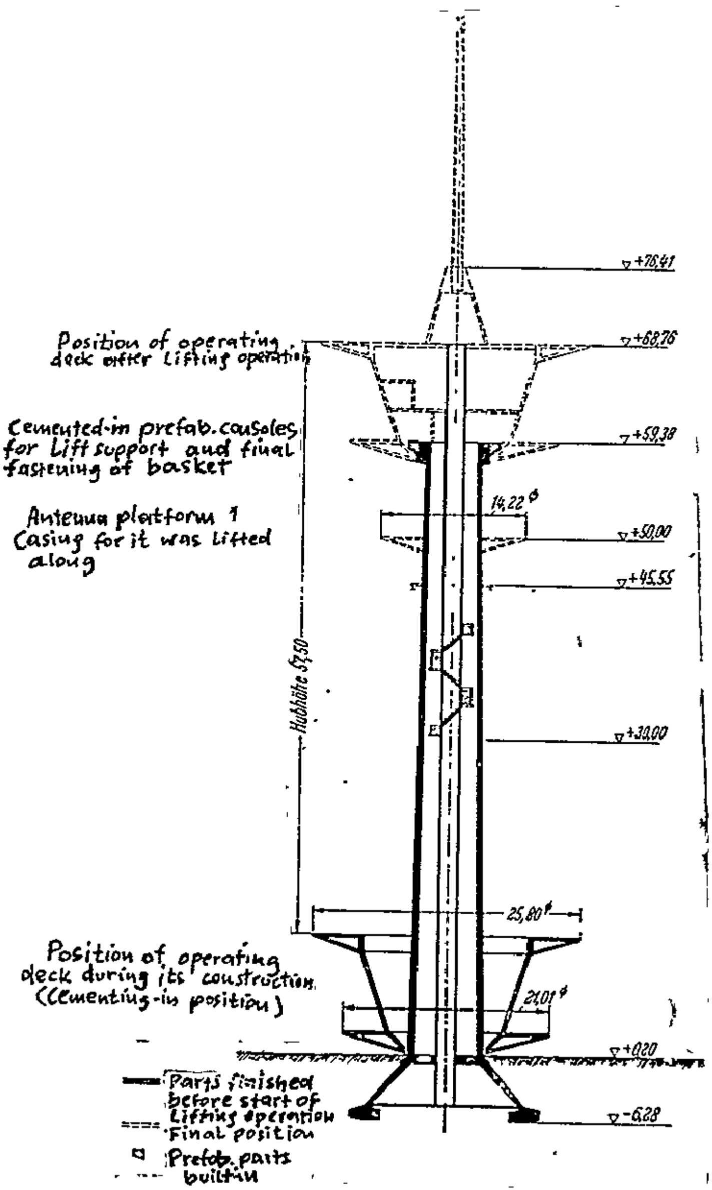
In addition to these program systems, a program building block "Heat Insulation" is being developed by RIB in Stuttgart, within the scope of the program system PROFES (Projection of Prefab. Skeleton Structures).

Data telemetry is to make the application of the individual programs available to smaller companies/architects offices, as well. /30

Report/ Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/50	Natl.Assoc.of Heat Vent. and Sanitary Enging.Technol. Düsseldorf	Heating, Ventilating, Air cond., Cooling	73-77		IST/KFK CAD 42
		"Loads and Outputs"	-76	HLKKLL	IST
51/52		"Costs"	-77	HLKKES	IST
51/54		"Networks for Fluids"	-78	HLKKNE	IST
51/56		"Air channels"	-79	HLKK	IST
51/58		"Instruments"	-79	HLKK	IST
51/60	TU Berlin Prof. Bahl	IST Building Block HLKK-Graphics	76-79	HLKKGR	IST
51/62	BBC,Mannheim	Dimensioning of Solar Installation	1978		
51/180	RIB,Stuttgart	Economically Optimal Heat Insulation	1977	OPTIW	Chain PROFES



BMW-High Rise Building from "Ingenieurbau" by F. Leonhardt



Telecommunications Tower Wiesa from "DER BAUINGENIEUR" Vol. 48/1975, issue 5, Grün & Bilfinger, Mannheim

State of Development

In the special field of reinforced steel construction, in which the program supply available heretofore consisted of a sum of heterogeneous isolated solutions, two comprehensive program chains stand out at this time, which meet the expectation of a complete treatment of problems presented and which are already finding partial practical application as pilot projects.

Developments have so far been marked by efforts to create programs as generally applicable as possible. This makes the input effort and the times for calculation large and the programs often run only on large-scale installations and computers of the MDT, which makes them useful only for medium and small businesses via Service-Computer centers. /32

Beyond this there exist only individual programs for partial problems, not well attuned to each other, whose intended usefulness is partially destroyed by too great an effort needed for application.

Numerous programs for structure analysis (rigid joint-frame, resp. finite-element-programs) exist today for linear applications.

For cases of application that are geometrically nonlinear (tower-shaped structures, network constructions, or similar) only a few special programs exist and treatment of problems outside the elastic limit (plasticity, flawed tension zone, shrinking and creep) is unsatisfactory.

A program choice that provides complete handling of problems specific to building technology must include, for instance:

--Determination of geometry
--Building technology (also technical implementation)
--Formation and selection of loading conditions
--Proportioning, all proofs
--Generation of plans

--Determination of mass, required concrete casing
--Calculation
--Accounting

The program development is influenced, however, by the, presently, DP-friendly formulation of the regulations. In a new edition of the DIN Standards, DIN 1043 for instance, care should be taken in advance that regulations can be transformed into algorithms with justifiable effort.

Setting of Objectives /33

Complete program chains are to be established for selected objectives (high-rise buildings, halls, towers, etc.). The following points must enter into the considerations:

--Uniformity in the application of all program parts belonging to a chain.
--Changes in planning must be considered in the program.
--Program parts must also be separately usable. Data flow over several building blocks should be executed only when it is also advantageous in the sense of the application.
--Requirements for storage in a core memory should be limited to about 64 KB to permit utilization of minicomputers.
--The use of the programs at so-called Interactive Construction Places (ICP) increases the user-friendliness of the programs.
--Expansion to geometrically nonlinear cases of application and to problems outside the elastic limits.
--Use and adaptation of individual programs already in existence.

Points of Emphasis in Development Work

The new proposals of 1978 aim primarily at the development and expansion of the "program chain DIN 1045" and of the "program system for rod statics problems" (PAS).

The data base is a total concept of the DIN 1045 chain. Data structures are realized in it, in which all data important for the process of design are filed and arranged according to definite criteria. Individual programs have access to these data from the data base; they can also expand or change these data. The data base thus represents an interface to which existing individual programs,or those yet to be developed, can be attached.

New individual programs, all designed for a core memory requirement of 64 KB, are: /34

S-RIB/141	"Design of reinforcement for reinforced concrete support structures. Part: Building construction supports"
S-RIB/142	"General Plate Systems in Building Construction"
S-RIB/122	"Building Calculations for Running Beams of Reinforced Concrete per DIN 4224"
DA-KRE/112	"Reinforcement of Support Elements Made of Reinforced Concrete"

The proposal "PAS" (Prof. Ebel, T.H. Darmstadt) also offers a point of departure for a program chain for which special reinforced concrete modules are set up by the Philipp Holzman Company, the pilot user. The existing bearing load module is expanded in a forthcoming proposal (DA-EBE/101).

The proposal F-KHE/101 "Framework Systems in Building Construction" provides a closed solution for calculation of building construction frameworks, in which the core of the high rise building (Proposal S-RIB/108,122) acts as central building block to which other framework systems are attached.

The other programs contained in the following catalog are individual programs where development is completed in most cases and which are available for applications.

List of program developments.

Report/ Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/70	RIB, Stuttgart	Data base DIN 1045 Reinforced concrete construction in the building industry	76-79	DAISI	Chain DIN 1045
51/72	RIB, Stuttgart	Continuous girder in building construction	72-73	DLTDIN	Chain DIN 1045
51/74	RIB, Stuttgart	Bending calculation for continuous reinforced concrete girders	77-79	CURVE	Chain DIN 1045
51/76	BGS, Frankfurt	Optimization of prestress in bar systems	76-78	OPTVO	Chain DIN 1045
51/78	RIB, Stuttgart	Continuous plates and flat slabs in building construction	76-77	DUPLA PILZ	Chain DIN 1045

Report/ Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/80	RIB,Stuttgart	General plate Systems in Building Construction	78-80	ALPLAT	Chain DIN 1045
51/82	RIB,Stuttgart	Core of High-Rise Building	73-78	KERN	Chain DIN 1045, PROFES
51/84	König-Heunisch, Frankfurt	Framework System in Building Construction	78-79	ASS	Chain DIN 1045 PROFES
51/86	RIB,Stuttgart	Oblique Flexure	72-73	ZWAX	Chain DIN 1045
51/88	BGS Frankfurt Radmer, München	Calculation and drawing of reinforced concrete continuous beams	1975	R10	
51/90	BGS,Frankfurt	Total concept of building structures	75-77	ALKOS	Chain DIN 1045
51/92	TH. Darmstadt Prof. König	Gen. program for tech. construction drawing	75-77	MENOS	Chain DIN 1045
51/94	BGS,Frankfurt	Determination and presentation of reinforcements	1977	MINOS	Chain DIN 1045
51/96	TH. Darmstadt Prof. König	Drawings of reinforcements for continuous girders	74-75	BEDUL	Chain DIN 1045
51/98	BGS,Frankfurt	Drawings of reinforcements for plates	76-77	PLABE	Chain DIN 1045 PROFES
51/100	RIB,Stuttgart	Design of reinforcements for architectural construction supports	78-80	KOBEST	Chain DIN 1045 PROFES

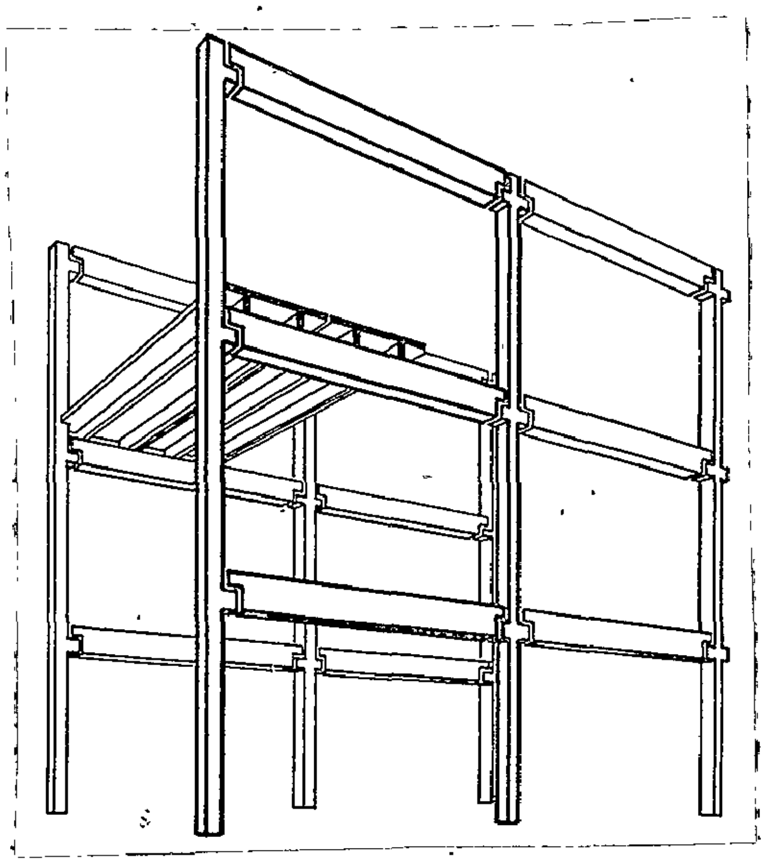
Report/ Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/102	Krebs-Kiefer Darmstadt	Reinforcement of supporting elements of reinforced concrete	77-80	MKBEWE	Chain DIN 1045 PROFES
51/104	TH. Darmstadt Prof. Ebel	PAS--Program System for problems in rod statics	74-80	PAS III	
51/106	P.H.Holzmann Frankfurt	Stability and nonlinear behavior of materials in reinforced concrete frames	76-78	PAS III Reinforced Concrete	
51/108	Hochtief AG. Frankfurt	Scope and Theory II. Order	74-76		Chain PROFES
51/110	Hochtief AG. Essen	Calculation and proportioning of planar rigid frames	67-75	BEST-PROB	Chain PROFES
51/112	Krebs - Kiefer Darmstadt	Continuous load bearing elements in architect. building construction	74-75	MKDULB	
51/114	Krebs-Kiefer Darmstadt	Proportioning, stresses, equations, buckling resistance	74-75	MKBEME	
51/116	Krebs-Kiefer Darmstadt	Measurement and proof of stability for orthogonal reinforced concrete frames	74-75	MKTZOR	

/36

Report/ Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/118	Radmer, Munich	Reinforced concrete bar loaded in two axes, per theory of II. order	74-75	R4	
51/120	Radmer, Munich	Reinforced concrete frame system with optimized metal reinforcement	74-75	R2	
51/122	RU. Bochum	Continuous girder	73-75	HKNOPF	IKP (Inter-active)
51/124	Prof. Flessner	Bending in one axis	73-74	DIABEM	IKP Construc-tions
51/126		Oblique Flexure	73-75	DIATRA	IKP (Place)
51/128		Planar Frames	73-75	BESID	IKP
51/130	TU Berlin Prof. Pahl	IST-Building block statics of arch. Building con-struction	76-77	BAUSTA	IST (In-formation System Technology)
51/132	Hochtief AG.	Interactive calculation and construc-tion of tower like buildings	76-78	TURM	Chain "Tower"
51/134	RIB, Stuttgart	Rotary shells	73-77	ROTAL	
51/136	TU Stuttgart Prof. Argyris	Finite ele-ment method reactor de-sign	1977	SMART	Not spon-sored by CAD funds
51/138	Nord-West Hannover	Planar sup-port systems w. rotational symmetry	74-76	FLAWER	Not spon-sored by CAD funds

Report/ Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/140	Consulting Engineers, Maack, Salzhausen	Wooden lattice girder	75-77	FWKZE	Not sponsored by CAD funds
51/142	RIB, Stuttgart	Quantities Metal reinforcement	74-75	MENGEN2	
51/144	RIB, Stuttgart	Genl. Building accounting	73-74	MENGEN T.3	Chain DIN 1045
51/146	TU Berlin Prof. Wiedemann	Design optimization of lattice girders accdg. to costing criteria	-78	SSIMP	Not sponsored by CAD funds
51/148	TU Berlin Prof. Wiedemann	Optimization of frame systems	1974		Study
51/149	T.H. Darmstadt Prof. Konig	Standardization of metal reinforcement drawings	75-76		Study
51/150	MBB, Munich	Reinforcements for penetrating structural elements and recesses	73-74		Study

2.5 Constructing [illegible] Prefabricated Reinforced Concrete Components /37



State of Development

The present fierce competition in the building construction industry and the rapid development of EDP has prompted several manufacturers of prefabricated reinforced concrete parts to carry out the design and planning procedure of construction using prefabricated reinforced concrete components, with the aid of DP. EDP is used here not so much as a "fast computer" but rather as "data processing instrument" for the optimal planning and control of production from receipt of the order to submission of the bill, and for full use of the operating capacities.

Unsuccessful attempts at standardization of prefabricated parts have in the past, as well as now, been a deterrent to a computer-aided planning process. /38

Objectives to be met

Most of the buildings in construction employing prefabricated reinforced concrete components are skeleton structures with a rectangular raster.

In a first step a program system PROFES (Technical Projection of Fabricated parts--Skeleton structures) is developed for these buildings which supports the entire process of planning and construction up to manufacturing planning and control.

To start with this programming system is to be used as a pilot project in one or two plants producing prefabricated components.

In a second step appropriate programs for other buildings (for instance, halls, sloping constructions) must be initiated. Within the scope of developing programs for manufacture of prefabricated reinforced concrete parts a classification of the usual fabricated parts is unavoidable. This classification (given in program PROFES by the standard element catalog (SEC)) and the coding required for handling it are to be the starting point for a generally accepted standardization of prefabricated elements and their description.

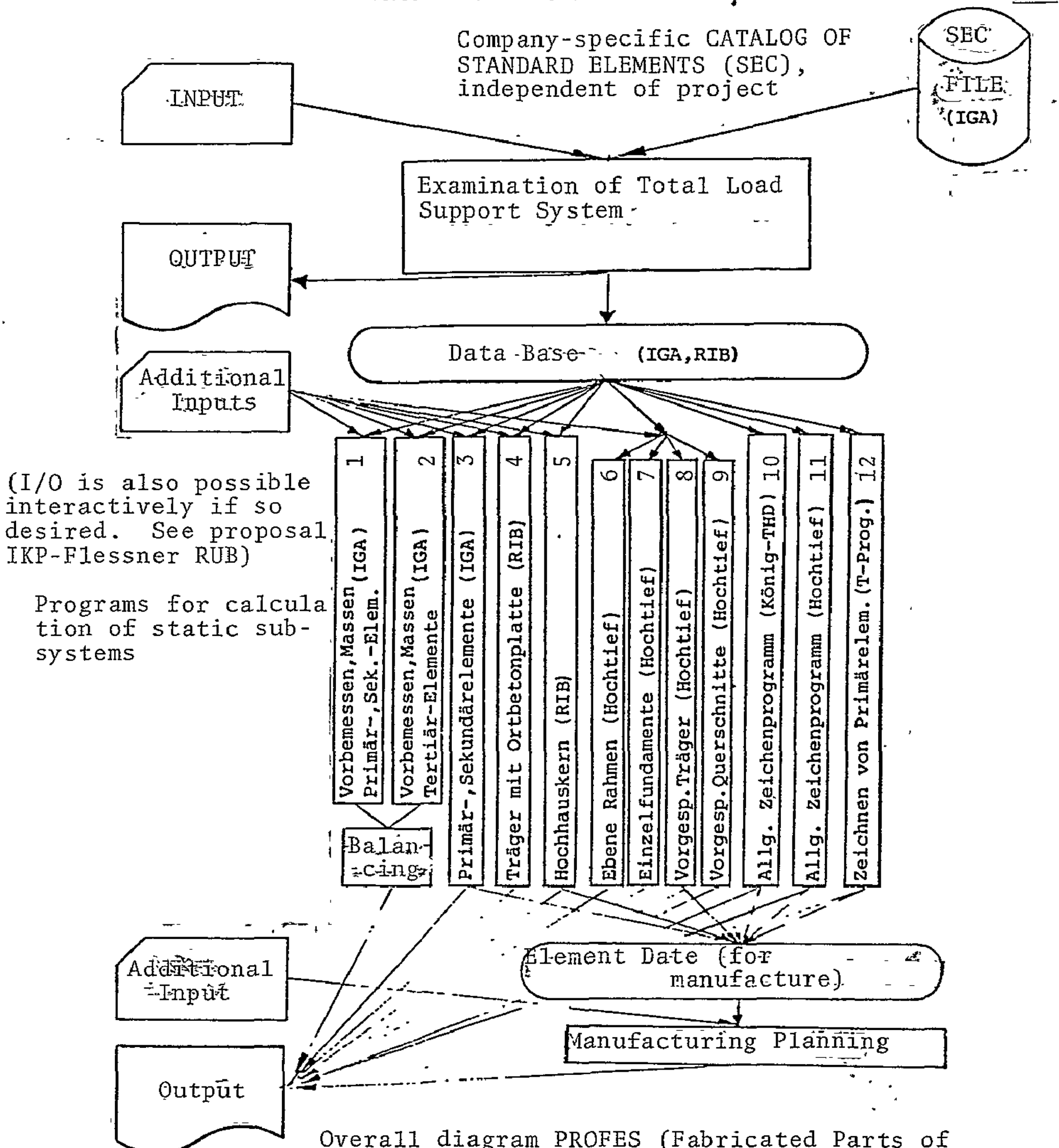
Points of Emphasis in Development

Development of the program system PROFES will be finished in 1978 and tested in practice as pilot proposal (FR-KOC/101). The practical test will show how far the system can be broadly applied, resp. where expansion and additions of program building blocks are necessary.

The following considerations were at the forefront in the concept of PROFES:

--Separation of data that are project-dependent, company-specific and generally applicable.

CONCEPT OF PROFES



Overall diagram PROFES (Fabricated Parts of Reinforced Concrete)

(1) Preproportioning, masses, Prim.-Sec. elements (IGA). (2) Preproportioning, masses, tertiary elements (IGA). (3) Primary-secondary elements (IGA). (4) Girder with concrete stringer plate (RIB). (5) Core of high-rise building (RIB). (6) Planar frames (Hochtief). (7) Individual foundations (Hochtief). (8) Prestressed beams (Hochtief). (9) Prestressed cross-sections (Hochtief). (10) General Drafting program (Konig-THD). (11) General drafting program (Hochtief). (12) Drafting of primary elements (T-Progr,).

--each company can set up its very own catalog of standard elements (SEC); only the coding is universally applicable. /40

--densification principle: The stack of data, which grows in the course of the planning process, is accounted for (densification principle).

--transparence of the calculation process (test statics).

--possible connection of available programs as subsystems.

--employment of minicomputers.

--use with ICP: The proposal by Dr. Flessner, Ruhur-University Bochum aims at achieving a PROFES-version capable of dialogue, which is suitable for use at so-called Interactive Construction Places (ICP). (See also KFK-CAD 26 for detailed information.)

List of Program Developments

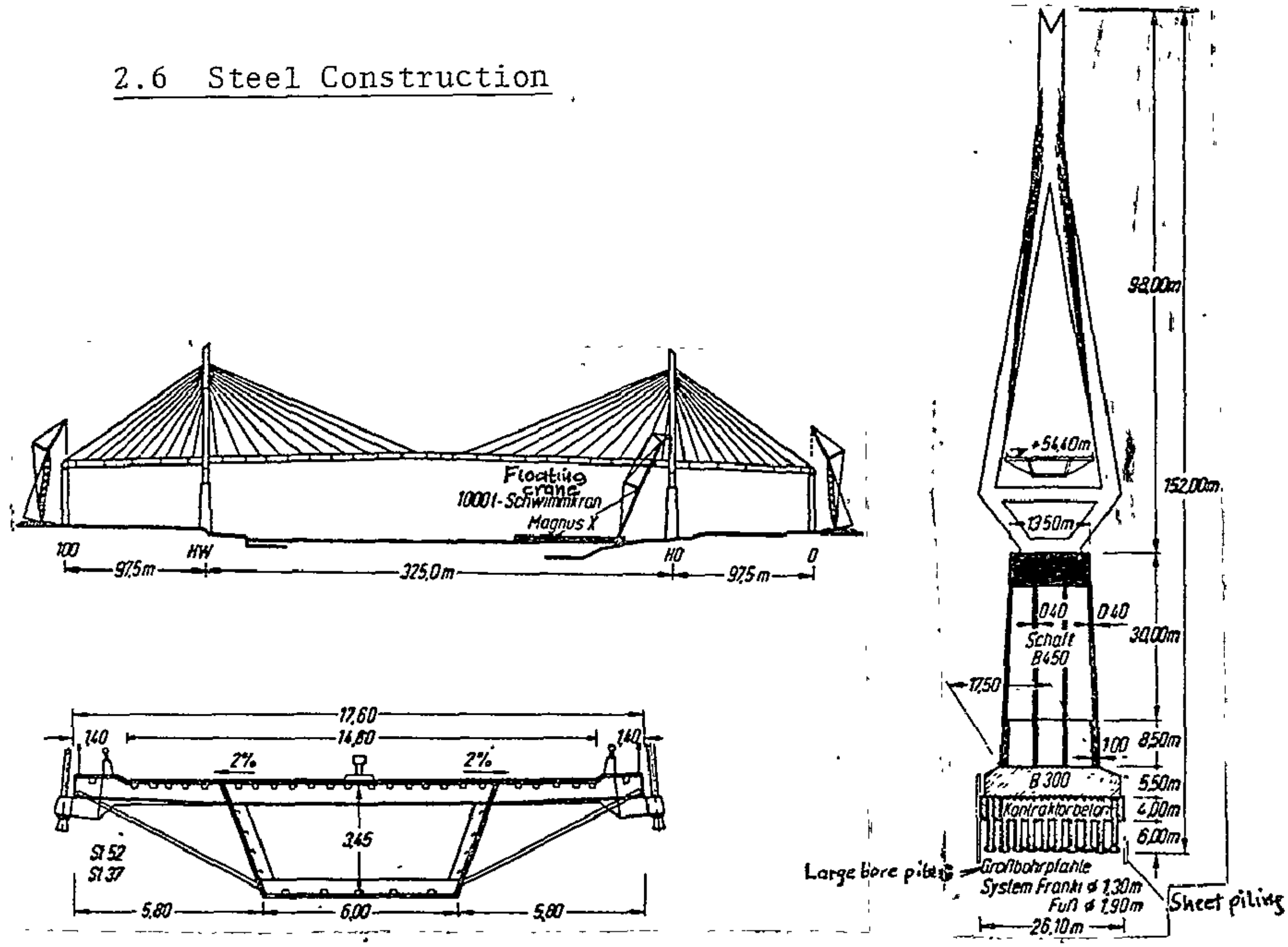
Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/156	RU Bochum, Flessner	Interactive input dialog for the program system PROFES	76-77	DIAPRO	Chain PROFES
	Engineering Group Assman, IGA Braunschweig	Technical projection of skeleton structures built of prefabricated parts			KFK-CAD 26
51/158		-overall system	75-78	PROFES	Chain PROFES
51/160		-Load computation	75-78	"	"
51/162		-preliminary statics, masses	75-78	"	"

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes	
51/164		-calculation, proportioning and drafting	75-78	PROFES	Chain PROFES	
51/166		-balancing of elements	75-78	"-BILEL	"	
51/168		-primary and secondary elements, static calculation and proportioning	75-78	"-PRISE	"	
51/170		-organization of standard element catalog (SEC)	75-78	"-ORSEK	"	
51/172		-prelim. statics proportioning and identification of tertiary element masses	75-78	"-VEMST	"	
51/174		-load transfer through support trains	75-78	"-SKS	"	
51/176	RIB e.V. Stuttgart	Proportioning of building construction supports	75-76	BEST	"	/41
51/178		Prestressed prefab. girders with subsequently installed concrete stringer plate	75-76	FERMO	"	
51/82		Core of high-rise building	73-79	KERN	Chain DIN 1045	
51/180		Economically optimal heat insulation for skeleton structures built of prefab. elements	1977	OPTIW	Chain PROFES	
51/92	TH Darmstadt, Prof. König	New construction and modification of tech. objectives according to the principle of Mech. Assy. Technique	75-77	MENOS	Chain DIN 1045	

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/182	Hochtief AG. Frankfurt	Designing with prefabricated reinforced concrete parts	74-76	FTKO	Chain PROFES
51/184	T-Program	Casing and reinforcement plans for prefab. concrete parts	74-77	STF-PLOT	"
51/186	Hochtief AG	Connecting program for the "statics of prefab. component fabrication"--system	75-77	ANSL-PROF	"
51/110		Calculating and proportioning of planar frames	67-75	BEST-PROF	"
51/332		Individual foundations	73-75	EIFU-PROF	"
51/188		Prestressed cross-sections	72-75	VORQ-PROF	"
51/190		Prestressed prefab. girders	64-75	VOFE-PROF	"
51/192		Index of elements	77-78	STUE-PROF	"
51/194	Krebs-Kiefer Darmstadt	Prestressed prefab. girders.	74-76	MKVOBI	
51/196		Prestressed Hyperboloidl casements.	74-75	MKHPV	
51/102	Krebs-Kiefer Darmstadt	Reinforcement of supporting elements made of reinforced concrete	77-80	MKBEWE	Chain DIN 1045 PROFES
51/198	Koch, Freiburg	Pilot application PROFES	78-80	PROFES	Chain PROFES

2.6 Steel Construction

/42



Köhlbrand-Bridge, Hamburg.

State of Development

The following task areas are usually distinguished in steel construction:

a. Static analysis

b. Proportioning and individual tracings

c. Planning and control of manufacture, assembly.

For the static analysis (a) the generally available frame and finite-element programs are applied; numerous programs exist for proportioning and individual tracing (b). Acceptance of these programs is small, however, because the general analysis programs are not sufficiently well suited to the requirements of building with steel (profile supply used, or similar matters) or to special building systems or steel building constructions. Another difficulty arises in that the analysis programs require larger computers while proportioning and individual tracing of proofs is carried out on small computers, separate from the analysis.

Programs for planning and control of manufacture (c) are often company-specific. A connection to (a) or to (b) does not exist usually.

Objectives to be Achieved /43

A connection between the three task areas mentioned is to be established, in line with the concept of the program chain. Program chains are to be developed, depending on the type of construction and the building system, which can be run from the acceptance of an order to NC-controlled manufacuture.

Attention must be paid to the following items:

--uniformity of operation for all program building blocks belonging to a chain.

--allowances for changes in planning must be made in the program.

--program components must also be applicable individually.

--data flow over several building blocks should be arranged where it is to the advantage of the application.

--program components are to be applicable for minicomputers; the core memory capacity requirements should be restricted to 64 KB to guarantee wide application.

--individual input steps are to be handled interactively so as to increase user-friendliness.

--use and adoption of already existing individual programs.

Points of Emphasis in Development

The proposal of a Steel Construction Databank (BO-ROI/103) forms a basic concept of the various program chains, similar to that in reinforced concrete building. Data structures, in which all the data important for the construction process are arranged and filed according to certain criteria, are realized in this concept. Individual programs have access to the data of this database, which they can also expand or change. The database thus represents an interface to which presently available programs, or those yet to be developed, can be attached.

Aside from this steel construction-data bank, the development and practical testing of program chains through pilot applications is being continued (Prof. Roik, Prof. Jungbluth, Goldbeck Co., GREBAU Co.).

The programming system for assignments in rod statics (PAS) /44 is expanded by the part "rigid body kinetics of moving support structures", and the carrying capacity procedure, very frequently used abroad, is accounted for by the program developments of

Prof. Ebel/Uhlmann, of "PAS-Yield Hinges" TH. Darmstadt and of the "program for proof of safety factory" by the MAN Co., Gustavsburg.

The connection to CAM, i.e., to computer-aided manufacture, is established by means of the proposal "design, work preparation and manufacture" by Prof. Roik, RU Bochum. The proposal by Prof. Wunderlich "program building block for the stability of a global rod," which is calculated by means of the method of finite elements according to the theory of II. order, is used as pilot proposal by ERS in Saarbrücken.

The following additional proposals are concerned with the development of program chains:

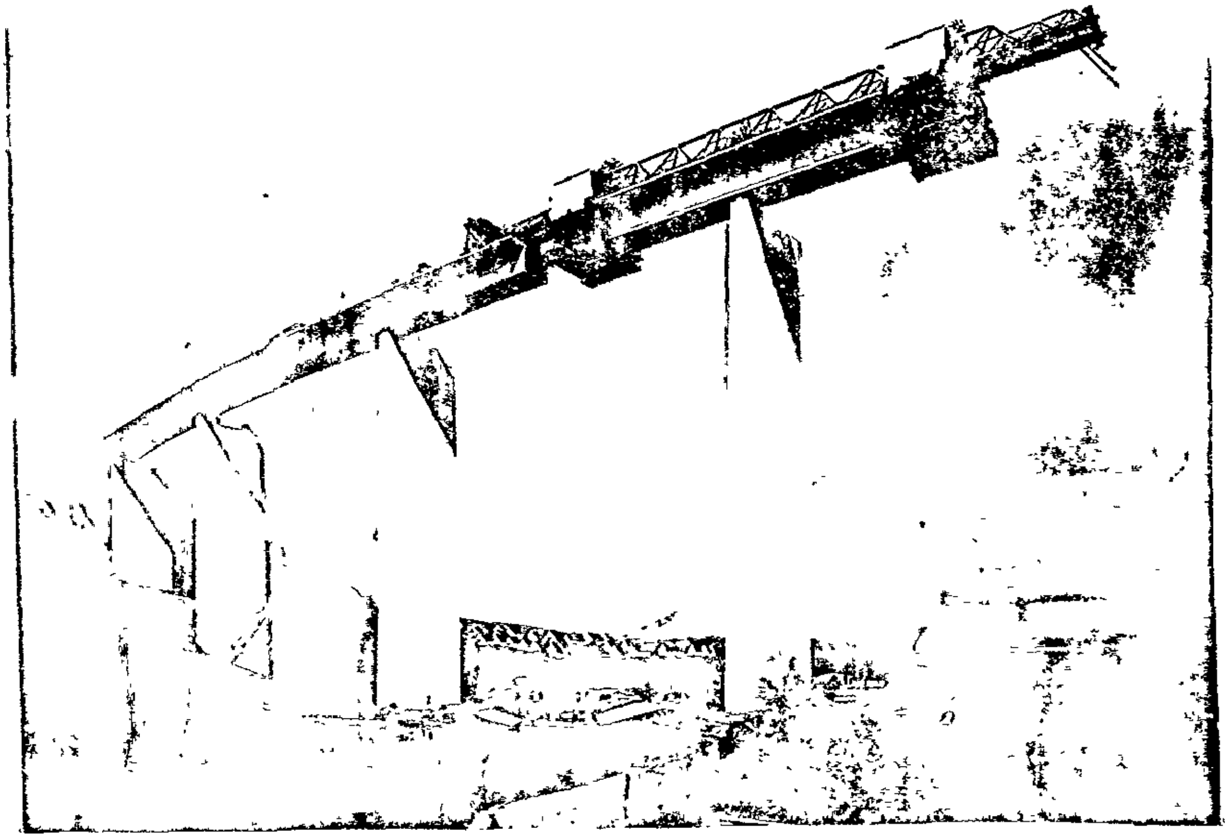
--steel bridges (Krupp Co.), completed.
--steel skeleton structure building (Krupp Co.).
--building of steel halls (Prof. Jungbluth, TH. Darmstadt, GREBAU Co.), Compound-bridges (ERS Soarbrücken).
--masts (ERS, Saarbrücken)
--towers (ERS, Saarbrücken)
--load capacities of framework towers.

List of program developments.

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/204	RU Bochum Prof. Roik	Interactive, individual proportioning and design with a steel construction databank	78-81	BO-ROIK/ 103	
51/206	Krupp Co. Esser	Steel skeleton structure	77-80		

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/208	TH. Darmstadt Prof. Jungbluth	Building of steel halls	77-79	RAITHA	
51/210	Grebau Co. Karlsruhe	Building of steel halls	78-79	HASTA	
51/213	Krupp Co. Essen	Bridge construction Data preparation -input	73-76	CHECK-TRASS	/45
51/216		Data consolidation -preparation of influence lines (EL)	73-76	ELSORT	
51/218	-	-evaluation of EL		ELWERT	
51/220		-plotting of EL		ELPLOT	
51/222	Krupp Co. Essen	Plotting of status data	73-75	GRAZ	
51/224	ERS, Saarbrücken	Compound bridges	76-78	VEBUND B.	
51/226	ERS, Saarbrücken	Guyed masts	76-78	MAST	
51/228	ERS, Saarbrücken	Towers	76-78	TURM	
51/230	RIB, Stuttgart	Thin walled cross-sections	1974	QUER 2	
51/232	RU Bochum, Prof. Roik	Construction work preparation and manufacture	75-78	BO-ROIK/100	
51/234	Goldbeck Co. Bielefeld	Pilot application BO-ROI/100	78-79		Report KfK-CAD
51/236	TH. Darmstadt Prof. Ebel Prof. Uhlmann	PAS program system part module TRAGLAST	75-77	PAS III	See also PAS s. 51/104
51/238	TH. Darmstadt Prof. Ebel Prof. Neugenbauer	PAS--crane building, load bearing structures in motion	75-78	PAS III	
51/240	MAN Co. Gustavsburg	Proof of safety factor system with variable arrangement (load capacity procedure)	78-79	SINA	

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/242	TU Braunschweig Prof. Scheer	Load capacity of framewokk towers; stability of a global rod	78-79	REUTLI	
51/244	RU Bochum Prof. Wunderlich	Development of program building blocks	78-78	STANAS	
51/246	ERS Saarbrucken	Testing (pilot application)	1978	STABIR	
51/248	TH. Darmstadt Prof. Jungbluth	Three-dimensional graphics for steel construction	77-79	GRAFIK	Not sponsored by means of CAD
51/250	TH. Darmstadt Prof. Jungbluth	Computer-assisted optimization of compound systems	77-80	VEROPT	"
51/252	TH. Darmstadt Prof. Jungbluth	Design preparation in building of steel bridges	1976	PUDES	"
51/254	TH. Darmstadt	Details of design of steel floor construction	76-77	DETKON	"
51/256	TH. Darmstadt Prof. Jungbluth	Fabrication, planning of the total computer-assisted engineering design	76-80	FERKON	"



Siegtal bridge, Eiserfeld, photography by Polensky & Zöllner Co.

State of Development

In this area DP found its earliest acceptance. Already in the early 60s a program system existed for concrete pier bridges, which offered a complete solution from the determination of cross-sections to stress proofs, based on the calculation of a three-dimensional framework.

Now there are many programs of that kind. It does take considerable effort, however, to apply these programs since their formulation is mostly in quite general form. Their application for special cases requires additional data input for that reason.

These programs are also mostly suitable for larger computer systems only.

Objectives to be Achieved /47

Complete program chains must be developed for the phases "Design" and "Implementation" for special types of bridges, like:

--Box-type construction bridges
--Concrete slab bridges
--Plate bridges

The program chains are to include longitudinal and crosswise direction as well as the bridge foundations. The implementation calculations are to be checked to find out to what extent available data from the street design could be used for formulation of the input geometry. Parts of existing programs must be considered in the course of development work. Modules of existing finite-element programs are also to be employed for planar load support structures.

The programs should, however, be suitable for processing on computers of intermediate data technology (-64 KB).

Points of Emphasis in Development

The development of program chains for special types of bridges is to be pursued beyond the already mentioned generally applicable programs of the Nord-West Co. and of RIB (PRAKSI). To be included:

--Box-type construction bridges (proposal RIB)

--Plate bridges (proposal RIB)

Emphasis will also be on program building blocks for bridge foundations in design and execution (proposal Nord-West Co., consulting engineers Maack and Prof. König).

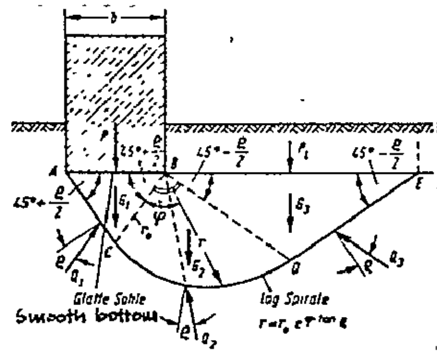
The other program developments contained in the following list are completed and are available for use.

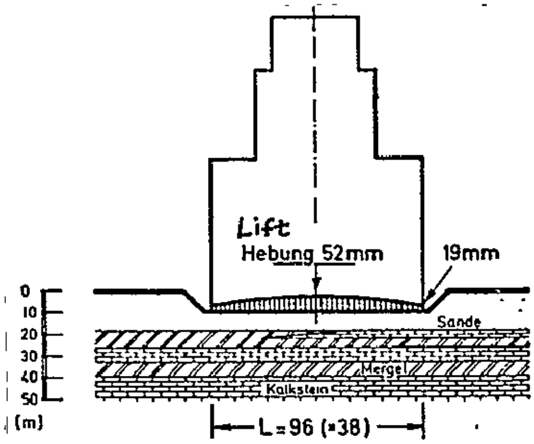
List of program developments /48

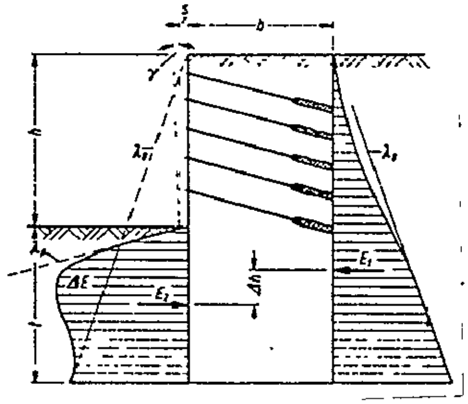
Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/262	Ed. Züblin AG Stuttgart	Bridge design in dialog (box-type, concrete slab)	75-76	PROLOG	Report KfK-CAD 57
51/264	RIB, e.V. Stuttgart	Plate bridges in the design stage	76-79	PENT	
51/266	RIB e.V. Stuttgart	Program system for construction engineering	71-75	PRAKSI	1
51/268	RIB e.V. Stuttgart	Plane load bearing structures --interface data, proportioning	72-74	PRAKSI	2
51/270	RIB e.V. Stuttgart	Plane load bearing structures --Prestress	1975	PRAKSI	2
51/272	RIV e.V. Stuttgart	Bridges with prismatic type cross-sections	76-80	IBS	
51/274	NORD-WEST Engineering Consultants Hanover	Program system for massive bridges	72-78	Bridge building	Not sponsored with CAD funds before 1976

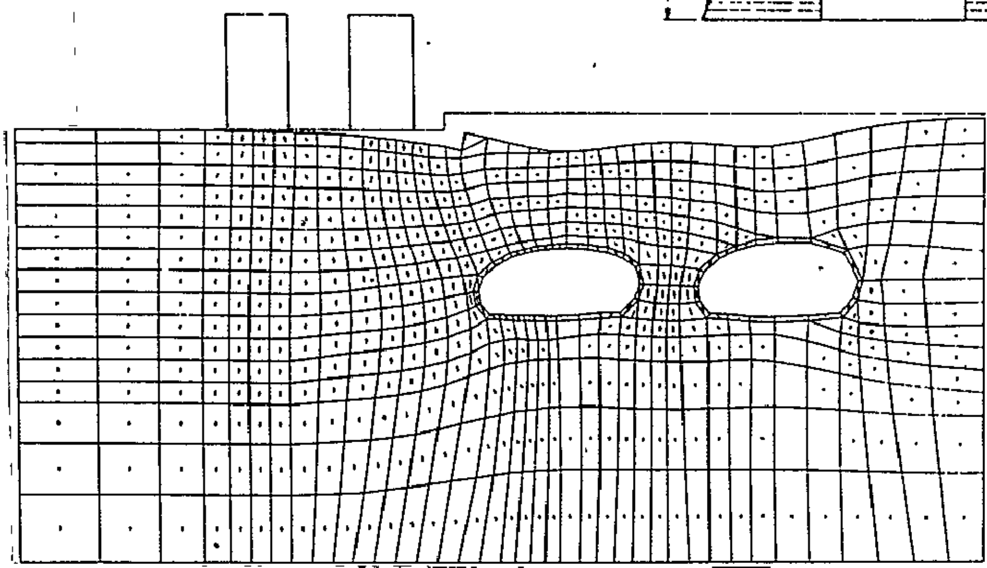
Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/276	Krebs & Kiefer Darmstadt	Massive bridges --superstructures	74-76	MKMABE	
51/278	TU Munich Prof. Werner	Program building block concrete pier safety proofs	76-77	PRESCO	
51/280	Krebs-Kiefer Darmstadt	Massive bridges --bridge bearings	74-75	MKBLAG	
51/282	RIV, e.V. Stuttgart	Pier with flexure in two axes	74-75	PFEIL 2	
51/284	TU Munich Prof. Werner	Globally [illegible] stressed reinforced concrete supporting structures (towers or piers)	74-76	TOP	Report KfK-CAD 67
51/286	Nord-West Hannover	Program system for substructures	78-80		
51/288	TH Darmstadt Prof. König	Box-shaped bridge supports	78-79	WDL	
51/290	Consulting Engineers Mack, Hannover	Drawing of layouts and designs of massive bridges	76-78		

2.8 Foundation Building /49









Publication of the Bavarian State Vocational Institute

State of Development

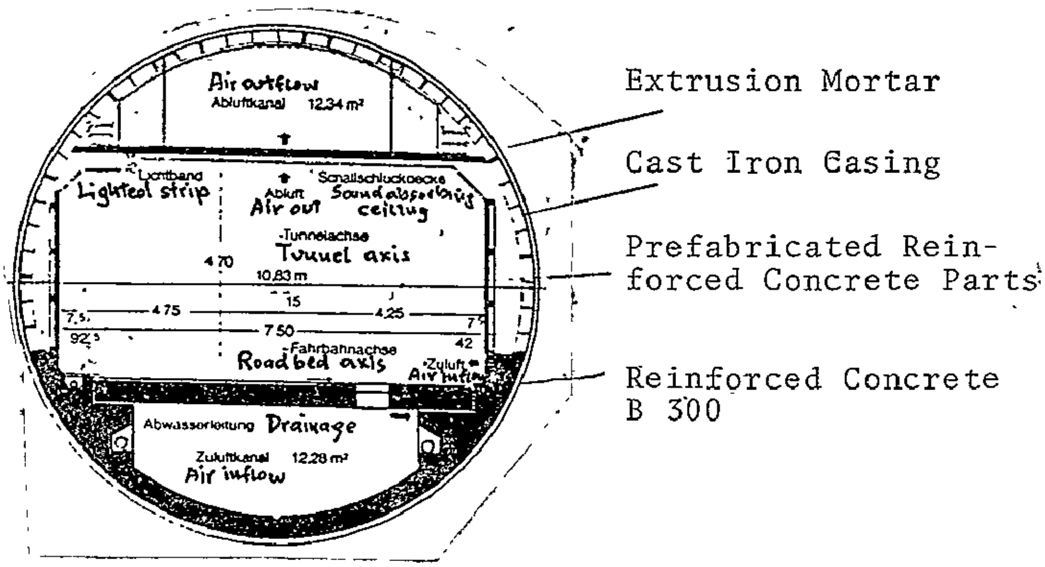
Calculations for foundation construction require a description of soil conditions. One depends here on results of measurements or on assumptions that often agree only roughly with real conditions. In addition, further simplifying assumptions are employed for the classical methods of calculation. The solutions are, therefore, approximate results that agree only partially with actual conditions. Programs exist for many of the classical methods, which are to be classified as typical isolated solutions according to the concept described within the scope of Section 1.

A special role is played by the finite-element method (FEM). By means of this method a comparatively good characterization of the soil (as far as its properties are known) is possible within the scope of analysis programs, so that now calculations, that were so far based on vague idealized conditions, can be carried out much more reliably. Application of the FEM is so far restricted to the universities and a few consulting firms. Existing FEM programs (mostly of American origin), which are generally applicable, have hardly found acceptance in the practice of foundation construction since application is tied to the use of larger ($\geq$128 KB) computers.

Objectives to be Achieved

The chain concept described in Section 1 is applicable only to a limited extent in foundation construction since the solutions of individualized problems predominate, which rarely can be connected in a meaningful way to program technology. The already existing collection of individual programs must, therefore, be completed with attention being paid to uniformity of interfaces between user and program (I/O convention, designations . . .).

The generation of program chains is limited to constructions like tunnels, for instance. Beyond that foundation calculations are parts of program chains from building or bridge construction.



Tunnel cross-section from "Ingenieurbau" by F. Leonhardt

All programs, including the FEM programs used here, are to be applicable on computers of medium size data capacity ($\lesssim$64 KB).

The following publications are singled out as results of sponsored proposals in the field of Foundation Engineering:

- --"Standardization of Interfaces" (Vocational Institute State of Bavaria). The results of this proposal are accompanied by a suggestion for standardization for the nomenclature to be used.
- --Program Chain "Tunnel Engineering" with the individual proposal by RIB, Prof. Werner, TU Munich and Prof. Gudehus, University of Karlsruhe
- --The Study "FEM in Foundation Engineering" by Professor Smoltczyk, TU Stuttgart.

All the above appeared as CAD-Report KfK-CAD 1. The rest of the proposals deal with individual programs whose development has already been completed in most cases.

List of Program Developments

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/296	RIB e.V., Stuttgart	Calculation of tunnel constructions	76-79	TUS	Chain "tunnel engineering"
51/298	TU München, Prof. Werner	Input for tunnel construction problems	76-77	EINTUN	"
51/300	TU München, Prof. Werner	Calculations for constructions below ground, foundation and tunnel engineering	78-79	SET	"
51/302	TU Karlsruhe, Prof. Gudehus	Networks of stress trajectories	76-78	TRAJEK	"

Report Page	Author of Program	Topic	Development Time	Name Program	Notes
51/304	TU Karlsruhe, Prof. Gudehus	Two-dimensional or axisymmetrical stationary seepage flows (FEM)	74-76	FREE-SURE 1	Tied to UNIVAC
51/306	TU Karlsruhe, Prof. Gudehus	Stresses and deformations in dams and terrain indentations (FEM)	74-76	LAGEN 1	"
51/308	Hochtief AG, Frankfurt	Calculation of friction circle	76-78	S105	
51/310	TU Stuttgart, Prof. Smoltczyk	Embankment stability per Krey/Bishop	73-75	KREBIS	
51/312	TU Stuttgart, Prof. Smoltczyk	Embankment/Janbu	73-75	JANBU	
51/314	TU Stuttgart, Prof. Smoltczyk	Conslidation; one-dimensional	76-78	KONED	/52
51/316	TU Stuttgart, Prof. Smoltczyk	Consolidation; two-dimensional	76-78	KONEV KONAX	
51/318	LGA, Bayern Nurnberg	Foundations for Subway beds	76-78	UBR	
51/320	LGA, Bayern, Nurnberg	Calculation of Support walls individual foundations	76-78	STM	
51/322	LGA, Bayern Nurnberg	Calculation of area foundations	76-78	EZG	
51/324	LGA, Bayern	--elastic foundation girder	74-76	ELBAL	
51/326	LGA, Bayern	--rigid foundation slab	74-76	STAPLA	
51/328	LGA, Bayern, Nurnberg	--elastic slabs and slab systems	74-76	ELPLA	
51/330	Hochtief AG, Frankfurt	Area foundations (dynamics)	75-77	BOPLADY	

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/332	Hochtief AG, Essen	Individual foundations	73-75	EIFU-PROF	Chain PROFES
51/334	RIB e.V., Stuttgart	Elastic imbedded continuous girder	73-74	DLTBET	
51/336	RIB e.V., Stuttgart	Bulkheads, support pilings, louvered slides, bore pile walls	73-75	SPUBOL	
51/338	RIB e.V., Stuttgart	Press anchorage	73-75	ANKER	
51/340	Krebs & Kiefer, Darmstadt	Built-up walls	74-76	MKBOHL	
51/342	RIB e.V., Stuttgart	Pallisades	73-75	PFAHL 2	
51/344	Krebs & Kiefer, Darmstadt	Pile foundations	74	MKPFAHL	
51/346	LGA, Bayern, Nurnberg	Standardization of cutting speeds	75-76	SNG	Study
51/347	TU Stuttgart, Prof. Smoltczyk	Application of the Method of Finite Elements (FEM) in Foundation Engineering	76-78		Study (KfK-CAD 1)

2.9 .Road Construction

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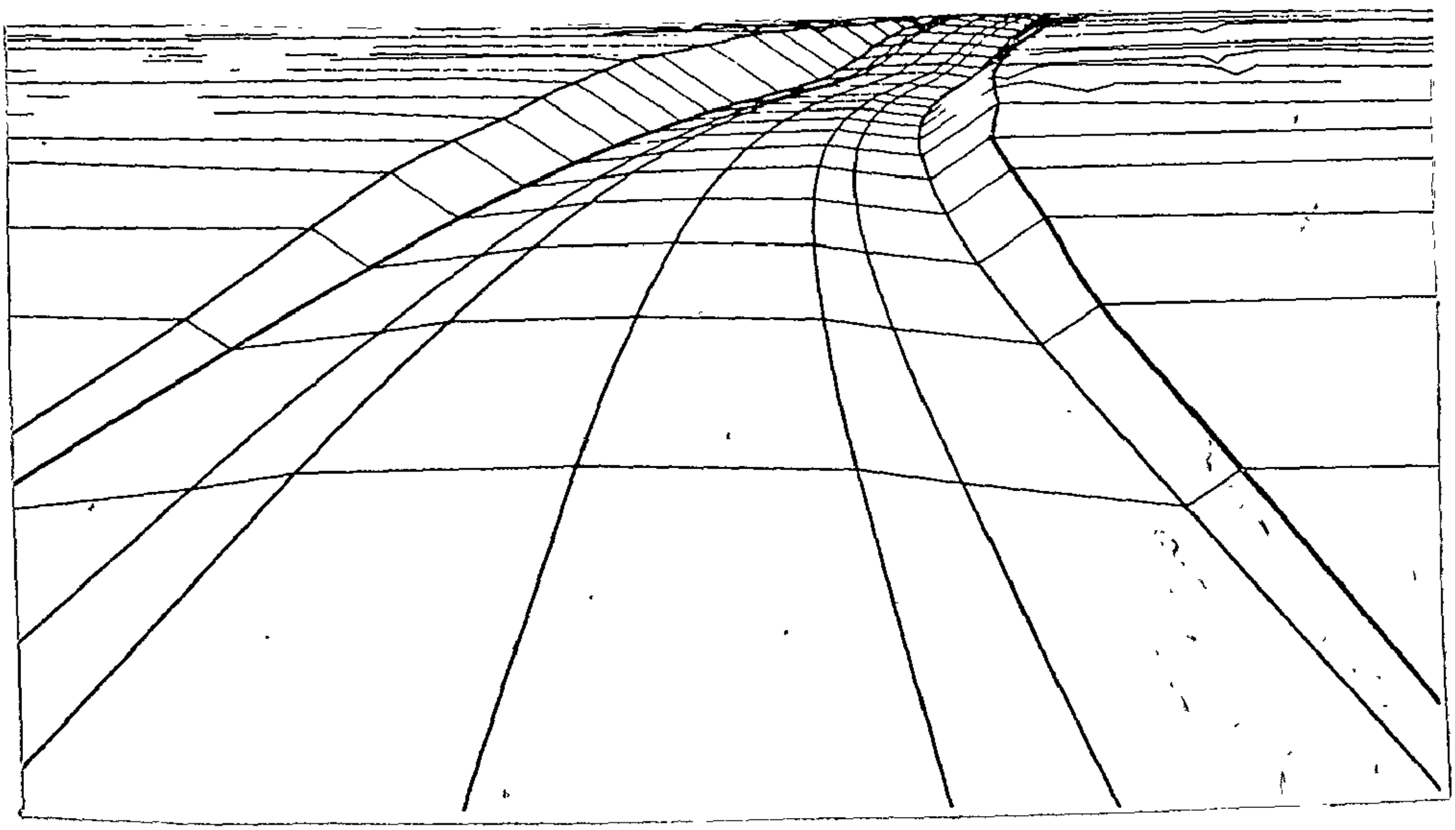


State of Development

The specialized field of road building can be subdivided as follows:

a. Projection

--planning
--design

b. Construction

--work preparations of contractor
--layout, control and design planning

c. Concluding Operations

--proof of contract fulfillment for acceptance and accounting
--documentation by contract awarding agency and receiver of contracts

Numerous programs exist, in particular for the projection phase. Generally these are individual programs or program packages offered by specialized DP-producers. Beyond that it is possible to carry out the activities of requests for proposals, award of contract and accounting (AVA), with the assistance of DP.

In Germany roadbuilding is carried out completely by public /54
agencies: the various interests of the agencies exert significant influence on the development and configuration of programs for that reason.

Objectives to be Achieved

The Research Organization for Highway Engineering, Köln, formulated the following objectives in a report published in 1975:

1. Determination of a high level data file; arranged according to structural data (for instance, terrain features) and project dates (for instance, a planned road).

2. Development of program chains in the sense of a CAD concept for the abovementioned phases (a) to (c).

These objectives are to be attempted in new programming but also where available programs are being utilized.

Parallel with it, efforts at standardization are to be increased, for instance, with regard to the Digital Model of the Terrain (interfaces) or in the AVA region (St LB: St LK). Available guidelines (for instance RAL) should also be so written, or formulated, as to permit program development with fewer problems.

Points of Emphasis in Development

The concept of the program chain "Road Building," arranged according to "Structural Data" and "Project Data" as worked out by RIB, Heusch-Boesefeldt and Prof. Linkwitz is now available as CAD-report. This concept must now be realized through the proposals by Heusch-Boesefeldt, RIB and Dorsch Consult. The proposal of MBB, of a "Layout of the existing DIGITAL Terrain Model", also fits into this program chain.

All program developments going on in the field of road building beyond that can be fitted into these data structures.

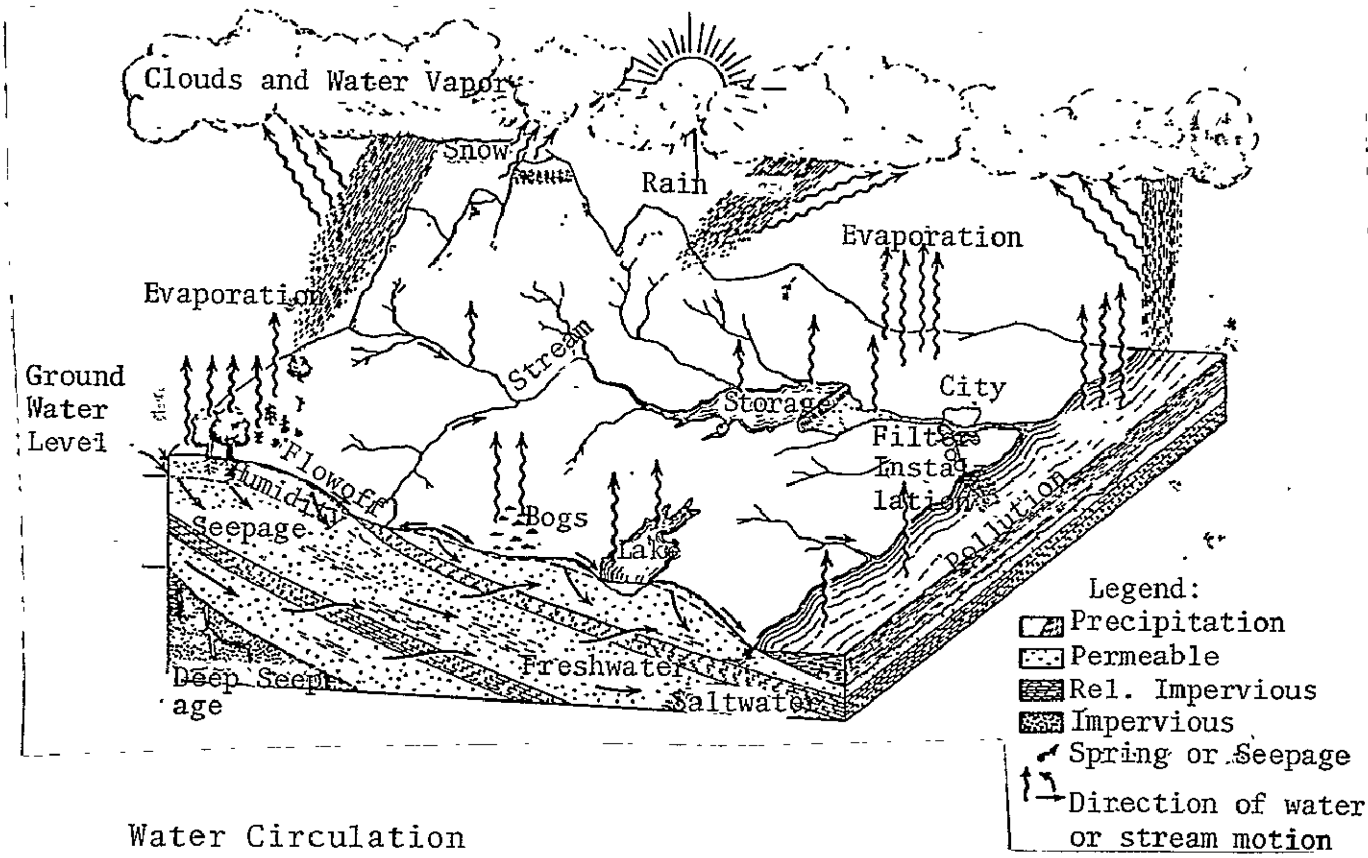
List of Program Developments /55

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/352	Consulting Engineers, Heusch-Boesefeldt, Aachen	Database "Processing of structural data in road design"	76-80	SOS	Chain "Road" KfK-CAD 32

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/354	RIB, Stuttgart	Database "Project Data"	76-77	OBJEKT DATEI	Chain "Street"
51/356	MBB, München	Digital Terrain Model	73-75	DGM	
51/358	Consulting Engineer, Heusch-Boesefeldt Aachen	Systems for road design and information	76-80	EPOS I	Chain "Road"
51/360	"	Determination of evaluation criteria	74-75	ZIELE	"
51/362	"	Evaluation design variants	74-75	NUANSE	"
51/364	"	Graphic presentation of evaluations--sensitivity analysis	74-75	GRANUT	"
51/366	TU Stuttgart, Prof. Linkwitz	Axis	73-76	ACHSE	"
51/368	Consulting Engineers B. Gunther, Leer-Loga	Construction geometry	75-76		Study
51/369	TU Stuttgart, Prof. Linkwitz	Optimization	73-75		Study CAD-Report KfK-CAD 3
51/370	TU Stuttgart, Prof. Linkwitz	Optimization of pipe line routing	76-78		Chain "Road"
51/372	RIB, Stuttgart	Line of sight	74-75	SICHT WEITEN	
31/374	RIB, Stuttgart	Interface road design/construction accounting	74-76	DATEN FLUSS	Report KfK-CAD 23
31/376	RIB, Stuttgart	Road building and road improvement	78-81	DECKEN-BUCH PLANUMSB	Chain "Road"

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/378	Consulting Engineers, B. Gunther, Leer-Loga	Data verification	77-78		Study
51/379	"	Optimization of roadway surface	76-78		Description of Procedure
51/380	RIB, Stuttgart	Optimization of roadway surface	76-77	DECKEN-OPTIMIE-RUNG	Chain "Road"
51/382	RIB, Stuttgart	Contact areas for mass determination	76-77	BEGREN-ZUNGS FLÄCHEN	"
51/384	RIB, Stuttgart	Determination of mass according to REB amounts REA 01-06,14,15	72-74	MENGEN 1 TEIL 1	
51/386	RIB, Stuttgart	Amounts REA 07, 09,10,12,13	72-74	MENGEN 1 TEIL 2	
51/388	RIB, Stuttgart	Amounts REA 17, 18,19,20	72-75	MENGEN 2 HORIZONTE	
51/390	RIB, Stuttgart	Calculation of bituminous roadway reinforcement	75-76	TVBIT 7/71	Chain "Road"
		--according to ragging thickness	78-79	TVBIT 7/71 STEP 2	
51/392		--according to areas and thicknesses			
51/394	Dorsch Consultants, Munich	Cross-sections of random flat stretched construction objectives	78-79		Chain "Road"
51/396	Siemens, Munich	Roadway divider for road intersections	74-75	STRAK	

/56



Water Circulation

State of Development

Voluminous program packages ("chains"), which have the capability to solve complex problems with alternate goals optimally, exist in addition to the large number of individual programs for the solution of certain partial problems ("islands").

The program chains or mathematical models were developed mainly for the treatment of hydroeconomical questions with regard to the quantitative and qualitative distribution of water, while the individual programs serve mainly for the design and the static and dynamic checkout of individual hydraulic structures (arch dams, dams, rivers, power plants, etc.).

It is primarily the interference of man into the hydro-economy of nature that brings about serious changes in the quantitative as well as the qualitative water circulation (storage and control water, sealing off effects by roads and cities).

Models of the flow area, which serve for simulation of the /58
part of the hydroeconomy changed by man, can be arranged as

--quantitative models
like
Stanford Watershed Model IV
or
SSARR Model
and as
--qualitative models
like
Stormwater Management Model
or
Quality-Quantity-Simulation (QQS)

These models all assume a certain amount of precipitation, consider the surface runoff due to different precipitation/runoff ratios, with seepage and, eventually, evaporation being included in the consideration. The runoff process in an actual stream bed, resp. canal, is simulated by a routing procedure.

Beyond this, a few procedures demonstrate extensive possibilities for statistical evaluation of the data material, which permits long-term simulation and prognoses as functions of the probability of occurrence.

The overwhelming number of models have been developed in the USA and are designed for their ample spatial conditions. They lay claim to solutions affecting all relevant problems being soluble in one program package. This has the following disadvantages:

--The program packages are very voluminous, the mutual influence of their systems building blocks on each other is difficult to detect.

--Large storage capacities and long computing times are needed because of the large size.

--Approximation methods are used for simulation of detailed physical phenomena (for instance, change of the wave form in the flow) but they do not always meet the requirements.

Beyond that, many of the program versions funded by the U.S. Government have since been developed further by private industry, so that the available versions do not represent the present state of the art any longer. /59

Objectives to be Achieved

In the field of urban hydrology quite powerful program systems are being developed for simulation of qualitative and quantitative runoffs. They deviate partially in their objectives from the American models.

In quantitative simulation the detailed calculation of the runoff event, based on the differential equation by St. Venant, occupies the main interest.

In qualitative simulation there is great interest in long-term prognoses, which requires statistical statements. That requires simulation of a long time period, which again requires much time on the computer.

The result is the requirement for development of faster and more powerful solution algorithms.

To allow user-friendly application, program systems are to be built up as interactive as possible to allow the user options for decisions during the run of the program. Interactive operation is particularly suitable for optimal proportioning of controlled installations like:

--power plant chains at rivers

--moveable overflow thresholds in drainage water systems

--water preparation and filter installations

--supply system (long distance water conduits)

Points of Emphasis in Development /60

In addition to continuation of developments and new developments of program chains in hydroeconomy, efforts will have to be devoted in the future to the improvement of the system building blocks. For that purpose Finite-Element-Methods, will increasingly take the place of the difference methods, which predominate at present. Trials with various elements have been very successful in hydroeconomy (flow of ground water runoff, of nonpressure runoff and pressure runoff).

Program chains can be visualized in Sanitation Engineering for optimum layout and control of filtering installations, with the condition of minimum expenditures of total energy.

With regard to the Federal Law on Sewage Water Taxes which will take effect in 1981, the program chain "qualitative simulation of drainoff" (Engineering Consultants, Dorsch), which is supplemented by building blocks for improvement of the hydraulic simulation, gains some interest.

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
51/404	TU Hannover Prof. Lecher	Frequency analysis, parameter determination and tests of hydrologic time series	77-78	STEST STAPA DAUTA HAEUF HAUER FUELL QTROC SUCH Q TAMAX	Not sponsored by CAD funds
51/406	TU Hannover Prof. Lecher	Calculation of return on investiment, time series modification and auxiliary programs	77-78	INVES GANGL NPROZ GRAGL DKLIS ESKIP IDENT LUKAS PRICO UPDAT	Not sponsored by CAD funds
51/408	TU Hannover Prof. Lecher	Calculation of overflow formation and overflow deformation	77-78	EGANA ZWIGE GEDAT AKDAT HYDRUN TAGMO SINAB OUTAB	Not sponsored by CAD funds
51/410	TU Hannover Prof. Lecher	Calculation of the load put on the water carrier by sewage drain water	77-78	RAAWK GEMVZ QSPEN PLAKA ABBAU TABAK	Not sponsored by CAD funds
51/412	Dorsch, Consult. Munich	Mathematical investigation of the qualitative loads exerted by drain floods from urban sewage installations	75-79	QQS	Partially sponsored by CAD funds

2.11 Problems of Cross-sections Specific to the Building Industry /62

Points of emphasis in Developmental Work

The studies listed here are not program developments but

--studies for clarification of the state of development and user requests with regard of what ought to be done, and

--case applications of a databank program for storage of building industry regulations.

List of Program Developments

Report Page	Author of Program	Topic	Development-Time	Name of Program	Notes
51/415	National Association of the German Building Industry Wiesbaden	"DP in the Building Industry"	1974	BAUSIT	Study
51/416	German Standards Institute	Databank "Controllers in the Building Industry"	74-76	BAUDOK	
51/418	Main Association of the German Building Industry Wiesbaden	Program requests "White Spots"	1975	PROWUE	Study

3. Mechanical Engineering Branch /63

The branch of "Mechanical Engineering" within the scope of project "Computer-assisted Development, Design and Manufacture" consists of proposals in the fields of

--General Mechanical Engineering
--Machine tool Engineering
--Precision Engineering
--Chemical Engineering and Shipbuilding,

based on the close professional links between them. Data processing has gained only hesitant admittance into the practice of construction and manufacture, among the relatively small business units+) characteristic for large parts of these fields (80% of all mech. engineering companies have less than 500 employees). About 26% of all Mechanical Engineering companies do not have a programmable computer. DP-applications are met with only occasionally and generally restricted to small, narrowly limited, solutions of problems.

Computer systems do play an important role today for Electronic data processing in construction.

Computation algorithms are transferred rather easily into the appropriate DP-programs; the possibilities offered by data processing installations, particularly the high operating speeds, contribute considerably in making theoretically found methods, often requiring intensive calculation, available for practical use in the construction field.

Next to computer systems, programs for design and layout, partially also for Configuration of Construction objectives, form an additional point of significance in computer-assisted design. They are primarily applied for new constructions and adaptations, but also for tasks with a high percentage of heuristic solutions. This fact explains that the programs--unlike most other computation

+Not counting Shipbuilding and Chemical Engineering.

systems--must be built up oriented for interactive operation. That means that a program cannot, for instance, be operated alone and independently by the user in a computer center.

The designer rather influences the run of the program directly, through a terminal for instance, by deciding between alternate solutions offered, at programmed spots, before the computer continues to work the problem. /64

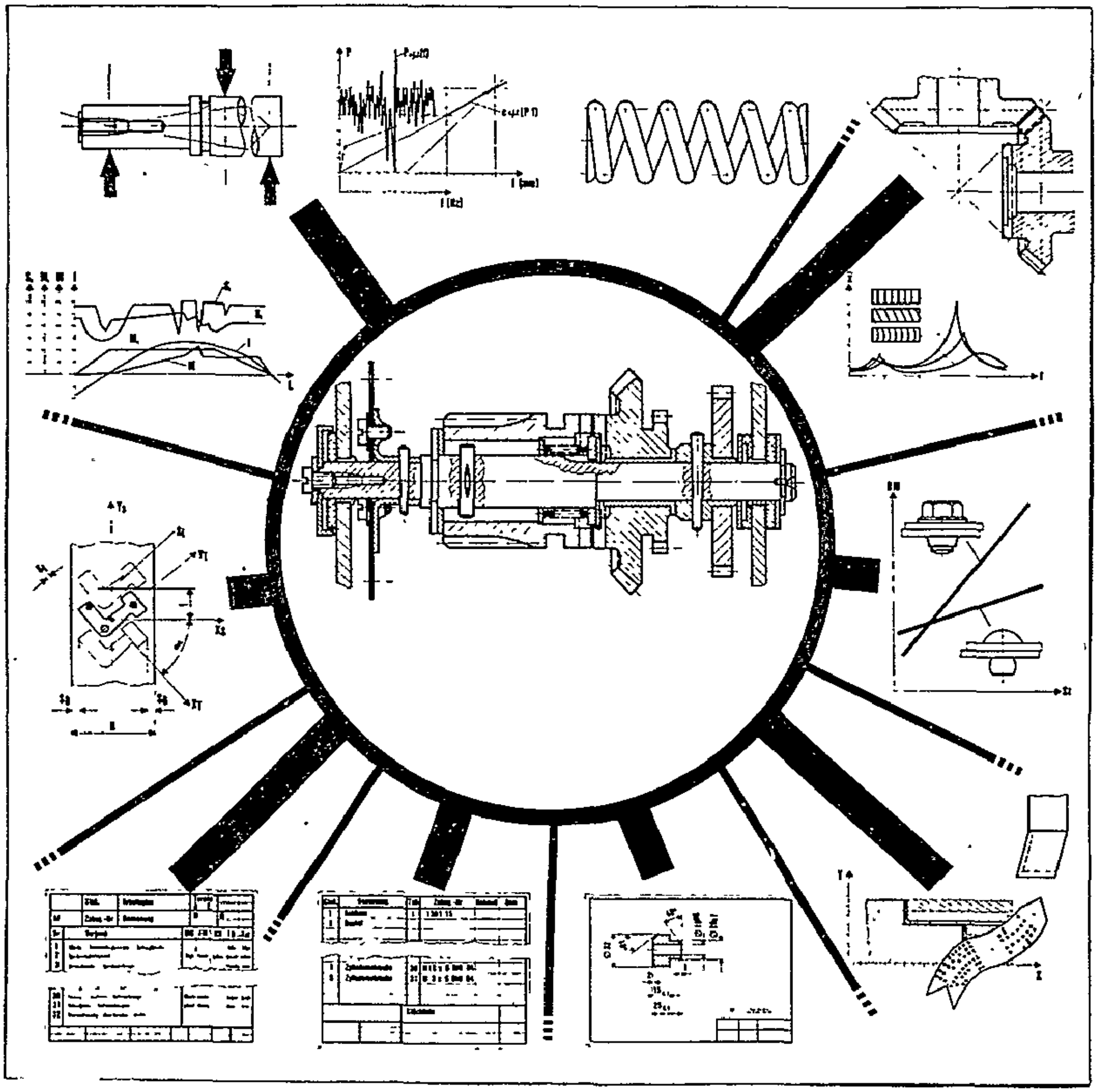
Programs for design and layout of design objectives exist, in particular for electrical and hydraulic hookups. Due to their concept they are transferrable to many other applications, as for instance the design of complete systems in chemical engineering or for generation of special systems for measurement control and regulation from a stockpile of solution elements. Appropriate programs are being developed.

When using programs for design, layout and configuration of design objectives, the user generally gets support through graphic presentations on the screen or plotter (two-dimensional) and in turn feeds progress in the solutions back into the DP-system via appropriate media (screen, digitizer). This brings up a basic problem existing today in computer-assisted design, i.e., the difficulty of describing complicated three-dimensional construction objectives "computer-suitable" for the fast interaction. In the above mentioned examples this difficulty is overcome by going back to a standardized symbolic presentation (two-dimensional) in the case of controls design and by making configuration problems applicable only for 2-1/2 dimensional parts (presentable in one plane). A descriptive language, easily applied, is presently being developed (configuration-oriented) for computer-assisted construction of geometrically complicated parts, since simultaneous operation in several two-dimensional planes (drawing-oriented) has proved to be too expensive and too prone to mistakes.

As the third significant application within this scope, programs for variant construction of technical objectives must be named, in addition to calculation and design systems. In their application several variants of three objectives are generated from individual components or building groups fixed by the program within certain constructive degrees of freedom but variable in their basic combination, which correspond to the actual problem requirements. These degrees of freedom in construction can be properties of materials (material variants) or /65 secondary dimensions, shown in a fixed ratio to main dimensions --while the main dimensions can again be results from calculations of strength carried out by the program (geometrical variants). The design of a bearing location, for instance, can be a design degree of freedom in a variant program; dependent on the special situation of the particular problem the bearing can be designed as slide bearing or ball bearing (variants of configuration and, on occasion, also of functions).

Programs for design of variants can be employed very efficiently since the entire construction process is covered by the program, including the furnishing of all production documentation. Depending on the requirements, these programs can be built oriented to interactive operation in certain parts. But the user is not asked to carry out time-consuming and error-prone data transfers between the individual program phases (calculation, configuration, generation of drawings, etc.) since the entire computer-assisted program is set to run off in a chain of program building blocks towards its goal. Prerequisite for the buildup of programs for design of variants is a basic buildup of the construction of the respective objectives, systematized in all details ("construction logic") and a transformation of this construction logic into a technical format for programming.

Systems for design of variants are presently used for transmission construction as well as for numerous design areas in tool engineering, in shipbuilding, chemical engineering and in precision instrument engineering. They are in nearly all cases company-specific (the construction logic of the corresponding part). In contrast to it computational programs, and even design and configuration systems in part, are transferrable to other fields because of their generally valid basic assumptions. At the moment, however, such a transfer is often either difficult or impossible because of adequate programming and documentation. /66



The picture above provides a good overall view of the CAD/CAM-applications, resp. developments, in Mechanical Engineering.

The Mechanical Engineering branch is arranged according to pertinent points of importance and explained with brief descriptions, according to the vertical division into "Design, Configuration" and "Generation of Production Documentation" and auxiliary means, not listed separately unless they are integrated into the individual solutions:

+Layout and Analysis of Machines and Machine Elements /67
- .Standardized machine units
- .Nonuniformly transmitting transmissions
- .Machine tool units
- .Mechanical components and systems
- .Electrical and hydraulic systems
- .Machinery materials

+Generation of Production Documentation:
- .Generation of drawings
- .Generation of work schedules

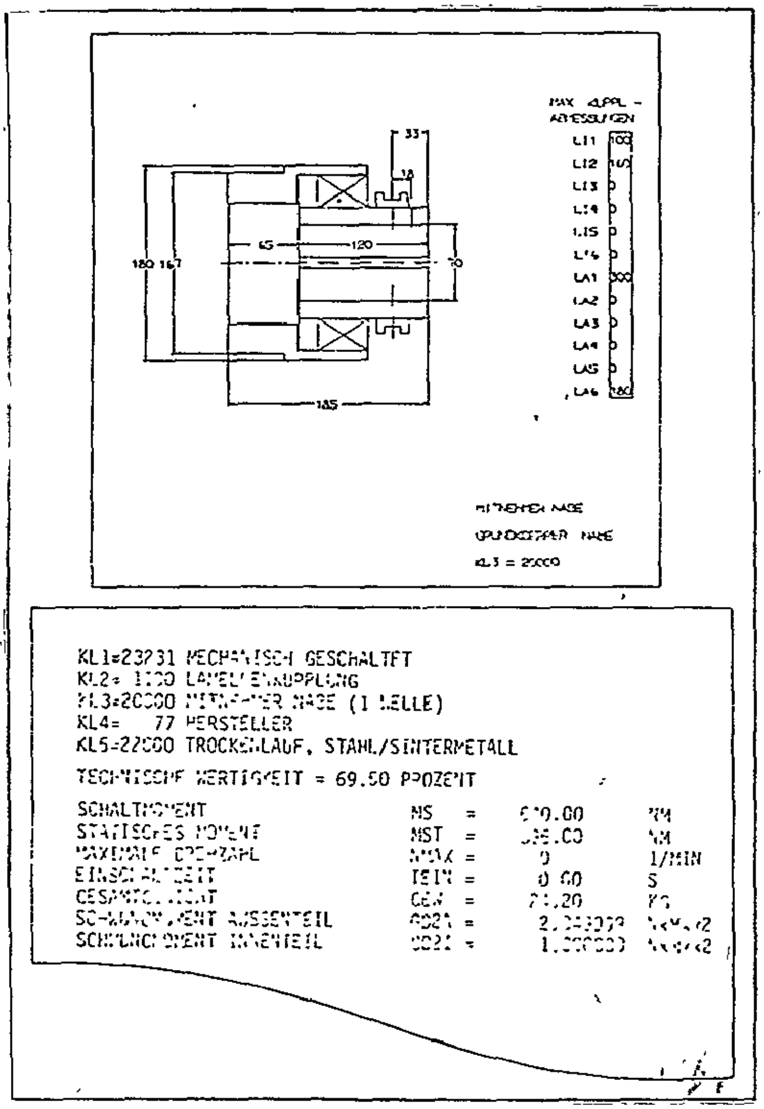
+Auxiliary Means
- .Files, catalogs
- .Guidelines

3.1 Design and Analysis of Machines and Machine Elements /68

3.1.1 Standardized Machine Units

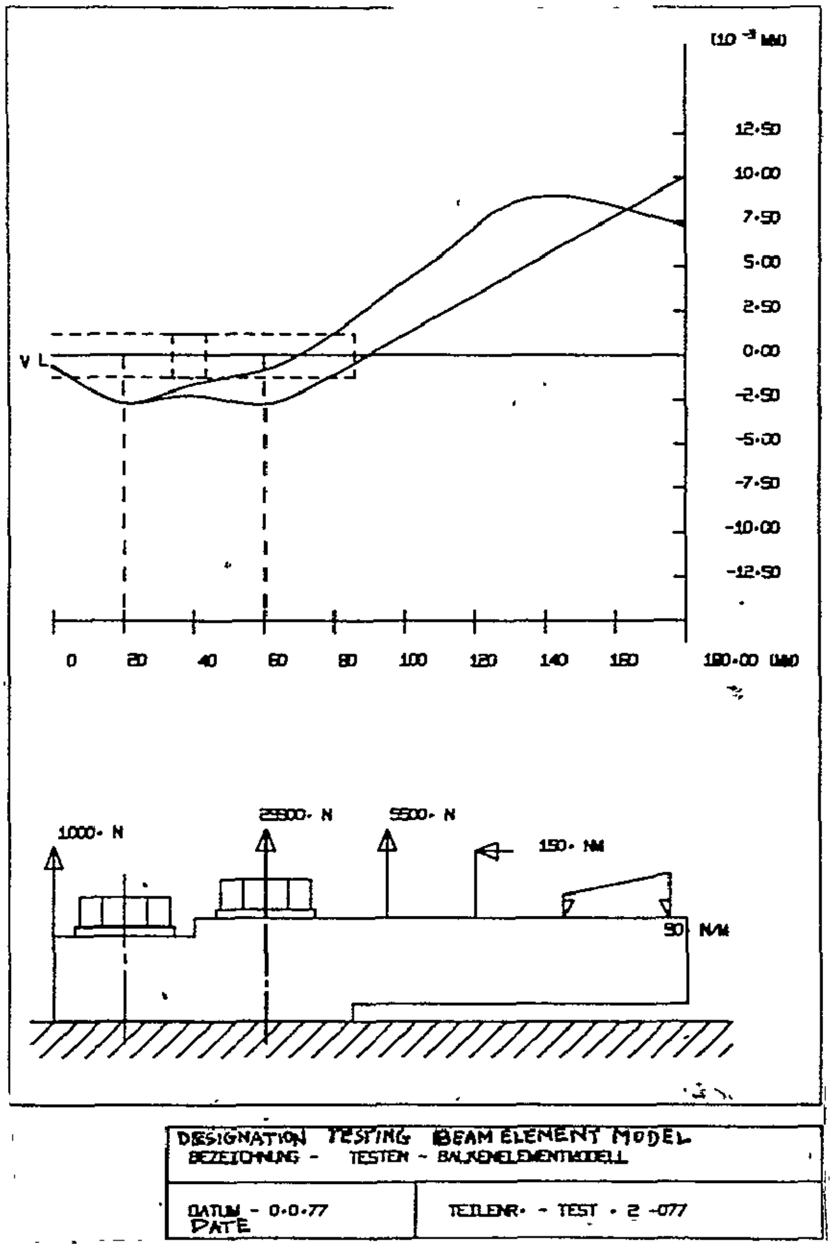
When creating the concept of a machine or installation it is useful to apply solutions that have proved to be reliable for partial functions. Reordered parts of in-house manufacture or parts made elsewhere and obtained from specialty companies are used. The search for them often involves considerable amounts of time and effort. Such indirect construction activities make up an appreciable part of all design work.

The following programs permit cataloging, selection, evaluation and calculation of machine elements of in-house or outside manufacture such as mechanical transmissions (transmitting uniformly), clutches, shaft hubs and screw connections. Particular attention is paid in these programs to the interactive mode of operation with the keyboard, resp. screen.



Description of a mechanical clutch and the computation result. Source: Institute for Machine Design, Construction Technology, TU Berlin.

Future studies are to deal with extension of the parts spectrum and of the application range, in addition to program configuration appropriate to the user and the introduction to practical use connected with it. /69



Design of a Screw Connection (Source: Institute for Machine Design/Construction Technology, TU, Berlin).

/70

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
52/28	Prof. Beitz TU Berlin	Choice of concepts for couplings	72-75	ALKOS	
52/30	Prof. Beitz TU Berlin	Selection of commercially used clutches	74-76	ASKUP	CAD-Report KfK-CAD 17
52/32	Prof. Beitz TU Berlin	Thermal calculations of clutches	74-76	BESKU	
52/34	Prof. Beitz TU Berlin	Design of random screw connections	75-76	BOLTI	CAD-Report KfK-CAD 48
52/36	Prof. Beitz TU Berlin	Calculation and selection of shaft-hub-connections	72-74	WENAH	CAD-Report KfK-CAD 18
52/38	Prof. Beitz TU Berlin	Selection and evaluation of transmissions	73-76	AUBEG	
52/40	Prof. Beitz TU Berlin	Calculation of mechanical transmissions and transmission elements	76-77	BAGET	
52/42	Olympia Co. Braunschweig	Calculation of tension, compression, and torsion springs	73-75	FEDER	
52/44	Prof. Beitz TU Berlin	Configuration of machine elements in interaction	73-76	REKO	CAD-Report KfK-CAD 58

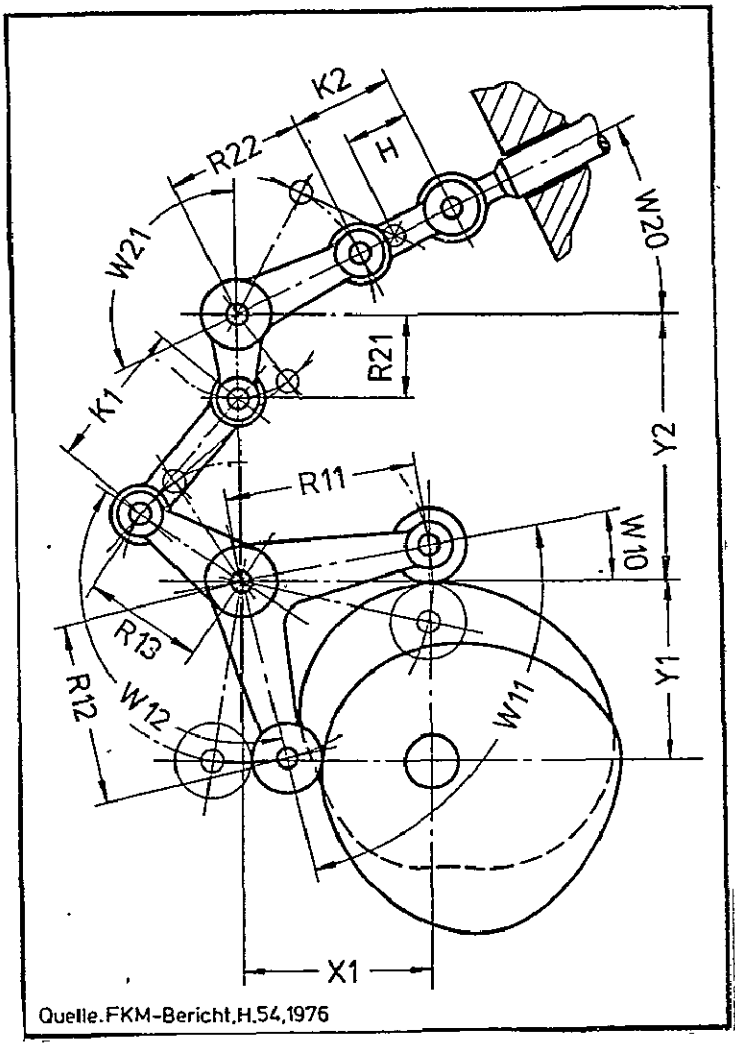
3.1.2 Nonuniformly Transmitting Drives /71

There is an increasing tendency of equipping machines with drives that permit the execution of specified motions and actions according to definite laws of motion.

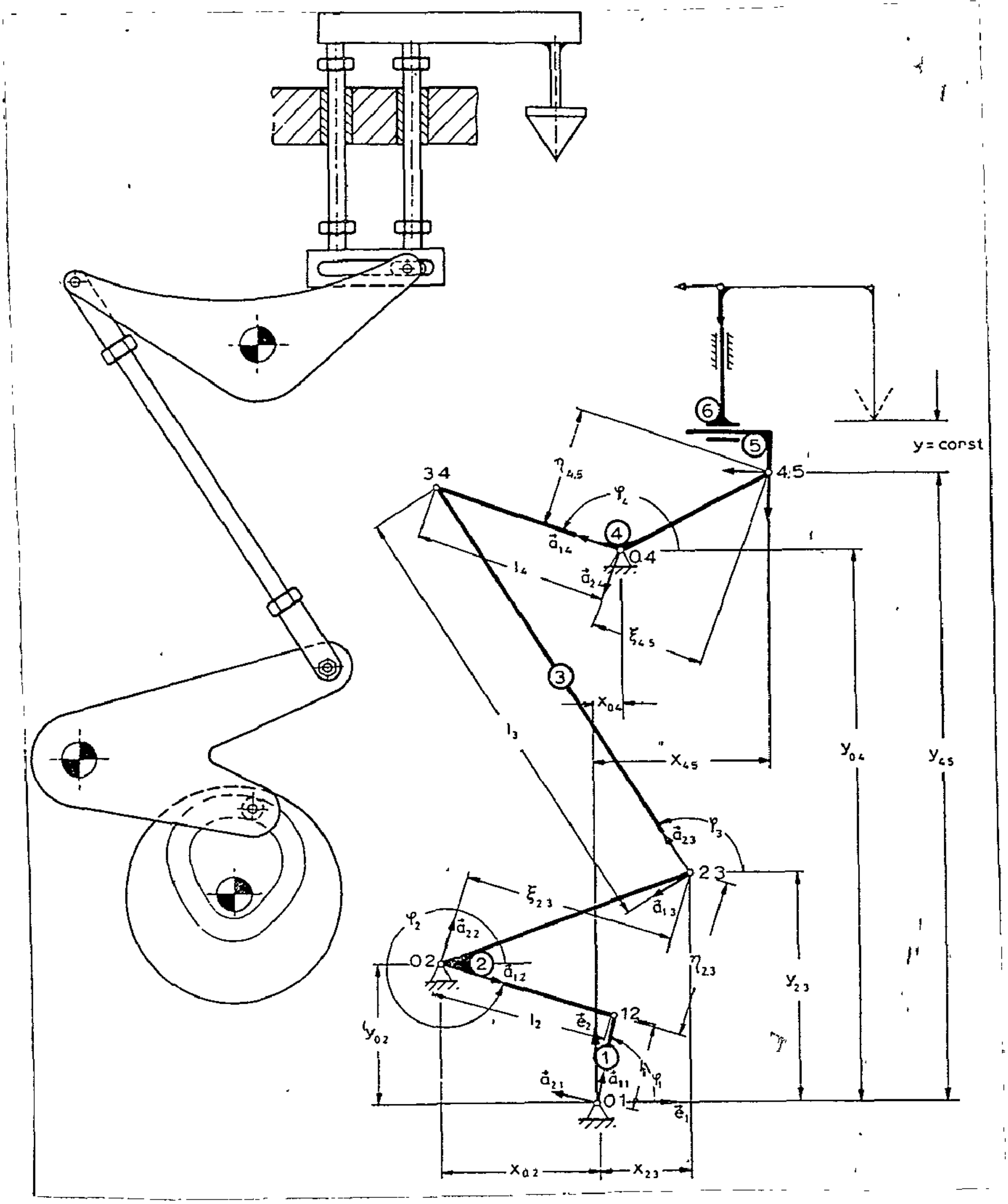
For the design of drives two action principles, resp. methods, are used:

--Determination of drive dimension (link length) from coupling positions, the coupling curve, power takeoff positions (synthesis).
--Analysis of drive characteristics from given dimensions.

Practical problems can usually be reduced to these principles, but will generally be considerably more complex.



Example of a Curve-Coupling-Drive (Source: FKM-Report H.54, 1976)



Example of a Curve-Coupling-Drive and Division into Partial Problems for Computation with System DISKO. (Source: FKM-Report, H.54, 1976)

The aim of additional efforts will be at first to complete the required analysis-algorithms and their proof on the basis of examples. The use of existing partial solutions for practical problems will receive primary attention. /73

Beyond that programs for support of qualitative design work (determination of drive types, choice of drive and its design) are to be developed in addition to algorithms for the drive synthesis.

In the following table programs are arranged for drive synthesis, as well as for analysis.

List of Program Development

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
52/50	Prof. Koller RWTH Aachen	Computer-assisted construction of cam gears and linkage drives	76-78	GEKON	
52/52	IKOSS Co. Stuttgart	Subroutine file for computer-assisted simulation of linkage drives and cam gears	74-79	DISKO	
52/54	Prof. Dittrich RWTH Aachen	Dimension synthesis of planar crank drives	76-78	MAKU	
52/56	Prof. Koller RWTH Aachen	Methods for computer-assisted design of drives for prescribed period laws of motion	74-75	OSGKON	
52/58	Olympia Co. Braunschweig	Design of lever systems	73-75	HESY	

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
52/60	Olympia Co. Braunschweig	Design of cam-plate drives	73-75	KUKON/ 370	Not sponsored with CAD-funds
52/62	IKOSS Co. Stuttgart Siemens Co. Regensburg	Optimizing of tolerance (pilot application DISKO)	78-79	DISKO II	

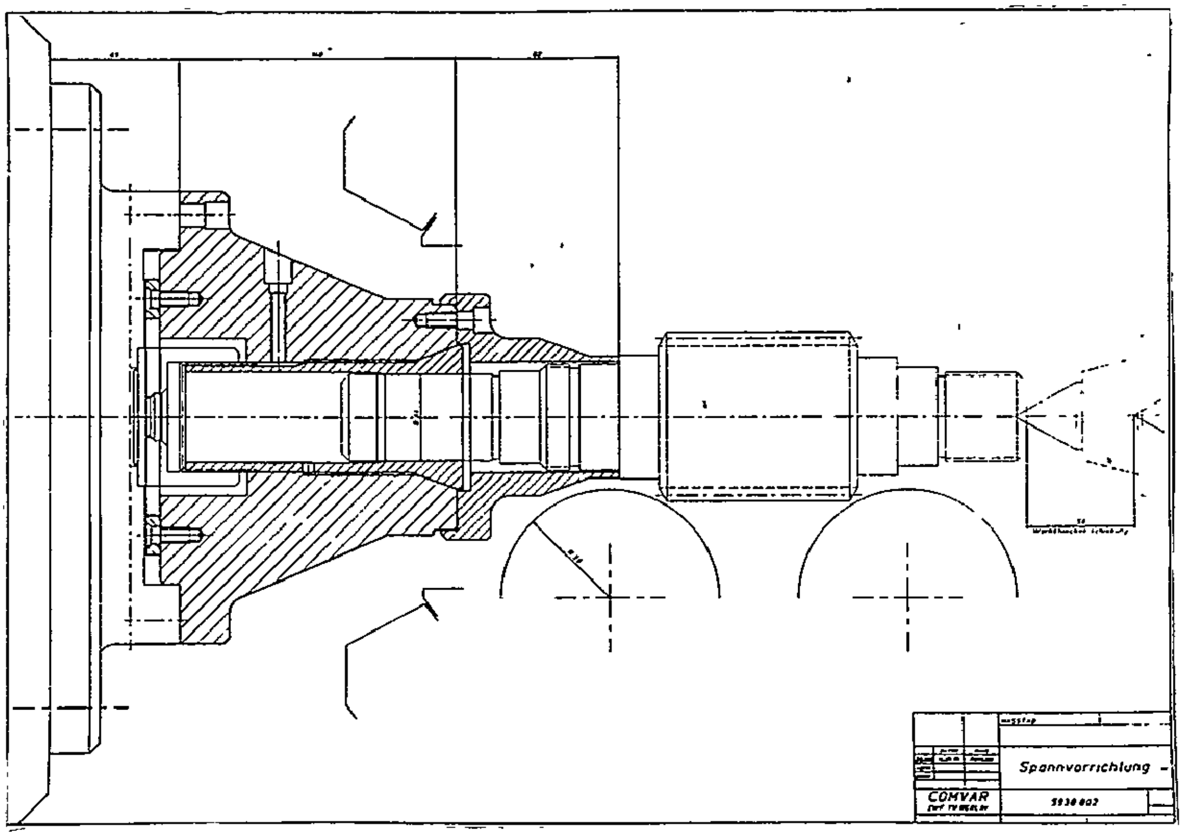
3.1.3 Machinetool Units

/74

In this group program solutions are collected, which permit configuration (including calculation) and layout of typical machine tool units, because of their frequent occurrence, particularly in tool engineering.

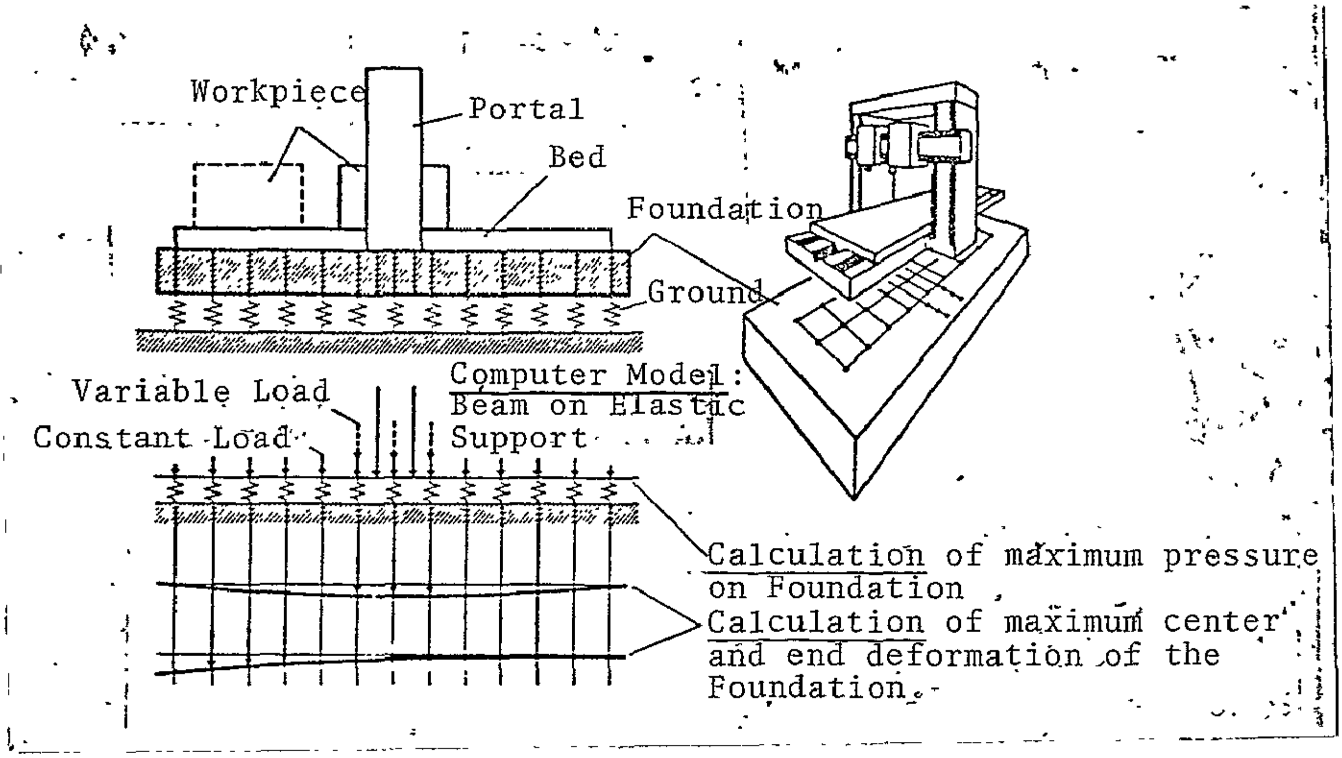
Standardization of the construction groups and elements used, as well as schematization and algorithmization of frequently occurring design activities, allows the design of corresponding objectives like headstocks, turntables, feed mechanisms according to the variant principle. Additionally required heuristic actions (for instance the selection of a bearing type) are carried out in interaction with the computer.

The use of the computer was shown as very effective for variant design, even though the available solutions are strictly limited to the objectives treated. The programs do show an extensive exemplary character pointing up the possibilities of this type of design for other applications as well.



Chucking Device (Source: Institute for Machinetools and Production Engineering, TU, Berlin)

Pilot applications by companies--particularly those in the machinetool industry--is seen as the aim of future work, in addition to completion of developments already started in a user-friendly manner. Beyond that methods and auxiliary means should be developed which will permit potential users the build-up of their own construction logic. /75



Static Calculation of Machine Foundations (Source: Machinetool Laboratory, Department of Tool Engineering, RWTH Aachen).

List of Program Developments /76

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
52/68	Prof. Stöferle TH Darmstadt	Variant construction of turntables	73-76	DREH	
52/70	Prof. Tönshoff TU Hannover	Computer-assisted layout of spindle-nut systems	73-75	AUTRAK	CAD-Report KfK-CAD 19
52/72	Prof. Tönshoff TU Hannover	Hydrostatic spindle-nut-system	74-75	HYSPIMU	CAD-Report KfK-CAD 19
52/74	Prof. Tönshoff TU Hannover	Calculation of spindle with spherical thread	74-75	BEKUS	CAD-Report KfK-CAD 19

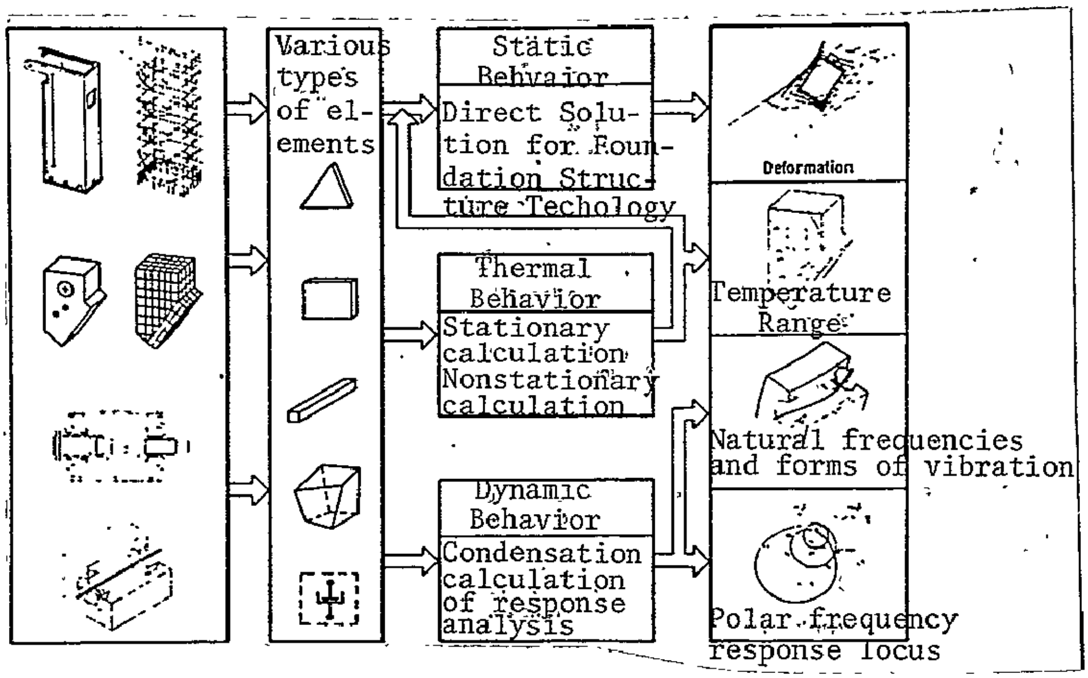
Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
52/76	Prof. Tönshoff TU Hannover	Variant design of feed slide units	73-77	MVAKOS HVAKOS	CAD-Report KfK-CAD 19
52/78	Prof. Tönshoff TU Hannover	Selection of guide ways	73-75	RAGRAF	
52/80	Prof. Tönshoff TU Hannover	Calculation of slide guide elements	74-75	REGLEF	
52/82	Prof. Tönshoff TU Hannover	Calculation of rolling guide elements	74-75	REWALF	
52/84	Prof. Tönshoff TU Hannover	Calculation of hydrostatic guide elements	74-75	REHYRF	
52/86	Prof. Tönshoff TU Hannover	Computer-assisted construction of prism guide elements	76-77	REPRIF	
52/88	Prof. Weck RWTH, Aachen	Calculation of static behavior of machine-foundation-ground-systems	77-79	BOFUMA	
52/90	Prof. Weck RWTH, Aachen	Vibration-behavior of the shock-stressed system forge hammer-foundation-ground	77-79	EINSCHW	
52/92	Prof. Weck RWTH, Aachen	Computer-assisted design of statically loaded foundations	77-79	ELABET	
5/94	Prof. Weck RWTH, Aachen	Project study of machine tool foundations	76		CAD-Report KfK-CAD 66

3.1.4 Mechanical Components and Systems

An exact determination of the actual characteristics of a design is of particular importance inasmuch as a high percentage of the cost of the finished product is already determined at the design stage.

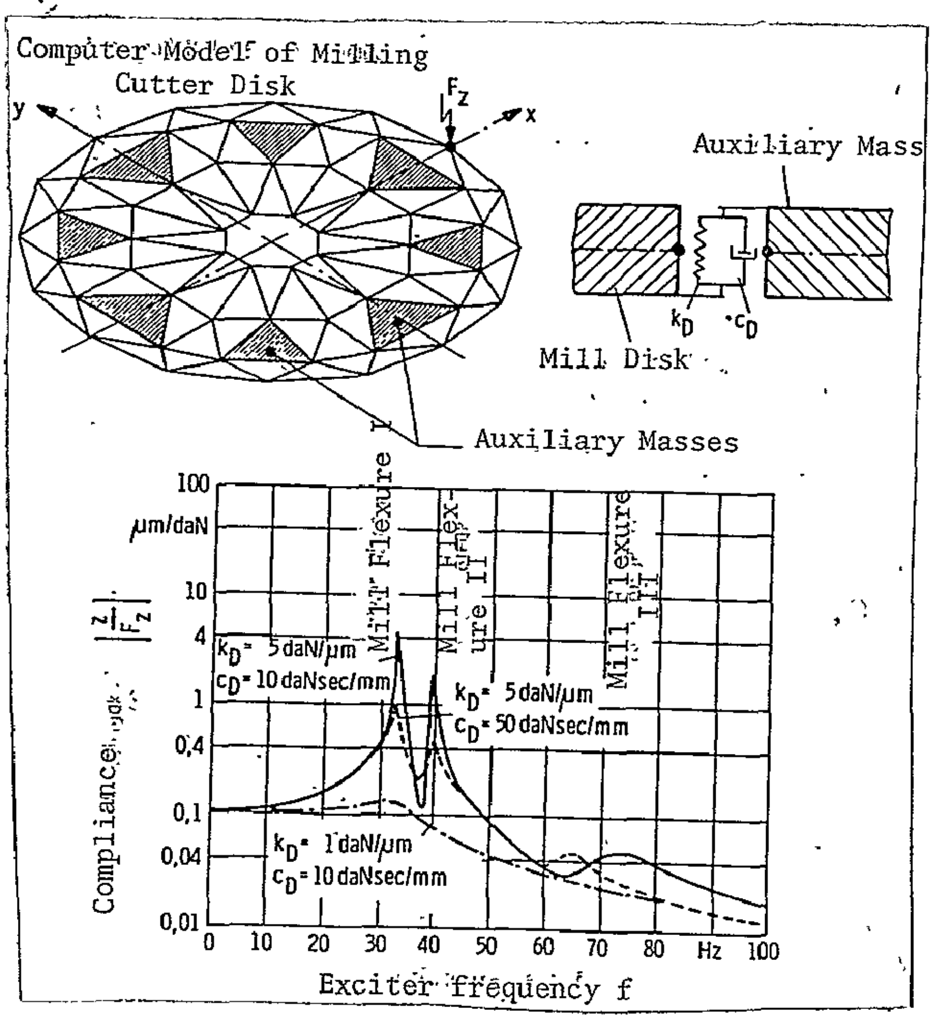
The predetermination of the static, dynamic and thermal behavior of machines, resp. machine components, has so far presented considerable problems.

With programs that operate predominantly according to the method of finite elements (FEM), the designer is in a position to test out various variants of a machine bed, for instance, on the computer to reach optimization of the design.



Structural Analysis according to the Finite Elements Method
(Source: Machinetool Laboratory, Dept. of Tool Engineering, RWTH, Aachen)

Broader application of the available solutions will be aimed for in future efforts, through user-friendly configuration of input and output of these programs, resp. inclusion of them in the design process. /78



Calculation of a milling cutter disk (Source: Machinetool Laboratory, Dept. of Tool Engineering, RWTH, Aachen).

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
52/100	Prof. Weck, RWTH Aachen	Calculation of elastic properties of components	74-75	ELAN	CAD-Report KfK-CAD 63
52/102	Prof. Weck, RWTH Aachen	Program system DYNFIN, calculation of dynamic behavior of linear elastic structures	74-75	DYNFIN	
52/104	Prof. Weck, RWTH Aachen	Calculation of noise transmission behavior of machine components	74-75	SOUND 1	
52/106	Prof. Weck, RWTH Aachen	Calculation of sound pressure distribution in the vicinity of machine components	74-75	SOUND 2	
52/108	Prof. Weck, RWTH Aachen	Graphic data control and presentation of results from FEM-computer models	71-72	DAFINE	
52/110	Prof. Weck, RWTH Aachen	Calculation of hydrostatic spindle-bearing systems	74-75	DYNSPI	
52/112	Prof. Weck, RWTH Aachen	Optimization, resp. calculation of hydrostatic bearings with the oil supply system: joint pump and capillaries	72-73	HYDROKA	

C-2

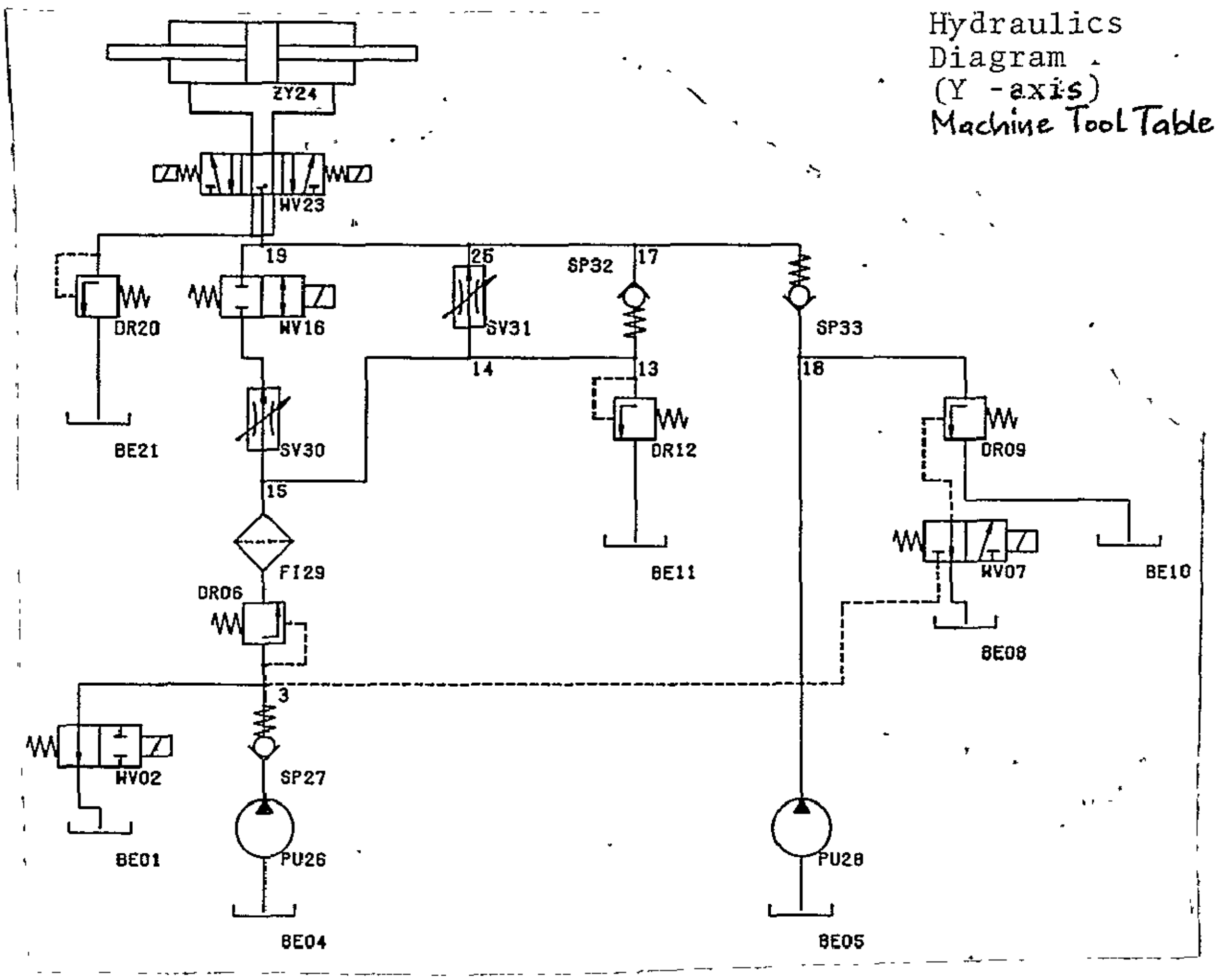
Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
52/114	Prof. Weck, RWTH Aachen	Optimization, resp. calculation of hydrostatic bearings with the oil supply system: one pump each per bin	72-73	HYDROPU	
52/116	Prof. Weck, RWTH Aachen	Calculation of dislocation and tilted positions of hydrostatic guide elements	72-73	FUEHR	
52/118	Prof. Weck, RWTH Aachen	Calculation of cross-section values for flat planes with random boundaries	71-72	QUUB	
52/120	Prof. Weck, RWTH Aachen	Calculation of deformation and stress of statically loaded linear elastic structures	71-72	FINEL	CAD-Report KfK-CAD 64
52/122	Prof. Weck, RWTH Aachen	Calculation and selection of ball bearings, hydrostatic and hydrodynamic bearings	73-75	LAGER	
52/124	Prof. Weck RWTH Aachen	Calculation of the static and dynamic behavior of spindle-bearing systems	73-75	SPINEL	CAD-Report KfK-CAD 65 /80
52/126	Prof. Weck, RWTH Aachen	Calculation of the system of second order differential equations of vibration	74-75	BADY1D	
52/128	Prof. Weck, RWTH Aachen	Calculation of planar linear elastic beam structures	73-74	BADY2D	

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
52/130	Prof. Weck, RWTH Aachen	Calculation of linear elastic beam structures in space	73-74	BADY3D	
52/132	Fa. Thyssen, Kassel	Computer-assisted design of frame and drive mechanism for O-frame presses	76-78		
52/134	Prof. Lange Univ. Stuttgart	Calculation of contact problems	75-77	KONOR3	
52/136	Prof. Weck, RWTH Aachen	Simulation of steady dynamic processes	76-77	UNIDYN	
52/138	Research Association for Drive Technology, Frankfurt	Program chain for bevel gear calculation	76-78	KEGRAD	

3.1.5 Electrical and Hydraulic Systems /81

Efforts are made to overcome the problems that came up in the use of mechanical components for driving and controlling tasks, particularly in tool engineering, through the application of electrical and hydraulic drive and control systems. The effort involved in projections and planning for it is to be reduced and the reliability of planning results guaranteed, with the aid of EDP-programs.

Advance calculations of the behavior of electrical feed mechanisms, with regard to loads and dynamics, permit the reliable determination of appropriate drives already during the preliminary design phase, for instance.



Plotter drawing of a hydraulic drive diagram (Source: Institute for Control of Machinetools and Production Equipment, University of Stuttgart).

Predetermination of dynamic behavior is to be considered as a particularly difficult problem in the conception of hydraulic equipment. Simulation of complete installation and an analysis of weak spots should often help avoid costly reworking. /82

For the programs that have so far been developed--in all cases with the cooperation of industry--user experience will be collected and additions provided to increase user-friendliness. The aim is their introduction into numerous companies of the machine tool industry.

List of Program Developments /83

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
52/144	Prof. Koller RWTH Aachen	Computer-assisted design and testing of hydraulic control blocks	72-78	HYKON I	
52/146	Prof. Koller RWTH Aachen	Testing of manually designed control blocks	73-75	HYKON II	
52/148	Prof. Stute Univ. Stuttgart	Computer-assisted design of hydraulic diagrams	73-75	REKONA	CAD-Report KfK-CAD 20
52/150	Prof. Stute, Univ. Stuttgart	Computer-assisted generation of hydraulic diagrams	74-75	RECHYP	CAD-Report KfK-CAD 28
52/152	Prof. Stute Univ. Stuttgart	Computer-assisted selection of regulated electrical feed drives for machine tools	74-76	ELAN	
52/154	Prof. Stute Univ. Stuttgart	Computer-assisted selection of controlled electrical feed drives for machine tools	73-78	REKONE	CAD-Report KfK-CAD 21

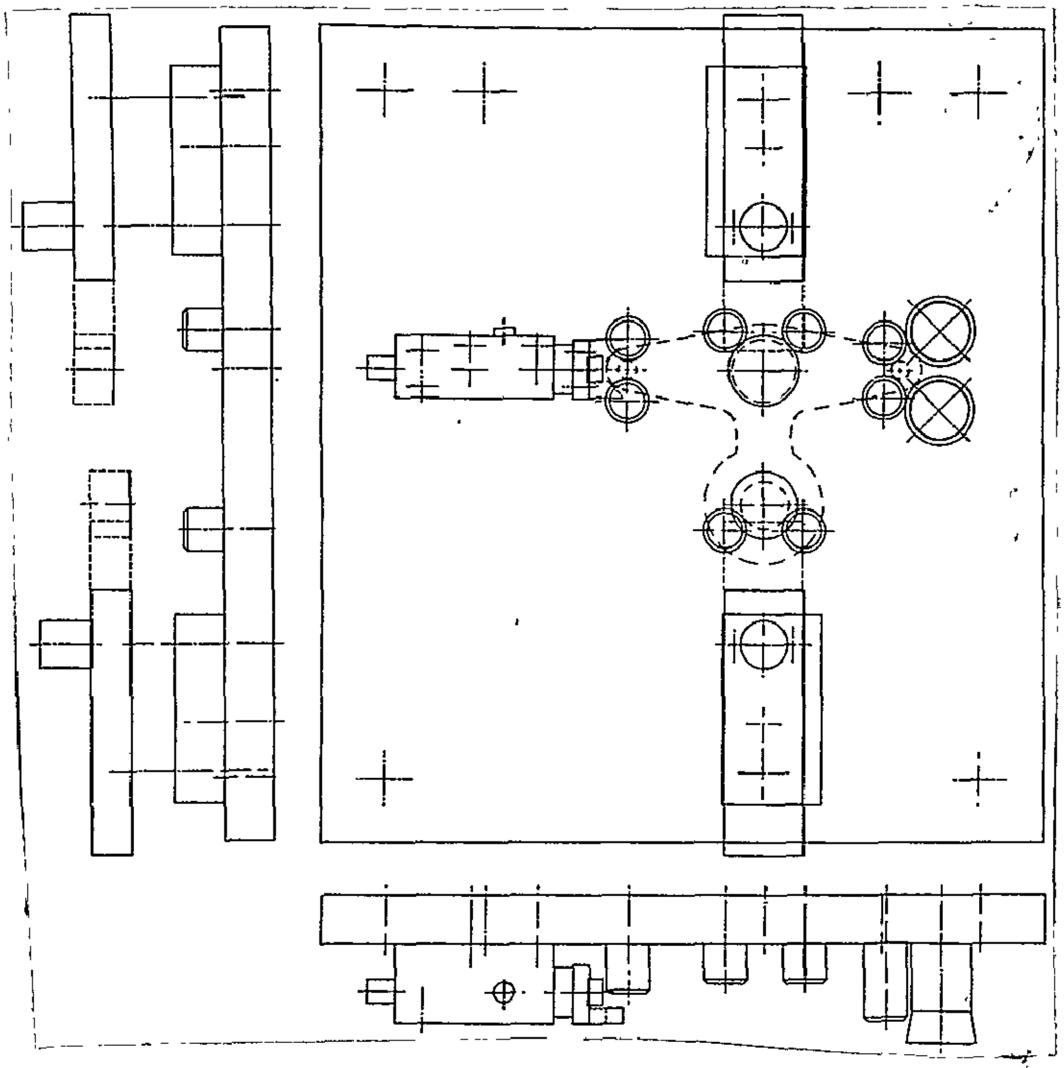
Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
52/156	Prof. Stute, Univ. Stuttgart	Computer-assisted selection of electrical drives as well as of control elements and output elements for machine tools	76-78	RAVAEL	
52/158	Prof. Stute, Univ. Stuttgart	Computer-assisted design of electrical controls	76-78	RENEST	CAD-Report KfK-CAD 22
52/160	Prof. Backe, RWTH Aachen	Determination of dynamic behavior of hydraulic hook-ups	76-78		
52/162	Prof. Backe, RWTH Aachen	Calculation of hydraulic control drives and main drives of high output for machine tools	76-78		

3.1.6 Machinery Materials /84

Within the scope of the process of product generation the machinery materials design, which is here divided into :

- tool design
- fixture design,

plays a special role in two respects. For one thing, it can itself be the subject of rationalization and automation activities, i.e., independent of actions in other product areas; for another, the gap between computer-assisted component design and automatic production can be closed through its inclusion in a CAD/CAM-system.

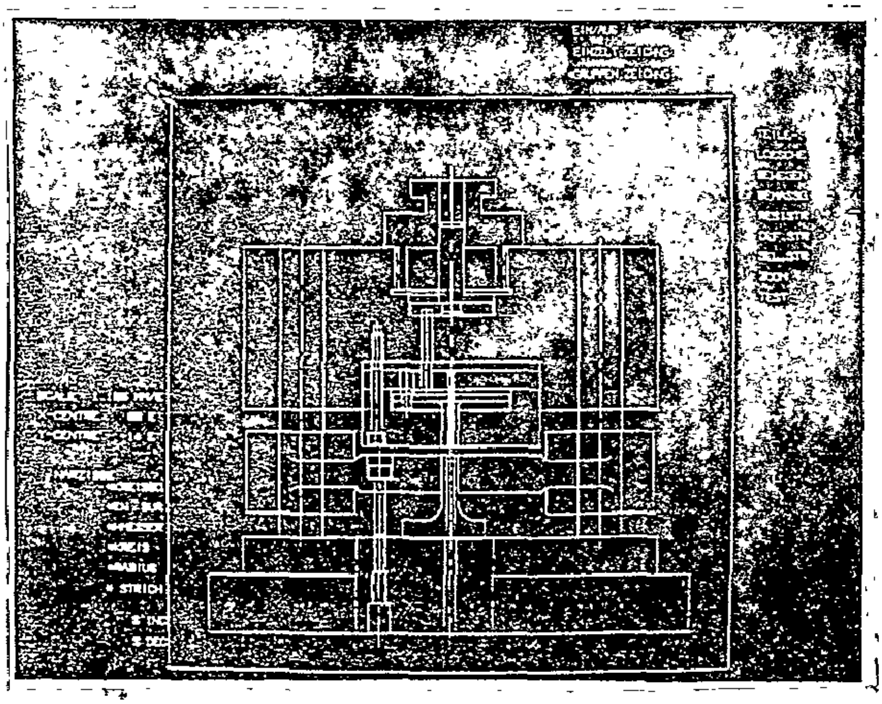


Design of a boring fixture with the program system VOKON (Source: Institute for General Design of Mechanical Engineering, RWTH Aachen).

So far tool design with DP-support has been carried out mainly for cutting tools in the sheet metal field. Master stamping dies were dealt with throughout. /85

In addition, the layout of conversion tools for massive coldforming assumes increasing importance. The totally controllable technological flow diagrams, which are examined in fundamental developments, require the development of aids for layouts that conform to practice and will be tested in pilot applications.

In the field of plastics processing a clear trend towards complex parts with integrated functions emerges. That again makes increased demands on the tool construction, for instance for diecast parts. The emphasis of future work will have to be on the layout of diecasting tools, therefore, with special consideration for the temperature/pressure/time behavior of the material to be processed.



Design of a punching die (Source: Philips Research Labs, Hamburg).

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
52/168	Krupp, Essen	Variant design of forming tools	75-77		
52/170	Philips GmbH, Hamburg	Dialog-Module for overall cutting die design	74-75	PHITOL I	
52/172	Prof. Koller, RWTH Aachen	Computer-assisted cutting die design	75-77	SNEKON	
52/174	Prof. Koller, RWTH Aachen	Development of (sheet metal) parts for bending	75-77	ABWILU	
52/176	Prof. Koller, RWTH Aachen	Automatic chad/ tape layout and waste minimization	75-77	OLENS	
52/178	Prof. Koller, RWTH Aachen	Computer-assisted fixture design	73-75	VOKON	
52/180	Prof. Tonshoff, TU Hannover	Computer-assisted design of rotating tools	74-76	CADOT	CAD-Report KfK-CAD 29
52/182	Prof. Spur, TU Berlin	Computer-assisted configuration of work piece feeding device	76-77	CADGRI	
52/184	Prof. Spur, TU Berlin	Examination of operation-related work piece areas on the screen		CADHAS	
52/186	Prof. Lange, Univ. Stuttgart	Calculation of shrink connections under radial internal pressure	74-75		
52/188	Prof. Lange, Univ. Stuttgart	Layout of simple prestressed extrusion molded matrices on a FEM basis	75-77	NOMO 1	

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
52/190	Prof. Lange, Univ. Stuttgart	Layout of doubly pre-stressed extrusion-molded matrices on an FEM basis	75-77	NOMO 2	
52/192	Prof. Lange, Univ. Stuttgart	Layout of doubly prestressed full-forward extrusion molded matrices	75-77	ZWEIVOR	
52/194	Firma Bosch, Wailblingen	Layout of die-casting tools	78-80		Joint Undertaking
52/194	Prof. Menges, RWTH Aachen	Calculation of die-cast parts with the aid of simulation models	78-80	SPRIGEO	

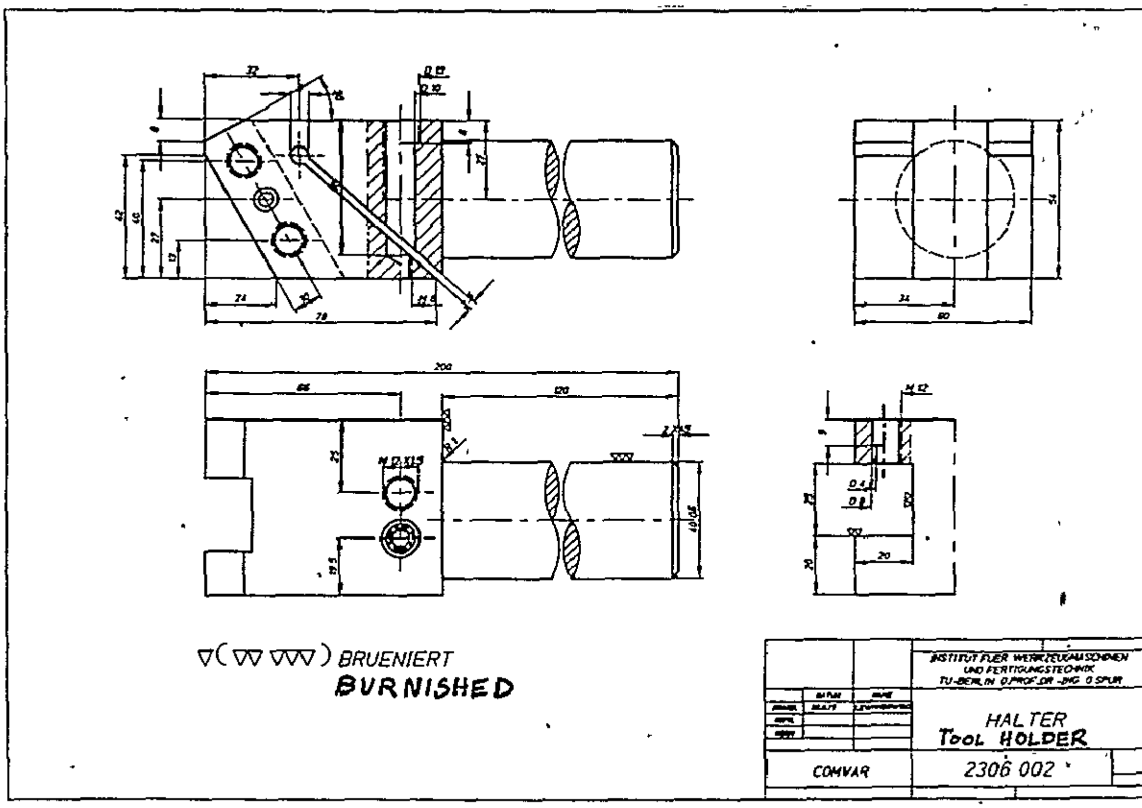
3.2 Generation of Documentation for Manufacture /87

3.2.1 Generation of Drawings

Generation of drawings represents a particular bottleneck in engineering and design companies today, since it is a highly labor intensive operation and since it is getting more difficult to have a sufficient number of personnel.

In this problem group all proposals are included that deal with the various possibilitiesof automatic generation of drawings.

By means of the following programs information about the workpiece is obtained, stored and kept in readiness, for miscellaneous tasks of further planning and fabrication.



Automatically Generated Shop Drawing (Source: Institute for Machinetools and Finishing Technology, TU Berlin).

The generation of drawings (generation of graphic information) is not treated as an isolated event but dealt with as part of an integration into information producing processing of engineering tasks by means of EDP, from design to fabrication. The following is considered essential in this case: one-time retrieval of information, its "conservation" and preparation for tasks like calculation, generation of drawings or work schedules, generation of NC-information. The availability of suitable "data structures" for storage of all object-related information of functional, geometrical, technological and organizational nature is a prerequisite for it. /88

The programs assembled here are of general importance beyond the scope of the mentioned areas of applications.

The objective of future work will be principally the development and unification of geometry-building blocks that are not objective-related (see also 6.2, Cross-section Task Geometry), in addition to expansion of systems already partially introduced into practice and the accumulation of experience through practice connected with it.

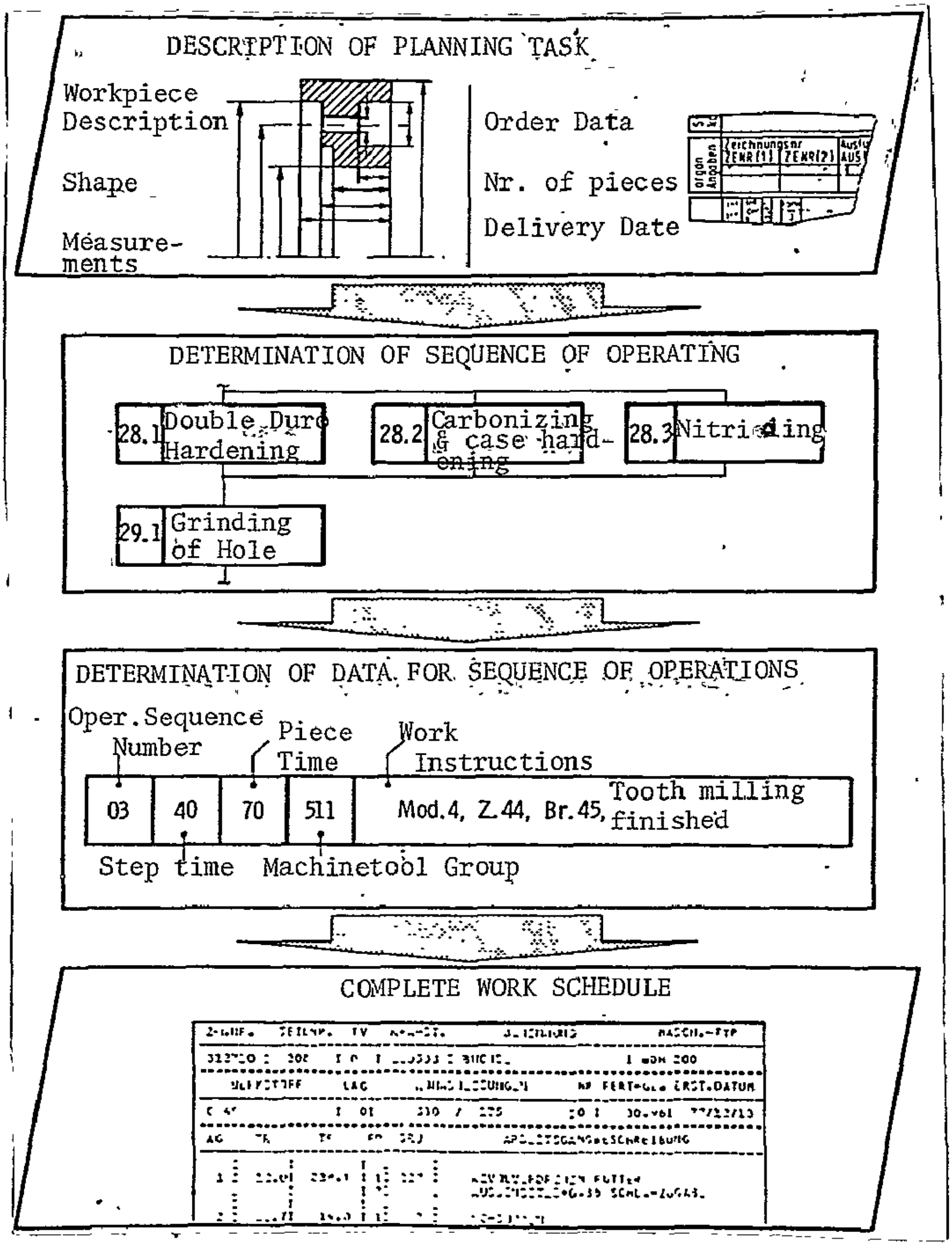
List of Program Developments /89

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
52/200	Prof. Spur, TU Berlin	Automatic generation of technical detail drawings of parts using the variant principle	73-79	COMVAR	
52/202	Prof. Seifert, Univ. Bochum	Software for generation of variant design drawings in Mech. Engineering	73-76	PROREN 1	
52/204	Prof. Grabowski Univ. Karsruhe	Program chain for building block products	76-78	MOSET	
52/206	Prof. Eversheim RWTH Aachen	Variant design and free design	76-77		
52/208	Firma Olympia, Braunschweig	Computer-assisted design (CAD) in Precision Engineering	72-76	OKYKON	CAD-Report KfK-CAD 30
52/210	Firma Philips, Hamburg	Integrated CAD/CAM system Precision Engineering	73-79	PHILIKON	Basic Version Available
52/212	Firma Philips, Hamburg	Dialog-Module for description of sheet metal parts	73-76	PHIPAD I	CAD-Report KfK-CAD 59

Report Page	Author of Program	Topic	Development Time	Name Program	Notes
52/214	Firma Olympia, Braunschweig	General card input language, CEFE-input language	73-75	KKOMP	
52/216	Firma Olympia, Braunschweig	Geometry-programs (2-dimensional)	73-75	GEO 2D/ GEO 2 EX	
52/218	Firma Olympia, Braunschweig	Graphic Software (Basic)	73-76	DIGRAPH	
52/220	Firma Leitz, Wetzlar	Calculation of tolerances for linear measurement chains	73-75	LINTO	
52/222	Prof. Eversheim RWTH Aachen	Free configuration of individual parts and construction groups	73-75	FREKON	CAD-Report KfK-CAD 63
52/224	Prof. Eversheim RWTH Aachen	Variant design of individual parts and subassembly	73-75	VABKON	CAD-Report KfK-CAD 60
52/226	Prof. Eversheim RWTH Aachen	Generation of individual parts drawings		DETAIL 2	Not sponsored by CAD funds
52/228	Prof. Spur, TU Berlin	System for 3D representation of technical objects	69-80	COMPAC	Not sponsored by CAD funds

3.2.2 Generation of Work Schedule /90

The increase in the volume of planning, the increased demands on planning quality and the shortening of the time available for planning, require rationalization of the work schedule generation.

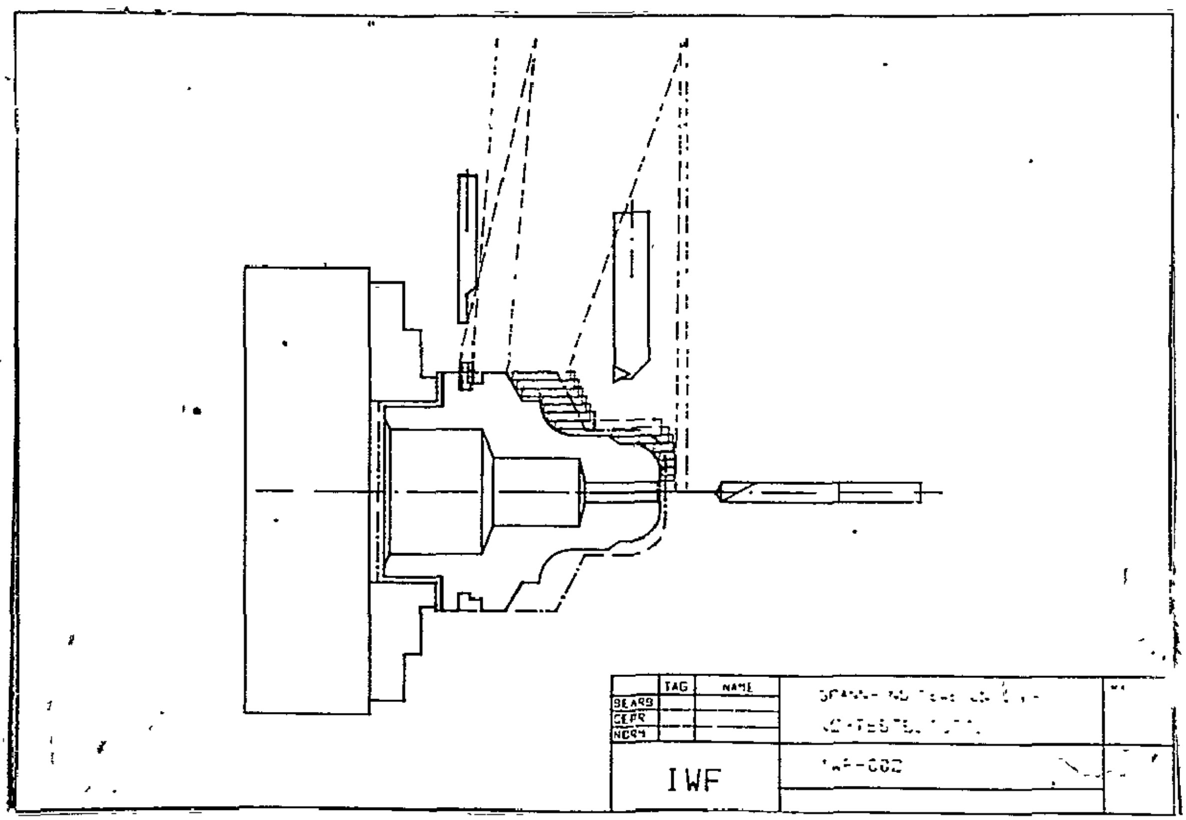


Process of Generating a Work Schedule by Machine (Source: Machinetool Laboratory, Department for Systematic Production, RWTH Aachen).

The separation of software into a neutral part and one that is specific to the operation has also proved to be very effective. /91

The principle of similarity planning underlying previous systems of work schedule generation, permits application for limited categories of parts only but findings from pilot operations show that it is possible to automate work schedule generation with a justifiable effort, since complete algorithimization of these planning activities can be achieved through restriction of the workpiece spectrum to variant categories.

In subsequent developments an attempt is made to achieve wide application potential, by inclusion and expansion of other parts categories, and to allow complete treatment in integrated CAD/CAM systems through coupling with design programs.



Example of a computer-assisted plan for chuck and tool motions in an NC-turning operation with program system CAPSY (Source: Institute for Machinetools and Finishing Technology, TU Berlin).

It is economical and can be accomplished in reasonable time through extensive application of AEDP, i.e., through automatization. Comprehensive amounts of information for planning, which reflect the available conditions of operational experience for various groups in design and fabrication through data and algorithms, must be obtained, systematized and documented suitable for EDP, for this purpose. /92

New methods of planning for the determination of the work operation sequences and of processing data have already been developed and procedures and auxiliary means for introduction of planning systems were designed and tested on examples.

Gegenstandsbezeichnung	MG	Wz-Nummer	TR-Nummer	Ergänzung	Fabrikatebezeichnung	Z	Fab Gr	LG	Kart Zahl	Arbeitsplan Nr.
WELLE					1LA3100	N		1	/	2183158201

St-Nr	Kon	Schreib	Mind.-Stück-Größe	Losgr.	DZ	GW	Kalk. Karten-Nr.	Bemerkungen:
1-								1

Umlage / Stck	Wzg Konstr	Wzg Kost DM	Modellkost DM	Basis
	Std			1.0

53001 129U61 56,0 DM MST60-2 DIN1013 3 0000141280									
5300153 ABSCHNEIDEN 591.00 LANG	02	1	A	05	C68385		53.37	5	
5300253 PLANEN UND ZENTRIEREN 590,0 LANG DM16,0 A-SEITE / A 4,0 B-SEITE	05	1	A	06	J10156		470,00	20	
5300353 KOMPLETT DREHEN	08	1	A	08	J10024		1944.24	60	
5300453 RIFFELN	08	1	A	07	J12195		129,80	20	
5300553 KOMPLETT SCHLEIFEN	48	1	A	07	J11187		579.04	35	
5300690 1-SPUL, FRAESEN UND ENTGRATEN	15	1	A	07	J10744		657.85	30	X
Arbeitsfolge – Art der Arbeit									

Work Schedule generated automatically (Source: Machinetool Laboratory, Department for Systematic Production, RWTH Aachen).

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
52/236	Prof. Eversheim, RWTH Aachen	Generation of Work Schedule	73-78	VARAPE	CAD-Report KfK-CAD 46
52/238	Fa. Siemens, Munchen	Automatic generation of work schedule	73-76	ALPAG	
52/240	Prof. Eversheim, RWTH Aachen	Generation of work schedule	75-78	AUTAP 2	
52/242	Prof. Eversheim, RWTH Aachen	Generation of work schedule	75-78	AUTAP 1	Joint Proposal
52/242	Keiserling and Albrecht, Solingen	"			
52/244	Olympia-Werke, Braunschweig	Postprocessor for wire AGIECUT-DEM 15	74-75	AGIE 15	
52/246	Olympia-Werke, Braunschweig	Postprocessor for wire erosion machine AGIECUT-DEM 25	74-75	AGIE 25	
52/248	Fa Philips, Hamburg	Dialog-Module for NC-programming (AGIE-CUT DEM 15, DEM 25)	74-76	PHINUC	I
52/250		Program generation for automatic generation of postprocessors for NC-tools	76-79	PPGEN	
52/252	Fa. Pfauter, Ludwigsburg	Hobbing machine setting	76-78	WEAEIN	
52/254	Fa. Salzgitter, Mashinen AG	Calculation of cost for complete processing of turned parts	78-79		Joint Proposal
52/254	Prof. Tonshoff, TU Hannover	"		DREKA1	

/94

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
52/256	Fa. Heller, Fa. Demag-Meer, Prof. Eversheim	Generation of integrated documentation for manufacturer	78-79		Joint Proposal
52/258	Fa. Boehringer, Goppingen	Generation of work schedule (pilot application)	78-79	RAN	
52/260	Prof. Spur, TU Berlin	System of work scheduling and NC-programming		CAPSY	Not sponsored by CAD-funds

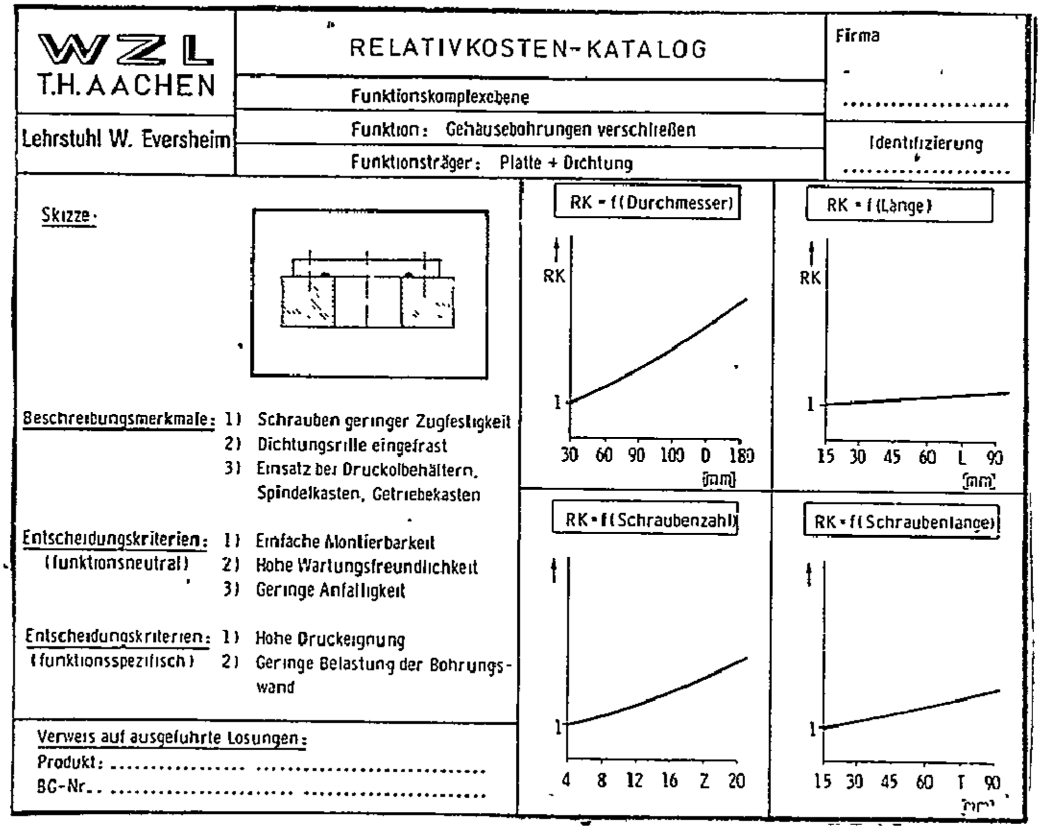
3.3 Auxiliary Means /95

3.3.1 Files, Catalogs

The high financial responsibility of the planning areas Design and Preparation for Manufacture requires the furnishing of actual information about the supply and manufacturing capabilities of the company.

Guidelines, values and standards, as well as tables and catalogs, contribute in putting appropriate data at the disposal of the designer and work scheduler.

Difficulties in the application of such documentation were shown, however, in that on the one hand the effort of producing a catalog is very high, for instance, but rational behavior and implementation are not possible otherwise.



Sample from a catalog of relative costs (Source: Machinetool Labs, RWTH Aachen).

Objectives to be Achieved /96

In addition to building up catalogs that are primarily technologically oriented and files for materials cutting speeds, tools and standard parts, cost-oriented files must be established.

A cost-information system not specific to any company, as well as suitable methods for its adaptation to specific company conditions and implementations, must be built up, based on experience in application of available relative cost catalogs on the one hand and analyses of cost information requirements on the other. For technical implementation results of developments, taken from technical databanks, may be utilized if necessary. (See Cross-section Tasks, Chapter 6.3.)

List of Program Developments /97

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
52/266	Gebr. Heller, Nürtingen	Materials catalog for the practice of chip-removing operations	76-77	WERKAT	
52/268	Gebr. Heller, Nürtingen	Tool-chuck catalog for computer-assisted choice of NC-programming	78-79	WERSPA	
52/270	Prof. Eversheim RWTH Aachen	System for computer-assisted generation and implementation of relative cost catalogs	75-78		CAD-Report KfK-CAD 45

3.3.2 Guidelines, Studies /98

The studies collected in this section do not deal with program developments directly but contain

--Guidelines for preparation and implementation of EDP application in design.

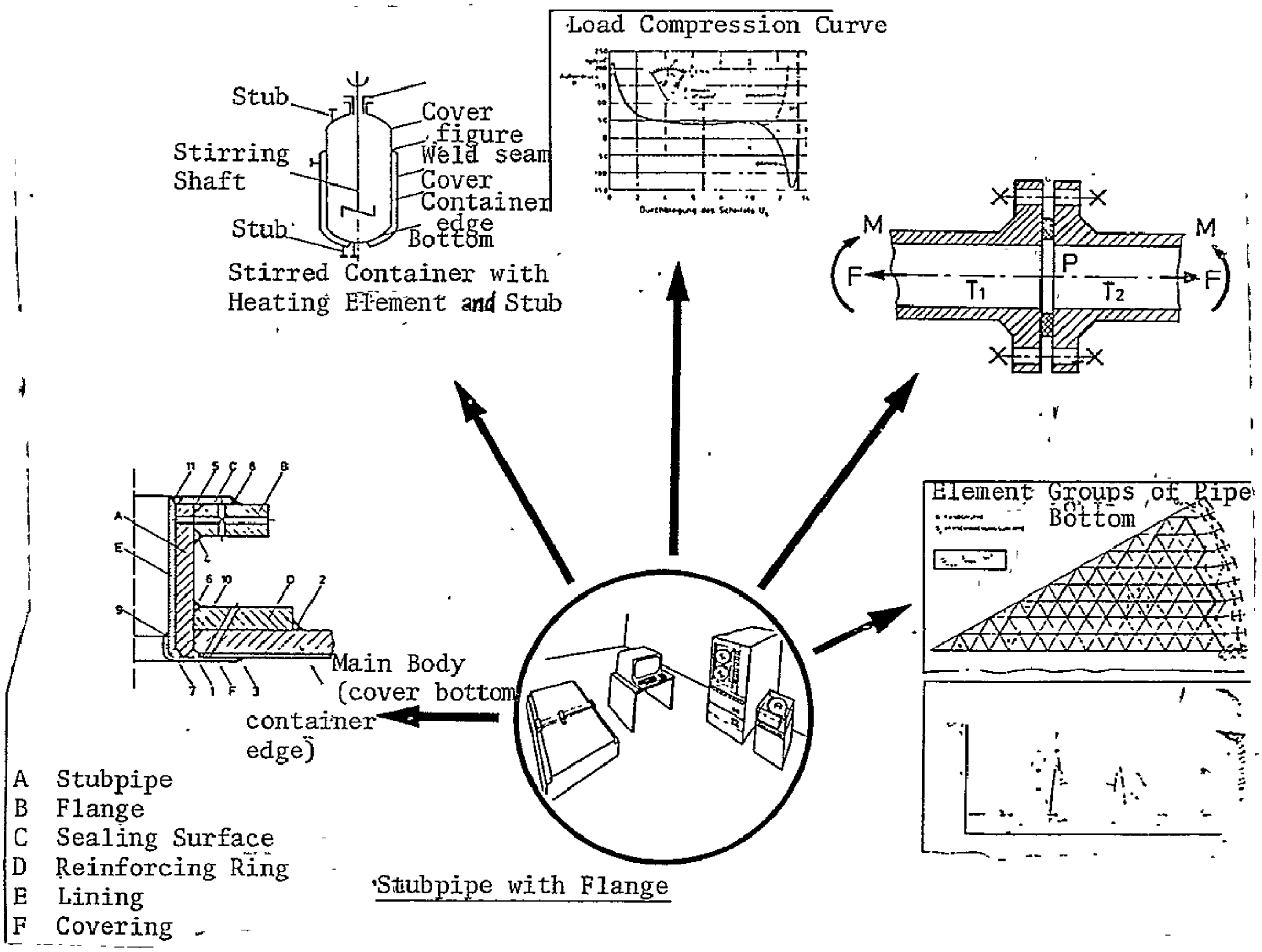
--Studies for clarification of the state of development and acquisition of user suggestions for further activities.

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
52/275	Prof. Eversheim RWTH Aachen	Analysis of manufacturing documentation	73-74		CAD-Report KfK-CAD 10
52/276	Prof. Eversheim RWTH Aachen	Procedure for the analysis of user programs	73-75		CAD Report KfK-CAD 61
52/277	VDI Düsseldorf	Analysis of the design process with respect to EDP application	73-74		Guideline VDI 2210 (Design)
52/278	VDI Düsseldorf	Task, principle and application of information system	73-74		Guideline VDI 2210 (Design)
52/279	VDI Düsseldorf	Calculation in design	73-74		Guideline VDI 2211, page 2 (Design)
52/280	VDI Düsseldorf	Methods and aids for generation of drawings by machine	73-74		Guideline VDI 2211 page 3 (Design)
52/281	VDI Düsseldorf	Systematic search and optimization of design solutions	73-74		Guideline VDI 2212 (Design)
52/282	VDI Düsseldorf	Integrated production of manufacturing documentation	73-74		Guideline VDI 2213 (Design)

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
52/283	VDI Dusseldorf	Program generation	73-74		Guideline VDI 2214 (Design)
52/284	VDI Dusseldorf	Organizational prerequisites and general aids	73-74		Guideline VDI 2215 (Design)
52/285	VDI Dusseldorf	Procedure in introduction of EDP in the design field	73-74		Guideline VDI 2216 (Design)
52/286	VDI Dusseldorf	Concept definition	73-74		Guideline VDI 2217 (Design)
52/287	Prof. Warnecke Univ. Stuttgart, Research Assoc. for Program Languages, Aachen	CAM Study	75		

(missing) /100

4.1 Chemical Engineering/Installation Building



Installation building,as well as the equipment industry supplying it in the Federal Republic, is increasingly coming under pressure from foreign competitors; next to general influences on the cost level it should be noted that in both branches the share in standard equipment is taken over increasingly by third party countries. Increasingly better technical performances must therefore be offered, on a more and more individual basis, with utilization of DP being expected to limit the increasing effort put into planning and design.[1,2]

The products of chemical engineering are destined for the /102
most part for the material transforming industries with the chemical industry, as biggest customer, investing more than 60% of its total investment volume in them (1973=4.7 Billion DM). This close relation has also influenced the equipment manufacture:

Large chemical industries in particular develop their own production methods and often order the required individual equipment according to their own drawings. So the main interest of many equipment manufacturers is not so much in independent design or in applied technology "know how" but in the--increasingly noncutting--manufacturing technology (competition in prices instead of in functionality[3]) for equipment serving in thermal and mechanical processing, as well as for container making.

Only in recent years have equipment manufacturers started to offer not just individual products but entire installations on their own responsibility, in part with independent designs and in-house functional know-how. They are moving in the direction of engineering companies, which are also required to provide the functional guarantee essential for installations. Individual fabrication predominates in installation building and individual equipment is fabricated in small series.

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[1]Computer-assisted Development and Design in Chemical Engineering, DECHEMA, June 1974.

[2]Computer-assisted planning of installations, DECHEMA, October 1977.

[3]Technological Development, Volume 3, H. Rupf et al., Verlag Otto Schwarz & Co., Göttingen, 1976.

Corresponding to this general development of equipment building the application of data processing has taken place to a highly variable extent. As described in (1) a great requirement for catching up with backlogs can be noted, particularly in small and medium size companies. Calculations with EDP-assistance are largely "state of the technology" but they are restricted to smaller, less complex, procedures for modest hardware; voluminous problem-oriented calculation methods, primarily those dealing with structure mechanics, design and manufacturing assistance, /103 as well as bid examination and order processing with the aid of EDP, are only insufficiently available for equipment and installations. Together with the increasing share of export and the requirement to do layouts according to foreign guidelines, which is connected with it, this leads to an increasing distortion due to competition in the branch.

Computer application in the technical part of chemical engineering is thus desirable for the following tasks:

- --generation of documentation for proposal and bid requests.
- --geometric and stress calculations of equipment and its components.
- --design, including generation of drawings, parts lists, work schedules and manufacturing schedules.
- --collection and linkage of data for design, operations and materials for planning, calculation and control of manufacture.

A number of programs exist for planning in the manufacture of installations, particularly for the design of installation components, for planning pipelines, as well as for the balancing of quantities and of energy. According to (2) there is increasing demand for a total system able to operate interactively, which can be used as a whole or partially and can be run on different computers or a combination of them. New developments are needed in particular in "Basic Engineering" of the planning phase, for location planning, the technical equipment, MSR-planning and the planning of pipeline locations.

The sponsorship, which has operated essentially since 1976, is oriented towards three main points, which are explained below, along with program descriptions:

- Calculation procedures for equipment and equipment components /104
- Generation of drawings and of geometry
- Planning of installations and their fabrication.

The present activities extend to the programming of reliable methods of calculation for tanks, equipment and equipment components according to German and foreign control installations. In addition, some newer methods of calculation are being developed according to the needs of industry.

Prominent is the treatment of drawing generation for chemical engineering; it was started in 1977 and is carried on in connection with corresponding work in mechanical engineering.

Considerable effort is still required for the main point of installation planning, which could only be funded from the start of the current year. The total concept is formulated and the work packages defined in 1978, based on the profile requirement from (2), so that the corresponding development and integration operations can start after user-approval of the concept.

List of Proposals

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
Method of Calculation					
53/26	Friedr. Uhde GmbH, Dortmund, Saamer Krupp Koppers GmbH, Essen Schmitt-Traub DVO-Data-Processing Service, Oberhausen, Straus	Program system for calculation of strength, according to technical control installation, of tanks, equipment and pressure components of steam generators	76-78	PROBAD	Joint Proposal
53/28	Friedr. Krupp GmbH, Essen, Pagenkamper	Thinwalled pressure tanks	74-76	DRAKULA	/105
53/30	DVO-Data Processing Service, Oberhausen GmbH, Kraft	Design system for sheet metal ducts	75-77	KOSYKA	
Method of Calculation (new)					
53/32	German Institute for Research and Development in Aeronautics & Astronautics, Braunschweig, Kerkhoff	Buckling program for cylinders with pure membrane stresses in the prebuckling region	75	FO4BO1	
53/34	DFVLK Braunschweig, Kerkhoff	Stress program for cylinders with rings and edge disturbance	75	FO4SO1	

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
53/36	DFVLR Braunschweig Kerkhoff	Buckling program for cylinders with the actual prebuckling stresses	75-76	F04B02	
53/38	"	Stress program for a rotary casement with random meridian form	75	F04S02	
53/40	"	Power input interferences	75-76	F04S03	
53/42	"	Buckling program for rotary casements with random meridian form	75-77	F04B03	
53/44	"	Rotary casements with finite deformations	75-77	F04S04	
53/46	Erlangen Univ. Institute for Instrument Technology and Installation Building Depmeier	Calculation of stresses in components with rotational symmetry, caused by local loads	76-78	BSBLOK	/106
53/54	TU Braunschweig Institute for Statics Harbord	Stubs and cutouts of containers	75-78	HYDAS	
53/56	TH Darmstadt FG: Machine Elements and Drives, Duda Fried, Krupp BmbH, Essen, Wormnest	Calculation and design of flange joints	76-78	FLANOD	Joint Proposal

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
53/58	IKO Software Service GmbH. Stuttgart, Kiesbauer	Calculation of pipe plates of special design and considera-tion of nonsym-metrical condi-tions	76-79	FENCER/ TOPAS	Joint Pro-posals
..	TU Stuttgart Institute for Statics & Dy-namics of Aeronautical & Astronautical Designs; Argyris				
Generation of Drawings and Geometry					
53/60	TU Stuttgart Dept. & Insti-tute for Chem-ical Process Technology, Blenke	Computer-assisted drawing in chemical engineering	77-79		
Planning and Construction of Installations					
53/62	TU Karlsruhe Dept. for Com-puter Applica-tions in Mech. Engineering Grabowski	Program default planning of in-stallations lay-out of installa-tions	78-80		

4.2 Shipbuilding

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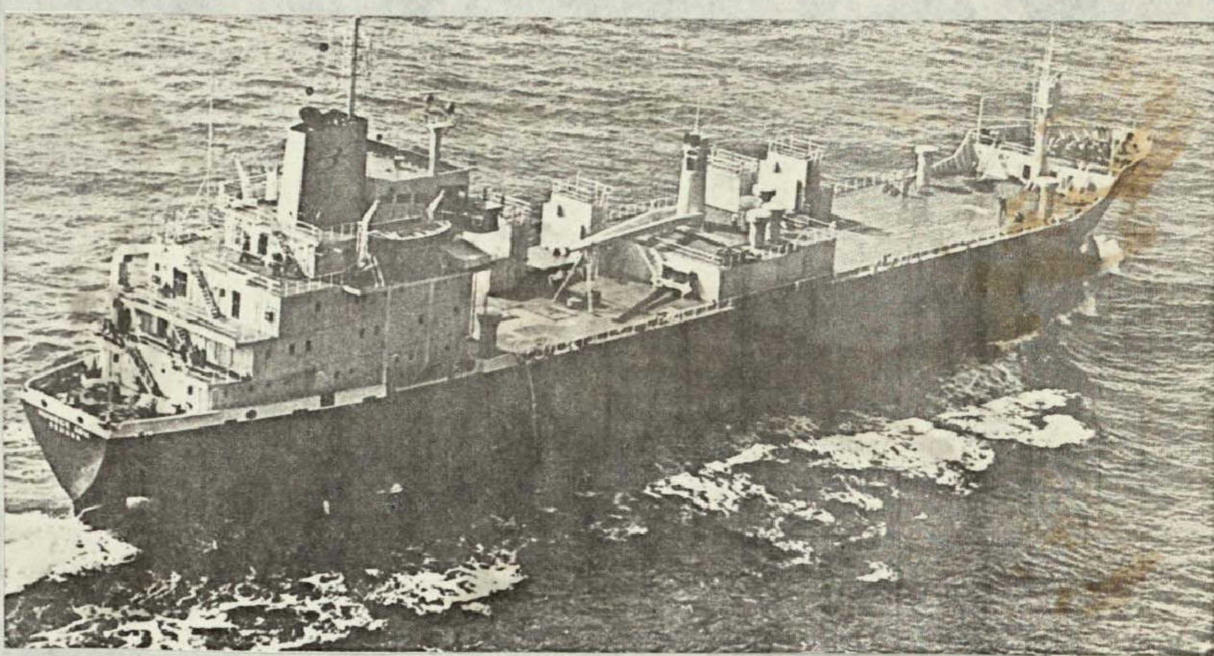

Highly complex (seagoing) transport systems are being developed, designed and fabricated in the shipbuilding industry, which are predominantly dependent on the specific order. Since the development of prototypes is not possible, each individual order inherently involves considerable technical and costing risks--particularly since different regulations of classification organizations must be considered because of high dependence on export.

As to application of DP in the technical areas of shipyards it can be stated that no difficulties worth mentioning are expected for the large shipyards (whose share is 90% of seagoing tonnage) because of the available hardware equipment.

The generation of the product "ship" can be divided, according to (1) into the main areas: /108

--Outline concept
--Design
--Manufacture

A multitude of programs exist, which can be used independently, particularly in the concept stage (calculation of stresses, hydrostatic calculation, lofting) and in manufacture and preparations for it (flame-cutting, parts lists . . .). The aim of studies funded since 1973 has, therefore, been the creation of an integrated program system for shipbuilding (ISP) with datakeeping, that is applicable to all phases of calculation. The information system Technik (IST) was chosen for that purpose, individual available programs were checked for integration capability and missing programs were incorporated in the development.

The emphasis of current efforts is on the main area of "Design" for which significant parts have been completed and incorporated into the test phase.

Linkage of design with manufacture is always direct, efforts for the "concept" area are planned mainly for the years 1979 and 1980.

In addition to the joint proposals of the shipyards another study for the development of appropriate optimization methods was also sponsored.

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[1]Investigation of the use of an integrated program system for shipbuilding technology in the German Shipbuilding Industry, Research Center of the Gernman Shipbuilding Industry, March 1972.

Efforts so far expended within the scope of the sponsorship are addressed exclusively to the bodies of exceptionally large seagoing vessels. The expected development of a market for seagoing vessels[2], including the more pressing safety requirements, bring the following considerations to the fore:

- The market will increasingly demand highly specialized ships (for instance tankers for LNG and chemicals) and new, more stringent safety requirements (for instance, double hulls). Units of medium size will predominate. /109

- If the shipbuilding industry is to avoid a trend towards becoming an assembly industry it must increasingly grow in the direction of mastering the tasks of ship equipment and furnishings (whose share of total costs already exceeds 50%). Mentioned here as examples are loading technology, propulsion installations, supply and discharge systems of ships, steering and control equipment, electrical board installations and navigation technology.

- The transport of (bulk) goods is rarely restricted to the seagoing ships as the sole means of transport; the loading ramps of docks can definitely include landbased technical equipment for preparation and loading (for instance, liquification and feeding installations for LNG, inland or at the coast).

How far new design principles and new task areas can be covered by means of ISP, and what other solution aids will be needed, requires clarification in the near future.

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[2]Tendencies in the market for shipbuilding, German Shipbuilding Industry Association, 85 pages, November 1977.

List of Proposals

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
		AUXILIARY FUNCTION			
		Building Block GEOMETRY			
53/74	Boeters, ff.	Auxiliary functions for computer-assisted planning and design in shipbuilding	74-78	GEOMETRIE	IST-building block part of ISP-system
		CONCEPT			/110
		Building Block HYDROSTATICS			
53/76	Langhein	Establishment of a ship configuration file	73-74	HYDROSØ3	
	Jacob	Establishment of a weights master file	73-74	HYDROSØ6	
	Jacob	Establishment of a loading condition file	73-75	HYDROSØ7	
	Eckhoff	Batch accumulation	76-77	HYDROS16	
	Langhein	Curve sheet calculation	76-77	HYDROSØ4	
	Langhein	Buoyancy center, locus calculation	74-75	HYDROSØ5	
	Jacob	Calculation of longitudinal stresses. Establishment of a file of moments of inertia	74-75	HYDROSØ9	
	Eckhoff	Identification of ship to be calculated	75-76	HYDROS69	

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
	Langhein	Combined calculation of trim, stability and longitudinal stress	76-77	HYDROS17	
	Eckhoff	Plotting of spar elements and side contour	75-76	HYDROS59	
	Langhein	Curve table, interpolation of spar element results	75-76	HYDROSØ4/41	
	Langhein	Loci of buoyancy centers for given displacement. Tables of buoyancy center loci	75-76	HYDROS42	
	Eckhoff	Establishment of a master file for ship's data	75-76	HYDROS59	
	Langhein	Establishment of a ship's configuration file and transition from the loft file to configuration file	76-77	HYDROSØ3	
	Langhein	Buildup of files for general planning and for space	76-77	HYDROS1Ø HYDROS11	/111
	Eckhoff	Leak calculation	76-77	HYDROS18	
	Langhein	Spatial curve sheet calculation	76-77	HYDROS12	
	Eckhoff	Plane table calculation	76-77	HYDROS15	

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
53/80		<u>Building Block LOFTING</u>			
	Pfeifer	Establishment of a lofting file	74-75	STRAKEØ2	
	Pfeifer	Programs for determination of ship surface contours.	75-76	STKON	
		<u>DESIGN</u>			
		<u>Building Block DIMENSIONING</u>			
53/82	Bannerjee	Prelim. dimensioning of tanker frame per Lloyd's register of Shipping 1974	74-75	DIMKLA1Ø	
	Madlung	Longitudinal bonding of tankers per regulation of the German Lloyd	75-76	DIMKLAD3	
	Kaube	Dimensioning file	75-76	DIMKLAØ6	
	Kords, ff.	Selection routines for profiles and built up beams	75-76	DIMKLA11	
	Kaube	Cross-section values and comparison weights of longitudinal bonds	75-76	DIMKLAØ7	
	Hermes	Permissible longitudinal bending moments and transverse forces per regulations of the German Lloyd, 1973	75-76	DIMKLA24	

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
	Madlung	Longitudinal bonds in the 0.4L midship region for freighters (Longitudinal spar building method)	76-77	DIMKLATE	
	Bannerjee	Longitudinal bonds in the 0.4L midship region for freighter (transverse spar building method)	76-77	DIMKLAE2	/112
	Bannerjee	Longitduinal bonds in the 0.4L midship region for container ships	76-77	DIMDCH	
	Reisiger	Watertight transverse bulkhead stiffened vertically or horizontally	76-77	DIMKLA69 DIMKLA6A DIMKLAEC	
	Madlung, ff.	Longitudinal bonds at the ends of the ships (independent of type of ship)	76-77	DIMKLALE	
	Hermes, ff.	Checking of components for buckling and twisted buckling	75-76	DIMKLAØE	
	Kaube	Weight determination of transverse components	75-76	DIMKLAØD	
	Hermes	Dimensioning routines corresponding to construction rules by the German Lloyd, 1973	75-76	DIMKLA69	

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
	Bannerjee	Tables of profiles	75-76	DIMKLADD	
	Weber	Graphic presentation of the main spar cross-section for dry goods freighters built in longitudinal spar manner	76-77	DIMPLOT1	
	Reisiger	Graphic presentation of watertight transverse bulkheads	76-77	DMKLA74 DMKA77	
	Reisiger	Transverse bulkhead outside the 0.4L in midship, special types like bilge bulkheads	76-77		
	Reisiger	Graphic representation of the tanker transverse bulkhead	76-77	DIMKLA74 DIMKLA76	/113
	Hornich	Graphic representation of longitudinal bending moments and cross forces	75-76	PLOTMQ	
	Bannerjee	Graphic representation of main spar for cross-section for containerships	76-77	CONPLOT	
	Weber	Longitudinal bonds in 0.4L-midship region for bulk goods ships	76-77	DIMBC1	

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
	Weber	Graphic representation of the main spar cross-section for bulk goods carrying ships	76-77	DIMPLOT2	
	Weber	Tapering of longitudinal bonds	76-77		
53/84		Building Block STRUCTURE MECHANICS			
	Weber	STRESS evaluation of results	75-76	POSTØ1 PLOTØ2	
	Weber	Shear stresses in thin-walled cross-sections	75-76	SCHUB	
	Weber, ff.	Natural frequencies of the ship	75-76	SCHWING	
	Weber	Contribution for application of STRESS	73-74	STRESS	
	Majumder	Establishment of a reserve system for tanker frames and the input data for STRESS	74-76	ESTARØ ESTAR1 ESTAR2 ESTRØD ESTR1D ESTR2D	
	Weber	Plotting of STRESS input data	74-75	PLOTØ1	
	Majumder	Reserve system and loads for calculating girder lattices for the loading tank region	77-78		
	Majumder	Reserve system and loads for calculation of girder lattices of a B.-C. double bottom	77	MDBGBC	/114

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
	ISP/GL	Reserve system & loads for costing calculation of a transverse bulkhead strip as continuous beam	78		
53/86		<u>Building Block DESIGN</u>			
	Gieseler	Buildup of spar table	76-77	STRAKE79	
	Gieseler	Generation of design lines	76-77	STRAKE7A	
	Gieseler	Main surface areas of be generated (outside hull covering, decks, longitudinal and transverse bulkheads)	77	GROBKO∅2	
	Gieseler	Generation of main compoment traces on other main components	78	GROBKO∅2	
	Hornich	Developed projection of outside coevering over spars	76-77	SPABS	
	Hornich	Seams and longitudinal spars to be included in the construction spar view	77	SPTP	
	Gieseler	Openings (for instance, portholes) to be placed in the main surface areas	77-78	GROBKO∅2	
	Gieseler	Reinforcement molding edges generation of seams and butt joints of main components	78-79	GROBKO∅2	

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
	Gieseler	Design of components for stiffening	78-79	GROBKO02	
53/88	Univ. Berlin Institute for Naval Technology, Novacki	Generally applicable optimization software	76	OSW	
53/90	TU Hannover Dept. & Institute for Naval Architecture and Ship's Theory, I. Poulsen Soding	Hydrostatic calculations for ships	75-76	ARCHIMEDES 76	
53/92	TU Hannover Dept. & Institute for Naval Architecture and Ships' Theory Soding	Hydrostatic calculations for ships	75-76	PEIL	

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The degree of computer application for development, design and manufacture, in the electrical industry is highly uneven. That situation is brought about both by the size distribution in this industry, which is the third largest with regard to business volume and takes first place for capital investment, as well as by the variety of rapidly changing technologies. As an example of such a rapid technology change, we will just mention the solid state component sector and the consequences that accrue for many product areas even outside the electrical industry.

For the majority of companies, the small and medium size firms, the reason for the narrow application is seen due to three causes.

Producers of DP-installations rarely offer user software together with hardware in the technical areas and indeed have that capability only in exceptional cases. But it is just the small and medium companies, where use is based on personal or financial reasons, that are not usually in position to generate the missing application programs on their own.

The problem solutions worked out by the few large companies are naturally oriented towards their own conditions; their transferability can be judged only on the basis of a representation of the selected solution procedure.

In recent years comprehensive program systems have been produced for the development of semi-conductors and computer hardware, which assist the production process from concept to acceptance test in its entirety. Partial programs of these systems, like one for printed circuit board disentanglement, can usually not be run independently, or only to a limited extent, and are not applicable for other companies.

The two product groups mentioned do, obviously, occupy a special position. That also becomes clear in observing CAD/CAM activities at universities that are weak in other phases of electrical engineering, by comparison. If we consider the other product sectors of the electrical industry and restrict ourselves to companies that employ up to 5000 people (42% of the total) the following picture can be drawn per (1): /118

Single "island" solutions are available in the development phase, in addition to computation programs, with a large backlog of requirements waiting to be filled in manufacture.

There is no question that the expected increase in output through more intensive use of EDP will only be achieved by maintaining data files of all stages of production, where possible; so far that has been realized only for a few products. The mentioned study indicates particularly strong requirements for programs in

--Geometric DP
projection, plotting of drawings, assembly documentation
--Circuit design
analog, digital and hybrid circuits
--Test preparation and tests
--Quality assurance

The limitation to companies with up to 5000 employees should not lead to the wrong conclusion that firms with more

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(1) Computer-assisted development, design and manufacture in the electrical industry, ZVEI, March 1976.

employees have necessarily broader production areas; that is only occasionally true. The findings of the study should actually be representative, beyond the 42% mentioned, of a good many more companies.

At this point a suggestion about the desired multiple use for developed programs is appropriate: The goal of sponsored development work must be--wherever possible--the creation of "standard building blocks", which are generated by cooperation with the appropriate organizations (Standards Committees, for instance). Standardization is surely one of the ways to guarantee broad application; another is directed information about available programs by an institution, preferably neutral, as is carried out since the beginning of this year by the Central Association of the Electrical Industry (ZVEI) by means of a "program exchange." /119

The product groups for which the requirement of programs assisting in development, design and manufacture is the clearest, can be summarized as:

- Equipment and installations for generation, transmission and distribution of energy.
- Equipment for communication processing.
- Industrial and equipment electronics.
- Consumer goods.
- Development of components/assembly parts.

The electrical engineering section of the sponsor project is arranged according to three areas of emphasis at the moment, in acknowledgement of this subdivision:

5.1 Energy Generation and Distribution

5.1.1 Electrical Machines, Transformers

5.1.2 Distribution Networks

5.1.3 Installations

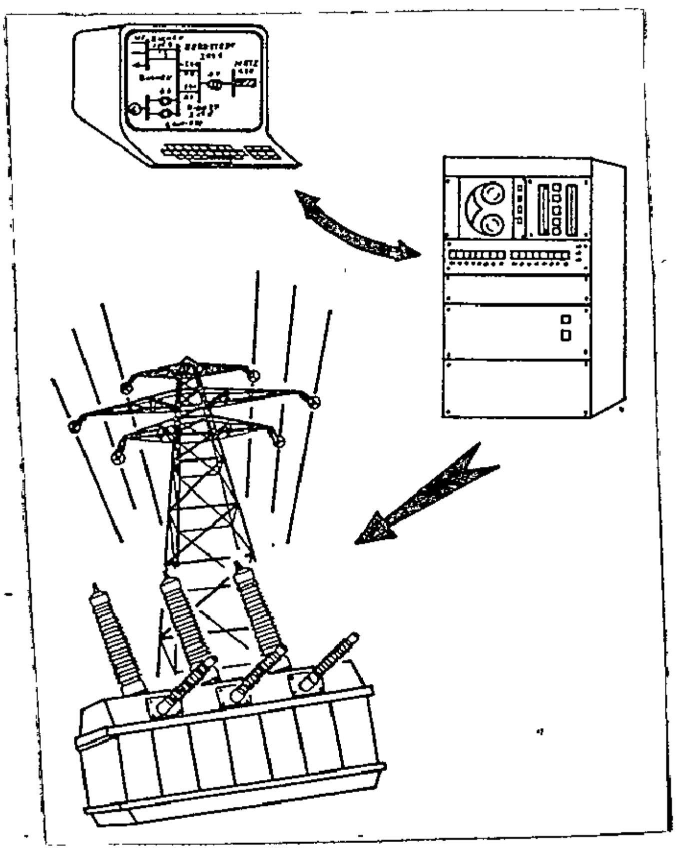
5.1.4 Power Electronics

5.2 Equipment Electronics

5.3 Components

Work involving computer hardware or semi-conductor components does not fall within the scope of this project.

5.1 Energy Supply and Distribution /120



The products of this subsector are distinguished by this fact, among others, that they are not subject to such short-term changes,due to rapid technology change, as the previously mentioned electronics. Program chains for assistance with development, design and manufacture are less in danger, therefore, to be obsoleted at completion or a little later by basically new components and processes. The possibility for multiple use over an extended period of time is available, similar to the situation in the building industry. What is important here for a competitive position in the market is not the superiority in know-how, which /121 is of short duration, but the logical exhaustion of all possibilities for implementation with particular emphasis on computer application, from the quick and reliable bid generation to the control of manufacture.

It appears that for mass production computer applications in development and design play a relatively subordinate role, as compared to control of manufacture, which can always be realized closely associated with the mass-produced article.

5.1.1 Electrical Machines, Transformers

State of Development

The use of data processing for this product group extends mainly to programs for electrical proportioning, organizational planning and materials economics. In addition, there are occassional programs for submission of bids and for design, with the majority of them being company-specific and dependent on hardware.

Objectives to be Achieved

Only a small portion of motors, generators and transformers are produced in actual mass production. A few hundred variants exist within the same class of rating even for standard motors. For higher power ratings custom fabrication is clearly the rule.

In custom fabrication the most important decisions affecting the cost are made between the bid phase and the design phase. By tieing existing calculation programs to design programs capable of alternating operation and including generation of documentation for manufacture, such decisions should be available faster and more reliably.

The problems of small scale manufacture with a high number of variants require a linkage of data flow from design to manufacture and assembly, with consideration of the work schedule as well as of the data acquired and prepared in manufacture.

Points of Emphasis in Development Proposals /122

The CAD-proposals for this product group are of exemplary character. The proposal "large transformers" (Transformer-Union, Nüremberg) deals with implementation of windings, cores, and tanks of large transformers. Continuous data flow from initial computation programs to the generation of manufacture documentation is secured. Transfer of results to asynchronous machines is provided for.

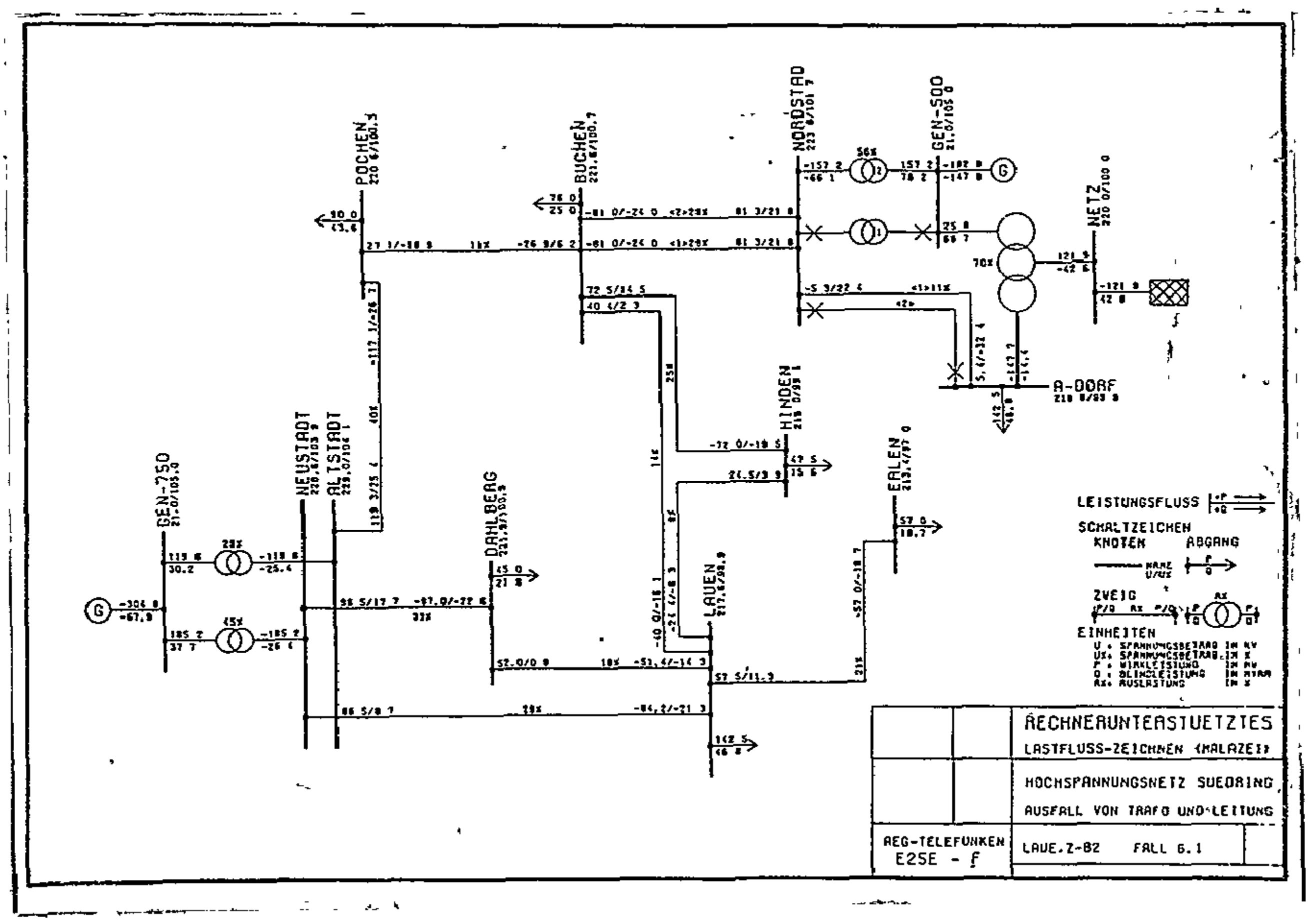
The proposal "small scale manufacture" (AEG-Telefunken, Esslingen) has the objective to establish a pilot system for manufacturing locations engaged in small series production, using manufacture of electric motors as example.

List of Proposals

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
54/26	Trafo/Union: Kapfberger, Wolf	Large Transformers	76-78		
54/36	Trafo/Union: Kapfberger, Wolf	Design drawings in interactive mode	77-79		
54/38	AEG-Telefunken: Gold, Neviger	Integrated manfacturing system for small series production	76-79		

5.1.2 Distribution Nets

/123



The economic importance of electrical distribution nets can be characterized with a few figures. The German supply net alone (380 kV/220 kV) included 17,000 current flow kilometers in 1972, the length of the actual supply nets at lower voltage levels is a multiple thereof. More than 3 billion DM were invested for completion and conversion in 1975.

State of Development

A number of programs exist for layout and operation calculations (load flow) of electrical supply nets in the 100 largest companies in the energy supply business (EVU), as well as in the industry that does the planning and implementation. The degree of standardization and the possibilities for an overall grasp of calculated (electrical) results, as well as the effort required for planning and designing the implementation of networks, is unsatisfactory.

Program systems for the design and manufacture of masts exist in the industry. At present the (n-1)-method is predominant for safety considerations in nets. There is also a desire by public institutions to obtain more reliable values about the reliability of networks and, with it, the current supply (see also BMFT-study "Electrical Highpower Transmission"). /124

Objective to be Achieved

Electrical distribution nets are calculated in planning (EVU, industry) and operational stages, for stationary operating conditions and for various malfunctions. The connection of available load flow programs with a machine-produced presentation of results quickly grasped by service personnel, as well as its introduction as standard with the help of the appropriate organizations, is a partial objective.

A method for calculation of the reliability of meshed medium and high voltage networks, which will be more informative, is also being developed; it is to provide an improvement in the reliability of supply under cost-effective conditions.

Establishment of a stabilizing program is also envisaged; it will permit the inclusion of neighboring network sections in the network combination. A corresponding specification has already been put together. The need for inclusion of transient phenomena in networks, as well as the eventual interactive employment of the computer for network control, particularly for small firms, is still being investigated.

Points of Emphasis of the Development Proposals /125

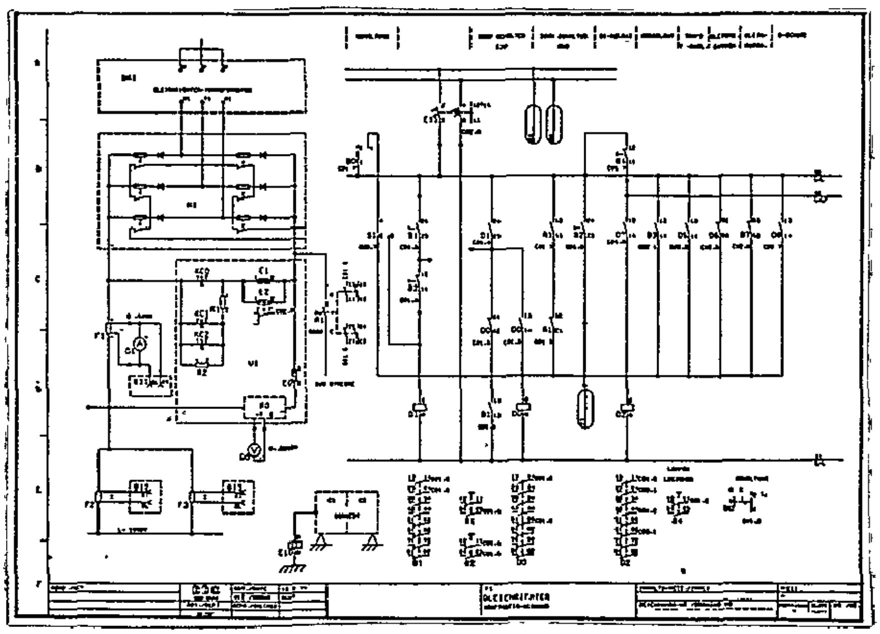
The proposal "Plotting of load flow plans by machine" (AEG-Telefunken, Frankfurt) aims at alleviating the evaluation of a large number of load flow variants, in planning and operation, through an appropriate program. Extension to results of short circuits and to interactive operation between the two calculations is planned.

The proposal "Reliability of networks" (Prof. Koglin, Tech. University Darmstadt) deals with the development of a procedure for quantitative analysis of network reliability. The more accurate determination of reliability prevents expensive overdimensioning of networks as well as underdimensioning, which could have serious consequences (blackout).

List of Proposals

Report Page	Author of Program	Topic	Development Time	Name of Program	Special Remarks
54/44	AEG-Telefunken: Nelles/Laue	Plotting by machine of load flow plans	75-77	MALAZE	Avail-able
54/46	TH Darmstadt: Koglin	Reliability of networks	76-79	ZUBER/ WANZE	

5.1.3 Installations /126



A multitude of functional units of varying complexity are present in the switching and control installations of all industrial processes, always in different arrangements. The setting up of such installations is of importance beyond the uses for electrical engineering (current rectifier technology and power drives) for other applications (power plants, rolling mills, assembly lines).

State of Development

In the past more and more functional units were integrated into individual building blocks, which reduced the projection and design effort, save for circuit and wiring technology. Data processing finds its main application, therefore, in the generation of wiring diagrams for electrical installations; that also means that computer use sets in at a phase where its assistance cannot generate new data or compress the existing data quantity.

Objectives to be Achieved

The aim of development efforts is to provide the developer in the design phase with data from already implemented functional units, all ready for computer input (variant principle), or to support required individual solutions (60% of all installations) by means of an appropriate work station so that the flow of data, which increases during the process of completing a design, will be generated as immediate input to programs for computation, wiring, or parts lists.

Datakeeping must also be usable for documentation of assemblies and of maintenance. We are now investigating whether, and to what extent, partial results are applicable for pipe conduit networks in shipbuilding and installation assembly. /127

Points of Emphasis of Development Proposals

The proposal CADAMES+ (Brown, Boveri & Cie, AG. Mannheim) aims at the establishment of a program system that provides complete assistance, from the concept of the current flow diagram to the assembly of the switching installation.

The proposal "Electrical equipment for industrial installations" (AEG-Telefunken, Berlin) deals with the creation of industrial installations according to the variant principle, from the bid for the contract to the work schedule.

Another proposal, IDEA (Hannappel-Automation, Mainz), contains the calculation and layout of installations up to their dimensioning. This is a safety program which can be of great importance for the planner and designer as well as for the customer and tester (public institution).

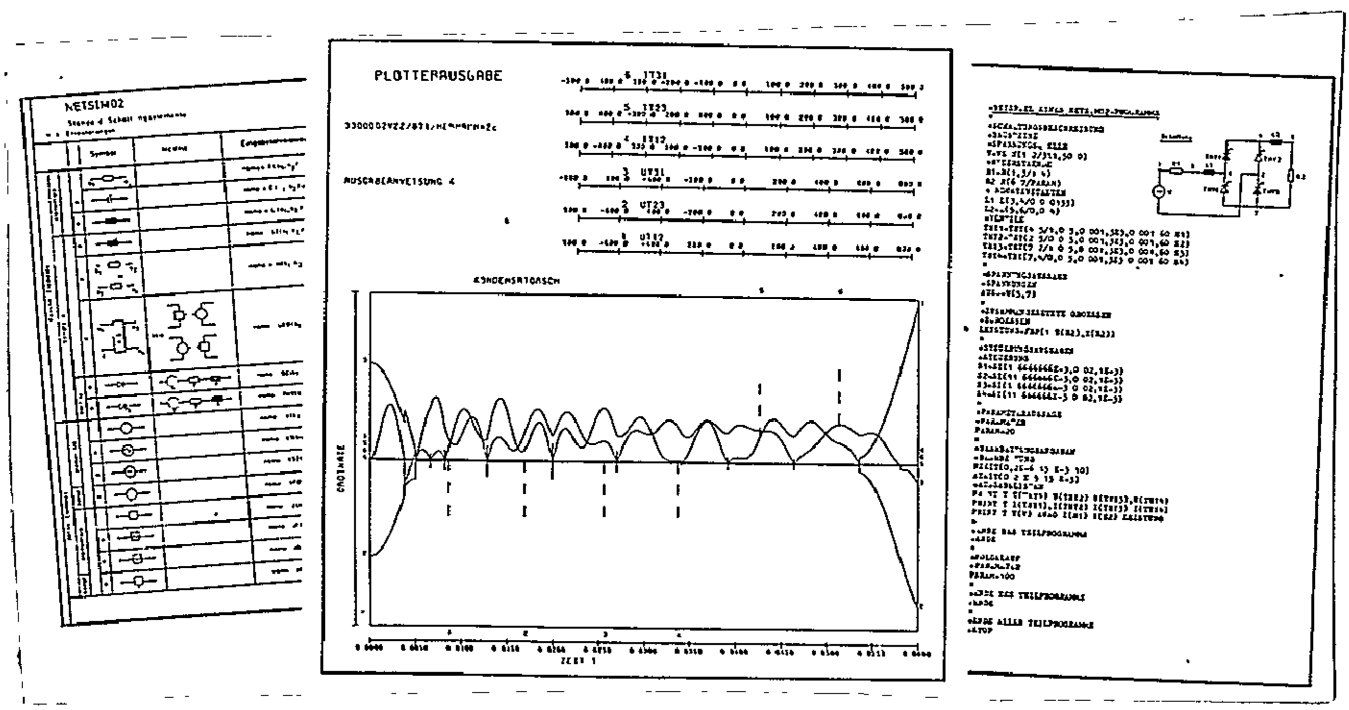
+) Computer Aided Design and Manufacturing Electrical Systems.

List of Proposals

Report Page	Author of Program	Topic	Development Time	Name of Program	Special Remarks
54/50	BBC/Mannheim: Abeln, Bethmany	Integrated program/system for planning, design and assembly of electrical installations	74-77	CADAMES	Available
54/14	AEG-Telefunken: Lottmann	Rationalization of processing electrical equipment for industrial installations	76-78		

Report Page	Author of Program	Topic	Development Time	Name of Program	Special Remarks
54/82	Hannappel, Mainz	IDEA integrated data processing for electrical installation technology	77-78	IDEA	Parts are avail-able

5.1.4 Power Electronics /128



The use of electrical energy keeps on increasing and with it grows the equipment of end-products with instruments and devices of power electronics for control and regulation (about 1 Billion DM in 1975), more than proportional. We will just mention the constantly ongoing changeover from electro-mechanical control of drives to solutions employing power electronics, which are not only better functionally but can also be more energy-saving.

State of Development /129

Individual programs for simulation and calculation are known for up-to-date circuitry, mostly providing files of physical data for the components.

Objectives to be Achieved

Starting with components of power electronics, an aid for the layout and simulation of power electronics networks is to be created in which the increasing demands of EVU for feedback freedom must be considered, as well as network behavior including the user (for instance motive power). The individual solution will be required in addition to the variant solution. Continuation towards instrument design or installation assembly must await some checking and consolidation of data.

Points of Emphasis of the Development Proposals

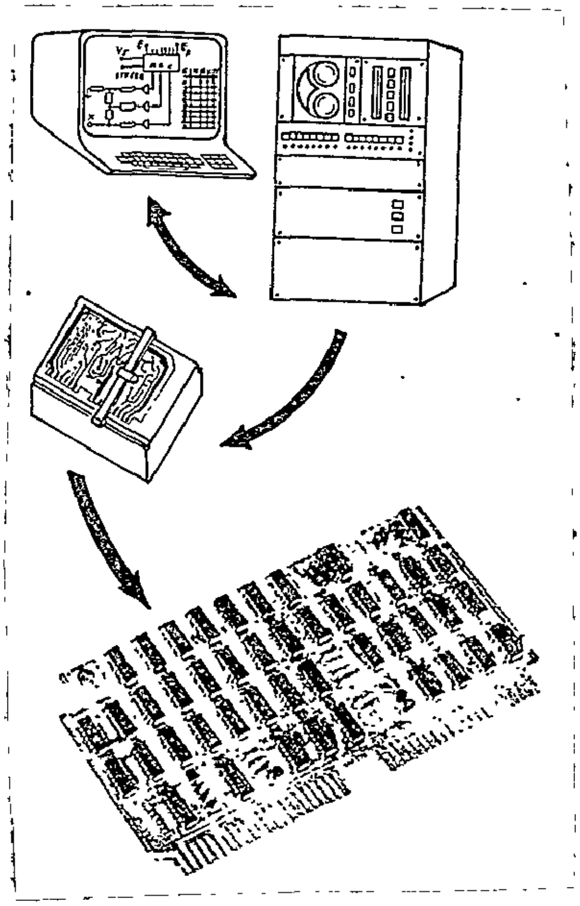
The proposal "Digital simulation system for power electronics" (AEG-Telefunken, Berlin) aims at simulation of network behavior in power electronics by means of descriptive language. Examples for application are direct current and three-phase current drives including current rectifier installations that supply them.

List of Proposals

Report Page	Author of Program	Topic	Development Time	Name of Program	Special Remarks
54/86	AEG-Telefunken Jentsch, Mehring, et al.	Digital simulation system for power electronics	75-78	NETASIM	Finished

5.2 Equipment Electronics

/130



State of Development

If we restrict ourselves to digital electronics--without the hardware and without solid state component production--the situation can be described as follows:

--Numerous individual programs exist, which are partially functions of a certain technology and/or of specific hardware.

--Development periods that lasted longer than 3 years for assistance programs could so far be supported only by those users whose product spectrum does not require the constant use of the latest components. /131

--There are indications towards complete assistance from circuit design to production documentation and testing.

Objectives to be Achieved

The development goal is a program chain for circuits and instruments of control technology (SSI, MSI and conditionally LSI), as well as performance assistance for the following processing steps:

--Formulation and testing of the task formulation.

--Circuit design, resp. synthesis.

--Assurance of accessibility for testing in the design.

--Circuit simulation.

--Partitioning.

--Formulation of test programs and testing.

--Generation of appropriate data (for documentation, maintenance).

--Assurance of safety and reliability.

Particular attention must be paid to the phases of task formulation and design, as well as of testing procedures; a carefully tested input may save expensive simulation and testing procedures account increasingly for the largest share of expenses. Existing solutions must be relied on for simulation and printed circuit board layout, even though their dependence on specific hardware is very annoying, from the sponsor's point of view.

Increasing importance must be attached to the requirements made by the customers and official licensing agencies for proof of reliability and safety of controls; proofs of that nature--if at all possible--are possible only through consideration of all design models and associated component models and data with computer assistance. Increased efforts must also be expended in future on diagnosis assistance (maintenance); key words to be used here are export and the associated customer network, as well as the exchange of individual complex components instead of entire functional subassemblies (spare parts maintenance).

Points of Emphasis in Development /132

The proposal "Memory-programmed Controls" (AEG Telefunken, Berlin) aims at a complete system for computer-assisted development, programming and documentation of controls programmed by memories. Starting from the representation of a function, a step-by-step refinement of the design is to be made possible in interactive operation. The proposal "Synthesis of synchronous control switch mechanisms" (Prof. Lipp, Karlsruhe University) deals with the design phase; the proposal "RAM/PLA-control switch mechanisms" by the same proposal supporter, represents an addition, also as an alternative to microprocessors (velocity, safety, costs). The establishment of an operating station for the development of digital devices, to start with, is the subject of the proposal "Performance aids" (Standard Electrik Lorenz AG, Stuttgart). Inclusion of the previously mentioned studies of the University of Karlsruhe has been assured, the same applies to the results of the proposal "TEPES," concluded in the meantime, which provides a logic simulator and generation of a test program (MSI).

The proposal "PELGROS" (Standard Elektrik Lorenz AG, Stuttgart) attempts continuation of testing aids for LSI-technology. Due to the complexity of LSI-technology the start of the method must be with consideration of the structure.

Providing proof of safety, of a circuit or an instrument, is the subject of proposal "Proof of safety and its relation to reliability" (Brown, Boveri & Cie, AG, Mannheim).

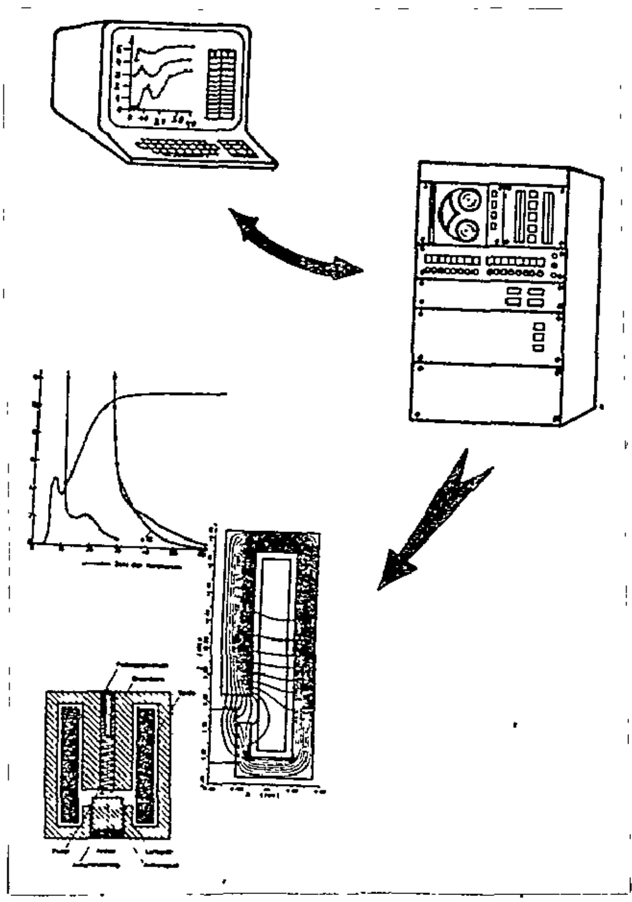
List of Proposals

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
54/92	Olympia Works AG, Braunschweig, Klingenberg et al.	Development and design in digital electronics; simulation of register transfer, design of logic circuits, synthesis of control switch mechanisms	73-76	LEKO MIVES ASEB 2000 DPS	Completed
54/100	AEG-Telefunken, Frankfurt, Jentsch	Program systems for controls programmed from memories	78-79		
54/102	University Karlsruhe, Lipp/	Synthesis of synchronous control switch mechanisms	76-78	LOGE SNE, SSM	

/133

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
54/106	University Karlsruhe Lipp/	RAM/PLA control switch mechanism	77-78	LOGE MAT	
54/108	Standard Elektrik Lorenz AG, Stuttgart, Mathias	Analysis and performance aids for development of digital instrumentation	78-79	ABEDIS	
54/110	BBC, Mannheim Tilgner RWTH Aachen, Geißelhardt et al.	System for testing and design of printed circuit boards	73-77	SYPKOL	
54/132	Standard Elektrik Lorenz AG, Stuttgart, Merz.	Generation of test program for digital circuits	74-78	TEPES	Parts available
53/138	SEL, Stuttgart, Rohrbacher	Generation of test program for printed circuits with LSI circuitry	78-79	PELGROS	
54/140	BBC, Mannheim Heisecke	Proof of safety and reliability	75-79		
54/142	Kienzle Apparate Villingen, Bien/Stremnitzer	Simulation of system in the planning phase	1975		Study
54/144	Standard Elektrik Lorenz AG, Stuttgart, Richthofer	Analysis of linear chain circuits		LANP	Programs made available by SEL, but not sponsored
54/146	SEL, Stuttgart	Optimization of chain circuits		LANOPT	
54/148	SEL, Stuttgart	Synthesis of reactance filters		Filter Synthesis	
54/150	SEL, Stuttgart	Optimization of a transfer, function or characteristic function		ADOPT	

5.3 Components /134



State of Development

All work that is performed less for independent products than for important component parts will be collected under this heading. A large number of programs for springs, bimetallic triggers, wire-wrap wiring and a few types of power capacitors is known, here, too, overwhelmingly related to a specific company or machine.

Objectives to be Achieved /135

Where a broad requirement and need for sponsorship can be shown, individual calculation and design programs can be included, as, for instance, some for permanent magnets, connecting plugs, capacitors and similar components.

The subject of development for the currently active proposal "Calculation of electromagnets" (Philips GmbH, Hamburg) is a calculation program for magnets with rotational symmetry and fast switching capacity, as they are used for printers' couplings and valves.

List of Proposals

Report Page	Name of Author	Topic	Development Time	Name of Program	Special Remarks
54/154	Philips, Hamburg Aldefeld	Calculation of electromagnets	74-78	PHIMAG	

(missing) /136

6. General Cross-section Problems /137

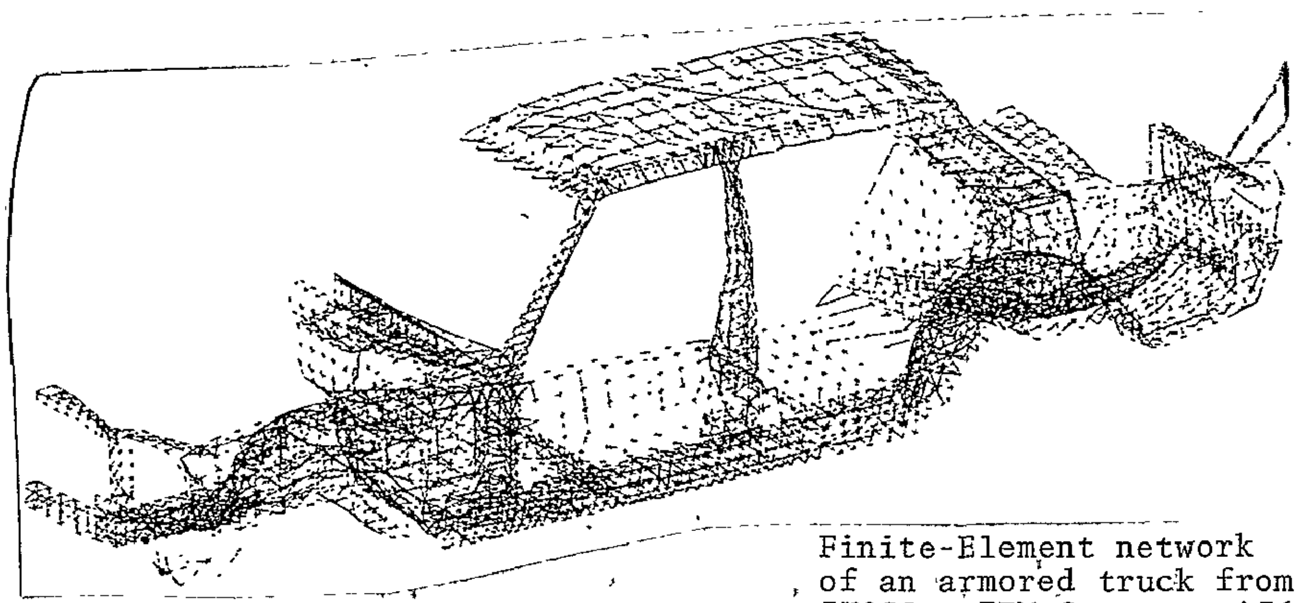
By "general cross-section problems" we understand problems of an importance that overlap the particular branches. When compared to programs described so far, these have predominantly a "tool character"; they can be used as standard modules in the branch-oriented program chains.

The development of the standard modules carries great importance because of its multiplier effect in use and the standardization effect connected with it.

Specifically, the following topics of emphasis are dealt with:

--Finite Element Method (Section 6.1)
--Geometry (Section 6.2)
--Technical Databank (Section 6.3)
--CAD/CAM-operating Terminal (Section 6.4)
--System Cores (Section 6.5)
--Input Interface (Section 6.6)
--Miscellaneous (Studies) (Section 6.7)

6.1 Finite Element Method (FEM) /138



Finite-Element network of an armored truck from IKOSS: FEM-Congress '76, Lecture by Dipl.-Ing. H. P. Spreng, Daimler Benz AG

State of Development

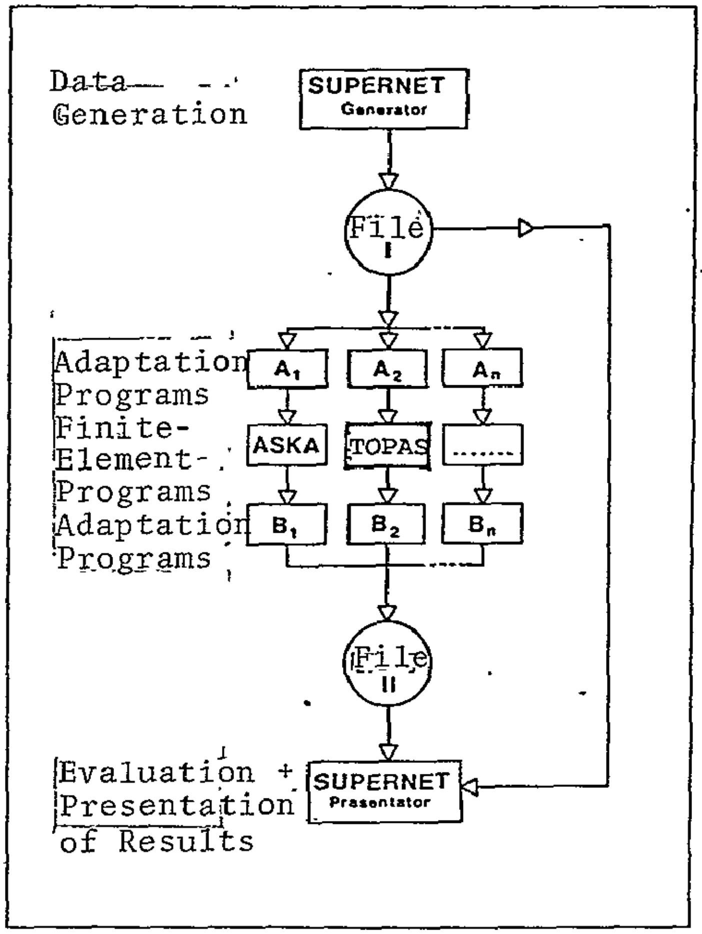
Development of the finite-element-method has been pushed ahead in many areas during the past years. Many FEM programs exist since theoretical investigation usually involves formulation of programs. They can be used for various engineering problems. (See CAD-Report KfK-CAD 4 or the investigation by Professor Stein, TU Hannover). The present bottleneck is the lack of user-friendliness of the programs.

Objectives to be Achieved

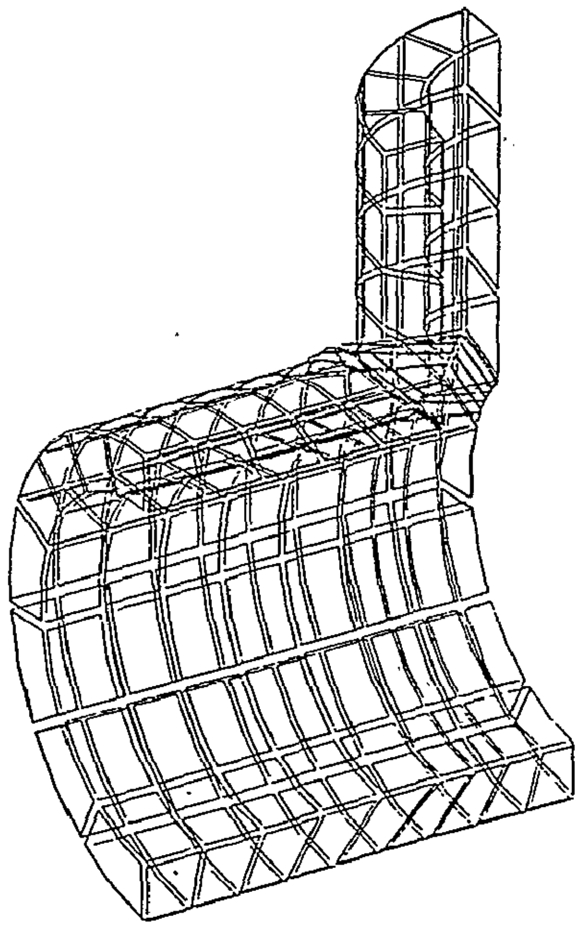
The objective of future work is the inclusion of FEM in the design process. This assumes the creation of programs for data preparation and consolidation which make application of the FEM, as well as the installation of FEM programs in object-oriented program chains (for instance, bridge building, ship building), easier.

Points of Emphasis in Development Work /139

With assistance from proposals being carried out at IKOSS and BBC an FEM-program chain is created with the program TOPAS as its central building block. The aim of these efforts is also the standardization of the interfaces between data generator and FEM program, as well as between FEM program and result evaluator, to make the use of other program blocks also easier.



Ablaufplan: Generierung - FEM-Rechnung - Auswertung (Quelle BBC)



Procedure: Generation-FEM-Computation-Evaluation (Source: BBC).

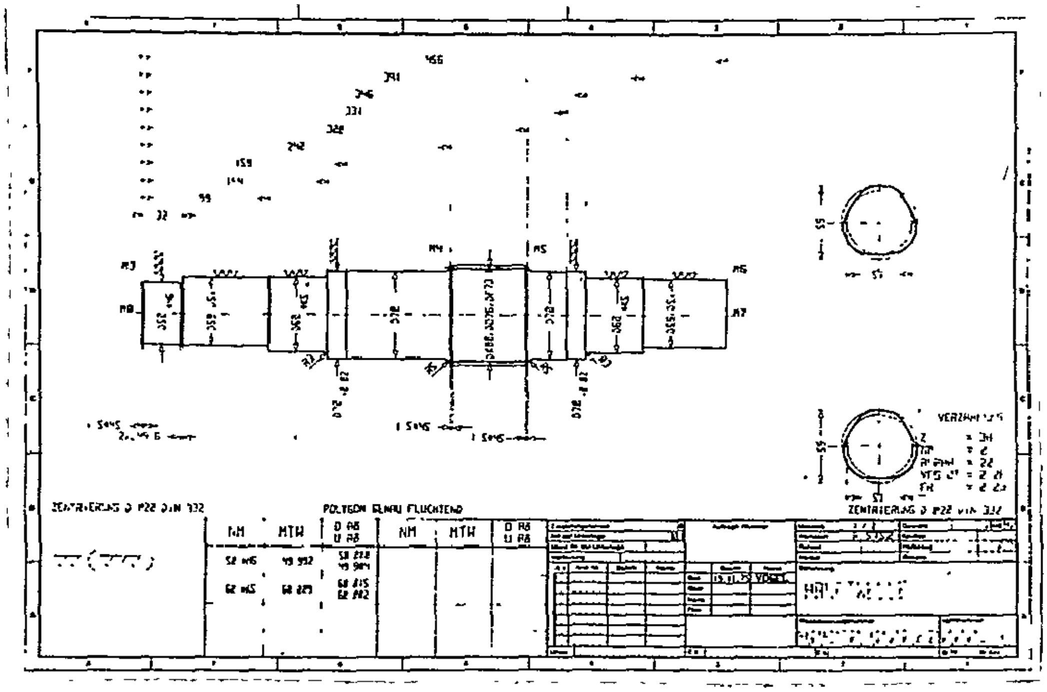
Report/ Page	Author of Program	Topic	Development Time	Name of Program	Notes
Q-6	Brown, Boveri & Cie. AG, Manheim	Finite element method (FEM): Data generation	76-78	SUPER-NET	FEM Chain
Q-8	IKOSS, Stuttgart	SUPERNET/TOPAS	77-78	SUPER-NET/ TOPAS	"
Q-10	"	Technically oriented program system for automatic structure analysis	73-78	TOPAS	"
Q-12	BBC, Mannheim	Result evaluator	76-78	FEPLOT	"
Q-14	IKOSS, Stuttgart	Techn. oriented program system for automatic structure analysis of IST	75-78	IST-TOPAS	1st-FEM Chain
Q-16	IKOSS, Stuttgart	Calculation of beam stresses	75-76	BEND	
Q-18	"	Section stress for	75-76	BQBEAM	
Q-20	IKOSS, Stuttgart	Processor for calculation of general inertia forces	75-76	ASKA DEAD-WEIGHT	Not sponsored by CAD-funds
Q-22	"	Initial elongation	75-76	ASKA-TETA	"
Q-24	"	Harmonic analysis	75-76	ASKA-HARMONIC	"
Q-26	"	Temperature field analysis	76	ASKA-T	"
Q-28	"	Rigid structure regions	74-76	ASKA-RIGID-BODY	"
Q-30	"	Absolute element RASKA	75	ASKA-RASKA	"

Report/ Page	Author of Program	Topic	Development Time	Name of Program	Notes
Q-32	TU Stuttgart, Prof. Argyris, Dr. Grieger	Graphic output		INGA	Not sponsored by CAD-funds
Q-34	T-Program, Reutlingen	FEM-program system	74-76	TPS 10	
Q-36	TU München, Prof. Werner	Structure plot for program SAP IV	75-77	PLOTSAP	Not sponsored by CAD-funds

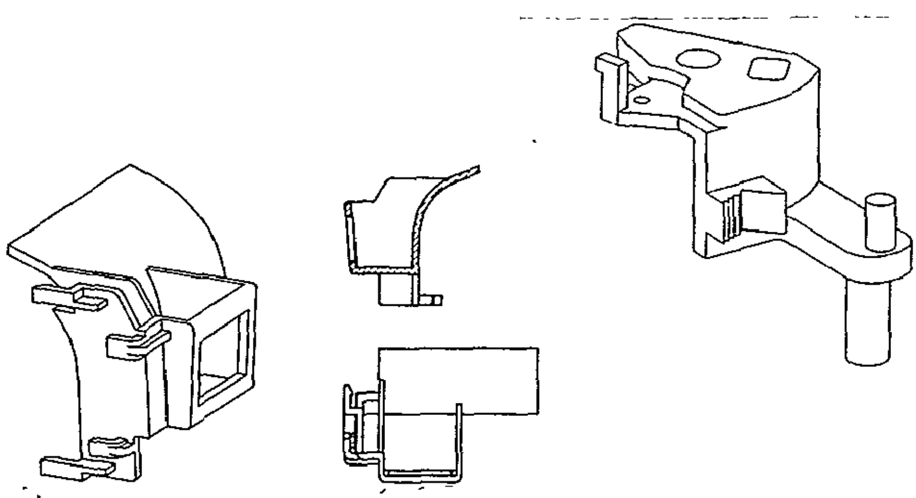
+) The pages with the letter "Q" are continued in all four reports, KfK-CAD 51-54.

6.2 Geometry /141

In an analysis of available CAD-systems, particularly in looking over the proposals being carried out within the scope of the CAD-project, it was found that a large number of them contain a treatment of geometrical information or are touched by it tangentially in subordinate tasks. No common approach has been formulated, however, so far in the search for corresponding solutions.

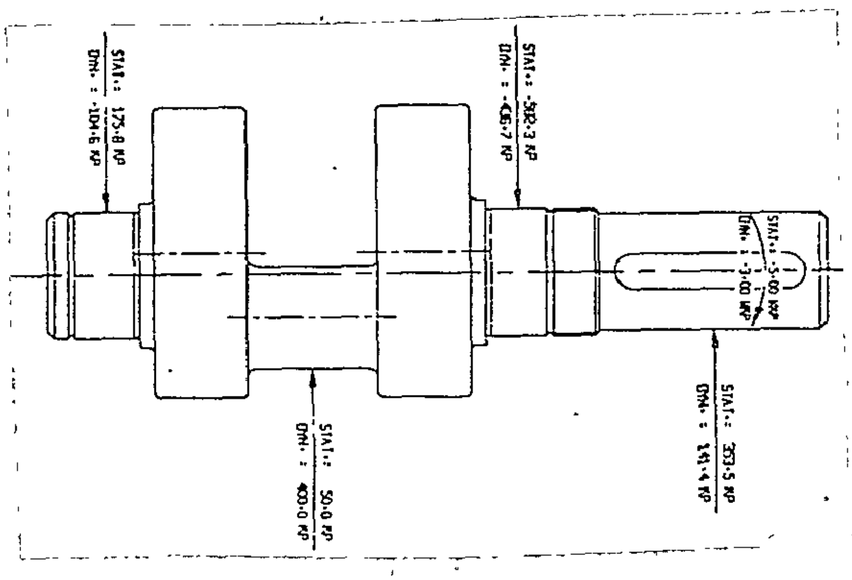


(Source: Machinetool Laboratory, Dept. for Production Systematics RWTH Aachen)



(Source: Olympia Co. Braunschweig)

The developments, which are rather heterogeneous in part, due to historical reasons, will in future be coordinated in a total concept of "Geometry." This will include available and usable solutions as well as directed new proposals to be worked on. /142

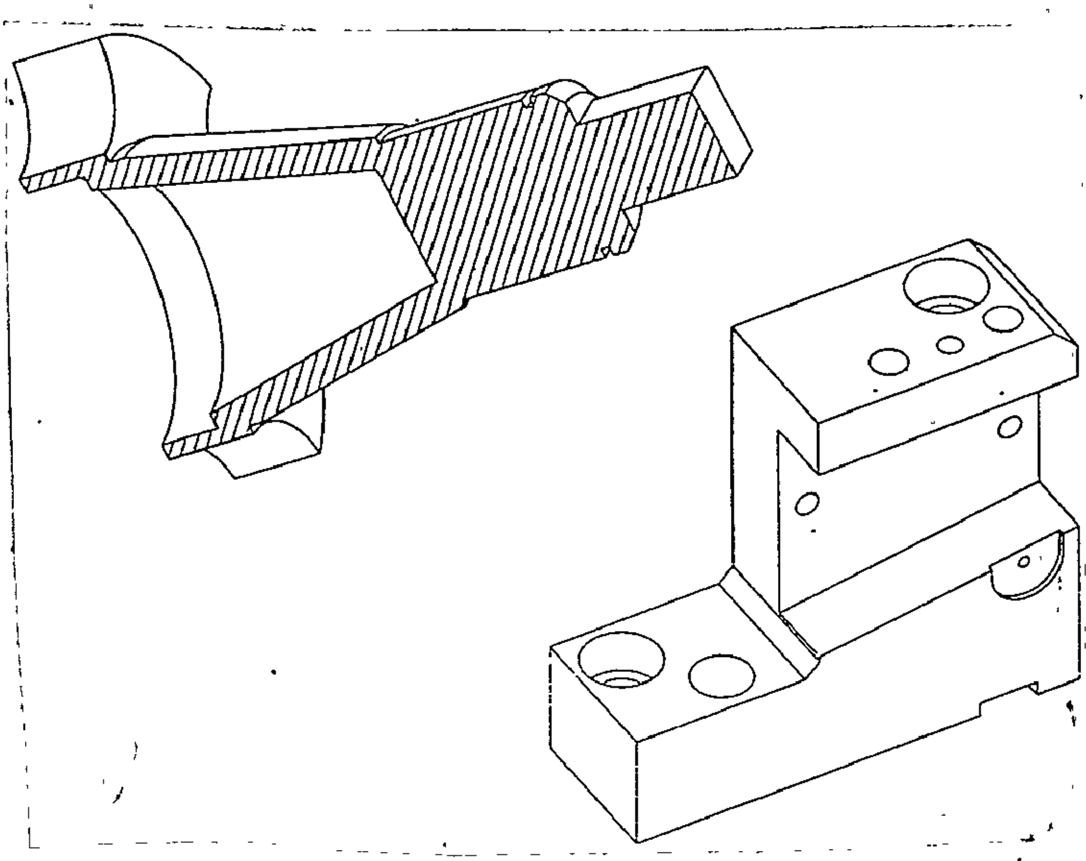


(Source: Institute for Mechanical Engineering and Design Technology, TU Berlin)

Against this background a joint study was started by the Institute for Machinetools and Finishing Techniques, of TU Berlin jointly with Messerschmidt, Bölkow-Blohm and the DECHEMA, under the title of "treatment of geometric objects in CAD-systems" and presented in the spring of 1977. In it existing systems were examined for commonalities overlapping across specialty branches (for mechanical engineering, tool engineering, precision engineering, chemical engineering, shipbuilding, aeronautical engineering) and opportunities for possible further developments were indicated.

In addition to it comprehensive amounts of information were collected by the Nuclear Research Center, Karlsruhe, Inc., on experience in the use of geometry programs, resp. requirements for new systems to be created.

This information was used together with the results of the project manager to set up a plan of requirements for a "standard building block geometry" from the point of view of an end-user, which was discussed and voted for by representatives of industry (practical and potential users, sponsored and unsponsored development locations). After incorporation of expressed positions the statements of the specification list correspond to the future needs of industrial practice. /143



(Source: Institute for Machinetools and Finishing Techniques, TU Berlin)

Particular attention was paid to the development of a CAD-work station. Discussions with German hardware manufacturers led to agreement with regard to realization of the planned specifications. /144

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PARTNO/BEISPIEL
   COAX/XAX
Q1=PRIREC/CENTER,15,20,20
C1=CYL/50,35
C2=CYL/20,80,BEVEL,XLARGE,5
   COAX/NOMORE
W1=SOLID/Q1,PLUS,C1,C2,BEVEL,5
   TRANSF/0,0,28
B1=CYL/XAX,-20,10
W2=SOLID/W1,MINUS,B1
   TRANSF/REF,60,30,-40
F1=PRIREC/15,20,80
W3=SOLID/W2,MINUS,F1
FINI
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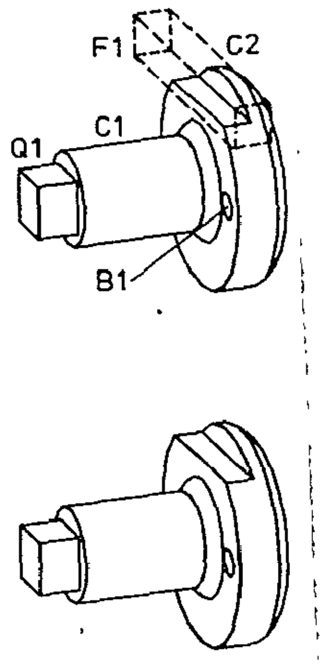


Source: Institute for Machinetools and Finishing Techniques, TU Berlin.

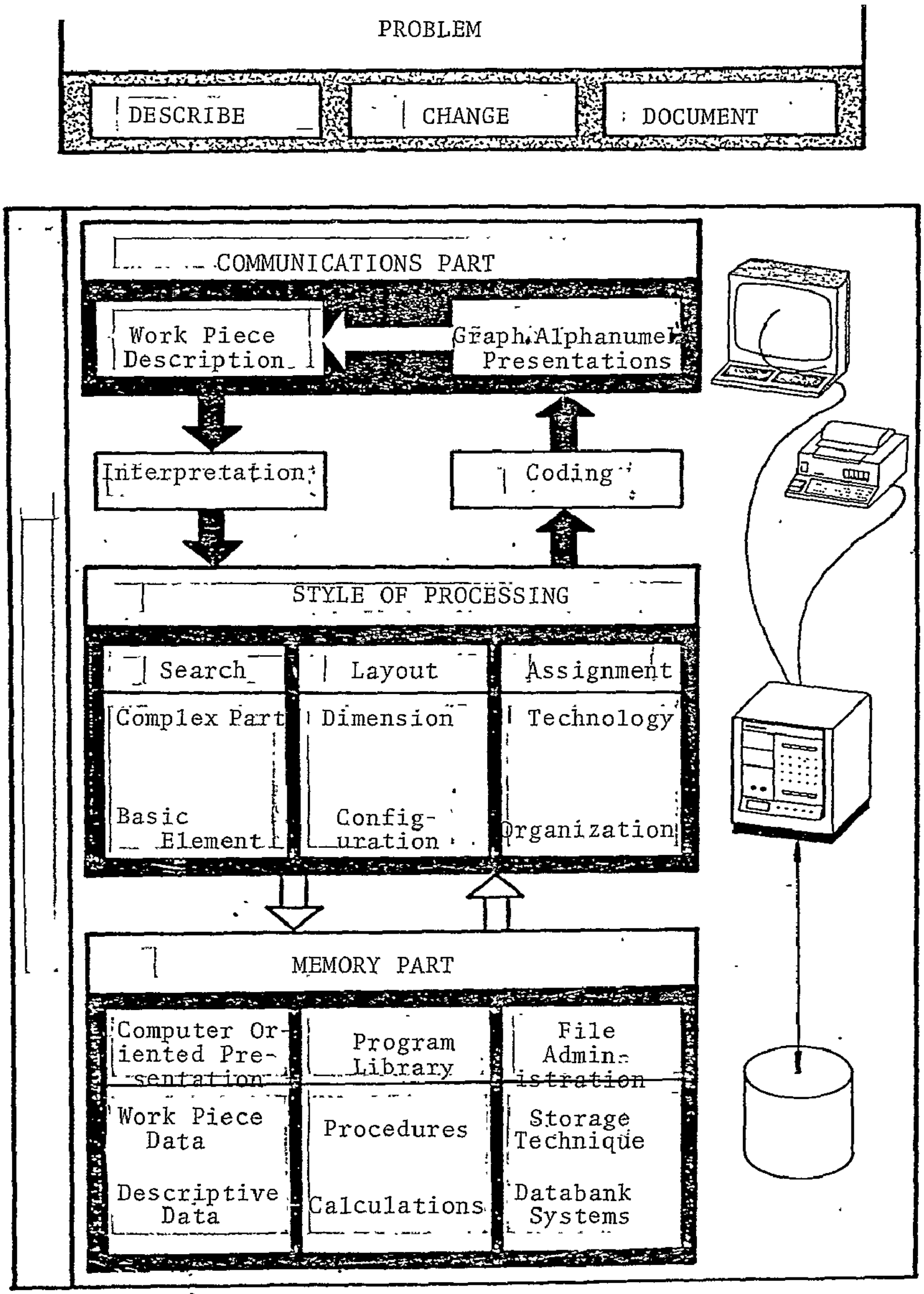
Objectives to be Achieved

The present development group consists of a University Laboratory and two industrial companies who are supposed to introduce a basic version of the geometry module, independent of any specific computor, within the next two years. The following criteria will take precedence in the development:

--Consideration of planned specification with regard to processing volume, interfaces internally and with other programs, use at the CAD work stations (see Section 5.4).

--Incorporation of previous experience and programs.
--User relation of development and result.
--Assurance of program maintenance and marketing.

In parallel with this development a configuration-dependent geometry module is being constructed as part of a proprietary industrial development, which is to be made available as CAD-work station, in connection with a small computor system.



Modules for geometry processing in CAD systems

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Points of Emphasis of Development Work (see list of program developments) /146

List of Program Developments

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
Q 45	TU Berlin Prof. Spur	Treatment of technical objectives in CAD-systems	76-77		Study CAD-Reports KfK-CAD 31 KfK-CAD 40
Q 46	Olympia Co. Braunschweig	CAD-assisted design in precision engineering	72-76	OLYKON	
Q 48	Philips Co. Hamburg	Integrated CAD/CAM system precision engineering	73-79	PHILIKON	Basic version available
Q 50	Olympia Co. Braunschweig	Geometry program (2-dimensional)	73-75	GEO 2D/ GEO 2EX	
Q 52	Olympia Co. Braunschweig	Graphics software (Basic)	73-76	DIGRAPH	
Q 54	TH Darmstadt Prof. König	Method for new design and modification of technical objectives	75-77	MENOS	KfK-CAD 27
Q 56	AEG-Telefunken Konstanz	Interactive graphics system	74-75	GRAFSY	CAD-Report KfK-CAD 25
Q 58	MBB, Munich	Geometric language	74-76	GEOLAN	
Q 60	MBB, Munich	Graphic processor of lathe work	74-75	GDP	
Q 62	Nuclear Research Center, Inc., Dr. Schlechtendahl IRE	REGENT-subsystem graphic DP	75-76	GIPSY	Not sponsored by CAD funds

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
Q 64	TU Berlin Prof. Spur	Standard building block "Geometry"	78-80		Joint Proposal
	IKOSS, Stuttgart	Standard building block "Geometry"	78-80		
Q 66	Aristo, Hamburg	Standard building block "Geometry"	78-80		
Q 68	Dietz-TECHNOVISION Inc., Mulheim	Interdisciplinary geometrical system (IGS)	78-80		

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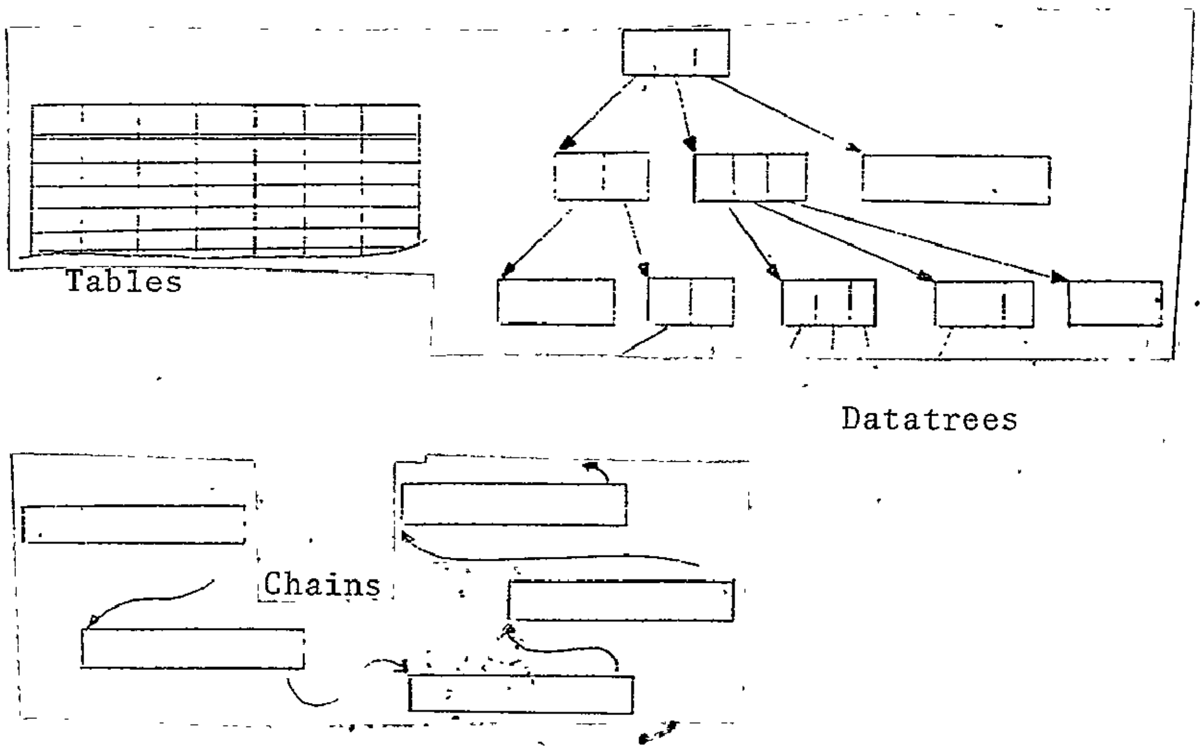
6.3 Technical Databank /148

State of Development

A distinction must be made between commercial and technical areas of application.

Numerous databank systems have been developed and put into use during recent years for commercial applications, with and without sponsor funding. These databank systems are capable of storing and manipulating large amounts of data, according to a variety of requirements. These systems can either be directly interrogated by the user, as information systems (formulation of inquiries can be in almost any manner, so that the data can be sifted according to the greatest variety of search criteria), or they are called up by a program in program language (almost exclusively COBOL). Capabilities for restarting, securing of data, data protection, etc., have been implemented to a large extent. Most of the present databank systems "grew" over a long period of development. They are mostly set up as assemblers and need large EDP installations for cost-effective application. Only very recently have systems designed for smaller installations become available.

The technical applications are limited to virtually continuous tables (mostly organized as "Inverted Files"), continuous datatrees and chains. In most of the larger program systems subroutines for data management exist.



which permit "paging" in a more or less elegant manner. As a rule these are highly sophisticated programs designed for special applications. /149

Parallel to the establishment of databank systems by software suppliers and DP-manufacturers there is great research activity aiming primarily at the mathematical preparation of problematics. In spite of great efforts no basic change in the situation should be expected seen from the theoretical end, rather from the introduction of new hardware technologies (for instance, associated memories).

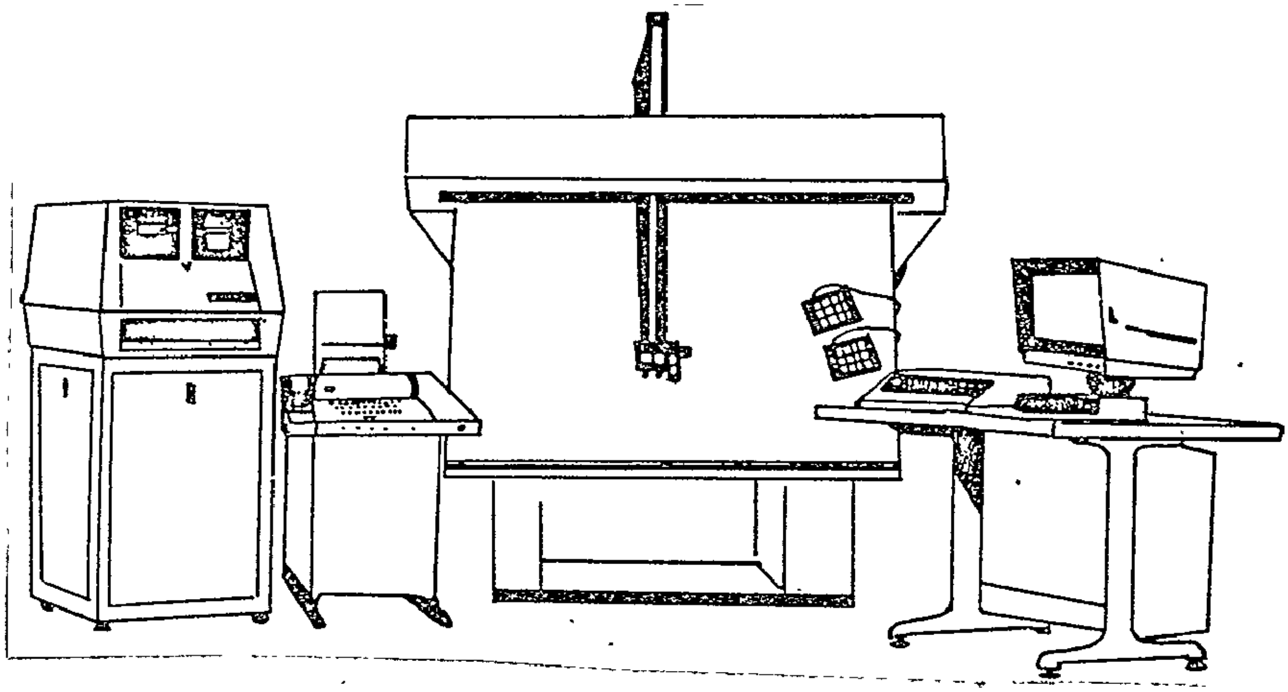
Objectives to be Achieved

Based on existing databank systems of commercial orientation a databank system answering to technical requirements is to be made available, set up for FORTRAN. To meet the goal of cost-effectiveness this system is to cover only the actual requirements for CAD/CAM (for instance, discard of special information language, no search algorithms that are only rarely used) so that it can also be used as replacement for data management subroutines used heretofore. This automatically determines the size of the memory available and permissible for such a system. Ability to convert the system to large commercial databanks is desirable (for utilization of available parts list processors, for instance). Interfaces are to be implemented according to CODASYL.

Points of Emphasis of Development Work (see list of program developments)

List of Program Development

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
Q 72	Philips Co. Hamburg	CAD/CAM-Databank system	78-80	PHIDAS	



State of Development

Small computers, together with peripherals and basic software, are offered for sale mainly by DP manufacturers and systems houses.

The bottleneck is presented less by the hardware in this case but by the insufficient software.

The development of so-called "turnkey systems" is still in its infancy in Germany. The software problem is compounded by the fact that the various equipments made by German manufacturers are not sufficiently adapted to each other.

Objectives to be Achieved /151

A CAD/CAM work station is to be developed, consisting predominantly of equipment made by German manufacturers (see 3. DP-program).

Suitable stages of perfection for various applications are to be defined, to be implemented by hardware and to be furnished adequately with basic software and software for user applications.

Points of Emphasis in Development Work (see list of program developments).

List of Program Developments

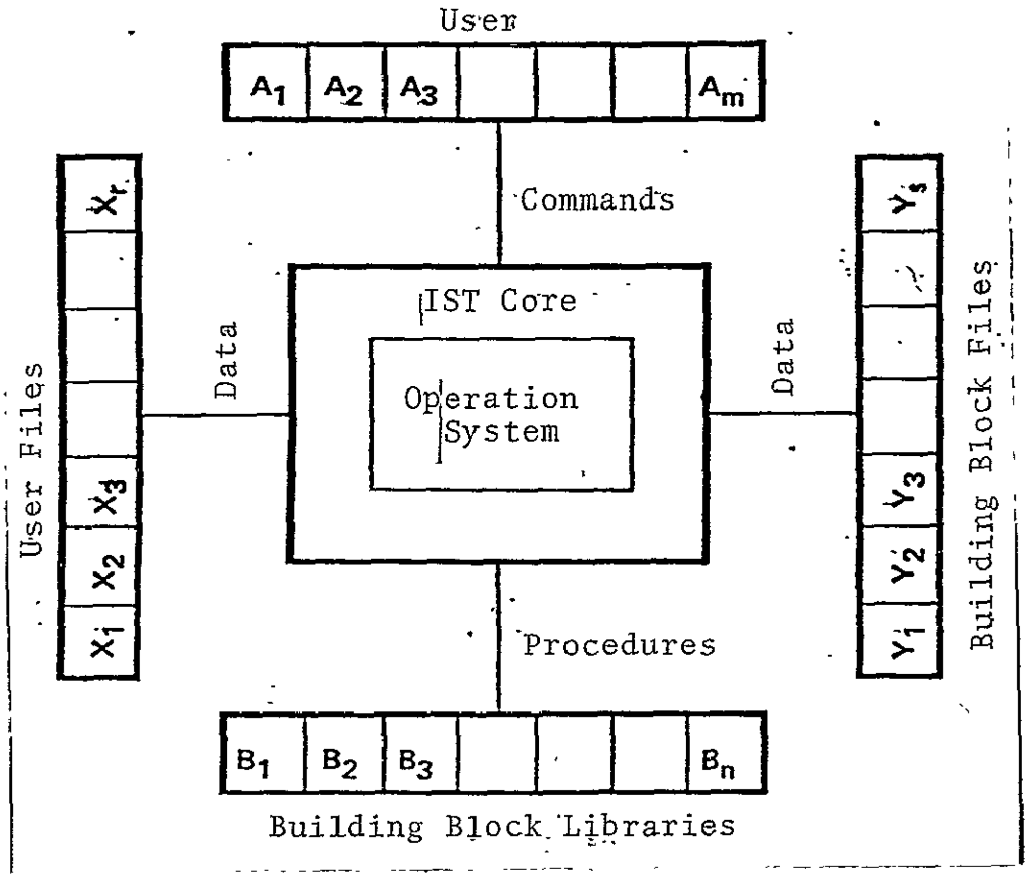
Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
Q 77	Dietz, Mulheim	Integrated CAD-work station	77-79		
Q 80	RU Bochum Flessner	CAD via an interactive design station	73-76	IKP	
Q 82	TH Darmstadt Emde	Interactive design system	75-78	GEAKON	

6.5 System Cores /152

State of Development

So-called integrated program systems, whose central program is designated as system core, have been developed over the past 15 years (MIT/USA: ICES; Loughborough/England: GENESYS; Great Western Steel/Canada: TASKMASTER; NASA/USA: IPAD; TU Berlin/BRD: IST; GfK/BRD: REGENT, etc.).

The system core contains within it functions applicable for system operation, particularly components for data and program management, which permit easier development, linkage and application of programs.



The development of system cores can in general be considered completed. The IST core for Siemens-BS 1000, BS 2000 and IBM 370 is applicable; the REGENT-core runs on installations with PL/1 capabilities (see also KfK-CAD 2).

Objectives to be Achieved /153

At first the system cores of IST and REGENT are to be introduced into practice. Perfection of and additions to the system cores are to be based on experience gained through application.

Points of Emphasis in Development Work (see list of program developments).

List of Program Developments

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
Q-86	TU Berlin, Pohl	Information System Technology-IST-Core	71-77	IST	System core on FORTRAN base
Q-88	Nuclear Research Center Karlsruhe, Inc., Karlsruhe Schlechtendahl IRE	REGENT-Core	-76	REGENT	System core on PL/1-base; Not sponsored with CAD funds
Q-90	MBB, Munich	IST-version f. BS 2000 Siemens installation	77-78		

6.6 The Input Interface /154

State of Development

By input interface we understand here the interface between the program user, generally an engineer, for CAD on the one hand and EDP (hardware and software) on the other.

Data formulation requires that the user observe the conventions dictated by the DP side. The presently valid conventions, often also referred to as input languages (POL=problem oriented language) are so variable in syntax and semantics that the user has to reorient his thinking for each new program.

To alleviate this disadvantage the presently current input conventions were collected within the scope of a study and recommendations worked out for standardization. After public discussions in the profession a set of subroutines was put together (CADINT) which take over part of the usual input processing (checking for errors, additions, dissolution of loops, etc.). The input is possible in formatted form (with or without prescribed form) or free of format.

Objectives to be Achieved

The available set of subroutines is to be applied. Since the interface will surely undergo variations over the long term the conventions are to be continued in development and, if necessary, to be reformulated anew as a program.

1 2 3 4 5	15	25	35	45	55	65
KOPF						

1 2 3 4 5	Nr. der 1. Seite (0 = ohne Seiten-Nr)	Echodruck der Eingabe (1 = JA ; 2 = NEIN)
Standard	1	1
SEIT		

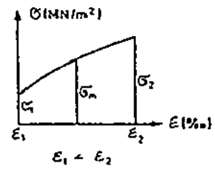
Folgt nach einem ENDE-Satz ein neues Objekt (neuer KOPF-Satz), so werden die Seiten fortlaufend weiter numeriert, wenn der Seit-Satz fehlt.

kann fehlen

Materialkonstanten	Beton (Material-Nr =1)		Betonstahl (Mat.-Nr.=2)	Sicherheitsbeiwert		Spannstahl (Material-Nr =3)			zulässige Größtdehnung			
Reihenfolge	1	2	3	4	5	6	7	8	9	10	11	12
Bezeichnung	β_R	E_b	β_S	ν	ν variabel? 1 ≙ JA 2 ≙ NEIN	Vorspannung? 1 ≙ JA 2 ≙ NEIN	β_{S3}	E_z	min ε_b	max ε_e	min ε_b mittig	max ε_e mittig
Dimension	MN/m²	MN/m²	MN/m²				MN/m²	MN/m²	‰	‰	‰	‰
Standard	27	37000	420	1.75	1	2	0.	210000	-3.5	5	-2	3
MATE												

kann fehlen

Zusätzliche Materialkennlinien							
Reihenfolge	1	2	3	4	5	6	7
Bezeichnung	Material-Nr.	Teilabschnitt	ε_1	ε_2	σ_1	σ_m	σ_2
Dimension	(1≤Nr. ≤9)	(1≤TEIL≤9)	‰	‰	MN/m²	MN/m²	MN/m²
MATZ							
kann fehlen							



Querschnitt allgemein				
Bezeichnung	Querschnitt-Nr. (< 100)	Druckglied? 1 ≙ JA 2 ≙ NEIN	N im Schwerpunkt? 1 ≙ JA 2 ≙ NEIN	Randabstand h'(m)
Standard		1	1	
QUER				

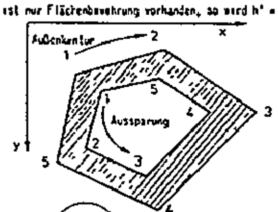
Wird der Randabstand h' im Satz QUER angegeben, so wird die Lage der am stärksten gezogenen bzw. der am wenigsten gedrückten Bewehrung jeweils im konstanten Abstand h' von der Zugecke angenommen.

Ist h' im Satz QUER nicht angegeben, so wird h' aus den Koordinaten der am stärksten gezogenen Einzel-, Strecken- oder Ringbewehrung errechnet.

Ist h' nicht angegeben und ist nur Flächenbewehrung vorhanden, so wird h' = 0 angenommen.

Polygonaler Teilquerschnitt						
Reihenfolge	1	2	3	4	5	6
Bezeichnung	Polygon-Nr (<100)	Material-Nr. des Betons	Flächenbewehrung: Material-Nr.	Flächenbewehrung: min μ ‰	Flächenbewehrung: max μ ‰	Querschnitt symmetrisch zur y-Achse ergänzen? 1 ≙ JA 2 ≙ NEIN
Standard		1	2	0	0	2
TQP						

Flächenbewehrung für Aussparung wie für zugehörigen Vollquerschnitt!



Koordinaten der Polygonpunkte

Bezeichnung	x(m)	y(m)	Punkt-Nr.
PU ·			1
			2
			3
			4
			5
			6
			7
			8
			9
			10
			11
			12
			13
			14
			15

x(m)	y(m)	Punkt-Nr
		16
		17
		18
		19
		20
		21
		22
		23
		24
		25
		26
		27
		28
		29
		30

x(m)	y(m)	Punkt-Nr.
		31
		32
		33
		34
		35
		36
		37
		38
		39
		40
		41
		42
		43
		44
		45

Beispiel für Formblatt-Eingabe mit CADINT

Example of Prescribed Form--Input with CADINT.

State of Program Development

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
Q 94	RIB e.V. Stuttgart	Study of input conventions, program development	1976	CADINT	CAD-Report KfK-CAD 39

6.7 Miscellaneous

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List of Program Developments

Report Page	Author of Program	Topic	Development Time	Name of Program	Notes
Q-96	Diebold Frankfurt	CAD in the USA	1975		CAD Report KfK-CAD 7
Q-97	Research Association Program Languages for Manufacturing Units, Aachen	Management and user organization	75-76		Study CAD Report KfK-CAD 8
Q-98	Central Association of the German Building Trades, Bonn	Criteria and procedures for evaluation of standard software for CAD/CAM	78-79		Study