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MANUFACTURING GROUP-WARE SYNTHESIS OR COMPUTER INTEGRATED INFORMATION AIDING DESIGN AND MANAGEMENT ACTIVITIES

Summary. In new organization of activities composed manufacturing information proces- ses, one can separate group-solved problems. The modelling of design and management tasks as problems of choice and taking a decision can be a structuralization basis of informa- tion resources for aiding of routine activities and human factors in synthesis of group-ware for problems solving. In synthesis of computer integrated activities organization (CIAO) systems for manufacturing, environment of users and multiuser computer structure environ- ment with internetworking as well as co-ordination of group-internetworking activities make a difference. Logistics of manufacturing information processes is a basis of modelling co-or- dination activities.

1. Basic concepts

Problems of computer aided activities determine aims of present investigation in almost all objective domains.

Searching solutions, already even in the begining state, is based on connection of investi- gation results of three domains [8]: general methodology (praxeological) of activity [3], methodologies of detailed objective domains [2, 6, 10, 11, 16, 17], information engineering methods and computer technics [4, 5, 13, 19]. Problems of system synthesis were taken into consideration with full particulars in reference to CAD and computer support management (CSM) systems. It was enough for the initial formulation of computer aiding foundations and computer aiding system (CAS) creation. These foundations allow to systematize the knowledge about computer aiding and clasify various solutions of CAS. Investigations to needs of CAD and CSM problems were helpful in creating CIM systems. Integration consi- derations were based on data and calculation modelling to make possible connection of computer aiding-wares created for improvement individually investigated and various acti- vities (design, production planning, assurance quality, management etc.).

Solutions of CAS are based on using presently traditional computer services i.e.: data proces- sing (calculation), data collecting(storage), user(man)-computer interaction. These services be- long to main factors, first separation and next extention of aiding activities.

CAS as well as aiding routine activities and aiding activities more so adapted to user needs, make aiding realization variants according to the model of which general diagram is presented

in fig. 1. Creating aiding-wares play (computer representation of problem domain - PD) the main role in creating CAS.
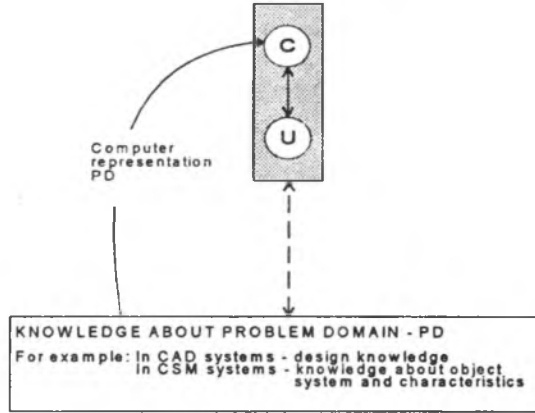
Fig.1. General structure of computer aided activities

In reference to design [6, 7, 9] design-wares include: data bases and algorithms (programs), computer catalogues, factographic data bases [8, 9, 14, 18]. In reference to management [10], computer aided resources include: common data files, common data bases and direct access to data and record-keeping procedures, data bases and representation of decision processes as well as routine service organization activities.

Design-wares and management-wares make a base of creating first CIM solutions [15].

Qualitatively new factors of the computer aiding are as follows:
— computers in network environment and connecting traditional computer services with new internetworking services,
— information engineering.

Searching new aiding solutions depends on creating computer integrated activities organization (CIAO), problem solving organization with group-participation of computer users.

CIAO systems (investigated and development activities information aiding, activities in problems of technical and economical management in composed organizations, activities in manufacturing problems, activities in administration) make model aiding realization variants which general schema is shown in fig.2.

The basis of CIAO is co-ordination of group-solving problems. It includes:

— using application and communication internetworking (local or wide when nacessary) in the multiuser environment (C1, C2, ...),

— separation of group-solving problems in the user environment (U1, U2, ...),

— synthesis of computer aided resources, like in solutions for created systems in the begining period; however at present for some computer-user systems, such as C1-U1, C2-U2, ... required in solving problems,synthesis will be completed with programmed realization of activity integration co-ordination by using internetworking services.
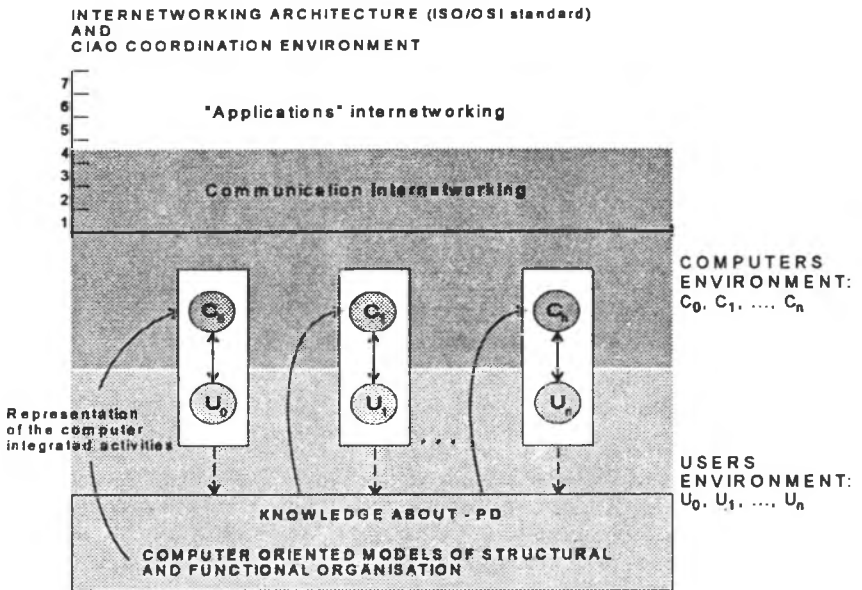
INTERNETWORKING ARCHITECTURE (ISO/OSI standard)
AND
CIAO COORDINATION ENVIRONMENT

"Applications" internetworking

Communication internetworking

COMPUTERS
ENVIRONMENT:
$C_0, C_1, ..., C_n$

Representation
of the computer
integrated activities

USERS
ENVIRONMENT:
$U_0, U_1, ..., U_n$

KNOWLEDGE ABOUT - PD

COMPUTER ORIENTED MODELS OF STRUCTURAL
AND FUNCTIONAL ORGANISATION

Fig.2. Multiuser structures in network environment for CIAO

2. Design and management computer aiding and CIM systems synthesis

Initial computer aiding systems were based on "thematic" solutions what corresponded to information system realizations suited to the needs of manufacturing processes. Design and management were separated. In the result of computer applications, one could use labour-saving systems of routine activities as well as data processing, documentation, optimization as to efficiency of designer's tasks, design, record-keeping, efficiency of technical service works (working readiness maintenance, operation) and administrative (economically - technical, finanse and counting - house) in manufacturing processes.

General structure of information processes corresponds to general models of processes what is shown in fig.3 and 4.
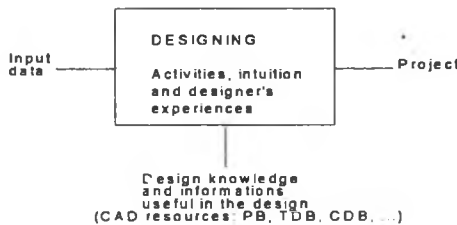

DESIGNING

Input
data ——————— Activities, intuition ——————— Project
and designer's
experiences

Design knowledge
and informations
useful in the design
(CAD resources: PB, TDB, CDB, ...)

Fig.3. Designing system structure and computer aided information resources: PB-program bases, TDB-temporary data bases, CDB-constant data bases
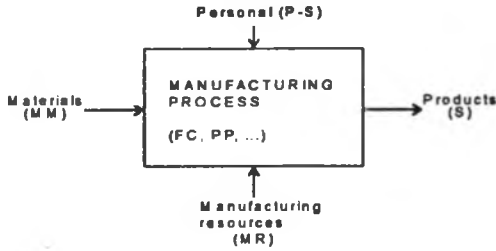
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Fig.4. General structure of the "thematic" information management systems and computer aided information re-
sources: MM-Material Management, MR-Manufacturing Resources, P-S Personal-Salary Record-Keeping,
PP-Production Planning, S-Sale, FC-Finance-Costs

In computer aiding, there are separated activities composed information processes attendant
upon as to design as to management with regard to a low degree to human factors.

In creating CIM systems there are combined CAD and CSM systems. In existing solutions
more so there is paid attention for so-called information flow automation range considered on
the strength of traditional solutions of CAD, CAP and CAQ systems [15].

It seems that CIM can at present consider as information system development aiding design
tasks and creating new models of information systems and stricly speaking system synthesis of
CIAO for manufacturing in the complex scope.

3. Logistics of manufacturing aiding information processes and information aiding for CIM

To main elements of the CIM synthesis on the computer integrated organization base, we
include: separation of group-problem solving, evident separation of information process logi-
stics in manufacturing, creation of new information systems for manufacturing based on exchan-
ge of information resources in multiuser computer structures and integration computer co-ordi-
nation of activities.

Group-solving problems of computer integrated manufacturing activities include (fig.5):

— material management i.e. raw materials, semi-finished products, ready-products, sale
  with regard to investigations to market needs, restrictions of raw materials and ecology,

— decision management i.e. finances, personnel analysis and development, work motiva-
  tion and salaries,

— production management i.e. manufacturing preparation with regard to expense analysis
  of designed products fulfiling market needs, accessibility of.manufacturing resources and
  investment changes.

So the main problem of computer aiding is concerned with information processes and
interconnections between users who take part in problem-solving as well as separation of
support-wares of technical, economical and co-ordinational information exchange. Activity
protection of CIAO system is realized by logistics of information processes of which general
structure is shown in fig.6.

The graph nodes correspond to "thematic" information processes, and the graph itself is the
logistic represention of information processes. At such understanding of information processes
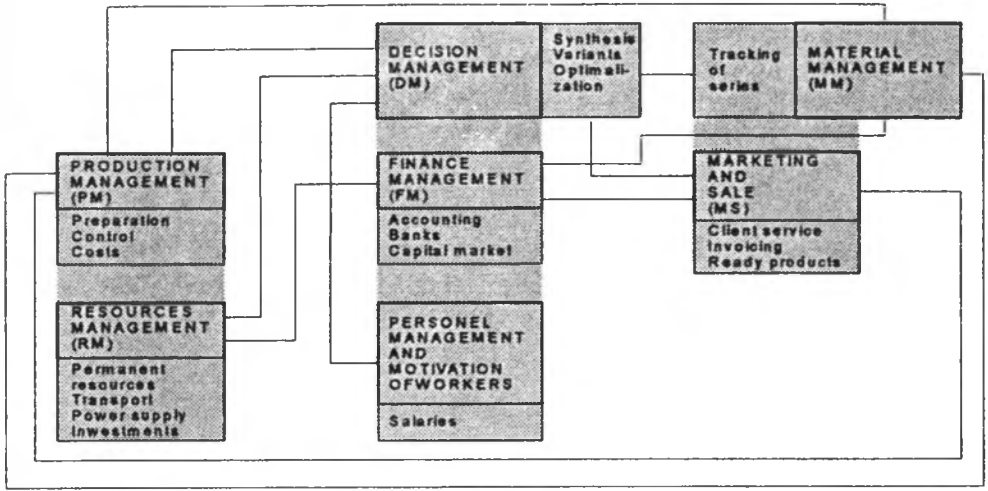
Fig.5. Information process system integration in range of CIM and separation illustration group-solving problems

logistics, edges should be interpreted as information processes between system participants. Then the graph edges interpretation would be as follows:

(1) transmission of attentions as to "technology" of manufacturing products,

(2) transmission of informations and instructions,

(3) informations about service rules,

(4) remarks about activity and damages,

(5) informations about demands for manufacturing resources,

(6) informations about technical possibilities,
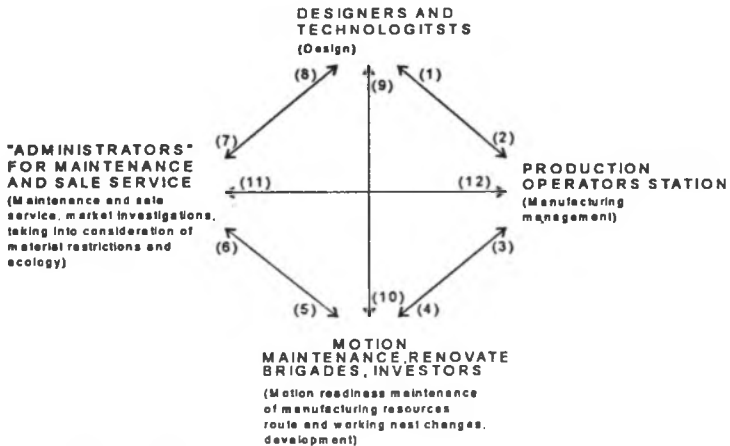

Fig.6. Logistic general structure of manufacturing information processes

(7) informations about new designs,

(8) informations about market demands for new technologies,

(9) informations about usefulness of existing technical wares to production, demands for new technical resources,

(10) informations about new design and manufacturing,

(11) informations about production possibilities,

(12) informations and questions about demands for determined products.

In substantial CIAO systems for manufacturing, process logistics realization make possible CIM system supplement about an additional element: logistic base - LB.

The LB determines the information resources of the CIAO system uniformly maintained and managed in multiuser computer structure on the C0-U0 stand (compare fig.2).

In creation of new systems one can use information methodology and technology in particular:

— information system development methodology [13, 19] for defining of success conditions of particular phases of creation and constant system development with active participation of users, CASE (Computer Aided System Engineering) products as well as modern information tools (ISDW - Information System Developers Workbench) for application creation improvement of user's resources,

— information engineering methods for defining system shell structure with regard to using resources in computer structure multiuser environment as well as using information tools,

— business engineering methods for settlement of aims and computer use development range mission through separation and upgrading problems and for settlement of works range and forms of their documenting (using information tools) and implementing them in particular phases of system development.

In shell model there are connected data and knowledge (information resources) with separated problems for realisation of aims and organization mission consisting of design and management tasks in manufacturing. Tasks use structure programs (i.e.functions corresponding to activities). In information aiding there are included data and procedures corresponding to routine activities (record-keeping for management and computationally for design) as well as data, knowledge and inference procedures for aiding of activities having non-routine character (intuition and experience).

Model creation phases of CIAO system include:

— strategy, i.e. information planning in notion models for activities in solving of particular problems,

— analysis, i.e. data and calculation modelling for information synthesis, information user needs,

— system design, i.e. system realization in substantial computer environment - system construction, i.e. application creation by system user. In system design phase we include using computer structure multiusers and internetworking services.

4. Additional remarks

CIAO in manufacturing systems include problems solved with group participation of multi-users. Computer aided activities co-ordination results from information process logistics for manufacturing aiding.

In information aiding there is a need for connection properly structuralized data, knowledge and procedures necessary for aiding routine activities with data, knowledge and processes of searching and conclusion for activity aiding having non-routine character (intuition and experience).

Creating CIAO sytems is based on using internetworking services in network structure multi-users, supporting of system development are the subject of interests for information engineering - in reference to detailed CIM problems - requires investigations over formulating computer oriented design and management methodology.

In design and management methodology one should include participation range extension and human factors in group-solving problems, as well as creation and methods of transfering information resources computer integrated activities.

Promising possibilities result from treating design and management tasks as choice decision problems.

Design process can be considered as a decision problem because in the design process there are made tranformation of design aims, usually expressed in very general notions into a set of design problem solutions, i.e. set of rationals possible to evaluation achieved results. The design task considered as a decision problem allow to express a process as a sequence of steps led to solving the decision (design) problem.
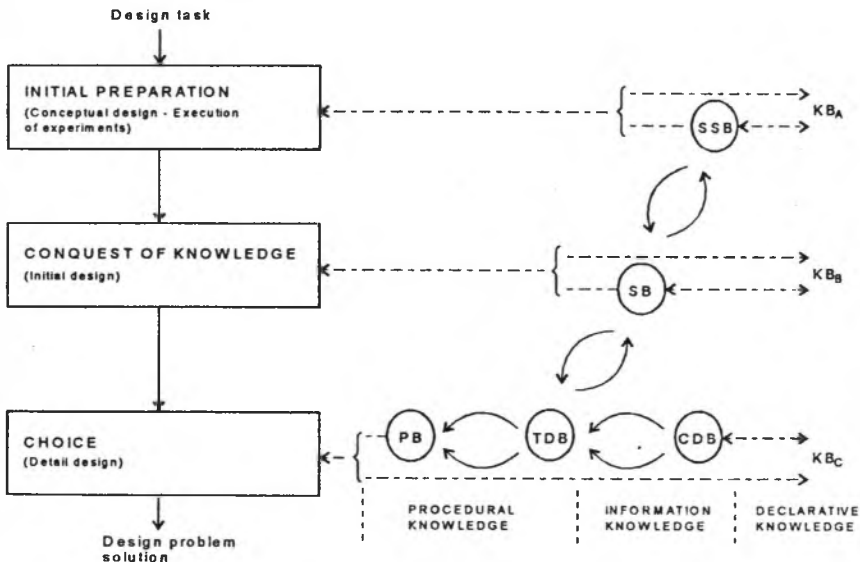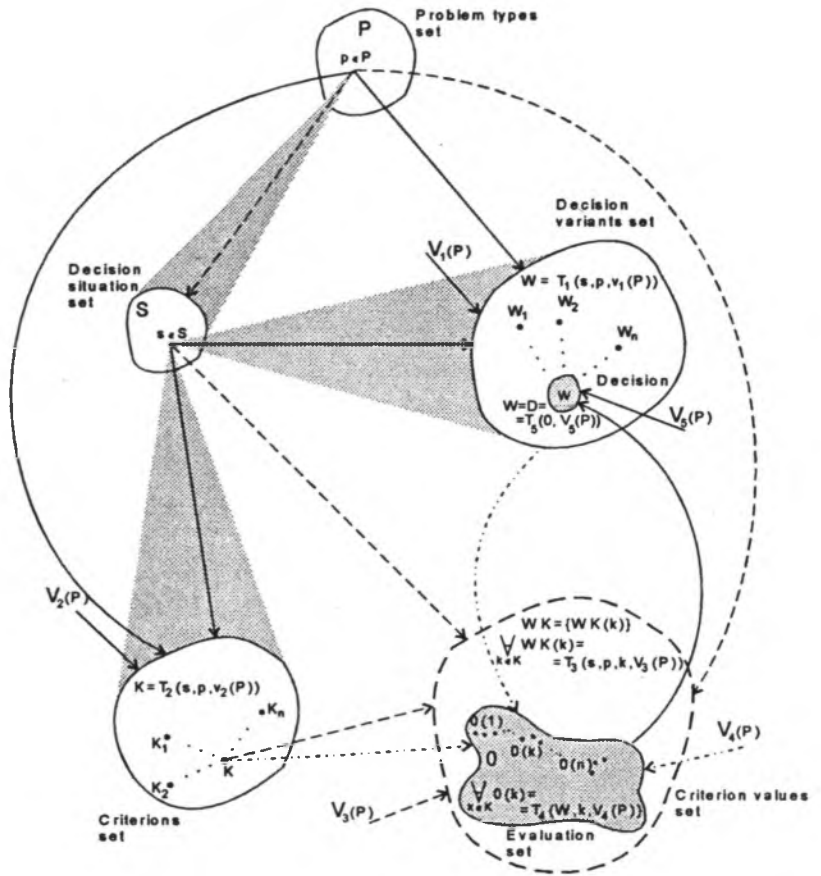

Fig.7. Data and knowledge and design-ware structure and their role in information aiding for multilevel processes of the choice in design

We have multilayer taking into a decision, i.e. activities which are hierarchically formulated (fig.7): choice of strategy and methods used in the process (initial preparation), reduction, i.e.

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$$W = T_1(s,p,V_1(P)), \qquad\qquad W = \{w\}, \quad w = w_1, w_2, \dots, w_n$$

$$K = T_2(s,p,V_2(P)), \qquad\qquad K = \{k\}, \quad k = k_1, k_2, \dots, k_m$$

$$\bigvee_{k \in K} WK(k) = T_3(s,p,k,V_3(P)), \qquad WK = \{WK(k)\}$$
$$WK(k) = WK(k_1), WK(k_2), \dots, WK(k_m)$$

$$\bigvee_{k \in K} O(k) = T_4(W,k,V_4(P)), \qquad O = \{O(1), O(2), \dots, O(n)\}$$

$$O(1) = O_1^{(1)}, O_2^{(1)}, \dots, O_n^{(1)}$$
$$O(2) = O_1^{(2)}, O_2^{(2)}, \dots, O_n^{(2)}$$
$$\dots\dots\dots\dots\dots\dots\dots$$
$$O(m) = O_1^{(m)}, O_2^{(m)}, \dots, O_n^{(m)}$$

$$W = D = T_5(O, V_5(P))$$

Fig.8. Model structure of decision process and human factors role

elimination of uncertain enterprises (conquest of knowledge), searching preffered actions for accepted conditions (choice). Information aiding includes: giving various data and knowledge: procedural knowledge - program bases (PB) with temporary data bases (TDB), information knowledge - constant data bases (CDB), solution (SB) and solution space bases (SSB) as computer catalogues and factographic data bases, declarative knowledge (DK) - methodological data bases and information useful in the design with conclusion procedures of which integration allows to set valuation of object manufacturing methods as to fulfilment of requirements by technically-operating characteristics (KB_A), knowledge valuation about solution spaces (KB_B), critical data valuation to properties in the object manufacturing (KB_C).

Decision problems also play a main role in computer management aiding. We have to settle with using computers in information system structure which allow to analyse and determine activity correctness of certain system of objects and aiding range development [2, 10], is mainly concerned with decision aiding range. Information aiding of decision problems for management can be determined for differently structuralized situations and leads to separation of various data and knowledge.

Analysing design and management tasks as choice problem is also full of promise from the point of view of useful information separation in aiding non-routine activities resulted from needs of human factors in problem solving (fig.8). From here it results that transformations of decision process ($T1 \div T5$) activities can include knowledge and experience in tasks solving ($V1(P) \div V5(P)$). This knowledge we can treat as additional and subjective factors included in problem solving.

REFERENCES

[1] Crips R. J., Smith F.: An information system to support the design activity. Journal of Engineering Design, vol. 4, No 1, 1993; pp. 3-10.

[2] Flakiewicz W.: Informacyjne procesy zarządzania. Podstawy budowy i funkcjonowania, PWE, Warszawa 1990.

[3] Gasparski W (ed.): Design studies - The elements knowledge on design - in Polish, WNT, Warszawa 1988.

[4] Kendall K.E., Kendal J.E.: Systems analysis and design. Prentice-Hall International. Inc., Englewood Clifts, New Jersey, 1988.

[5] Kierzkowski Z.: Komputery w środowisku sieciowym. LII, Pol. Poz., 1993; s. 1-23.

[6] Kierzkowski Z.: Introduction to computer aided design systems - in Polish, In: 17.

[7] Kierzkowski Z.: Computer aided design - An attempt at global approach. In [19]; pp. 474-494.

[8] Kierzkowski Z.: The evolution and integration of computer aided design systems. International Conference on Engineering Design, ICED 91, Zürich, Edition HEURISTA 1991; vol. 2; pp. 861-866.

[9] Kierzkowski Z.: Design-ware synthesis. International Conference on Computer Integrated Manufacturing 1992, seria: Mechanika. Z. 108, Politechnika Śląska, Gliwice; pp. 189-196.

[10] Kierzkowski Z., Płonka-Szydłak E.: The evolution and integration of management support computer systems. Computers in Industry. Elsevier Science Publishers, Amsterdam, 16 (1991); pp. 69-79.

[11] Kierzkowski Z., Rohatyński R.: The conceptual structure for computer aided education. International Conference on Computer Aided Engineering Education CAEE'93, Bucharest 1993; pp. 41-46.

[12] Korzyń Z.: The present status and prospects for development of logistic (in Polish). Problemy Maszyn Roboczych. Logistyka. Komitet Budowy Maszyn PAN, Vol. 2, Z.2, 1993; pp. 35-52.

[13] Martin J.: Information Engineering. Book I-III. Prentice Hall, Englewood Cliffs, New Jersey, 1989.

[14] Pankowski T.: Podstawy baz danych, WNT, Warszawa 1993.

[15] Renbold V., Nnaji B. O., Storr A.: Computer integrated manufacturing and engineering. Addison-Wesley Publ. Co., 1993.

[16] Rohatyński R.: Some problems of product data modelling for CAD and CAM systems. International Conference on Computer Integrated Manufacturing 1992, seria: Mechanika. Z. 109. Politechnika Śląska, Gliwice.

[17] Rohatyński R., Miller D. (eds.): Problems of engineering design methodology and computer aiding (in Polish), Polish Society of Mechanical Engineers, Center of Engineering Development, Rydzyna 1993-1994.

[18] Włodarczyk Z.: Graficzna prezentacja danych w systemach wspomagania projektowania. IX Konferencja: Metody i środki projektowania wspomaganego komputerowo. Warszawa 1993; s. 607-614.

[19] Wrycza St. (ed.): Information systems developers workbench. Proceedings of Second International Conference. Gdańsk 1990.

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