Strojniški vestnik - Journal of Mechanical Engineering 55(2009)2, 131-140
UDC 658.511 Special issue
Paper received: 09.01.2009
Paper accepted: 12.03.2009

Functional and Information Modeling of Production Using IDEF Methods

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Suitable CASE tools are developed for modeling processes. When building this process a standard is used for the functional modeling of IDEF0, through the use of the BPWin tool. The family of integrated IDEF methods presents the basic tools of some modern strategies and methodologies of business process improvement. This paper details the functional and informational model of "Investment building of production facility" using graphical language IDEF0; i.e., CASE BPWin tool. We also suggest a context diagram, an information model and a decomposition diagram of production - investment building.

Keywords: business process, process modeling, IDEF

0 INTRODUCTION

IDEF (*Integration Definition)* is represented as set of standardized methods and family of graphical language used for informational modeling in the field of Software Engineering (SE), business processes and objects, and improvement of business process. In the frame of project ICAM (*Integrated Computer Aided Manufacturing*), it was developed at the end of 1970 as the IDEF (*ICAM Definition*) standard, by the USAF (*United States Air Force*), whose goal was to improve manufacturing production productivity using Information Technology (IT) and modeling [1] to [7].

The goal of these newly developed IDEF techniques is to enable experts to comprehend problems from different viewpoints and levels of abstraction. In this regard, integrated IDEF methods present basic tools of some modern strategies and methodologies of business process improvement, for example: BPR (*Business Process Reengineering*), CPI (*Continuous Process Improvement*), IPD (*Integrated Product Development*), JIT (*Just-in-Time*), PPC (*Production Planning and Control*), QFD (*Quality Function Deployment*), TQM (*Total Quality Management*), TPM (*Total Productive Maintenance*), etc. [6] to [14]. The application of integrated IDEF methods can solve narrow class problems, as well as eliminate deficiencies of these problems by proposing general methods.

Ang. C.L. Luo et al. [7] conducted a research on the development of a Knowledge-based Manufacturing Modeling System based on IDEF0 for the metal-cutting industry. A model for integrating process planning and production planning and control in machining processes was reviewed by Ciurana, J. et al. [8]. Hernandez-Matias, J.C. et al. [9] reported on an integrated modeling framework to support manufacturing system diagnosis for continuous improvement. Kang, H.W. et al. [10] commented on a unified representation of the physical process and information system. The development of a novel simulation modeling system for distributed manufacturing was presented by Qin, S.F. et al. [11]. Eldabi, T. et al [12] made an evaluation of tools for modeling manufacturing systems design with multiple levels of detail.

Strong software support exists, which integrates IDEF methods, and enables connection of IDEF methods with other tools, such as software for simulation of business processes, software for activity based management of costs etc. Some integrated IDEF methods are: IDEF0 for function modeling, IDEF1 for information modeling, IDEF1X for data modeling, IDEF2 for modeling simulations, IDEF3 for modeling processes, IDEF4 for object-oriented projecting, IDEF14

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for modeling networks etc (Table 1) [15]. Some types of IDEF methods are described in the works: IDEF0 [16] to [25], IDEF1 [26], IDEF1X [27] to [31], IDEF2 [32], IDEF 3 [33] to [36], IDEF4 [37], IDEF5 [38], IDEF6 [39] etc.

All of the aforementioned IDEF versions are used for different purposes, as techniques for informational (semantic) modeling of data and as formal graphical language; also for needs of relation modeling of data and forming relation database (RDB). Initially the IDEF0 language for functional modeling was created in the frame of the SADT (*Structured Analysis and Design Technique*) technique, and one subset of these methods (the IDEF1X method, which was the first published in 1993) combined with the NIAM (*Natural Language Information Analysis Method* or previously *Nijssen's* or *An Information Analysis Method*) method presents the precursor of EXPRESS software tools for development of STEP (*Standard for the Exchange of Product Model Data*) applications. Complementary use of IDEF and UML is given in [4] to [40].

Table 1. *List of IDEF methods*

Type	Description of IDEF methods
IDEF0	Function Modeling
IDEF1	Information Modeling
IDEF1X	Data Modeling
IDEF2	Simulation Model Design
IDEF3	Process Description Capture
IDEF4	Object-Oriented Design
IDEF5	Ontology Description Capture
IDEF6	Design Rational Capture
IDEF7	Information System Auditing
IDEF8	User Interface Modeling
IDEF9	Scenario-Driven IS Design
IDEF10	Implementation Architecture Modeling
IDEF11	Information Artifact Modeling
IDEF12	Organization Modeling
IDEF13	Three Schema Mapping Design
IDEF14	Network Design

Suitable CASE (*Computer Aided Software Engineering*) tools are developed for modeling procedures. During manufacturing of this process is used standard for functional modeling IDEF0 realized through BPWin (Business Process Windows) CASE tool [41]. In Fig. 1 a general model of system development is shown [5] and [13].

In the early 1990's, the IDEF Users Group, in cooperation with NIST (*National Institutes for Standards and Technology*), formed standards for IDEF0, (U.S. Government standards documents), known as FIPS (*Federal Information Processing Standards*) [42]. Published in 1992, these standards are under coverage of IEEE and accepted by ISO [43]. IDEF0 and IDEF1X are techniques of modeling based on the combination of text graphics which are presented in an organized and systematic manner to increase reasonability and to supply logics for potential exchange, specified requests, or in another manner, to support system analysis at various levels.

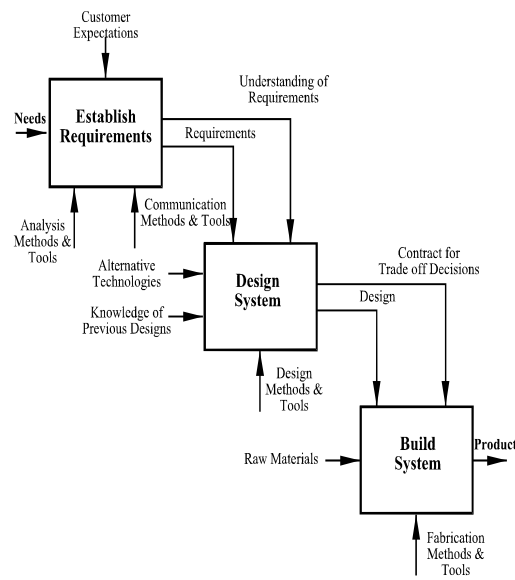

Fig. 1. *System development (IDEF0 Model)*

The integrated concept of modeling has been accepted by the USA government, the Pentagon and NATO and neither document can be defined until it is described using this methodology. A task which achieves this methodology must involve problems characterized by client/server architecture, that is, to connect multiple computers. This

approach enables connection of future IS and demands systems of quality defined by the ISO 9000.

1 IDEF0 - FUNCTIONAL MODELING

The demands which have motivated the creation of activity modeling are [13] and [16] to [25]:

- To serve as documentation and a manual for the description of complex activities, procedures and manuals demanded by the ISO 9000standard. One of the basic rules is: the larger the documentation – the less reading. A one or two pages long document containing a diagram is going to be cursory previewed and only when there is enough time. Documentation consisting of many pages will not have to be read for months.
- To enable fast organizational changes and to give insight into critical activities which need to be performed using suitable resources.

The most important benefit in the application of activity modeling is the prototype access where alternative ideas are simply and quickly checked. It is much cheaper to draw process and data models than to develop a new information system.

IDEF0 and IE *(**I**nformation **E**ngineering)* standards enable [13] and [16] to [25]:

- Execution of system analysis and design at all levels, for manned systems, machines, materials, computers and information;
- Making documentation as a base for integration of the ISO 9000 standard;
- Better communication between analysts, designers, users and managers;
- Discussion within a teamwork to accomplish mutual understanding;
- Management of large and complex projects.

IDEF0 formalism is based on the SADT methodology. Developed in 1985, by Douglas T. Ross from company SoftTech Inc. seated at Boston (Massachusetts – USA) [19].

The semantics of the graphical language IDEF0 implicates the meaning of syntax language components and lightens the interpretations of corrections. The stage of interpretation describes parts like notations for activity and arrows and interlines of functional relationships.

Through functional analysis of IS, the folowing are presented:

- Diagram of context, indicating system boundaries,
- Activity stem to establish vertical connection between activities;
- Decomposition diagram to establish horizontal links between activities.

Rectangle (activity) and arrows (information carrier) determine the relationship between activities and information. This relationship is shown in Fig. 2.

Arrows from the left side of the rectangle are defined as Input. Arrows which enter rectangle from above are defined as Output. Exits are data or objects produced by activity.

Elements shown in Fig. 2 can be described by the sentence: ″Under Control, ACTIVITY, Input makes Outputs, using Mechanisms″. Arrows on the bottom side of rectangle present mechanisms. Arrows pointed up identify meanings that support executed activity.

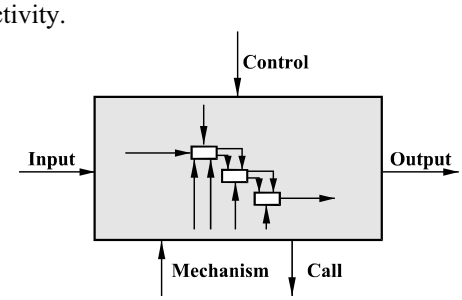

Fig. 2 *Basic concepts of IDEF0 methodology*

Arrows of mechanisms pointed down are defined as Call arrows. Arrows on diagrams are called ICOM (abbreviation of):

- I - Input, something used in activity,
- C - Control, controls or conditions on activities,
- O - Output, activity result and
- M – Mechanism, for example, employees who perform a given activity.

A question is frequently asked: which resources carry certain arrow types?

An Input arrow represents material or information which is used or transformed aiming at defining Output. A possibility of certain activities not needing Input arrows is allowed; certain activities do not need to have input arrows.

Control arrows regulate when and whether the activity will be performed. Every activity must have at least one control arrow.

Controls are commonly in the form of rule, regulation, politics or standards. They affect activity without possibility to be transformed or performed. There will be cases when a goal of activity is to change a rule, regulation, politics, procedure or standard. In that case, it is expected that arrows containing this information are actually inputs.

Output arrows are materials or information created by activity. Every activity must have at least one output arrow. An activity which does not create output is not to be modeled.

Mechanism arrows are these sources which perform activity and do not wear themselves. Mechanisms can be humans, machines and/or equipment i.e. objects which supply energy needed for performing activity. By free will of the project performer, mechanism arrows can be let out of activity.

Call arrow is a specific case of mechanism arrow and it denotes that the calling rectangle does not have its own detail diagram but a more detailed preview is performed on another rectangle of the same or other model.

In IDEF0 standard knowledge capturing and reuse approach is based on an ontology and relevant database. The ontology provides formal specification in modular product development and the design relations and graphical modeling tool, a clustering method is used to capture potential relations in the abundant data, and the ontology is used to record and reuse these relations.

M-IDEF0 method is developed as an improved graphical modeling tool to achieve the visualization of modular product conceptualization. Basic syntax for an IDEF0 representation, in M-IDEF0, is intended for modular representation of a product M-IDEF0 (Fig. 3) [14].

2 FUNCTIONAL AND INFORMATION MODEL

Based on the above defined assumptions, the first discuss is functional modeling where with functional decomposition would be identified *Information model of production-investment building* in the frame of functional model process *Production-investment building*. For performing these activity, it is used graphical language IDEF0 that is Case tool Bpwin. IDEF0 technique is typical graphical language which enables process description according ISO 9000:2000 standards request.

Functional decomposition needs to be performed through next subordinate activity:

- To define model limit,
- To define activity tree,
- To define user's requesting,
- To define decomposition activity diagram.

Resulted activity by decomposition, on the last level, needs to be described.

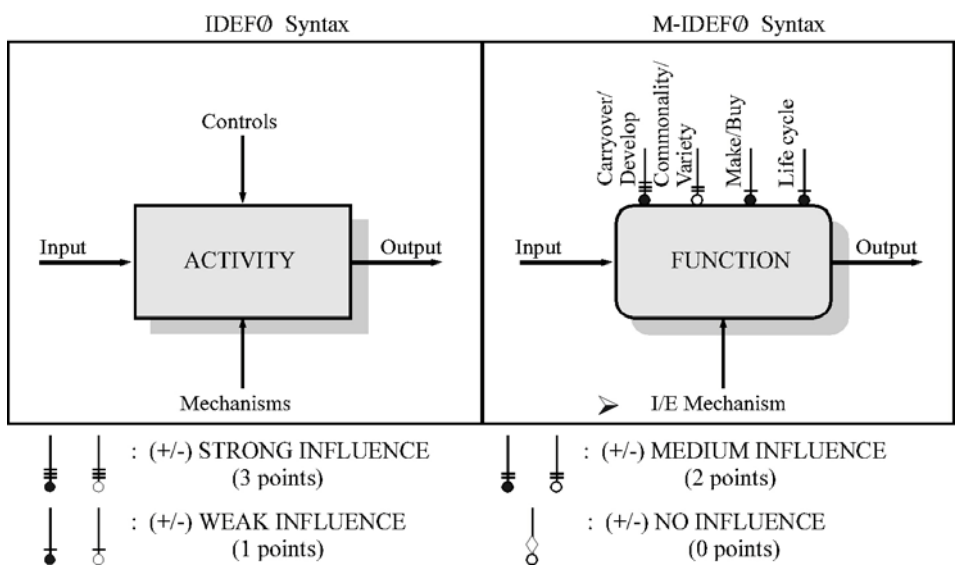

Fig. 3 *Modified IDEF0 (M-IDEF0) syntax* [14]

2.1 To Define Model Limit

To define model limit is connect for supposition given for developing process "*Information model of production-investment building*".

In the frame of determining model limit it needs clearly define the targets which must to next elements content:

- reason of model modeling,
- results of activity presentation,
- what model user would made with it,
- model purpose.

Answers on these questions must give to help in focusing on problem supposition.

Next questions which requests answers, are:

- which are assignments on given task or activity,
- which is sequence of events,
- how is control performs and
- which resources are used.

Context diagram defines with rectangle which represents study of model limit. The arrows show how, in that model and out of them, information flow.

Context diagram is the highest level of abstraction which, by decomposition diagrams would be lead in lower level of abstraction.

To define model limits is necessary because, where its must be stopped with modeling, before all.

This problem must be considers from aspect:

- width (to define watching elements), and
- depth (to define detailed level).

Model width is connected for context diagram defined (which is in IDEF0 notation marked with A0) and the first level of decomposition is signed as A1. In the frame context diagram it must to take care of defined input sets, controls and mechanisms, which produce output sets that is in this level to generalize observed problematic with less details.

Model depth is defined with decomposed levels, where are defined detailed levels. Decomposition went according defined possibility of primitive process. It recommends that is needed to start with defined output arrows, and move on to input, resources and controls. It starts from the act that every activity has appropriate outputs which can be identified. During defining the outputs, it must take care of negative outputs, which causes feedback arrows.

Next elements which must be defined are input arrows, which are transformed because appropriate output with help of appropriate mechanisms and control.

With aspect IDEF0 standard like and ISO 9000:2000 standards requests, it would be defined like the first step appropriate context diagram, it sets and observing model limit.

2.2 Context Diagram of Functional Production-Investment Building

Fig. 4 shows functional model context diagram of Information model production-investment building developing in regard model limit define.

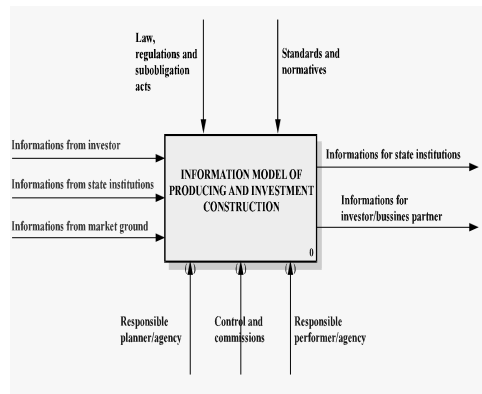

Fig. 4. *Context diagram which defined model limits*

Context diagram consist next elements:

1) Input information are:
   - Investor's information,
   - Information from State institutions,
   - Ground's information.
2) Output information are Information to State institutions,
   - Information for investors.
3) Mechanisms are:
   - Responsible planner/agency,
   - Commissions and controls,
   - Responsible performer/agency.
4) Controls are:
   - Laws, regulations and sub obligation acts,
   - Standards and normative.

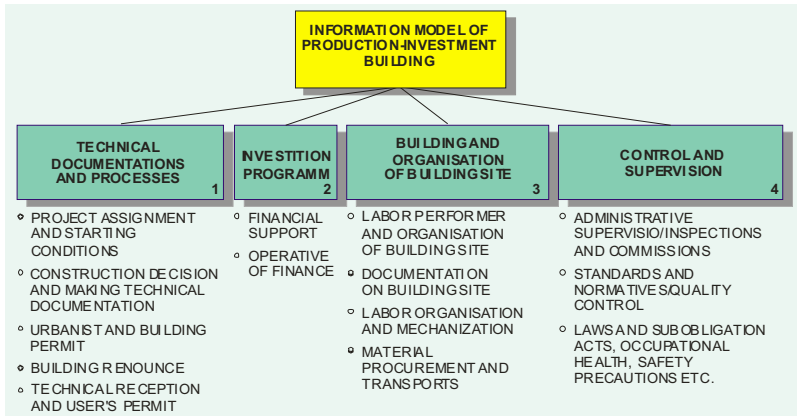

Fig. 5. *Information model production-investment building- activity tree process*

Fig. 5 shows information model production-investment building model. The first step is established decomposition diagram that is horizontal link definition between jobs/activity defined in the first level.

2.3 Decomposition Diagram of Information Model Production-Investment Building

The model of decomposition process diagram production-investment building would decompose on four global activities (Fig. 6):

- Technical documentation and process,
- Investment program,
- Building and building state of organization,
- Control and supervision.

With respect on IDEF0 standard, appropriate arrows presents sets of documents, which we define like information. Each information would be divided until to activity level where like arrows define concrete documents.

Internal communications present a number of activities. One of them is a basic assignment of passing correct information for all partners in all segments of production-investment building. This has a task of following a trend of modern building aspects and new methods in planning and realization in order to increase productivity and efficiency.

Production-investment building process is a very complex project. It needs to be systematically planned with convinced justification, successful realization and to reach useful value and efficiency. With analysis of individual problematical segments, which are very large and long-term, and time of real action is very short, we will show all justification of IDEF0 standard modeling.

Investment choice problematic in one common admission has its own two sides and two different supervising levels. The first one is choice of global investment structure which means investment allocation between production sector, branches of production and different production activity, as their whole suitable arrangement. The second one is investment choice in the frame of one homogeny kind of production, that's to say, the choice between a different investment variant, with reference on homogeneous production, on production of same useful value. With the first kind of choice determines production structure of economy, and the second one searches the most satisfactory decision for realization of certain production assignment.

Realization of optimal investment arrangement between production sectors and branches of production presents, without doubt, the most complex area of economy developing politic. With full reason, it captures central place, because with that choice it decides strategy questions of each economy.

In any investment project, the greatest care is, or would be, *how to profit from that investment*? Answer depends on two components: *the profit of investment project output sales (output quantity which is multiply realized with sales price) and costs of output production*. If a planned profit is bigger than planned costs, then it is good to investment and reverse.

Next segment of process is planning. The planning is very complex activity as it tries converting the ones uncertain (future), to certain (based on known past and present) in acceptable risk. That means the risk and uncertain future is not to be moved, but with planning it may be reduced on probability which may be successfully controlled and with that also realized.

That extraordinary human activity may not be left on strong consolidate methods like: approximation, commanding, with right date, politics and similar, than with modern methods operation research techniques, according to science-technological progress, with modern computer systems support and corresponding software support.

The planning may not be leaving only intuition, what in real life is a very usual case. With respect on the fact that intuition is based on experience and knowledge obtained by education, it must be considered and defined that intuition is subconscious memory and that it expressive subjectivity event, which would not be majority in creating plans because it brings with itself, more or less expressive subjectivity mistake of unexpected disposition. Planning should be, like scientific discipline, degrading in individual skill, and dynamic plans shown graphically.

In real life, the fact that planning of building project realization is connecting traditionally for talent, skill and long range individuality experience. In the focus of contemporary project-management, is not important how much is built, than building "Just in time" which characterizes unrealized construction at the expiration of agreed time limit, than right in time, and means building, with minimum expenses and building without quality defect.

Next important chain link is, certainly, Investment program.

Investment program is review and working out of enterprises idea and targets which is accomplishment of plan with determine investigation.

The reason of investment project making is to enable and enterprise management and other partners, who needs to engage in investment realization (business partners, bankers and local governments) to get fully and systematized clear picture about enterprise status, project clarity and condition for project realization.

Investment project may not to be established on unrealistic suppositions, wishes and dreams of any member in their realization. Realization has a sense if it is established on realistic enterprise status (investor), market and management, and like that, it can give foundation for bringing realistic decision about investment in realization of ideas and projects. It is necessary technical-technological analysis to support investment project with special regards on both segments.

Technological analysis starts from detailed description of producing and working process flow which is executed or will be executed in the enterprises after investment. It is necessary to describe equipment like expended normative of inputs in production of a single product, immediate use of capacity and production of desired volume, like projection and plan for these categories after investment, with expenses analysis.

Technical analysis mean accessible and developed infrastructure necessary for technological process of free development (building object, internal transport, energetic approaching and other elements). It is necessary to work out the management of labor, plans for training and qualifying.

In this segment of investment project it's obligated to pay attention to ecological aspect of firm business by influence and protection of life surroundings and influence and protection of engaged labor.

Namely, described documentation has more than hundred or thousand pages which are very difficult to be presented to investor or to donators, in the necessary time period for informing and conviction, volume and complex of project, expected results and guarante.

IDEF0 standard, this very complex process is described, with diagrams on several pages, on which you can see the whole process with all needed elements. It's easy for presentation and not necessary high education of investor or donator, so that they follow marked flows. Everything is very clear, every connection, controls, call, all kind of information, results can be expected and

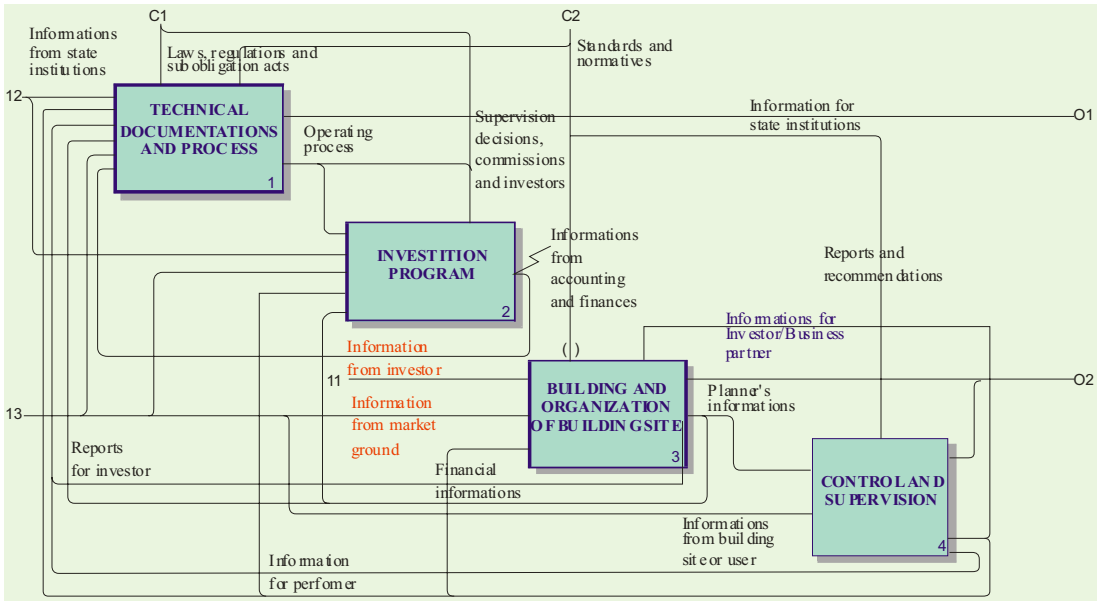

Fig. 6. *Decomposition diagram of information model production-investment building*

reaching optimism which is necessary for successful project start and realization.

To be in competition today is not question of success, but a question of survival.

We must apply what we know, notice that we don't know and be occupied by observation on expanding our area of understanding.

3 CONCLUSION

IDEF standard was developed at the end of 1970 by USAF with assumption to improve manufacturing productivity using IT and modeling, and represents a set of standardized methods and family language for information modeling in field software engineering, and improvement of business process.

We have defined context diagram, information model and decomposition diagram for developing process *"Information model of production-investment building"*. Information model contains basic tree activities of IDEF standard: Input information, Output information, Mechanisms, and Controls.

User's requests for model decomposition process diagram of production-investment building are defined through four main activities: Technical documentation and process, Investment program, Building and building state of organization, and Control and supervision (Fig. 6).

Process of production-investment building presents a very complex project, which requires systematic planning with successful realization in order to accomplish useful value and efficiency.

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