Realization of project procedures in the item designing companies of the Industry 3.0 and Industry 4.0

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Abstract. The actual task under consideration is to organize the project activity in an item designing company of the Industry 4.0. A comparative analysis is given to realize project procedures in the companies of the Industry 3.0 and Industry 4.0. It is clear that the primary means to create technical documentation for an item designing component in the Industry 3.0 company is the so called CAD systems which help the designer to create construction, program and technological documentation according to the given samples. The Industry 4.0 companies require the cloud technologies to function, Industrial Internet of Things, the technology of imitating modelling and others, which help to organize project procedures in the company virtual space. Virtual tests help to reduce the costs of development of an item and to reduce the amount of time spent for creating the item technical documentation by reducing the expenses. The main result of modelling in the Industry 4.0 company is the item 3D-model which exactly is the digital twin of an item designing component. There is a scheme how to organize project activity in the Industry 4.0 company to generate the project solutions space and choose the best one (optimal) of project alternatives. The optimal criterion includes technical specifications to describe external influencing factors which influence the item during exploitation and which is a part of the technical task to develop the item.

1. Introduction

The activity project of the item designing company is to create technical documentation for an item designing component. The item technical documentation is the collection of construction, program and technical documentation. Today the computer aided design (CAD) helps [1, 2] to create electronic documentation for the item. The CAD systems are installed in the computers of the automatic work places (AWP) of the item designer.

Normally technical documentation is being [3-5] prepared with standard project procedures inside the company which primary goal is to generate some project solution options by the designer. A plurality of such options will form a space of project solutions from which the designer with the optimal criteria searches for the best one. The procedure of justifying the made choice is quite different in the Industry 3.0 companies and in the Industry 4.0 companies [6, 7].

The companies of the Industry 3.0 are project companies which automatically process the preparation...
of technical documentation. The automatizing key here is to implement the means of CAD. The documentation quality is proved with natural tests. It is clear that for now such way of projecting an item in the item designing company is far from the modern one [8, 9]. Today the main ideas are to implement the virtual tests of natural processes and the technologies of imitation modelling in the project activity. These technologies are the key for project procedures in the companies of the Industry 4.0 (digital factories). To successfully implement in some digital factories perspective information technologies, some new mechanisms are required to realize project procedures based on cloud technologies, industrial Internet of Things (IoT) and others [10-12].

The collection of new informative technologies implemented in project activity will help to transfer some project and production procedures in the virtual environment which helps to prepare the item technical documentation with improved quality and the reduced amount of time. So to implement new informative technologies in the project activity of the item designing company is a tool of automatizing which helps science and technological progress in the industrial economy sector to develop.

2. The preparation of item technical documentation in the Industry 3.0 companies
To create item technical documentation for item designing components in the Industry 3.0 is a process the scheme of which is given in figure 1. The project process begins from analyzing the requirements for a technical task. A technical task (TT) is a general document where the tactical and technical characteristics are listed for the future item to be designed. The tactical and technical characteristics include the requirements of the item purpose; technical requirements for the item; the supply requirements for the item itself and its manufacturing process and others.

![Image of development scheme of the item technical documentation in the Industry 3.0 companies](image)

**Figure 1. Development scheme of the item technical documentation in the Industry 3.0 companies.**

Having analyzed the requirements of TT, there are some technical solutions created (ideas of a designer) to define a detailed structure and consistency of the future item. They need to define separately the complexity of supply for the item being projected meaning the item exploitation documents, spare parts and etc. The structure and consistency of the item later will be the base of the construction (CD), program (PD) and technological (TD) documentation for the item itself and its assembly units.

Construction documentation for an item designing component in the Industry 3.0 companies is a collection of text and drawing documents made according to some standards. The preparation of...
construction documentation is made by the designer in CAD systems (AutoCad, MS Word and etc.) installed in the computers of automatic work places. Those computers may have different models and manufacturers, but still it does not matter at all which special computer aided design program will be installed as long as it satisfies the program installation requirements. So the construction documentation is a set of electronic documents which describe the structure of the future item. The list of construction documentation for a particular item and its components is done by the designer having analyzed the complication of the item itself and characteristics of technological equipment which is supposed to be used to manufacture this item in a serial plant.

Program documentation for an item designing component in the Industry 3.0 companies is a collection of text and drawing documents made according to some standards. Text program documents are a listing and description of programs, specifications and others. Program documentation files are being downloaded into the item and item components are executed on a microprocessor. The files themselves are registered in external and internal static memory connected to the microprocessor. The program documentation is prepared in special CAD programs (Visual C++, Borland C and others) installed in the AWP.

A separate type of the technical documents for the item is programming data being registered in the microchips of programmed logic. Microchips of programmed logic are semiconductor crystals with the components of digital logic and analogue components. Initially they are separately realized components (freely). To configure the microchips of programmed logic means to unite the separate components into complicated electric schemes. To configure the microchips of programmed logic they use special CAD programs (Xilinx Foundation, ALTERA and other) installed in the AWP. To finish the configuration of microchips of programmed logic you need to form a file which will be downloaded directly into the microchip or the static memory component, connected to the crystal. Despite the fact that the projection is finished with a data file, such file is mostly a component of construction documentation. In this case the data file is a fragment of the electric scheme realized on a highly integrated microchip.

Technological documentation for an item designing component in the Industry 3.0 companies is a collection of text and 3D (Dimension) models files made using some standards. Text technological documentation is the description of the procedure of some technological operations united in a single technological route of item manufacturing in a plant. Item 3D models are necessary to manufacture automatically some components in some special machines equipped with computerized numeric control (CNC). They prepare 3D item models under the control of the technical supervisor which are based on drawings of construction documentation. The 3D model controls the machine functioning program (technological equipment) which is a part of technological documentation.

Standards for the construction, program and technological documentation is a collection of norm and technical documents with document samples and description of rules how to fill the documents. Those standards may guarantee that the project and production task will be completed in the field of development and production. The key component to standardize the electronic documents of the Industry 3.0 company is compliance with the version of CAD programs which designers use to prepare the documents and manufacturers apply in the production process.

Technical documents made according to the standards for the item designing components are transferred to the electronic archive of the project company. This is the document which can be read or understood and in some cases probably studied in a thorough way by the designer. The quality of documentation is proved with natural tests being done with a sample. The positive results are signs of the sample compliance with technical task requirements and proves the documentation quality. Documentation errors found and sample defects are reasons why the construction, program and technical documentations are changed. And corrected technical documentation for the item is the result of project activity of an item designing company of the Industry 3.0.

3. The preparation of item technical documentation in the Industry 4.0 companies

The project activity of the item designing company of the Industry 4.0 is directed to create item technical documentation as its digital twin. The item digital twin [8] is a collection of physical and chemical,
optical, kinematic and some other ways to describe the item being projected. In their mathematical form such descriptions allow to study the objective space of ideas as a part of the space of the digital solutions which are precisely the results of projection.

Some item properties like physical and chemical, optical, kinematic, electrical and physical also can be used as new modes to describe the functionality of the item itself or its components (parts) and also can be used to characterize the properties of materials in their molecular level and sometimes atomic. But they can also organize the projection procedures and virtual tests for the items which can be temperature control, pressure, the level of humidity and some other required tests.

![Diagram](image-url)

**Figure 2.** Interaction scheme of components to synthesize project solution for creation of item digital models in the Industry 4.0 companies.

The company virtual space is a collection of cloud services of a digital factory of the Industry 4.0. The components of cloud services in a digital factory are given in figure 2 and include:

- exploitation environment mathematical models where the item will be exploited according to its technical task. The models of exploitation environment include the model of humidity, the model of pressure, the model of temperature and some others;
- mathematical models of testing equipment being used in the Industry 3.0 companies to organize physical tests with an item designing component. In the Industry 4.0 companies physical equipment (test equipment) is changed by mathematical models which are full informative copies of their originals. Mathematical models of test equipment shows physical influence on the item digital model which is like natural tests being done in the Industry 3.0 companies;
- mathematical models of materials and components which are part of the item being projected and are used to describe components behavior under different conditions. As the example of such alteration can be given the geometrical dimension of the item (heat expansion) when the environment temperature has changed. Another example is temperature coefficient of the capacity (resistance) which can be used to characterize the capacitors (resistors) which are parts of radio and electronic items;
- library components in their digital form available for the designer like state standards for the
item designing components; methods and scenarios of tests which support the technology of
imitation modelling; the technical task for the item and others.

The key component for the item projection technological cycle and its digital model tests is the
control program. The control program is a part of program support of CAD and has the following
functions:

- initial data input for virtual project and production activity (modelling task input, initial condition
input);
- the setting of mathematical models which are part of cloud services for the project activity in a
digital factory of the Industry 4.0;
- the test of the 3D-model (digital twin) for an item designing component. Tests are to apply on
the model in a particular sequence or at the same time (tests scenarios) of different types of
influencing factors which imitate the exploitation conditions of the item;
- formation of a data bank of project solutions with which the technical task for the item will be
completed;
- the project selection of the best (optimal) project solution to comply with some particular points
to show the project quality. Selectively they choose the project alternatives in the space of project
solutions judging by the quality criteria. They double the particular quality points in additive or
multiplicative ways united in an integral criterion.

The project solutions bank is the collection of best solutions from which the designer choose the
project alternative which is the digital twin of the item. The item digital twin is a form of item technical
documentation which is used in a smart factory of the Industry 4.0 and this is how the item will be
manufactured. The item digital twin of the Industry 4.0 company is the more advanced form of the
technical documentation in comparison with CD, PD, TD which are being projected today in the
Industry 3.0 company.

4. Conclusion

The vector of world industry aimed at standards of digital economy includes the transfer of some project
and production procedure in its digital form. First this is for organization of company project activity
which is responsible for scientific research and development sector in the item designing field.

The implementation of new CAD systems which supports the perspective ways of storage and
graphical representation of engineering data is the way how to modernize the Industry 3.0 companies
and has its limit. A transfer to the digital technologies of projection can be realized with the
implementation of a group of new informative technologies, the base of which is cloud technologies,
industrial IoT technology, virtual technologies and imitation modelling and others. The companies
which have the full collection of this new informative technologies will be the base for digital factories
of the Industry 4.0.

A transfer of project activity into virtual environment for a designer is a perspective step in the
development of item designing which requires from the government the new generation of industrial
and professional standards, way of storage and representation of the project engineering data in a
company and others. The work of such digital companies is based on the job description, professional
skills and quality of specialists which training should begin already today.

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