Multi-media animation technology for cyber-production design

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Abstract. The cyber-production animation design multi-media paradigm is to construct together the technological division architecture and industrial object control laws. In architecture solutions the designers pay attention to space plant and technological aggregates models (geometrical). The object control laws design is based on regulation models in time area. To reach the target cyber-production characteristics they apply automatizing tools where the primary optimal criterion is the technological processes parameters indirect measurement minimal inaccuracy. There is a scheme how the cyber-production project quality criterion is formed. The cyber-production components control methods and approaches identical state can be seen through a separate workshop cyber-segments level and also in the general industrial object level. There are algorithms how to project a cyber-production with a given criterion. The cyber-production project virtual tests and production and time models validation are based on unique experiments made by a designer in the multi-media environment.

1. Introduction

The Industry 4.0 advanced achievements in engineer and computer processes synthesis of machine constructions requires from the researchers the new and more accurate methods and means of automatizing adapted specifically for digital content work [1, 2]. The man and machine modern automatized design system is a multi-media three-dimension environment reflecting geometrically accurate construction parametric models, which are to transform mathematically the project data equal to the object being projected expectations through the dynamic exploitation process [3, 4].

An absolutely new object type being constructed is the cyber-production architecture model, which is based on technological aggregates combination creation, which forms the production equipment automatic cyber-segments division [5, 6]. New technical solutions and cyber-production configurations being formed in a multi-media three-dimension design environment realizes an object oriented approach to create industrial objects if the original design is a result of the computer models control system [7]. The real production system imitation is the new design paradigm base where the end product is dynamic geometrical models with some freedom restrictions of aggregates moving parts through the entire constructive parameters possible changes range [8, 9].

The cyber-production architecture components detailed representation provides the designer with the
aggregates electronic samples behavior results being understood or measured, which is critically important to adequately describe mathematically the real equipment third dimension objects in a model environment [10]. The design multi-media environment main technological feature is to unite physical aggregates, production processes and their models with the industrial object business-system architecture. The cyber-production interior design visualization is based on new vector graphics methods and the calculation methods are used in parallel integrated into a complex model to create an innovation break-through in the industrial objects design technologies to provide full and adequate infrastructure appearance formation of the real digital plant [11, 12].

The object oriented cyber-production model being corrected with technological parameters is an advanced solution to implement trans-disciplinary mechanisms of the industrial aggregates effective coordination and resources distribution into the digital twin electronic documentation, which can be used in the real object subsequent construction. The rationally balanced production infrastructure may avoid unnecessary economic losses, which function is to duplicate the equipment and designers constructive errors [13, 14].

To provide a full cyber-production functioning picture with some multi-media animation tools to reflect in «transparent» mode geometrical models movement to give the designer visual ergonomic industrial object representation to accompany the project from the initial idea to the exploitation entering for the designing results. The end-element cyber-production modelling is to give the location details of each technological aggregate to divide mounting areas into sections and to developed object control laws, which can be expanded together to the industrial net centering ecosystems scale [15].

A group of aggregates realizes in star-stop mode typical technological processes according to the cyber-production structure, which changes dynamically. The simple plant infrastructure improvement requires to formalize some new design methods, which may create an algorithm how to transfer from the project to the construction solutions, which will be noted in the electronic drawings later [16, 17].

To work out a cyber-production work project requires the necessary technologies and programs organization level with theoretical and practical aspects of the design object. The project activity complex automatizing necessary conditions are the project company high level of computer provision and the designer quality engineering preparation. Those factors influence the general labor efficiency and let designers plan and develop cyber-production models, which are as much similar as possible to the real plant structures being mounted [18, 19].

2. Cyber-production model representation as a design object
The parametrized cyber-production model representation are visual third-dimension drawings of real technological aggregates made as some vector graphics with dynamic properties in space and time (physical and model).

The technological aggregates groups space models in the physical world have the same components of functional cyber-systems to realize production processes. The cyber-production physical environment distinctive construction features as a design object are:

- the technological division concept synthesis and components are made of the existing system components (they apply sample solutions based with cyber-physical systems);
- the cyber-production complex automatizing is done with forces and means of technological aggregates functioning in the same plant conditions;
- the cyber-production system functioning technology is described with discrete technological processes terms with concentrated parameters and other.

The technological aggregates functional structure space models of the virtual world use informative representation of the equipment constructive features. The cyber-production virtual macro model as a design object has the following features:

- it uses parametric descriptions of inter-production transfers and functionally finished sequences
(routes) of technological operations;
- it provides cyber-object division into levels (stage by stage increase of the design object complexity) and in details visualizes with animation united means the moving parts trajectory movement with technological aggregates (inter-machinery constructive equipment unification);
- it is mathematically analyzed and clearly visualized with machine graphic means with different alternative solutions examples how to mechanize the industry according to the cyber-object existing rules and other.

The cyber-production physical world time model is based on discrete and event functional connections establishment mechanisms among the technological aggregates. The time model maximum approximation (adequacy) to the real characteristics and cyber-production process is done through the production object following features:

- the same priority establishment for all universal informative and special control connections appeared in dynamic groups and technological aggregates cyber-segments;
- collision avoiding process control and contradiction solution is done with end element methods in technological aggregates production relations;
- to regulate cyber-production processes and operations in the technological parameters altering range is done to the minimal hold-up criterion in the item manufacturing keeping the production cycle accuracy and quality and other.

The cyber-production time model in the virtual world sees the plant as a technological control object, which manufacture the planned products range. A cyber-production mathematical model adequate to real processes and aggregates may divide the design object into controlling and being controlled sub-systems, which have the following properties:

- digital data, which are intermediary calculations to characterize attributively different technological processes may put some restrictions on available solutions plurality, which influence the cyber-production general productivity;
- to control a cyber-production technological aggregate with associative relationships is based on a system of rules (subjugated control laws) oriented to reach the necessary digital plant functionality;
- technological operations representation in details is done with a set of electronic drawings to characterize functioning conditions and each aggregate behavior model in production cyber-segments dynamically formed configurations and other.

A set of calculation modules to synthesize some project solutions to select the equipment and to develop complicated technological object control laws keeping in mind the conditions of its functioning, which is project environment brainware and software. Theoretical and model work-out automatizing of all cyber-production arrangements may avoid a lot of errors how to control engineering projects and evaluate operatively all digital plant sketch options made with necessary technological aggregates class.

3. **Cyber-production design animation technology in a multi-media environment**

The cyber-production being researched processes complexity justifies that a design third dimension multi-media environment is an expert technology system tool to provide intellectual comparison with each other technically permissible options evaluating their potential possibilities taking out the project, which do not meet the requirements of present day. The design object requirements massive formal keeping is to develop a criterion to characterize generally a cyber-production according to the selected metrics.

Technologically concord cyber-production metrics are:
• technological aggregates geometrical dimensions formed with detailed drawings made by manufacturer as an electronic set of operational sketches;
• the cyber-production general productivity, pace, manufacturing dead-lines, inter-operational dimensions of the product being manufactured using the question-answer technology for technological aggregates to interact and industrial object control system;
• technological aggregates control parameters through, which the cyber-production process necessary corrections are made and other.

The factors being studied and their combinations engage the mode of individual design of a cyber-production option where each technological aggregate is a dynamic object with parameters being controlled interacting in an industrial infrastructure. Quality compact criterion of a cyber-production project option in comparison with available analogues (known), which is the technological parameters indirect measurement inaccuracy, which depends on the aggregate properties from the passport. To minimize this quality criterion, which is reached through the automatic design process in the third dimension multi-media environment to gain the optimal solution to define the digital plant components being proved with the animation means with the example of real orders manufacturing. A cyber-production project quality formation criterion is given in figure 1.

The cyber-production design technology in a multi-media three-dimension design environment requires to create the industrial object visual model, which is adequately real to the processes, which shows the content side of the product manufacturing. The design space is an electronic windows system presented as a user menu where the designer analyzes dynamically the technological aggregates behavior into some fixed product production moments. The test technological route is given with an electronic table of aggregates connections, which may research the cyber-object properties in the plant divided representation mode into functional equipment groups.

![Diagram](image_url)

**Figure 1.** The cyber-production project quality criterion formation principle.
Each technological aggregate attributes is edited depending on the operation type being completed and the equipment type. The multi-media three-dimension environment ergonomics and aggregates modelling representation of formed geometry (the equipment esthetic properties) let designer project new cyber-productions and re-construct the existing infrastructure evaluating economically important indications how to dominate and produce the product of a limited range. Designer imitation activity is an important section of modern animation technology to construct industrial objects, which makes it significantly easier to analyze the cyber-production quality indications in the stage of its automatic design.

A multi-media three dimension design environment let designers not only choose the optimal dimensions and proportions combined with technological aggregates architecture facilities but also to view a cyber-production as a control object. The technological cycles setting parametric changes made by researchers influence the multi-level matrix values of cyber-production target indications. The industrial object view-ability and control-ability model check is done through technological aggregates actual conditions mathematical analysis, which are being inquired simultaneously with parameters in the functioning equipment all types. Dynamic processes models appeared in a cyber-production are components of the general industrial object control task. The cyber-production animation design algorithm in a multi-media environment is given in figure 2.

![Figure 2](image)

**Figure 2.** The cyber-production animation design algorithm in a multi-media environment.

4. Conclusion
The cyber-production model representation with visualized geometrical constructions is the design main base of complicated industrial objects. The cyber-production animation model reduces design documentation correction risk and let designers search for new technological aggregates description forms, which is adequate to the real equipment to reflect their dynamic properties.

The cyber-production design innovation environment is based on multi-media technologies engaging functional working construction aggregate models to project the equipment behavior under real industrial conditions. Predictable and understandable technological aggregates actions are provided with the model complex sense, which include technical system different aspects. The technological processes
Parallel design is quite actual for a cyber-production including industrial equipment control processes. The defiance current level corresponds the world market requirements to justify the actual state for original technologies designing, which are project accompanying tools to create a cyber-production. Gathered today science and technical experience may construct complicated industrial objects avoiding the paper drawings. To designing quality and transparency are made with application solutions in automatizing and some intermediary technologies to guarantee a high level of the production processes visual representation.

The cyber-production super computer engineering forms with some special applications the organization and technical solutions options where the full production processes monitoring possibility is reached and critical areas (characteristics) revealing to reflect a non-sufficient project work out depth. The automatizing accent to create an advanced production requires to use the technological aggregates attributive components into project procedures. The multi-media design environment geometrical core could be reasonably added with methods being actively developed today how to control an industrial object.

The cyber-production design relevant experience the project and estimation documentation quality increase to apply the target minimal indications of the technological parameters processes indirect measurement inaccuracy, which can be calculated through the exploitation industrial object status monitoring. To evaluate the project technological feasibility (cyber-production concept) in the design first stages applying engineering centers advanced resources functioning as visual fields including the national base of the three-dimension industrial aggregates models.

The project activity expert accompanying in a multi-media environment let designer gain easier-visual and secured project solutions compatible with the architecture and constructions (electronic documentation) of production partners providing the business data centralizing and investment security of the cyber-production sub-technologies. The cyber-production digital content computer control guarantees the high degree of graphical and functional models working out, which will be later in the construction drawings of the real industrial objects.

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