Modern Prototyping as a Basis for Industrial Design

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Abstract: The paper presents methodological bases for designing object-oriented processes as applied to industrial design via the targeted activity and system approach to make production efficient for the petroleum industry. Possibilities of introducing scientific advancements into practice have been overviewed.

1. Introduction
Currently, design methods [1] rely on the research system–sociological analysis [2], logic modeling [3], system approach [4]. The desire to solve problems (eg., stylistic solution of shape in deeper structural links between a man and a work suit) remains decisive for designers.

2. Research
In order to take into account and link in a single system multiple targets, converging on the subject of a work suit for the petroleum industry as a design object, you need to build targeted programs. This may be a “tree” of goals, a matrix of goals, a list of requirements to the subject in a certain sequence and interrelation, structural and functional model of goals. Prototypes play a crucial role in traditional design. This concept, as a rule, is the basis of the design solution and largely defines it and allows efficient management of production using modern methods of information processing.

Analysis of prototypes from the position of industrial production suggests that in traditional design they allow you to develop standard products meeting the requirements of the social functioning of the object and processes for its production. However, naming the design process a stage of clothing manufacture we encounter prototypes that have no analogues in standard design concerning manufacturing garments for the petroleum industry, and as a result, no possibility to manufacture single products based on them.

Production specialist skills and knowledge are aimed at manufacturing specific products, samples of which are based on the continuity of culture and traditions. The division of labor required for sewing complex industry-oriented products (coats, suits of mass production, etc.) has led to the fact that the work of individual masters came to regard specific sites of the garment (welt pocket in the frame) or certain operations (for example, connecting collar to a neck hole). The product as a whole fell outside the scope of competence of one master. The appearance of design as a stage of the production process is connected with the need to organize the division of labor of many masters to achieve the ultimate goal - the manufacture of the garment of mass production. Being thus functionally linked to the organization of work and responsible for the final result of the product manufacture, design must be provided with appropriate professional tools. These tools were in the form of drawings, diagrams, standards, calculation methods, knowledge, etc. Instead of “samples” there were complex systems of symbolic tools, knowledge and principles that are transmitted both in writing and orally (with the help of the costume language). These tools, combined by the type of the object and traditional forms of design, organization and sewing activities, are the basis of prototypes of “specific” objects of design.

The specificity of the professional design activities is the need to reproduce a plurality of similar objects. Consequently, their samples and prototypes were created so that the expert could make necessary refinements and adjustments, in accordance with the cultural values, conditions and requirements (also considering the specifications of the petroleum industry).
A prototype includes the most important characteristics of the object necessary for the organization of work. It captures not a single object, but some very specific “type” of an object (jacket, pants, etc.). Expansion of tasks of professionals (designers, fashion designers), complexity of social life and development of material culture led to an increase in the number of “model” prototypes.

Social dynamics of the present day, intensive and, as a rule, independent and uneven development of various areas of production, science and technology creates a situation of activities disagreement and leads to the formulation of tasks for which there are no prototypes in modern design (especially if talk about clothes for the oil and gas industry).

Schematically, the role and place of design [5] in the new environment can be represented in methodological models of the social reproduction cycle (Figures 1, 2). They contrast two different mechanisms of social reproduction, conventionally called “society with culture” and “society with design”.

**Figure 1.** Interaction cycle of “society” and “culture” (culture, production, consumer society).

**Figure 2.** Interaction cycle of “society” and “design” (design, production, consumer society).

Reproduction of “society with culture” is provided by the fact that “culture” stores standards, samples of objects of production and consumption. In the mechanism of “society with design” production patterns are developed in design. If reproduction with “culture” implies social statics, reproduction with “design”, by contrast, focuses on the dynamic type of society.

The presented methodology models define the semantic opposition of “design” and “culture”. A combination of these mechanisms of social reproduction in developing social systems is schematically presented in the configuration diagram (figure 3), in which “design” and “culture” interact.

**Figure 3.** Interaction cycle of “design” and “culture” (design, culture, production, consumer society).

Analysis of the interaction cycle of design and culture suggests that specific prototypes of design objects is a special form of presenting cultural norms in the design.

Thus, the functions of the suit as a subject are manifested in different contexts of social and cultural human activity: transformation of the environment (instrumental function), maintaining the environment in a state that ensures the normal course of life processes (adaptive function), social integration of people (integrative function). Each of these functions is a special theme in the design of costume objects and creation of a holistic design image.
In [6, 7] the authors presented a methodology of targeted orientation of clothing design on the example of a classification of men's business suit design. Customer satisfaction is a result of the company's activity to identify the target of its products depending on the price group that indicates the status of the owner of the suit and the company they work for. Products of low-price group comply with fashion trends and modern requirements, but they have a simple, economical construction with minimum wet-heat treatment and the minimum number of finishes, which is insignificant for industrial clothing.

Average-price group costumes have a typical simple design (for example, one slit on the back) for industrial production of standardized parts and standard manufacturing. These products are a compromise between the high and low price groups: a more complex design compared to the low price level, but manual types of work are replaced by the use of special machines.

Higher-price group products are characterized by a complex design (that is worked by hand), and a large number of seams, which results in a perfect fit on the body (company’s dress-code policy). Such suits both outside and inside do not tolerate any compromise; details of the jacket lining repeat the design of details of the top fabric. Original finish is used (hand finishing stitches and perhaps with contrasting threads).

Using the targeted orientation of design on a particular consumer proves the logic of using prototypes in industrial production and makes it necessary for enterprise to plan product release. There are currently a large number of economic and mathematical methods used by enterprises to plan their work and find optimal solutions to a number of problems: the largest amount of output per year, the highest profit or the lowest expenditures, the lowest cost, etc. As solving these problems is carried out under limited conditions, it takes form of optimizing the use of the available resources, i.e. their most advantageous use under these limiting conditions.

Table 1 shows an example of calculating the cost of production, taking into account the sum of all financial expenses for production and sales of ООО «Fashion studio «Silhouette», Tyumen.

| №  | Notion of expenditure items | Expenditures in the base period, thous.rub | Expenditures in the reporting period, thous.rub | Sensitivity, thous.rub/pc | Expected expenditures, thous.rub. |
|----|----------------------------|-------------------------------------------|-----------------------------------------------|--------------------------|----------------------------------|
| 1  | Mz                         | 1026.50                                   | 1452.85                                       | 1.37                     | 525.01                           |
| 2  | Za.c                       | 1175.50                                   | 1296.80                                       | 0.39                     | 1032.83                          |
| 3  | Po.r.                      | 2050.00                                   | 1850.00                                       | -0.64                    | 2285.25                          |
| 4  | Oc.c.                      | 59.45                                     | 53.65                                         | -0.01                    | 66.27                            |
| 5  | Om.c.                      | 65.60                                     | 59.20                                         | -0.02                    | 73.13                            |
| 6  | Op.f.                      | 410.00                                    | 370.00                                        | -0.13                    | 457.05                           |
| 7  | Ostr.vz.                   | 20.50                                     | 18.50                                         | -0.01                    | 22.85                            |
| 8  | Oam.                       | 10.00                                     | 10.00                                         | 0.00                     | 10.00                            |
| 9  | Pp.                        | 5.00                                      | 20.00                                         | 0.05                     | -12.64                           |
| 10 | Lkr.                       | 50.00                                     | 70.00                                         | 0.06                     | 26.48                            |
| 11 | Zrem.                      | 0.00                                      | 30.00                                         | 0.10                     | -35.29                           |
| 12 | Zdr.                       | 15.00                                     | 50.00                                         | 0.11                     | -26.17                           |
| 13 | $\sum_{i=1}^{n} Z_i$       | 4887.55                                   | 5281.00                                       |                          | 4424.76                          |
| 14 | $n$, pcs                   |                                           |                                               |                          | 311.00                           |
| 15 | $V_{opt}$, pcs             |                                           |                                               |                          | 366.00                           |
| 16 | A, %                       |                                           |                                               |                          | 7                                 |

Analysis of Table 1 shows that the cost in the reporting period compared to the base one fell by 7% with the release of 311 units of products.
The calculated sensitivity of each expenditure to the released 311 pieces of products made it possible to calculate the maximum number of products (366 pcs) in order to reduce the cost to a minimum value of the expected 4424.76 rubles, which reduces cost by 9% compared to the base option. Such results can be achieved due to better organization of production and effective use of internal resources.

3. Conclusion
In conclusion, it should be noted that the design that is based on prototypes is more properly termed “design by prototypes”. Prototype as the form and way of existence of design should be distinguished from various specific prototypes of design objects. A particular prototype as the object meaning and essence can be regarded as knowledge, models, tools, techniques, etc., at the same time understanding it as the structure of the project activity. This work aims at reducing terminological confusion and creating an effective system approach to designing.

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