IOP Conf. Series: Materials Science and Engineering **125** (2016) 012030 doi:10.1088/1757-899X/125/1/012030

Systematic Classifier OF Manufacturing Processes For Medium Size Shafts

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Abstract. The article considers some issues of increasing efficiency of manufacturing preparation as a part of manufacturing processes design at a machine building enterprise. A tree of routing manufacturing processes for machining shafts of medium size is described as an example of clustering parts according to their structural and technological characteristics. Processing route for a certain part included into a certain group is developed through choosing machining operations for elementary surfaces of a part from the process route developed for a template representative of the group.

1. Introduction

Machining of products under the conditions of small-lot and single-piece production has its unique features. Manufacturing process specifications for an article are not developed in details. Sometimes general processing route is assigned but small operations depend on machine tool operator skills. General purpose equipment and tools are applied. If the procedure specifications are necessary the development process takes a great amount of time which leads to increased manufacturing preparation period. Modern mechanical engineering is characterized by intensive application of new technologies and constantly changing business trends [1]. In this context it is important to provide flexible production [2].

Modern quality requirements and frequent change of manufactured products stipulate the need to improve manufacturing preparation process [3, 4]. Systematization of technologies enables to develop unified manufacturing process specifications. Unification of technologies provides reduction of minor works associated with technological, planning and accounting documentation necessary for preparing and managing a manufacturing process. In view of the above it is reasonable to classify the parts produced at an enterprise according to structural and technological factors and to develop systematic classifier of routing manufacturing processes for a certain kind of parts (here they are shafts). Further on it will allow simplifying development of manufacturing processes and reducing manufacturing preparation time.

The idea to cluster up manufacturing processes belongs to professor S.P. Mitrofanov [5, 6]. Similar concepts can be found in other works [7, 8] including those using graphs [9]. Modern automated design tools allow modular design with which an article is made of structural modules that is unified units of the article. The range of structural modules is much less than the range of products to be assembled of them. Describing a wide range of structural modules is the main trend in the development of the systematic classifier. Such approach enables to cut down the number of the variants being developed. Thus developing a processing route does not take much time and calculation tools are used more effectively [10].

When designing manufacturing process specifications under the conditions of small-lot production there are always a great number of different variants which effect project solutions. As far as the design process is not formalized enough such problems as choosing a blank, developing processing route, choosing a machine-tool and cutting tools can be solved only by means of choosing a variant from some available common representatives. That means that typical solutions make basis for formalization when solving informal tasks in computer aided design of manufacturing processes.

In this account a machine-building enterprise has made a decision to work out a systematic classifier of manufacturing processes for manufacturing standard component parts of power hydraulic systems based on their structural and technological attributes [5, 6, 7] or economic characteristics [11]. The parts are combined into larger groups, which enables to increase series production and reduce process design time due to making template solutions. Unified highly productive machining methods and flexible equipment chosen depending on tools performance figures [12, 13, 14] are assigned for certain groups of parts with similar attributes.

When working out the classifier for an enterprise they aimed to make a description of a set of template solutions to cover the whole range of structural and technological parts and conditions under which each of those solutions can be applied. This work results in reducing manufacturing preparation period, improving data storage safety due to account policy as well as providing easy replication, availability of cooperative work of designers on the same project and easy information exchange between different enterprise departments.

A wide range of products and technological manufacturing processes has been analyzed within the project work. Performance characteristics of the equipment applied at the enterprise as well as jigs, fixtures and tools have been examined. Great attention was paid to fabricability of the group parts which is an important factor of the process design.

The parts were classified depending on their structural and technological characteristics. As a result the parts have been divided into certain types, i.e. classes of parts subjected to common machining operations or manufactured with the same equipment and machine setup, having similar elementary surfaces and installation geometry. Operation-routing sequence for a certain part is formed by selecting appropriate operations for machining the part elementary surfaces from the sequence developed for a template or complex part.

The work on developing the systematic classifier is divide into separate stages according to the parts being considered.

A systematic classifier of medium size shafts is described here to provide an example. Fig. 1 shows parts which were combined into one technological group based on the following main characteristics: similar surfaces or combination of surfaces to be machined, precision of machining, outline dimensions or the possibility to machine differently shaped parts with the same equipment and machine setup. This classification will allow using the same tools and equipment when designing the manufacturing process and accelerate computer-aided design.

After that a complex part which comprises all main structural elements is developed (the part shown in Fig 1 can be considered as a complex part). This part includes all the elements which the parts of the group can contain, for example holes, bevels, notches allowing precise machining.

Then based on major manufacturing process different operation-routeing sequences of machining the parts were developed depending on thermal treatment, some specific operations [15], enterprise special conditions, etc.

Results and Discussion

Modern computer-aided design systems use two methods of manufacturing process design:

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- the first method consists in using a general technology reference guide which contains descriptions of template solutions of manufacturing processes.

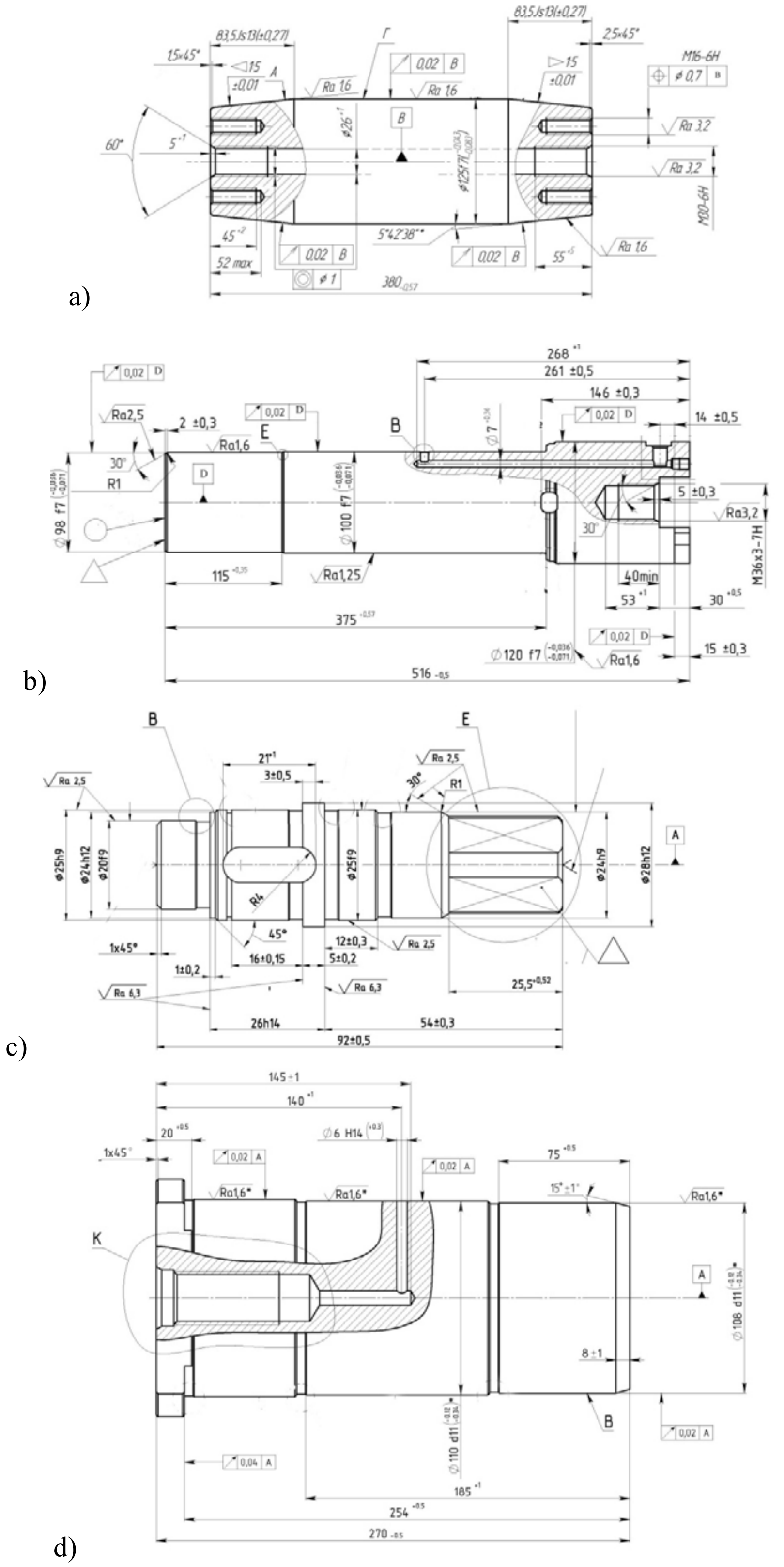

Fig. 1. Parts combined in a group

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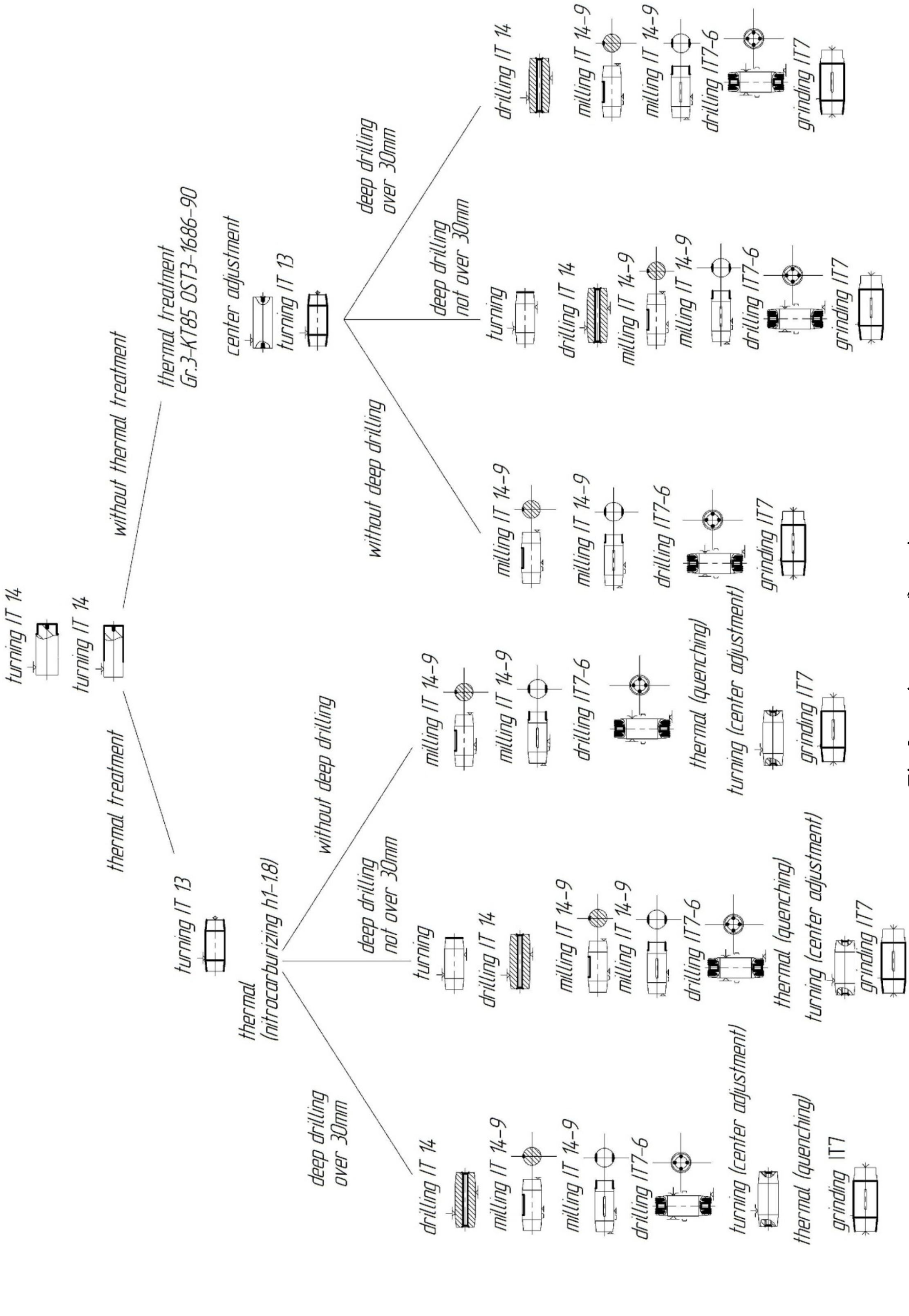

Fig.2 routing manufacturing processes tree

The solutions can form the whole manufacturing process, some of its parts or a separate operation or step.

- the second method uses "Technology Tree" application. With this method the design consists in copying operations from analogue manufacturing processes and their modification to make up a required manufacturing process.

In our case the systematic classifier structurally corresponds to the method using a general technology reference guide. The graphical part consists of a description of template solutions and application conditions.

The operation routeing sequence shown in Fig.2 as a tree-like structure is designed for machining a complex part.

Further on to design a manufacturing process for a new part we should determine its type that is to determine what group of parts characterized by common machining operations or manufactured with the same equipment and machine setup it belongs to. When developing the operation routeing sequence for parts included in some group, the tree branch to be followed is chosen according to the type of thermal treatment, parameters of deep drilling of holes in the parts, equipment to be applied for machining, standard sizes of structural parts.

All parts are divided into two groups depending on whether they are subjected to thermal treatment. Then each group is divided into three subgroups depending on whether deep drilling is applied. Fig.3 shows examples of deep drilling of holes with different diameters. When a hole diameter is less than thirty millimeters drilling is performed by UTB-16 deep drilling machine-tool. Drilling is preceded by end face preparation which consists in cross cutting with minimal deviation of flatness and axis perpendicularity. When a hole diameter is more than thirty millimeters drilling is performed by Rheinmetall machine-tool with relocation of the part. In this case end face preparation is not required but a hole which will serve as a guideway for further machining.

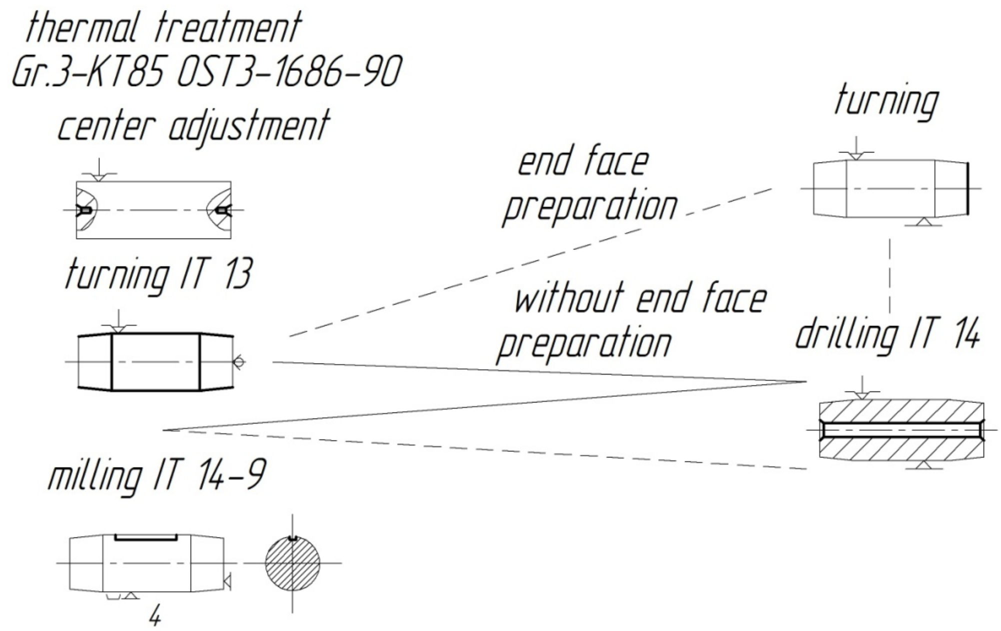

Fig.3 Variants of hole making

3. Conclusion

The example described above shows that based on the developed systematic classifier of manufacturing processes it is possible to deliberately increase production output in small lot and single piece production following the given procedure. It provides the prospects for designing and applying special batch equipment for parts manufacturing to increase accuracy and productivity of the machining process. It reduces the use of multipurpose equipment and the time period required for designing the manufacturing process.

The work can serve the basis for increasing efficiency of manufacturing preparation, extending shop floor material logistics, enlarging regulatory reference data base, improve employees' production skills.

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