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MECHATRONIC PRODUCT INTERCHANGEABILITY MANAGEMENT: ELECTRONIC COMPONENTS

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Abstract: *This paper connects with the previous paper published at the DAAAM 2009 Mechatronic Product Interchangeability Management: Mechanical Components. This paper deals with the electronic components and modules interchangeability from the production planning viewpoint. The primary approach leading to interchangeability domain results is based on creating electronic components classification according to their incidence and failure rates values. The paper has a character of theoretical generalization of practical knowledge to be further employed in practice, research and education.*
Key words: *intechangeability, electronic component, reliability, failure rate*

1. INTRODUCTION

Since the pyramids building times to present of prefabricated components the interchangeability is the important factor in building and in chemistry, food industry and medicine too, but we can see it everywhere where we can start to deeply investigate development of work processes. The arbitrary development change displays in the relations between objects (and subject), but the resource of these changes is the change of objects and subject state in certain surrounding and time (Slimak, 2001).

The interchangeability system theory described by prof. Slimak offers a new and extensive view, not only towards independent production of the same industrial components theme, but at the theme of formation, development maintenance and demotion of the arbitrary systems.

The term interchangeability is prevalent in the industrial production, in the engineering, electronics and informatics mainly, but its comprehensive research is absolutely unique in the mechatronic production area.

2. INTERCHANGEABILITY, V-MODEL AND REALIBILITY

The system approach we are considering should serve as the definition respecting the system and relating postulates. The system is determined by: purpose function, elements (components), and affinities between elements and enviroment.

Many interchangeability rules can be used for the structure of interchangeability concept directly; they can be implemented by these ways (Slimak, 2001):

- What have we reached, pertinently what is the purpose function of interchangeability implementation,
- How and what subject parts have been under interchangeabilty implementation,
- What are reference and specific attributes and functions by interchangeability implementation,
- What is the concrete life-cycle phase for interchangeabilty implementation,
- What interchangeable level have be reached,
- What are the economic indicators of interchangeabilty implementatntion?

Bernardo in his article The Concept of Exchangeability and its Applications defines the general concept of exchangeability that allows the more flexible modelling of most experimental setups. The joint density p(x1, . . . , xn), which we have to specify, must encapsulate the type of dependence assumed among the individual random quantities xi. In general, there is a vast number of possible assumptions about the form such dependencies might take, but there are some particularly simple forms which accurately describe a large class of experimental setups. Suppose that in considering p(x1, . . . , xn) the scientist makes the judgement that the subscripts, the "labels" identifying the individual random quantities are "uninformative", in the sense the information that the xi’s provide is independent of the order in which they are collected. This judgement of "similarity" or "symmetry" is captured by requiring that p(x1, . . . , xn) = p(xπ(1), . . . , xπ(n)), for all permutations π defined on the set {1, . . . , n}. A sequence of random quantities is said to be exchangeable if this property holds for every finite subset of them. (Bernardo, 1996).

The aim of our wide research is contemplating about the mechatronic systems’ components and modules interchangeability by planning, realization and offering neither technical nor social-technical and social-economic-technical objects and phenomenon. In the paper we aim at mechatronic production planning in respecting of the electronic components and modules interchangeabilty especially, according to their reliability.

The most simple component intechangeabilty interpretation is connected with the idea of its installing into complex without adapting and we suppose that the component is satisfying materially. Also we expect that it meets required functions with their tolerances, material characteristics, reliability and geometric parameters component tolerances.

German standard Design methodology for mechatronic systems (VDI 2206:2204) includes **design approach** known as V model (Fig. 1). The V-Model (or VEE model) is a systems development model designed to simplify the understanding of the complexity associated with developing systems. In systems engineering it is used to define a uniform procedure for product or project development. The model contains componets design

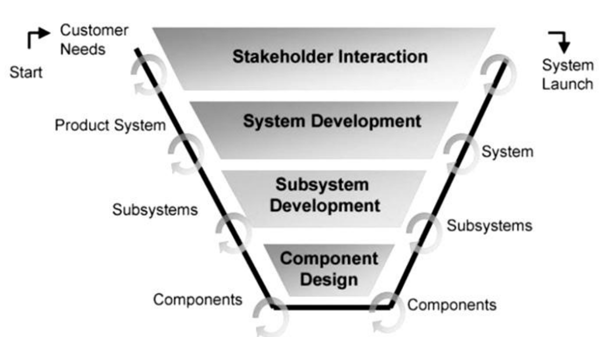

Fig. 1. The V model

No.	Component type	Incidence (%)	Incidence without “Others“ set (%)
1	Resistors	34	41
2	Capacitors	25	30
3	Integrated circuits	8	10
4	Diodes	6	7
5	Transistors	6	7
6	LED diodes	4	5
7	others	17	-

Tab. 1. The general electronic components incidence

as one of the inherent step in mechatronic product development. The design will be life-cycle phase that is used in our research. Quality as complex property of each product can by expressed during all life cycle by set of more attributes, the suitable set is selected from them. As we are dealing with the **reliability of mechatronic products electronic components**, we ought to find initially a definition that could be representative for all the functional subsystems. Searching the literature, we could form a set of relevant definitions, which could be stated as follows:

- Reliability is the ability of an item to work properly.
- Reliability is the probability that the system produces correct output.
- Reliability is the probability of non-failure of an item for a given period of time, and for certain operational and environmental conditions.
- Reliability is probability that an item performs a required function under stated conditions for a stated period of time.

Reliability is the probability of survival against failures or malfunctions, which mask out one or more functions, or limit them in unspecified ways. Reliability is defined as the probability that a device will perform its required function under stated conditions for a specific period of time. Predicting with some degree of confidence is very dependant on correctly defining a number of parameters. For instance, choosing the distribution that matches the data is of primary importance. Failure rate (λ) is the incidence with which an engineered system or component fails, expressed for example in failures per hour.

3. ELECTRONIC COMPONENTS AND MODULES INTERCHANGEABILITY STUDY

We surveyed the electronic components incidence dates. The first phase of our study was finding of general electronic components incidence. The resource was the set including 102 equipmets of 3505 electronic components. In this set was wide range of equipments with various purpose functions and constructions. Table 1 shows the results of the first phase study.

The next phase of study was determining the order of the most frequent components according to their average failure rate values. We used average values from three electronical producers. After this computation we obtained values shown in Table 2.

The last phase in presented study was assessing of order shown in Table 3. This is the final classification of the most frequent electronic components that gives informations about total reliability adding.

Also quality and reliability are major concerns for any electronic component used today. We divided our results of electronic components interchangeabilty study into two sets – economical and reliability perspectives. According to reliability

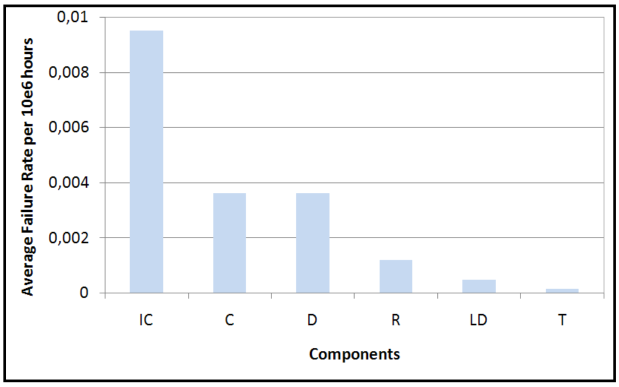

Fig. 2. The electronic components order according to their average failure rates values

No.	Component type	Average λ (/10E6 hours)
1	Transistors	0,00015
2	LED diodes	0,00047
3	Resistors	0,0012
4	Capacitors, diodes	0,0036
5	Integrated circuits	0,0095

Tab. 2. The electronic components order according to their average failure rates values

No.	Component type	λ x Incidence
1	Transistors	0,00105
2	LED diodes	0,00235
3	Diodes	0,00329
4	Resistors	0,0492
5	Integrated circuits	0,095
6	Capacitors	0,108

Tab. 3. The total reliability adding of the electronic components

perspective we can claim that if the equipment has to be more reliable then capacitors must be interchanged for capacitors with higher reliability (lower failure rate). This result is the same with the integrated circuits and resistors. The second, perspective based on reducing costs, says that the cheaper equipment has to include cheaper the transistors. Also they can be interchanged for the transistors with lower reliability (also with higher failure rate). This result is same for the diodes and LED diodes too.

4. ACKNOWLEDGEMENTS

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5. CONCLUSION

The study can be used by the further interchangeable theory developing in reliability prediction and mechatronic product design.

6. REFERENCES

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