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## Demand of High Quality Technical Education at Field of Automation

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Tekst jest udostępniony do wykorzystania w ramach dozwolonego użytku.

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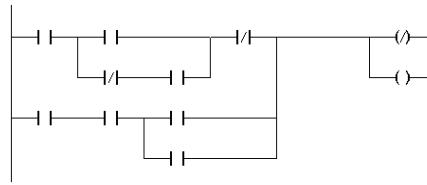
## **Demand of High Quality Technical Education at Field of Automation**

### **Introduction**

Education routing to different sides which are essential for long-time and continuous development of society is important. This is true also to ensure production process at different areas of human activities, to produce material goods demanded by market. Large, productive and effective production lines able to produce corresponding amount of goods with required quality and with relatively small series because of fast innovation of separate parameters of particular products, as well as large variability structure and equipment of particular products by specification of consumer are needed for it. Production of identical products at big series is not competitive and in consequence of it sentenced to fatal at present time. Thereat, production facilities should be quickly adaptable to production of different products at short time as possible with as small production costs as possible. This for is needed of course suitable organization of production process ensuring as small number of ineligible changes and adjusts of production facilities as possible, because it leads to shutdown of production process, decreasing of productivity and increased cost to qualified manpower able to realize changes. Just in consequences with qualified manpower, which should be suitable educated at technical field, are manifested bigger and bigger complications, because this manpower absents on labour market in increasing volume and employers are complaining to limitations at preparation of optimally qualified technically educated workers by schools at secondary or university level. Requirement of automation at production process, transportation and other services results from: shortness of optimally qualified technically educated workers, requirement of increasingly higher effectiveness of producing process and increasing productivity of labour.

### **Development of automation systems as basis of educational plans creation**

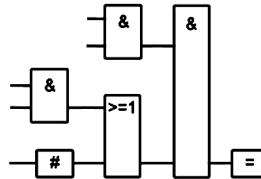
At the beginning, automation consisted in production lines based on interconnected machines situated in suitable sequences with fixed adjusted hardware elements.



**Fig. 1. Ladder Diagram – LD**

Automation and control elements were mostly relays which controlled switching of heavy-current power elements. At present time, this type of automation is solved by software shown in Fig. 1. This way of automation was demanding to realization, adjusting, inspection, service and with low flexibility to changes in production process. It needed educated, skilful workers with experience for particular machine equipment.

When semiconductor elements spread abroad, qualification of technical staff was focused into area of electronics and light-current technique with progressive exercitation of integrated circuits and large establishment of digital technology which is realized by software program type FBD at present time, shown in Fig. 2.



**Fig. 2. Function block diagram – FBD**

This was reason why orientation at technical education changed. Circuits created for automation were exactly determined for particular purpose and there was not possibility to change it except new or innovative circuit.

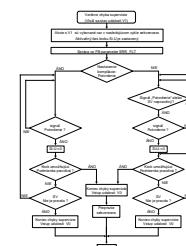
Radical change come into begin when microprocessor technique was established. Microprocessor with needed additional hardware elements become certain universal base for different areas of using.

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AN Q 0.5
A I 0.4
L S5T#3S
SP T 4
A T 4
= Q 0.4
AN Q 0.4
A I 0.4
L S5T#4S
SP T 5
A T 5
= Q 0.5

K:=0
FOR I:=1 TO 3 DO
  FOR J:=1 TO 3 DO
    IF mistake THEN EXIT
    END_IF
    K:=K+J
  END_FOR
  K:=K+I
END_FOR

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**Fig. 3. Instruction List – IL, Structured Text – ST, Sequential Funct. Chart – SFC**

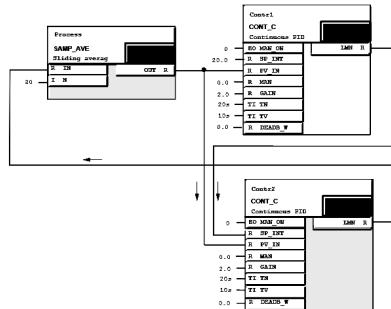
Demonstration of three programming languages for automation is shown in Fig. 3. Each of programming languages has its advantage and disadvantage, by which is chosen for creation of particular application.

Usage for particular application is determined by installed software, which can be modified more operatively, changed and upgraded without requirement to change hardware equipment. Development, because of this reason, depends mostly on power of human thinking, invention and creativity. This situation originated changes in education at schools: preparation specialists for hardware and software – that means programmers. Mostly, programmers for different applications were and are needed at large numbers. Programmers have common quality which is excellent knowledge of corresponding programming language and suitable algorithm making.

This was and actually is strong limiting factor of satisfactory number of people who are able to create suitable software applications for different automatic systems. Using of completed software product was not easy moreover, because there was need ability to orientate oneself exactly at program with instructions in the range thousands, tens thousands lines and do not make unacceptable intervention which signify inactivation of all program. Unacceptable interventions resulted in complications and time consuming downtime at time of research and debugging of software mistakes. Correction operation were able to realize only relatively few individuals who were in detail familiar with particular software application and who understand corresponding programming language. Software solution makes it possible to create the most complex solutions also, including different conditions, branching, cycles with relevant number of iterations which are changing in dependence of actual specification and state of controlled process appropriately processed for example in programming language Sequential Function Chart – SFC. There is possibility to apply knowledge from expert systems and fuzzy logic at corresponding proportion.

Man who solve problem to make automation system for some process at production process, transportation or different services should focuses to the best solution from the point of view of automation, without inadequate duty by programming. Cooperation of automation specialist and programmer bring effects of course, but no one of them knows completely all resources of the other and possibilities of the other and manner of thinking of both of them is not totally identical moreover. Because of that, there can come into existence different inaccuracies, misunderstandings and not completed solutions of needed details. In effectual consequence, problem is distributed in two heads and its solution is developing separately in time, this is reason why no one of them has 100% overview about actual solution of problem. Necessity of systematic detail communication results from it, which is serious to time consuming, remark and concentration towards solved problem. Because of mentioned reasons, it is better if automation specialist has software equipment for automation problem solving, but

only with minimal (the best neither) requirements to programming. That means, system which is similar to devices using which is familiar for people from Windows system. That means, system of in advance prepared devices – tools that represent equipment required for individual elements of software solutions of automatic circuits in the shape of icons shown in Fig. 4.



**Fig. 4. Continuous Function Chart – CFC**

Each of icons enables to justify its parameters – consequently parameters of automatic element by actual requirements of its action. Within icon hide out more or less complex program, which realizes required action, but automation specialist does not have to make program of specific application. It is enough, when automatic specialist inserts modifications into corresponding general program, which from general program for specific action prepare program with parameters exactly defined by specification for given application. Automatic specialist does not have to look for place where to write parameters in the program, because there are conducted away of icon places into which he can write required parameters. Icons (consequently individual programs which realize corresponding activity) are chosen by automatic specialists from organized libraries by mouse to desktop. Automatic specialist arranges icons in desktop by logic of automatic problem solving in that manner, so as problem solution was transparent and schematic. He connects icons each other by, how individual operations of process follow each other, which in reality means: interconnection of individual programs (representing processes) into integrated, consistently working compact program. For reasons given above results: it is created program on professional level which consist of individual in advance prepared subprograms, by which automation specialist does not to deal with. Automatic specialist puts his mind only to automatic problem solving in desktop, by which he retains needed overview about solved problem. Process of problem solving is markedly accelerated by thereby and it is possible to suggest alternative solutions at the same time, which makes it possible (by mutual comparison of their actions) to choose the best solution (by chosen criteria) which the most performs requirements of automatic action of designed controlled system. Automation

specialist, working with such complex overview, has to cooperate with specialists of process which is needed to transfer into automatic action. Their communication has to be more and more simplified, well-arranged and to ensure as better as possible limpidity construction of solved problem. This requirement relates with next using and operating of automatic system after start-up into operation. Such requirements are better satisfied by visual representation of situation with appropriate description, or displaying parameters directly by ask of customer when system is created or by operator when system is in real operation. So visualization of solved processes is advantage during creation and next exploitation of automatic systems. During creation, service, diagnostics and innovations of control system for visualization as desktop is used display of computer. During operation of automatic system are used touch displays, which present state of controlled system or unit. It is possible to display, by corresponding displays, separate subunits with their actual parameters and in such a way to take needed more precise information. This practice is extra suitable during diagnostics of system action in case of failure, or action outside of required parameters. Different messages about failures and recorded evolution of parameters enables to operator find out place of failure at short time and to repair failure, eventually to communicate with automation specialist and to give him all accessible and recorded information for situation solving by specialist instructions. In the course of complicated state of automatic system, specialist can even more particularize diagnostics to know situation in detail for situation solving, including consecutive modifications of part or whole control circuit, so as operator is able to solve originated situations easily in future. Since beginning of control circuit design, automation specialist has to think about possibilities how to monitor automatic circuit and presentation of information about automatic system state to operator. Because system is automatic operator usually realize monitoring of system action. Information does not have to be shown and instructions produced directly at place of automatic system working. This implies need of communication to shorter or long, eventually very long distances solved by data network interconnection of whole system including internet using on the present. It is necessary to protect intensively whole automatic system against intent. Protected system has, of course, larger software which continuously inspects data flow. Protected system creation is more complicated, more powerful computing and transmitting power of hardware and more serious software is needed.

## **Conclusion**

Certain summary about control circuit evolution of automatic systems is mentioned above including requirements to modern system. Development of seriousness of control part of automatic system and its projection results from it, and operating moreover in light of: operating, diagnostics and service, monitoring and remote control. Information is introduced in logic connections in light of

control circuit of automatic system but at the same time information create postulate for successful plan of qualitative prepared study program of study specialization for automatic systems. By given information about functional system, there is possibility to specify single professional study subjects and their following at educational process. By mentioned above, determination of common professional study subjects is possible and their distribution into needed professional specializations with next detailed completion by study subjects for specific specializations. Selection of general educational subjects and its content, as preparation for professional subjects, is naturally easier and more complex without individual favours. Creation of software parts of control circuits of automatic systems is activity which needs convenient education. This day created qualitative study programs determine quality of graduates after 5–10 years and about society development after 10–15 years in future. All consequences associated with forward-looking vision of high quality preparation of electronic and electrical specialists at field of automation at future results from it.

It is possible to make basic conception about needed size of knowledge of specialists who works at field of automatic systems (design, operation, diagnostic) by the article. Such conception is needed at different spheres for: persons interested in study, educational system in light of qualitative education and training, producers and users of automatic systems, users those systems are operated manually on the present but with possibility to convert it to automatic systems, persons at different positions that project society development.

## Literature

[https://cache.industry.siemens.com/dl/files/182/15236182/att\\_80396/v1/CFC\\_for\\_S7\\_e.pdf](https://cache.industry.siemens.com/dl/files/182/15236182/att_80396/v1/CFC_for_S7_e.pdf).

## Abstract

The article deals with evolution of control parts of automatic systems and changes in consequence with it, which were needed for knowledge to designers of automation systems. It analyses basic requirements at running of modern control systems and structure of specialist qualification of automatic systems and related areas of information and communication technologies caused by requirements.

**Keywords:** automation, software, education.