Survey on modularity

Thank you for participating in this survey!

Is your company prepared for the challenges of Industry 4.0? This current survey of the chair AIS (TUM) makes it possible to classify your company concerning modularity of software in your plants and machines. 20 minutes of time investment that will be worth it!

Appropriate software interfaces are requirements for flexible and adaptable production systems that can handle a component's failure robustly and continue the production or that can easily be adapted to other products. Further, in case of a fault the maintenance staff has to be supported in order to find a point for restarting. This is not realistic or achievable as your software was growing historically during the last years and decades and the number of variants and versions is not manageable anymore? Established approaches from informatics like product line approaches, feature models and code configuration or code generation from ElectroCAD or from models by means of module libraries slowly become a part of machine and plant factoring concerning control applications.

In the following questionnaire, information about the approach of software development for machines and plants in your company will be gathered. Our target group are especially people who deal with control software of machines and plants. Thereby, no concrete firm-specific data will be gathered, but merely some general characteristics. At some points, you will have to choose between several response categories. At other points, you will be asked to give a short description.

Of course, the gathered data will be treated in confidence and anonymously. Please answer the questions completely.

Block 1: Questions on company and equipment

1.1. In which market does your company operate?

- ☐ foods
- ☐ chemical industry
- ☐ biotechnology
- ☐ pharma
- ☐ military
- ☐ automotive
- ☐ medicine
- ☐ robotics
- ☐ aerospace
- ☐ other/further:

1.2. With which tasks and disciplines in your company are you concerned?

- ☐ mechanical engineering
- ☐ hydraulics/ pneumatics
- ☐ electronics/electrical engineering
- ☐ automation
- ☐ software
- ☐ MES-department
- ☐ material flow planning
- ☐ management
- ☐ project leadership
- ☐ other/further:

1.3. To which area of activity does your company belong to?

- ☐ plant manufacturing
- ☐ special purpose machinery
- ☐ standardized machines
- ☐ other/further:

1.4. How many projects/machines/plants including software, mechanical engineering and electrical engineering do you realize on average during one year?

○ 2-5 ○ 6-10 ○ 11-50 ○ 51-100 ○ 101-500 ○ >500

○ n.a.

1.5. How many employees work at your company?

○ 1-9 ○ 10-50 ○ 51-250 ○ 251-1000 ○ 1001-5000 ○ >5000

○ n.a.

1.6. How many automation specialists/software engineers are involved in the development of a project/machine/plant on average?

○ 1-2 ○ 3-5 ○ 6-10 ○ 11-20 ○ 21-50 ○ >50

○ n.a.

1.7. How many automation specialists/software engineers are involved in the commissioning on site on average?

○ 1-2 ○ 3-5 ○ 6-10 ○ 11-20 ○ 21-30 ○ >30

○ n.a. ○ not given

1.8. Which type of logic controllers do you use in your company?

☐ Siemens ☐ Rockwell ☐ Beckhoff ☐ Schneider

☐ B&R ☐ Fanuc ☐ Bosch ☐ not given

other/further:

1.9. How many CPUs (number) are utilized per machine?

○ 1-2 ○ 3-5 ○ 5-10 ○ 11-20 ○ 21-30 ○ >30

○ n.a.

1.10. How many CPUs (number) are utilized per plant?

○ 1-2 ○ 3-5 ○ 5-10 ○ 11-20 ○ 21-30 ○ >30

○ n.a.

1.11. What scope do your software projects usually have?

☐ components ☐ particular modules ☐ parts of a machine

☐ entire machine ☐ entire plant ☐ n.a.

If your answer was entire machine/plant:
How big are software projects of a machine/plant on average?
Number of POUs

◯ <200 ◯ 201-500 ◯ 501-1000 ◯ 1001-2000 ◯ 2001-5000 ◯ more than 5000

◯ n.a.

1.12. How would you describe the complexity of control software projects for the machines/plants in your branch/domain/market in general (1: very low complexity, 6: very high complexity)?

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ n.a.

1.13. How would you describe the complexity of control software projects for machines/plants in your company (1: very low complexity, 6: very high complexity)?

◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ n.a.

1.14. What are the most critical applications/functions of your control software projects from your point of view?

☐ communication field level ☐ activation of drives ☐ safety functions

☐ communication superposed systems (SCADA) ☐ CNC ☐ time-sensitive functions

☐ data tracing across several control systems ☐ n-axis-positioning tasks ☐ other/further

☐ n.a.

Block 2: approaches in development

2.1. Who takes part in the meetings in order to exchange views between the different disciplines?

- ☐ mechanical engineering
- ☐ hydraulics/ pneumatics
- ☐ electronics/electrical engineering
- ☐ automation
- ☐ software
- ☐ MES-department
- ☐ material flow planning
- ☐ management
- ☐ project leadership
- ☐ there is no exchange
- ☐ other/further:

2.2. How often do meetings take place in order to exchange views between the different disciplines on average?

- ○ only spora-dically
- ○ semiannual
- ○ monthly
- ○ biweekly
- ○ weekly
- ○ daily
- ○ there is never a personal meeting

2.3. In which form is the specification of requirements available?

- ☐ only textual
- ☐ text with graphics
- ☐ oral transfer of the distribution
- ☐ n.a.
- ☐ other/further:

2.4. Which development documents are created/exchanged during the collaboration at the engineering and during the requirement elicitation?

2.5. Which modeling tools are utilized in your company?

- ☐ MagicDraw
- ☐ Enterprise Architect
- ☐ Eclipse Modelling Framework
- ☐ Matlab/Simulink
- ☐ other/further:

2.6. Are there cross-disciplinary (mechanics, software and electrical engineering) mechatronic modules in your company?

- ○ no
- ○ partially
- ○ standard method
- ○ n.a.

2.7. Which disciplines are modularized in your company?

- ☐ mechanical engineering/ mechanics
- ☐ hydraulics/ pneumatics
- ☐ electronics/electrical engineering
- ☐ drive engineering
- ☐ software
- ☐ safety engineering
- ☐ material flow
- ☐ n.a.
- ☐ other/further:

Block 3: software and reusability

3.1. Which programming languages are used for control software in your company?

- ☐ High programming languages like C, C#, C++, Java
- ☐ Matlab/Simulink
- ☐ IEC 61131-3 - ST
- ☐ IEC 61131-3 – SFC
- ☐ S7-GRAPH
- ☐ IEC 61131-3 - FBD
- ☐ IEC 61131-3 - IL
- ☐ IEC 61131-3 - LD
- ☐ Continuous Function Chart (CFC)
- ☐ further (detailed specification if high programming language)

3.2. Do you use the object-oriented amplification of the IEC 61131-3 programming languages?

- ◯ no
- ◯ partially
- ◯ standard method
- ◯ n.a.

3.3. Which standards do you consider during the implementation of your software projects?

- ☐ ISA TR88 (OMAC state machine)
- ☐ ISA 88 structuring
- ☐ Weihenstephaner Standards
- ☐ GEMMA
- ☐ ISA 95
- ☐ other/further:

3.4. What kind of software standard functions are utilized for control software projects in your company?

- ☐ company-specific standard functions
- ☐ external standard functions of suppliers
- ☐ intelligent field device
- ☐ functions to actuate components

- ☐ communication
- ☐ drives
- ☐ positioning work (NC)
- ☐ diagnosis
- ☐ fault detection
- ☐ n.a.
- ☐ other/further:

3.5. Towards which criteria are the interfaces between software components/functions oriented in an average control software project?

3.6. How are interfaces predominantly implemented within an average control software project?

- ☐ in-/output variables of components/ functions
- ☐ data exchange across global variables/flags
- ☐ interfaces/ properties (object orientation)
- ☐ n.a.
- ☐ other/further

3.7. Which functions are included in every module by default?

- ☐ fault detection
- ☐ diagnosis
- ☐ positioning work (NC)

☐ operating modes

☐ n.a.

☐ other/further:

3.8. What is the amount of library blocks in an average control software project?

◯ 0% ◯ 1%-10% ◯ 11%-25% ◯ 26%-50% ◯ 51%-75% ◯ 76%-100%

◯ n.a.

3.9. What is the procedure form the creation to the release of a library block?

☐ no defined process

☐ developer develops and tests

☐ developer develops, another employee tests, it is documented and released

☐ developer develops, another employee tests, it is documented and released. Changes are intercepted in parallel.

☐ n.a.

☐ other/further:

3.10. Do you use version management tools in your company, and if yes, which ones?

☐ none

☐ Subversion with SAP

☐ VersionDog

☐ Tortoise SVN

☐ Eclipse Subversive

☐ Rational ClearCase

☐ Team Foundation Sever

☐ other/further:

3.11. If you use a version management tool, across which disciplines is it applied?

- ☐ mechanical engineering/ mechanics
- ☐ hydraulics/ pneumatics
- ☐ electronics/electrical engineering
- ☐ drive engineering
- ☐ software
- ☐ safety engineering
- ☐ material flow
- ☐ n.a.
- ☐ other/further:

3.12. How does the change tracking work with versions?

- ☐ manual/history in the block header
- ☐ in separate text file
- ☐ status in SAP
- ☐ with version management tool
- ☐ integrated in the workflow of PLM
- ☐ n.a.

3.13. Do you use continuous integration[1] in your company?

- ☐ no
- ☐ partially
- ☐ standard method
- ☐ n.a.

If yes, which tool do you use for continuous integration?

3.14. Do you use variant management tools in your company and if yes, which ones?

- ☐ none
- ☐ Excel (Makros)
- ☐ CodeSmith as configuration tool
- ☐ pure::variants or other product line tool

[1] Continuous integration (also called ongoing or permanent integration) is a term from software development and describes the process of the ongoing assembly of components to an application. The aim of the continuous integration is to increase software quality. Typical actions are the translation and linking of the application parts, but in general, any other operation to generate derived information can be accomplished. Commonly, not only a new total system is built, but also automated tests are accomplished and software metrics are created. The whole process is triggered automatically by committing the version administration.

☐ TIA Portal ☐ other/further:

3.15. Do you use an automated configuration of the control software based on project templates from engineering tools?

☐ no ☐ partially ☐ standard method ☐ n.a.

If code creation is used: From which tools/models do you use the code creation?

☐ EPLAN Engineering Center ☐ Excel (Makros) ☐ CODESYS UML Plugin ☐ other/further:

3.16. Are software project templates used and adapted to new variants (machines/plants)?

○ no ○ partially ○ standard method ○ n.a.

3.17. How are your control software projects on average made up at the moment and what is your target value for 2020 (voluntary statement)?

	at the moment	2020
machine-specific code		
project templates/created		
libraries (may not be applicable if template/created)		

Block 4: quality assurance

4.1. Which measures for quality assurance are utilized in your company?

- ☐ code reviews
- ☐ manual dry run tests
- ☐ automated software testing
- ☐ automated integration tests, e.g. by the help of HiL
- ☐ manual tests at the machine/plant
- ☐ automated tests at the machine/plant
- ☐ tested only at commissioning
- ☐ n.a.
- ☐ other/further:

4.2. Which scenarios are tested respectively towards which guidelines do you create tests?

- ☐ acceptance tests, only good behavior respectively directional stability
- ☐ towards FDA, every critical alarm is tested
- ☐ code coverage criterion, every possible scenario is tested
- ☐ requirement coverage, every specified scenario is tested
- ☐ n.a.
- ☐ other/further:

4.3. On which amount of the software projects is simulation used for testing?

- ◯ 0%
- ◯ 1%-10%
- ◯ 11%-25%
- ◯ 26%-50%
- ◯ 51%-75%
- ◯ 76%-100%
- ◯ n.a.

If simulation is used, what is simulated?

If Simulation is used, which tools are applied for the simulation?

☐ by forcing I/Os	☐ WinMOD	☐ PLC Sim
☐ programming language	☐ Matlab/ Simulink	☐ other/further:

Block 5: handover to the customer and commissioning of the plant

5.1. How long does a typical commissioning at the construction site take?

- ◯ < 2 weeks
- ◯ 2 weeks - 1 month
- ◯ 1-3 months
- ◯ 3-6 months
- ◯ 6-12 months
- ◯ > 12 months
- ◯ n.a.

5.2. When does the application engineer/programmer at the construction site take the machines/the plants into operation?

- ◯ never
- ◯ only with new machines/plants
- ◯ always
- ◯ other/further:

5.3. How is the software committed to the customer?

- ◯ The customer does not receive the source code
- ◯ The customer only receives parts of the source code
- ◯ The customer receives the whole source code
- ◯ n.a.

5.4. How are updates done or respectively software adaptions performed?

- ◯ Every technician of the customer on site can adapt the software.
- ◯ Only total software projects are loaded
- ◯ per remote maintenance
- ◯ n.a.

5.5. How often will the software of a machine/plant be updated during the life time of the machine/plant after the factory acceptance test?

◯ more than biweekly	◯ biweekly - every 3 months	◯ every 1-3 months
◯ every 3-6 months	◯ every 6-12 months	◯ less than every 12 months
◯ n.a.		

5.6. When does an exchange between the service department/the software department inhouse and at the customer on site concerning the current software status take place?

☐ only at the factory during acceptance testing

☐ As soon as the service technician is on site, he backs up the current status and takes it with him

☐ Regularly within a remote access

☐ other/further:

Voluntary statement for potential requests
name and mail address:
