

Test Execution and Test Management for Numerical Control Software

Best Practice Action IST-1999-20333

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Author(s):	Joachim Mayer, Andreas Grosse, Thomas Bürger
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Table of Contents

1 Abstract	3
2 Objectives of WP-3	3
2.1 Objectives of WP-3.1	3
2.2 Objectives of WP-3.2, WP-3.3 and WP-3.4	3
3 Set up of analytical QA activities (WP 3)	4
3.1 Specification of analytical QA activities (WP 3.1)	4
3.1.1 Tailored V-Model Requirements.....	4
3.1.1.1 Procedure.....	4
3.1.1.2 Methods	5
3.1.1.3 Tool Requirements	5
3.1.2 Analytical QA activities to be set up at ISG	6
3.1.2.1 Procedure.....	7
3.1.2.2 Methods	8
3.1.2.3 Tool Requirements	9
3.2 WP-3.2 Definition and Realisation of Test Cases	9
3.3 WP-3.3 Realisation of the specified analytical QA activities	9
3.4 WP-3.4 Validation of analytical QA activities.....	9
4 Glossary	10
5 References.....	10

1 Abstract

The submitted paper contains the results of the Workpackage 3.1 (WP-3.1) of the IST project IST-1999-20333. The work performed in WP-3.1 is described in the present “Specification of analytical QA activities” as planned in the Description of work (DOW) /1/ (WP-3.1).

2 Objectives of WP-3

WP-3 contains all activities related to the set up of analytical QA activities. Generally, WP-3 is subdivided into the four subtasks

- WP-3.1 Specification of analytical QA activities
- WP-3.2 Definition and Realisation of Test Cases
- WP-3.3 Realisation of spec. analytical QA activities
- WP-3.4 Validation of analytical QA activities

2.1 Objectives of WP-3.1

The objective of WP-3.1 in particular is to specify the analytical QA activities to become set up within WP 3. In the specification a technical description of the test methods to be performed for NC component assessment shall be elaborated. According to the specified test methods of WP-3.1 particular test cases for the new test methods will be realised within the subsequent work packages.

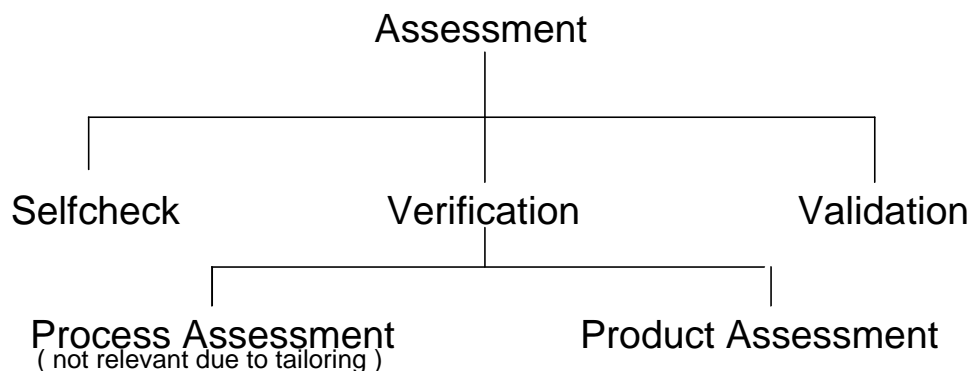
2.2 Objectives of WP-3.2, WP-3.3 and WP-3.4

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3 Set up of analytical QA activities (WP 3)

3.1 Specification of analytical QA activities (WP 3.1)

According to the V-Model, the purposes of analytical QA activities are to assess, check, evaluate and also document the quality of a certain, existing product (SW). The V-Model gives a hierarchical division of analytical assessment activities as follows:



The analytical QA activities to become established at ISG will have a focus on the Product Assessment.

3.1.1 Tailored V-Model Requirements

For all its submodels, the V-Model establishes three levels as follows:

3.1.1.1 Procedure

"What has to be done?"

This level establishes what activities are to be performed in the course of system development, which results are to be produced in this process and what contents these results must have.

QA Initialization (QA 1)

The QA initialization defines the assessment plans.

Assessment Preparation (QA 2)

The assessment preparation comprises generation of Assessment Specification and Assessment Procedure; completion of the Assessment Plan, and of requirements for the assessment environment. The assessment criteria have to be defined such that success or failure of an assessment may be decided on unambiguously and in a comprehensible manner.

QA 2.1 Definition of Assessment Methods and Criteria

QA 2.2 Definition of Assessment Environment

QA 2.3 Definition of Test Cases

QA 2.4 Generation of Assessment Procedure

Product Assessment (QA 4)

The product assessment takes place in two steps: assessment with respect to the formal criteria and the contents of the product. The SW code is to be assessed according to the Assessment Specification and Assessment Procedure. The result is recorded in an Assessment Report.

3.1.1.2 Methods

"How is something to be done?"

Here it is determined what methods are to be used to perform the activities established in the first level and what kinds of presentation are to be used in the results.

The methods within Quality Assurance are:

- Audit
- Blackbox-Test
- Whitebox-Test
- Static Analysis
- Test
- Review

3.1.1.3 Tool Requirements

"What is to be used to do something?"

At this level, the functional characteristics of the tools, used in the various parts of software development process, have to be specified.

3.1.2 Analytical QA activities to be set up at ISG

There are two focal points where ISG intends to improve the test activities on the CNC software.

For this two focal points, the procedures, methods and tool requirements shall be specified with respect to the Tailored V-Model Requirements mentioned above.

A.) Analysis of the code itself

Identification of problematic code portions containing things like:

- memory corruption
- memory leaks
- memory allocation errors
- variable initialisation errors
- variable definition conflicts
- pointer errors

Note: within this activity coverage analysis seems to be necessary too because code portions that are executed rarely, may contain bugs to occur rarely. So they won't be found easily on the traditional way.

B.) Analysis of functionality by regression test

As described within the current state evaluation, the ISG's NC-Kernel software (baseline project) is a huge and continuously growing project. Therefore, it is a particular problem to detect side effects due to new function development or bug fixes. It is practically impossible to execute a test covering all functions of the NC Kernel after each development step „by hand“. Using regression tests, shall make it possible to test the unchanged functions automatically.

It For this two focal points, the procedures, methods and tool requirements shall be specified with respect to the Tailored V-Model Requirements mentioned above.

3.1.2.1 Procedure

"What has to be done?"

A.) Analysis of the code itself

A certain version of the software has to be got out of the configuration management system. This version will have to be prepared in an appropriate way in order to become evaluable by the code evaluation tool. Depending on the tool to use, the activities can be on the tool side i.e. creation of a tool specific project. The tool has to be run and the specific tool output has to be judged by an experienced developer. The test result has to be kept in a suitable way, mostly it will be to store the results by the tool itself.

B.) Analysis of functionality by regression test

The main idea of a partly automated regression test is to define input and output patterns. If two identical versions would be compared against each other, identical input patterns must lead to identical output patterns. If two subsequent versions are compared against each other, the input/output patterns must only differ in function areas where changes took place.

Input and output categories can be i.e. as follows:

Input categories

- NC-part program
- Operator action (GUI)
- PLC action

Output categories

- NC axis movement behaviour
- Signals from the NC to PLC
- Protocol data of internal data like status, function blocks and so on

The test procedure in detail:

A certain version of the software has to be got out of the configuration management system. This NC version will have to be run in a predefined environment. An additional tool will have to be started up. Its purpose is to apply „inputs“ to the NC. Another tool (or even the same one) will be responsible to record the according „outputs“ of the NC and compare them to the expected „output“ created by a reference version.

3.1.2.2 Methods

"How is something to be done?"

A.) Analysis of the code itself

Discussing the method in detail seems to be senseless here because it will depend a lot from the ability of a certain commercial tool and specific features. Anyway, in accordance to the V-Model, most of such tools will perform

- Static and/or dynamic Code Analysis

So the focus here must be to have a look on the features of commercial tools offered on the market.

The V-Model gives criteria to research tool requirements systematically

B.) Analysis of functionality by regression test

Regression test can be executed both, as

- Whitebox-Test
- Blackbox-Test

in this context, „Whitebox-Test“ shall mean that the „output“ of the NC-Kernel is picked up somewhere from inside the NC-Kernel. This could be for example function-block data which is the result of the control data preparation. With respect to the V-Model's definition of a „white box“ test, such a test would better be called „gray box“ because not all internal states and conditions become monitored in this case of test.

„Blackbox-Test“ of a NC-Software would be to monitor the axes motion finally, because this is the purpose of all NC software.

Regarding the time point at which the comparison takes place, two possibilities are to distinguish:

off-line comparison (the reference output and actual outputs are recorded and stored on disk separately.)

on-line comparison (the reference output and actual outputs are generated simultaneously, they aren't stored on disk completely, but only the differences are detected online and written to file.)

For black box testing, an online comparison seems to be the only practical way of test execution because the enormous amount of output data would prevent an effective evaluation.

For a first step, it seems to be easier for ISG to implement an „off line gray box test“. This decision is made due to the internal structure of ISG's NC-Kernel software.

3.1.2.3 Tool Requirements

"What is to be used to do something?"

A.) Analysis of the code itself

The job for ISG here is to do a limited research about commercial tools. Their analysis features should include at least the features mentioned under chapter 3.2.1 above.

B.) Analysis of functionality by regression test

For the above mentioned „off line gray box test“, ISG will create and apply a self made test environment. The tools involved, must be able to pass NC part programmes to the NC Kernel and record the function-block data as a result of the control data preparation.

3.2 WP-3.2 Definition and Realisation of Test Cases

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3.3 WP-3.3 Realisation of the specified analytical QA activities

... to be continued in deliverable D-2.2

3.4 WP-3.4 Validation of analytical QA activities

... to be continued in deliverable D-2.2

4 Glossary

ISG	Industrielle Steuerungstechnik GmbH
TEAM	Test Execution and Test Management for Numerical Control Software
NC	Numerical Control
HLI	High Level Interface
HMI	Human Machine Interface
PLC	Process Logic Control
QA	Quality Assurance
WP	Work Package
DOW	Description of Work
MS	Milestone
IST	Information Society Technology

5 References

- /1/ ISG: TEAM Project - Description of Work Version 5, Annex I of IST Contract No. IST-1999-20333, Stuttgart, 2000.
- /2/ N.N.: Entwicklungsstandard für IT-Systeme des Bundes - Vorgehensmodell, 1997.

