RobSE Competition

Development Folder

Template

Work Packages and Delivered Documents

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German Chapter of INCOSE

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CONTENT

Version	Modifications	Date
V1.1	First issue, text from AFIS adapted for GfSE	22.08.2017

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INTRODUCTION
PURPOSE OF THIS DOCUMENT
The purpose of this document is to provide a Development Folder template; it is structured following the major systems engineering processes.

REMINDER ABOUT THE OBJECTIVES OF THE ROBSE COMPETITION DEVELOPMENT STAGE
At the end of the development stage, each team has to provide to the RobSE Organizing Committee the complete Development Folder that includes the compilation of architecture and design, configuration, justification, and realization documents related to the prototype, which will take part in the final phase of the competition.

PRESENTATION OF THE DEVELOPMENT FOLDER
The complete folder does not exceed 20 pages for the preliminary documentation (DDP) and 60 pages for the final and complete documentation (DDC), including annexes. It shall be presented as one single document; titles and numbers of chapters and paragraphs are imperatively the same as those used for Work Packages (WP) of the template. This document clearly identifies the participating Engineering School or University. This document will be sent as a single delivery in electronic format. Authorized formats are doc, xls, pdf, excluding any other format. Documents can be appended, if they are related to computer tools outputs used for development purposes. They have imperatively to be converted in pdf format. These documents also identify the participating Engineering School or University, as well as the Work Package number to which they relate.

The documentation shall be entirely in English; also modelling languages like SysML can be used.

The present template outlines and details the fundamentals that have to be addressed in the Development Folder.

REMINDER ABOUT AVAILABLE DOCUMENTS & SOURCES FOR THE COMPETITION
List of documents and tools available for the development:
- RobSE Competition Rules (document RobSE Wettbewerb_Regelwerk)
- Stakeholder Requirements Document (document RobSE Competition_Specification)
- The present template (RobSE Competition_Template for Documentation)

METHODOLOGY AND TERMINOLOGY
To access methodology and systems engineering proven practices recommended by GfSE, AFIS and INCOSE, as well as related terminology, do not hesitate to visit the related websites.

STAKEHOLDERS AND ROLES
Beyond the competition as suggested to Engineering Schools and Universities and to participant teams, RobSE can be viewed as a project including various stakeholders, each having a well-defined role and participation.

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The customer: the customer role is played by the RobSE Organizing Committee. This one owns the customer position facing the competing teams, and a supplier position facing GfSE members (individuals and companies) as well as any person expecting systems engineering educational methods.

The prime contractor: the RobSE Competition prime contractor role is played by the RobSE Organizing Committee, supported by the assessment board, and by any person participating to the event logistic management.

The cooperating suppliers: each team participating to the development of a robot and to the final phase of the competition.

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DEVELOPMENT FOLDER TEMPLATE

NAME OF THE UNIVERSITY AND OF THE EDUCATIONAL COURSE

Version	Modifications	Date

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1. SYSTEM REQUIREMENTS DEFINITION (WP 10)

1.1. GENERAL DESCRIPTION OF THE SYSTEM (WP 11)

1.1.1. Purpose, mission and objectives of the system

Reminder about the content of the RobSE Specification

This chapter is presented as a table.

1.1.2. Physical context of the system

Objects, components of the context of use of the system-of-interest

Physical interfaces (or physical connections) between the objects or components of the context of use and the system-of-interest itself.

1.1.3. Functional context of the system

Functions or missions of the objects composing the context of use

Input and output flows between the functions/missions of the objects of the context and the function or mission of the system-of-interest

1.2. SYSTEM REQUIREMENTS DOCUMENT (REQUIREMENTS BASELINE) (WP 12)

Suggestion of a requirements typology (informative and not exhaustive)

1.2.1. Functional Requirements

1.2.2. Performance or Effectiveness Requirements

1.2.3. Interface Requirements

1.2.4. Operational Requirements

- Operational modes/states and operational scenarios
- Ergonomic Requirements
- Dependability Requirements (RAMS: reliability, availability, maintainability, security)
- Environmental Requirements
- Transportation and storage Requirements
- Maintenance Requirements

1.2.5. Constraints

- Design and realization constraints
- Physical constraints (dimensions)
- Transfer for use, mounting constraints
- Maintenance constraints
- Disposal constraints (dismantling)

1.2.6. Validation Requirements

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2. SYSTEM ARCHITECTURE OF THE SYSTEM (SUB-SYSTEMS AND TECHNOLOGICAL COMPONENTS) (WP 20)

2.1. GENERAL DESCRIPTION (WP 21)

The aim of this general chapter is to briefly present architectural solutions that have been <u>studied</u>, and the <u>selected and validated</u> architectural solution. The describing text can be illustrated with photos/pictures or 2D or 3D views of the product.

The interest of this chapter is globally to allow understanding the selected and validated solution, and to facilitate the understanding and the utilization of the documents set that constitute the development folder.

2.2. FUNCTIONAL AND BEHAVIOURAL ARCHITECTURE (WP 22)

It is recommended to use graphical representations intensively.

Functional and static tree

Description of functions, Description of internal input-output flows

Functional and behavioral architecture

Dynamic scenarios and models including the functions with their input-output flows

2.3. PHYSICAL ARCHITECTURE (WP 23)

It is recommended to use graphical representations intensively.

Physical tree

Description of the components of the system-of-interest, Description of the physical interfaces (connections)

Physical architecture

Physical architecture diagram of the system-of-interest composed of sub-systems and technological components, including the physical connections

2.4. CONSUMED, USED, PRODUCED MEANS (WP 24)

Volume or quantities of necessary inputs, and/or produced outputs in order the system works well; or volume of necessary consumables.

2.5. INTERFACES (WP 25)

Definition of external interfaces of the system

Allocation of input-output flows to the external physical interfaces

Definition of internal interfaces of the system

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Allocation of input-output flows to the internal physical interfaces

Definition of Operators interfaces

2.6. DESCRIPTION OF SUB-SYSTEMS AND TECHNOLOGICAL COMPONENTS (WP 26)

For each sub-system composing the system-of-interest, indicate:

- The functional and behavioral architecture
- The physical architecture
- The traceability of functions allocated to sub-systems

For each ended technological component (mechanics, electricity, software, etc.), indicate:

- Its detailed design characteristics
- The traceability of functions allocated to components

3. CONFIGURATION BASELINE (WP 30)

This document contains:

- The parts list corresponding to the <u>selected and validated solution</u> in a functional state (hierarchical tree of the components of the system)
- The general schema of electrical interconnections (power and control-command)
- The kinematics chain schema description
- The identification instructions of the system and of its parts, in order to know the configuration at any time and to follow the traceability of evolutions and the deviations

4. JUSTIFICATION DOCUMENT (WP 40)

4.1. JUSTIFICATION OF THE SELECTED ARCHITECTURE (WP 41)

Explain and justify the selection of functional, behavioral and physical architecture, the selection of the composition into sub-systems and components, their arrangement regarding the system requirements.

We should find here, in particular:

- The decision model of criteria that enabled to select the architecture
- The description of the rejected solutions and the justification of their rejection

4.2. JUSTIFICATION OF THE DESIGN (WP 42)

We should find here, in particular:

- The technical analyses and studies (feasibility, calculations, performance allocation, sizing, tuning, etc.)
- The allocation matrices and the traceability matrices
- Etc.

This overall document should indicate for each system requirement:

- the textual expression for qualitative requirements, or the value for quantitative requirements,

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- the technical answer to qualitative requirements, or performance value obtained for quantitative requirements,
- the possible dispersions because of the definition or of the realization, about performances, about technical characteristics, about characteristics of interfaces,
- the approach to prove the required performance has been obtained (theory or testing),
- the available references of documents for proves: study report, sizing calculation report, modeling/simulation results, test results reports.

A presentation as a table is preferred for this overall view that can be joined in annexes of justification documents containing proves.

5. INTEGRATION VERIFICATION VALIDATION PLAN (WP 50)

This document presents:

- The mechanics and electricity integration plan that allows verifying and validating the sub-systems and the system.
- The verification and testing plan (synoptic for control) that corresponds to the integration plan describing the methods (demonstrations, tests) used to verify and validate the functioning of the system.
- The final validation plan against the system requirements

This document is used to assemble the prototype during the in-plant development activities.

It is also one of the references with the architecture and design description to assemble the prototype during the final phase on site with the customer.

6. MAINTAINABILITY STUDY AND MAINTENANCE DEFINITION (WP 60)

6.1. MAINTENANCE PLAN AND MAINTENANCE SHEETS (WP 61)

The maintenance plan contains the exhaustive list of proposed preventive and corrective maintenance actions.

This document is presented preferably as a table.

For each maintenance action, the following data are indicated:

- the instructions in short,
- the list of possible spare parts,
- the list of necessary tools: test and mounting/dismounting/tuning,
- the necessary time to operate the action.

This document is presented as single sheets (one per action) or as a global table.

6.2. VALIDATION OF THE MAINTENANCE PLAN (WP 64)

The maintainability performances justification, the maintainability requirements, the validation approach and the satisfaction proves are incorporated to the Justification Document (synthesis and annexes). The day of the final phase, it will be requested to the team to operate one maintenance

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operation selected by the jury among those listed in the maintenance plan, applying the related maintenance sheet.

No specific document is requested; the result of this work is incorporated in the Justification Document (WP 40).

7. PROJECT MANAGEMENT (WP 70)

7.1. PROJECT PLANING AND ASSESSMENT (WP 71)

- List of milestones and expected deliverables at each of them

- Work Breakdown Structure (structure and scheduling of tasks)

- Expected and realized schedule

- Summary of intermediate progress reports (brief).

- End of Development Internal Review report.

7.2. RISKS MANAGEMENT (WP 72)

This chapter presents the list of identified risks and the plan of cut-out/mitigation actions during the development phase and during the operations, distinguishing project risks and technical risks about the product.

8. IMPLEMENTATION FOLDER (WP 80)

The Implementation Folder supplements the architecture and design description document, the configuration document and the IVV plan. It allows assembling one or several exemplar(s) of the product, which has to:

- conform the validated configuration,
- take into account production and procurement resources and constraints,
- optimize the shift works and production teams in an efficient industrial company.

The Implementation Folder ensures, in a repetitive way, the implementation of products compliant to the reference configuration, optimizing the implementation cost of the product, controlling the quality and delivery time.

Required Documents (minimum):

- *General assembly and control synoptic*
- *Description of the organization of shift work(s) for the assembly and control*
- *Mounting instructions (as necessary if IVV Plan is not sufficient)*
- *Final control instructions (as necessary if IVV Plan is not sufficient)*
- *Necessary means or tools to upload the software pieces.*

In the context of this competition, the Implementation Folder allows ensuring the feasibility of the assembly of the robot taking into account the required conditions of the configuration audit; that is to say:

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"The robot will be entirely dismounted and the parts will be displayed in front of the jury. A group of two operators, members of the registered team, excluding the project manager and the tutor, will have 20 minutes to assemble the robot. They will exclusively use the reference Configuration proposed in the Development Folder, in order to upload the system software and insure the conformance verifications as well as the forecast verifications of good functioning. This operation will be performed in the presence of the project manager and the tutor of the concerned team, under the control of the jury who will check the conformance to the Design Folder and the reference Configuration Folder."

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SCORING CRITERIA AND WEIGHTING

The RobSE Organizing Committee will use the following scoring grid:

Deliverables DDP (preliminary documentation)	Weight
System Requirements Definition	**1**
General description of the system	0,5
System Requirements baseline	0,5
Architecture and Design Document	**3**
General description	0,5
Selected functional and behavioral architecture	1,25
Selected physical architecture	1,25
Justification Document	**2**
GLOBAL SCORE	**60***

Deliverables DDC (final and complete documentation)	Weight
System Requirements Definition	**1**
General description of the system	0,25
System Requirements baseline	0,75
Architecture and Design Document	**6**
General description	0,25
Selected functional and behavioral architecture	1,5
Selected physical architecture	1,5
Consumed, used, produced resources or means	0
Interfaces	1,5
Descriptions of sub-systems	1,25
Reference Configuration	**1**
Justification Document	**2**
Integration, Verification and Validation Plan	**1**
Maintainability study Document and Maintenance Definition	**1**
Maintenance Plan and Maintenance sheets	1
Maintenance Validation plan (incorporated in the Justification Document)	0
Project Management	**1**
Project planning and assessment	0,5
Risks Management	0,5
Implementation Document	**1**
GLOBAL SCORE	**140***

Scoring on 200, taking account of weighting and unit mark assigned to each deliverable.

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SCORING SCALE

The scoring scale applied to the assessment of each deliverable will be the following:

Absolute score	Relative score	Qualitative report
17 - 20	A	Excellent result
15 – 16,x	B	Very good result
12 – 14,x	C	Good result
10 – 11,x	D	Some weaknesses
0 – 9,x	E	Not sufficient

The relative score is intended for comparison of results obtained by each team. The absolute score allows determining the general ranking of the competition. The qualitative report will be supplemented for each team and for each WP by details about points of deliverables considered as strong or weak; this will be transmitted confidentially.