



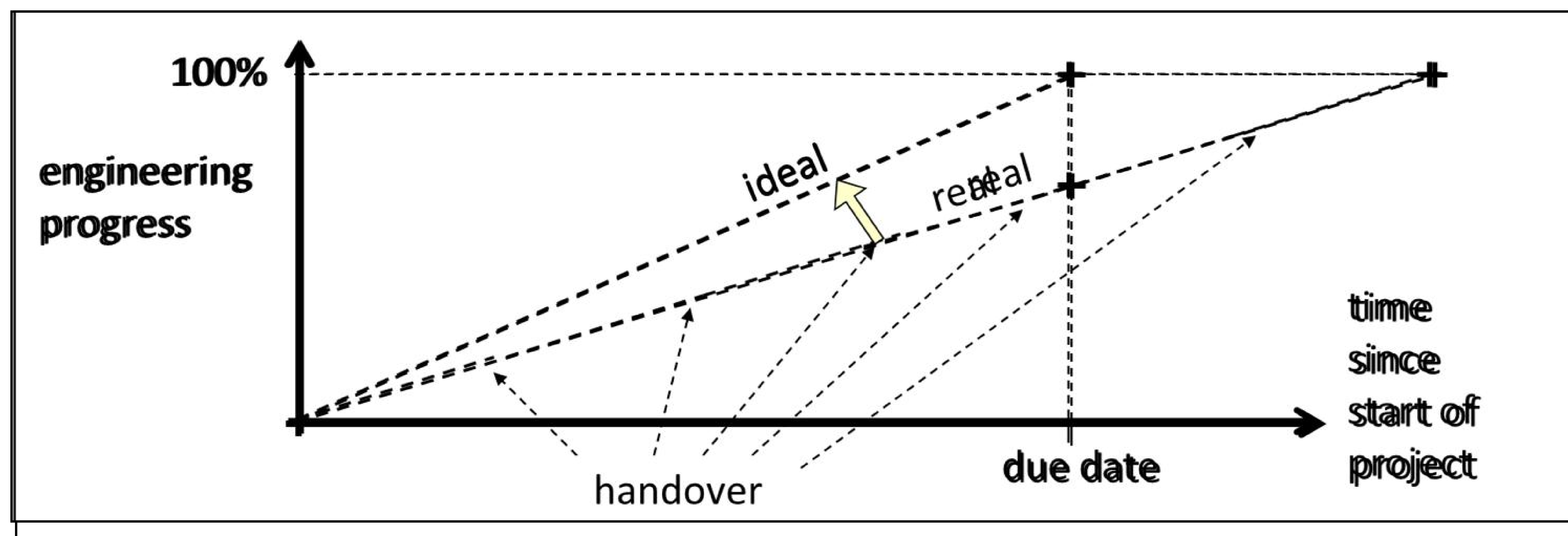
Dr. Mike Barth | DECRC | 2012

# Openness of Engineering Tools Metric for an objective assessment

# The engineering process of automation systems

## Real world engineering projects

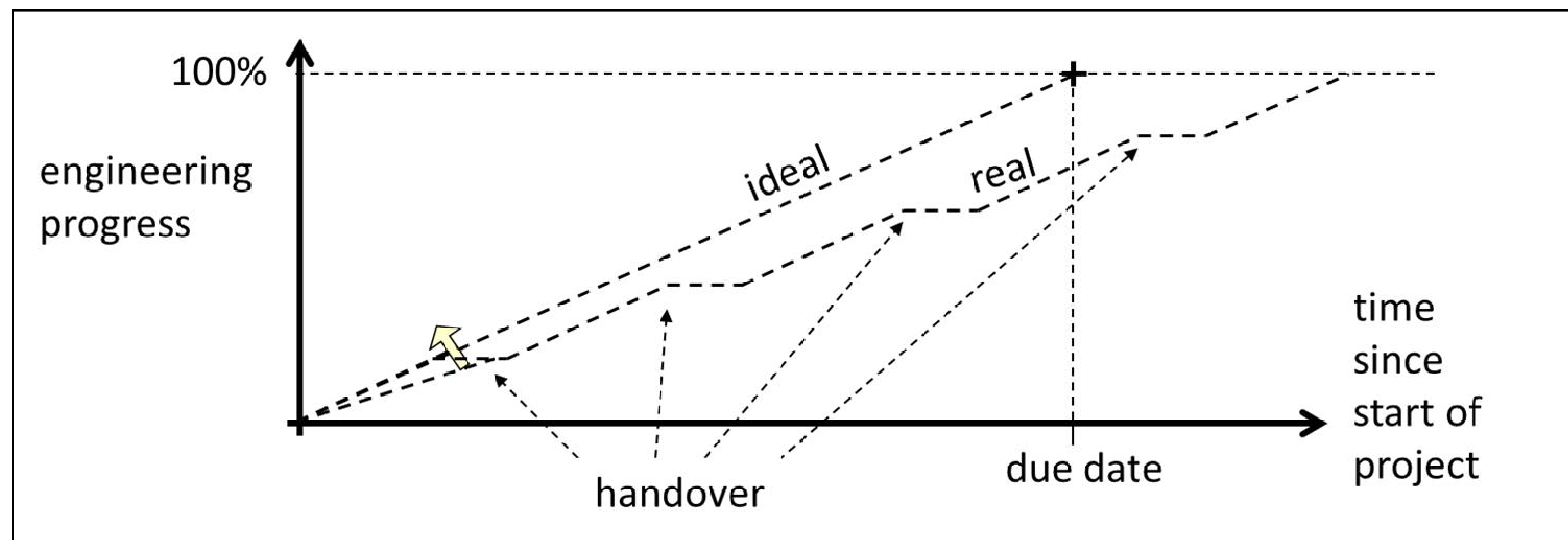
- In engineering practice, **projects** are often **not finished** at the **deadline** but significantly afterwards (e.g. new Berlin Airport).
- The engineering processes is accomplished by **different technical disciplines**, e.g. electrical planning, cabinet planning, PLC programming, drive applications, safety applications, or robotics.
- **Automation engineering is intertwined with other engineering disciplines**, e.g. process engineering, mechanical engineering, electrical energy engineering, civil engineering.



# The engineering process of automation systems

## Effects of data transfer

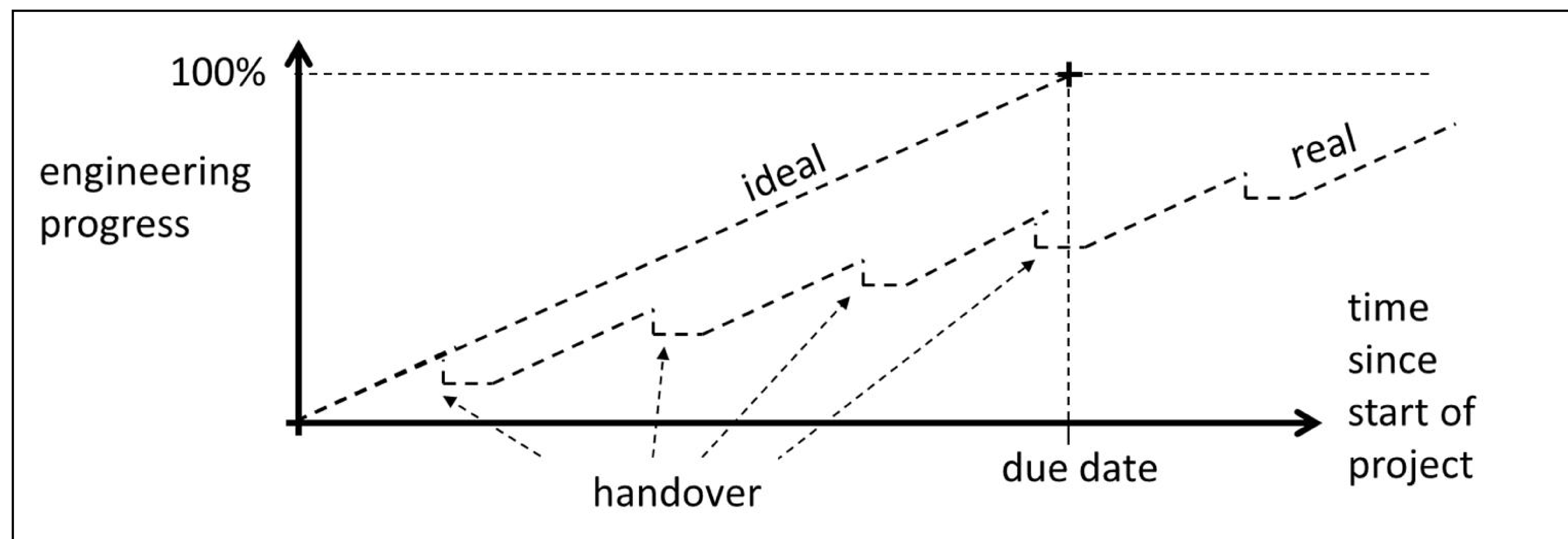
- For each technical discipline, **individual customized engineering tools** are available.
  - This leads to a “**heterogeneous tool landscape**”
  - The **data transfer is time-consuming and results in delays** of the project, even though the individual tasks are carried out with high efficiency



# The engineering process of automation systems

## Handover activities

- **Not all engineering results** from previous phases **can be taken over** for a later engineering task.
- Instead, **some results are usually lost** and have to be reworked, which results in even longer delays. Reasons are:
  - difficulties in understanding other engineers' work and
  - **difficulties in transferring** other engineers' **results** into one's own engineering tool



# Tool Interoperability

# The aspects of interoperability

- *“Interoperability describes the ability of software tools to collaborate with each other”.*
  - consistent
  - open
  - interconnected
- To reach the state of an appropriate interoperability, the system suppliers of engineering tools have to
  - implement data interfaces,
  - make those interfaces accessible
  - implement those interfaces based on commonly agreed data models

# Openness of engineering tools

- The openness of engineering tools raises four questions:
  1. Is openness quantifiable ?
  2. What unit refers to openness ?
  3. What criteria define openness ?
  4. Can openness be quantified in a objective way, so that multiple assessors would reach the same result ?

# University cooperation

## ABB ↔ HSU Hamburg

- “Evaluation of the openness of automation tools for interoperability in engineering tool chains”



**Prof. Alexander Fay**

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+ Team



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# Openness Metric

# Openness Metric Assessment Sections

3 assessment sections

Openness Metric V 4.0  
07.11.2011

## Tool



Tools	Evaluation	0	0	1	1	1	1	1	1	100%
	Block results	1		1		1		1		100%
	Final Result	100%								

I. Export Functionality										
1.) Export Format			2.) Identifier		3.) Formal requirements		4.) Library		5.) Completeness	
a) Export of Open format (PLCOpen, AutomationML, ...)	b) Export of Proprietary data format (XML-Proprietary-Scheme, binary code, ...)	c) API for remote tool control	a) ID available for all objects	b) ID is stable for multi export	a) Version control: timestamp	b) Data integrity / authentication check	a) unique Reference: Element to library class	b) Export of related library class	a) percentage of completeness of considered data from 0 to 100 %	
0	0	1	1	1	1	1	1	1	100%	
true/false	true/false	true/false	green/yellow	green/yellow	green/yellow	green/red for safety	green/red	green/yellow	percentage	
1			1		1		1		100%	
Rule (EF = ExportFormat = Red/Yellow/Green) "IF (a or c) THEN EF = GREEN; ELSE IF (b) THEN EF = YELLOW else EF = RED"			Rule (ID = Identifier) "if (a AND b) then ID = green else if (not a) then ID = red else ID = yellow"		Rule (V = Version) "if (a) Then V = Green else V = yellow"		Rule (DI = Data Integrity) "if (b) Then DI = Green else DI = yellow"		Rule (Lib = Library) "if (a AND b) then Lib = green else if (a AND NOT b) then Lib = yellow else Lib = red"	Rule (CD = Completeness) "CD = a"
EX = (EF==RED) * (ID==RED) * (LIB==RED) * (0,5 + 0,4*ID + (EF + V + DI + Lib)/40)*CD										
100%										
Export										

II. Import Aspects					
1.) Import Format			2.) Manipulations		3.) Completeness
a) Import of Open format (PLCOpen, AutomationML, ...)	b) Import of Proprietary data format (XML-Proprietary-Scheme, binary code, ...)	c) API for remote tool control	a) Change or Add Data	b) Feedback about validity of manipulations	a) percentage of completeness of considered data from 0 to 100 %
0	0	1	1	1	100%
true/false	true/false	true/false	true/false	green/yellow	
1			1		100%
Rule (EF = ExportFormat = Red/Yellow/Green) "IF (a or c) THEN EF = GREEN; ELSE IF (b) THEN EF = YELLOW else EF = RED;"			Rule (CH = Change) "if (a) Then CH = Green else CH = red"		Rule (FE = Feedback) "if (a) Then FE = Green else FE = yellow"
EX = (IF==RED) * (CH==RED) * (0,7 + (IF+FE)/6,66)*CD					
100%					
Import					

III. Documentation		
1.) Documentation		
a) Export actions documented	b) Export / Import format documented	c) Import actions documented
0	0	0
0	0	0
Rule (EA = Export Actions) "EA = a"	Rule (EID = Export/Import format documented) "ED = b"	Rule (IA = Import Actions) "IA = c"
Doc = (a+b+c)/3		
0%		
Docu		

IV. Comments
Recommendations

# Openness Metric Assessment Sections

- Main sections consist of several sub-sections
- In order to support an objective assessment, each criterion shall be assessed with “true” or “false”
  - only the criterion “completeness” has to be provided in percent
- The overall assessment finally consists of three independent results

# Criteria of the category “Export”

# Export assessment

## Export Format

- **Export format:** This criterion assesses whether the export functionality of the considered engineering tool is provided
  - a. file based by means of open and standardized file formats (e.g. PLCopen XML, AutomationML, CAEX etc.).
  - b. file based by means of accessible but proprietary file formats (e.g. Excel lists, proprietary XML) or
  - c. software based by means of a dedicated Soft-API.
- A direct access to the tools database is not considered as “open”.

# Export assessment

## Identification

- **Identification:** This criterion assesses whether
  - the data objects provide any unique identifier (ID)
  - the provided ID is stable.
- Many engineering tools use the object name as ID, which may change over time.
- Without a stable identifier, associations between objects across different engineering tools are instable.

# Export assessment

## Formal Requirements

- **Formal requirements:** This criterion assesses whether
  - the export result allows the detection of the export date
  - the exported data can be checked against file errors, e.g. by means of a checksum.
- Both are independent criteria, therefore they form separate results and result in either “green” or “red”.

# Export assessment

## Object Library

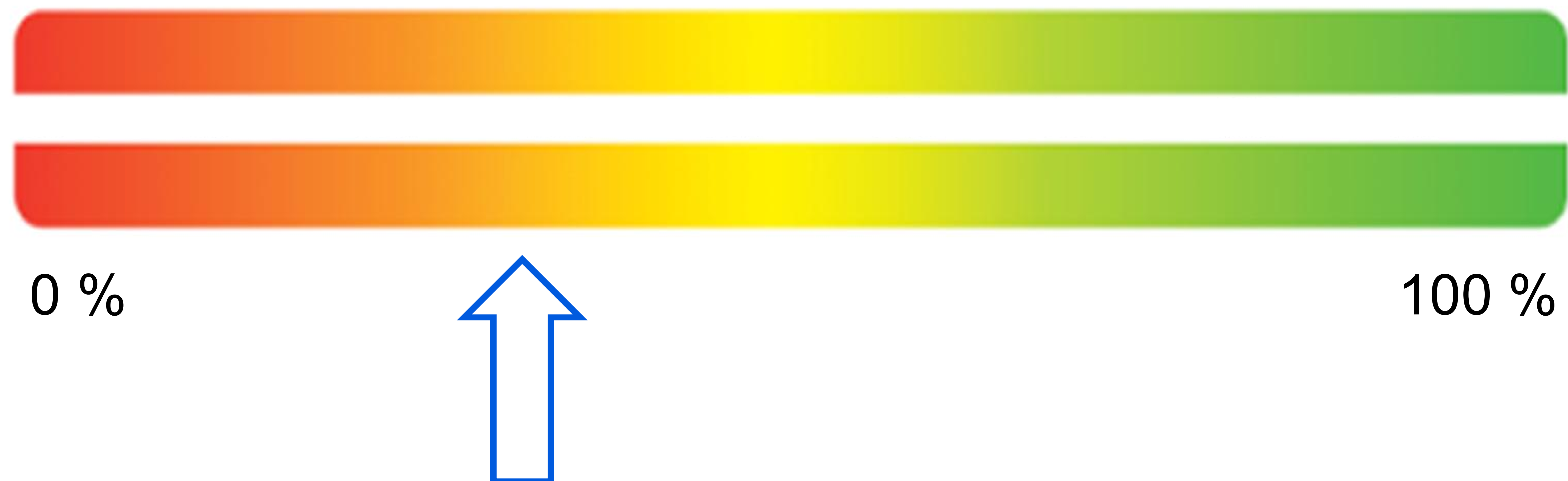
- **Object library:** This criterion assesses whether
  - every exported data object provides information about its data type or class
  - the corresponding data types or classes are exportable.
- Without information about data types or base classes, bulk data management is hard to achieve.



# Export assessment

## Completeness

- **Completeness:** This criterion assesses the completeness of the exported data. Whereas the other criteria are assessed in a binary way, the completeness is assessed – dependent on the assessors use case – in a scale of 0-100 percent.



# Export assessment Result

- The overall score with respect to the data export is calculated by combining the cumulated results.
- For this purpose, the different cumulated results are weighted differently:
  - The criteria “**Export-Format**”, “**Identification**” and “**Object library**” are must-criteria.
  - If one of them is “red” because a data export is not supported or objects have no identifier or no type/class information is provided, the overall openness score for the category “export” is “0”.
- Values above 80% are judged with “green”, values over 50% with “yellow” and values below 50% with “red”.

# Criteria of the category “Import”

# Import assessment

## Import Format

- **Import format:** all criteria of this category are identical to the export.

# Import assessment

## Manipulation

- **Manipulation:** This criteria assesses whether
  - the target engineering tool provides functionality to manipulate (create, change, delete) data during an import process,
  - the target engineering tool provides a feedback about the success of the import procedure.
- Both criteria are weighted differently; therefore they result in individual cumulated results.

# Import assessment

## Completeness

- **Completeness:** In analogy to the corresponding criteria in the category “Export”, this criterion assesses the completeness of a considered use case on a scale of 0 to 100 percent.
- Remark: Some of the already assessed engineering tools are not able to import all aspects that they have exported.

# Criteria of the category “Docu”

# Documentation assessment

- **Documentation:** this criterion assesses, whether
  - all actions to export data are documented,
  - the export/import format is documented
  - all actions to import data are documented.
- The overall score with respect to the category “Documentation” is calculated without weight, all cumulated results contribute with one third.





# Example assessment



# Example assessment

## Fictive engineering tool - export

- **Export format:** Proprietary data format
- **ID:** Element Name
- **Formal requirements:** Time stamp available, automatic export report and test
- **Library:** Type reference available, no library export
- **Completeness:** Use Case: Signals need → 100 %

Exportformat	Identifizierung	Formales		Objektbibliothek	Vollständigkeit
0,5	0,5	1	1	0,5	100 %
78 %					

# Example assessment

## Fictive engineering tool - import

- **Import format:** Proprietary data format
- **Manipulation:** Change, add, remove data → no feedback
- **Completeness:** Use Case: Signals need → 100 %

Import Bewertung			
Import Format	Datenmanipulation		Vollständigkeit
	Daten: ändern, löschen, hinzufügen	Rückmeldung zu Import	
0,5	1	0	100
85 %			

# Example assessment

## Fictive engineering tool - documentation

III. Documentation		
1) Documentation		
a) Export actions documented	b) Export / Import format documented	c) Import actions documented
1	1	1
1	1	1
Rule (EA = Export Actions) "EA = a"	Rule (EID = Export/Import format documented) "ED = b"	Rule (IA = Import Actions) "IA = c"
Doc = (a+b+c)/3		
100%		

- The actions that need to be done to perform an export within the engineering tool are well documented (= "1").
- The proprietary export and import format of the engineering tool is well documented in terms of an XML-scheme file as well as a written text (= "1").
- The actions that need to be done to perform an import within the regarded engineering tool are well documented (= "1").

# Example assessment

## Fictive engineering tool

- Recommendations
  - Possible export/import of standardized data format or API
  - Implement stable ID

# Summary

- The growing amount of export and import interfaces of **engineering tools** underlines the increasing interest of engineering tool **vendors and users regarding interoperability**.
- **Developed Openness Metric** allows an objective **assessment** of the actual **openness** of engineering tools
- For tool users, this metric offers **objective criteria** to **examine the interoperability** offerings of tool vendors.
- **Tool vendors are invited to position their tools** with respect to this metric and to augment their product developments by the new interoperability aspects.

# References

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- **A. Fay**, R. Drath, M. Barth, **F. Zimmer**, **K. Eckert**: Bewertung der Fähigkeit von Engineering-Werkzeugen zur Interoperabilität mit Hilfe einer Offenheitsmetrik. In: Tagungsband "Automation 2012", 13-14. Juni 2012, Baden-Baden.

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