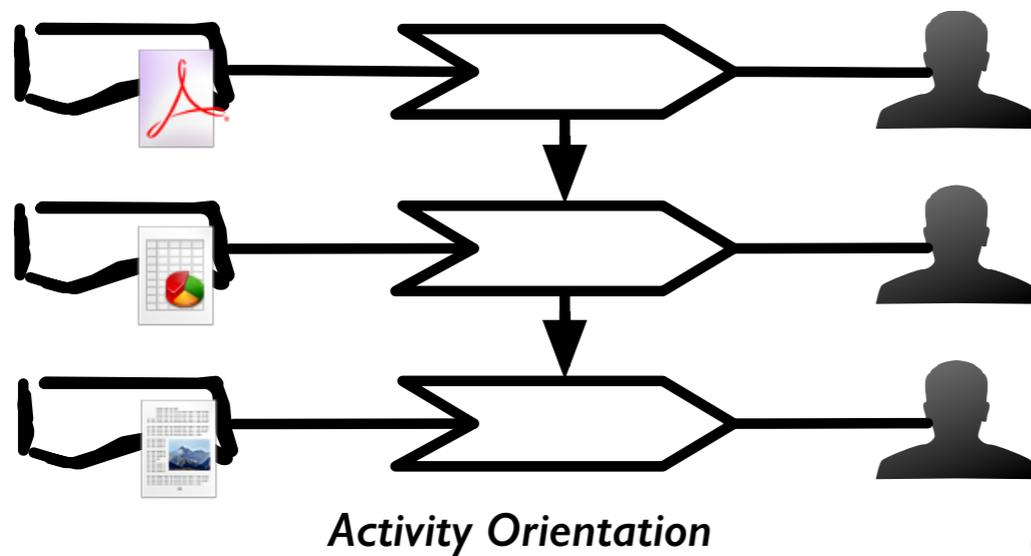


Two Replication Studies for Evaluating Artefact Models in RE: Results and Lessons Learnt

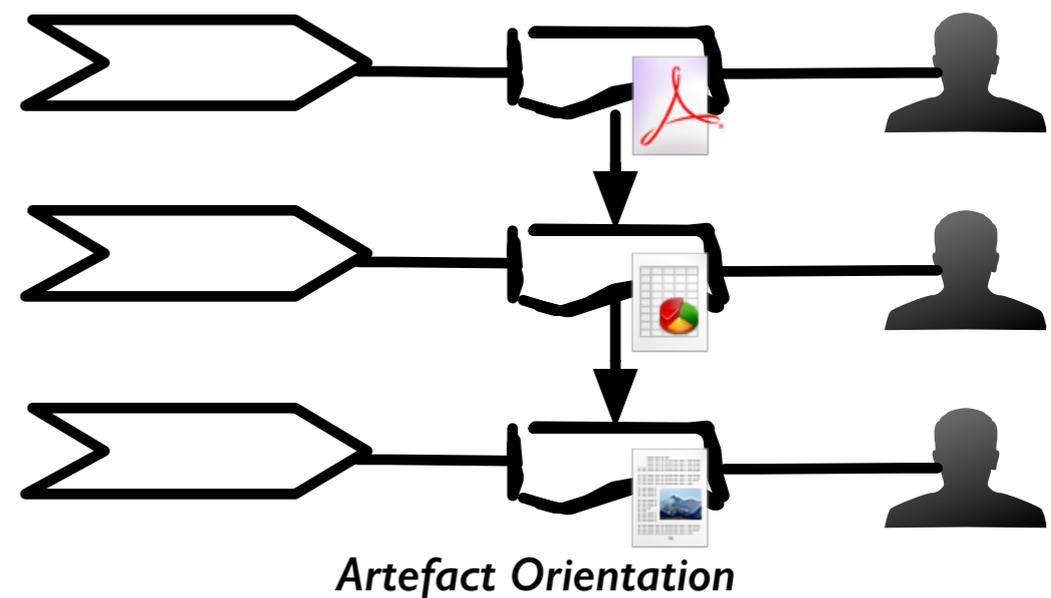
- Birgit Penzenstadler¹, **Jonas Eckhardt**², Daniel Méndez Fernández²
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 - ² Technische Universität München, Germany

October 9th at 3rd International Workshop on Replication in
Empirical Software Engineering Research (RESER'13)

Context - Artefact-based RE

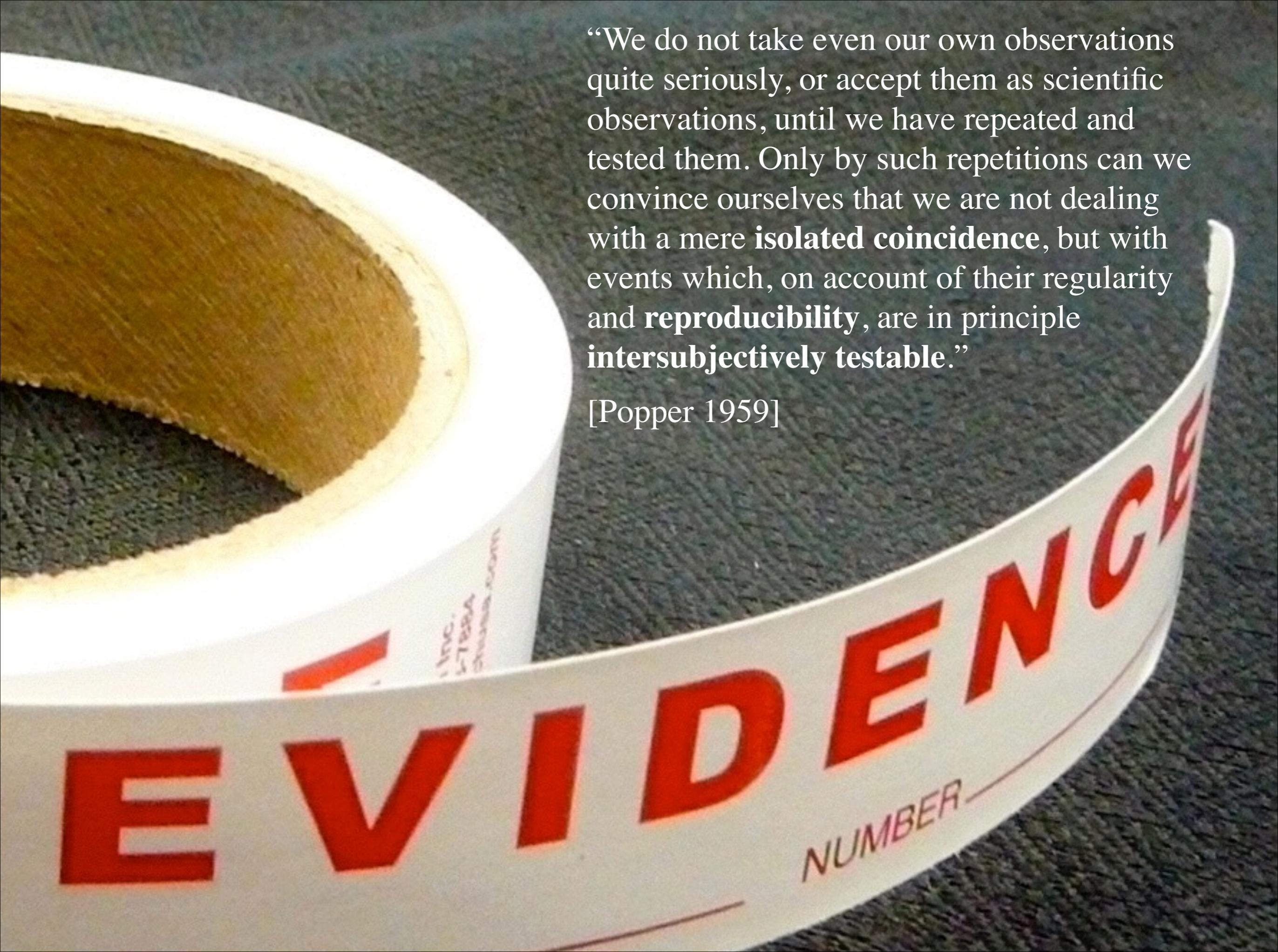


VS



“We do not take even our own observations quite seriously, or accept them as scientific observations, until we have repeated and tested them. Only by such repetitions can we convince ourselves that we are not dealing with a mere **isolated coincidence**, but with events which, on account of their regularity and **reproducibility**, are in principle **intersubjectively testable**.”

[Popper 1959]



EVIDENCE
NUMBER _____

Overall Goal & Contribution

- Reliable repository of empirical studies on RE
 - Strengthen an initial theory of expectations
- Two replication studies
 - Strengthen confidence on the benefits and shortcomings of artefact-based RE
 - Deeper insights in artefact-based RE
 - First conclusions on the actual impact of AO on RE
- First steps towards a reliable database

Study Design

RQ1:
Does the artefact-based approach improve the **usability** of the RE reference process?

RQ2:
Does the artefact-based approach improve the **syntactic** quality of the created artefacts?

RQ3:
Does the artefact-based approach improve the **semantic** quality of the created artefacts?

We invite you to join the talk on Thursday (btw. 15:30 and 17:10)

Understanding the Impact of Artefact-based RE – Design of a Replication Study –

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Abstract—Artefact-based requirements engineering (RE) describes the idea of establishing a company-wide RE reference model by putting the focus on the RE artefacts and their dependencies rather than dictating a strict process with interconnected methods. Previously conducted case studies already strengthen our confidence in certain advantages and shortcomings of the paradigm. Still, our case studies by now remain isolated focussing on particular socio-economic contexts and, thus, the findings can hardly be generalised. Therefore, we need further replications.

In this paper, we contribute the design of a replication case study to better understand the impact of artefact-based requirements engineering and, as a long term goal, strengthen an initial theory of expectation we could already infer from results and experiences we made in previous case studies. The replications shall lead to a reliable empirical base due to comparability among the studies. This allows for a (still restricted) generalisability of conclusions on artefact-based requirements engineering.

Index Terms—requirements; artefact model; artefact; model-based; evaluation; case study; replication;

I. INTRODUCTION

Artefact orientation in requirements engineering (RE) is a means to focus on artefacts (work products) instead of small process steps, i.e. instead of defining *how* the individual artefacts shall be created, the basic idea is to define *what* artefacts are relevant, and what information they shall contain. Recent studies strengthen our confidence on some advantages, for example, a higher flexibility in the process and the choice of methods, which leads at the same time to a variety of interpretations and application areas [6].

Evaluation of artefact orientation in requirements engineering, however, can only assess one concrete instance of such an approach at a time. In [5], we have reported on such an evaluation and also the various encountered challenges, for example, disadvantages when using complex development processes and the unknown effects of the approach in a different socio-economic context. In fact, as artefact orientation comes with a plethora of interpretations and manifestations in different industrial environments, we still have little knowledge about what general benefits and especially shortcomings exist when applying artefact orientation in practice.

Problem Statement: So far, available case studies on artefact orientation in requirements engineering always focus on specific cases and subjects in sensitive contexts, whereby the investigation of benefits and shortcomings and the generalisation of the findings remain a challenging task. Therefore, it is

of crucial importance to define an initial theory of expectations and to replicate¹ the data to support such generalisations and a reproducible learning curve.

Research Objective: Our objective is to define a family of studies that analyses the effects of different occurrences of artefact orientation in requirements engineering in varying socio-economic contexts over a long time span.

Contribution: In this paper, we present the design of the replication of a study (reported in [5]) including the overall integration in the replication process as well as an initial underlying theory of expectations.

II. FUNDAMENTALS AND RELATED WORK

In the following, we describe fundamentals and related work in the fields of artefact orientation in RE and empirical evidence for artefact orientation. Then, we briefly describe the study, which serves as replication basis.

Artefact Orientation in RE: Artefact orientation comes with a plethora of interpretations and manifestations in practice. For example, Berenbach et al. [1, chap. 2] describe an RE artefact modelling approach with selected key components to be a measurable reference model, a process tailoring approach, and respective process guidelines. Further artefact models range from generic templates like the Volère Requirements Specification Template² to domain-specific languages.

In [6], we discussed the different notions of artefact-based RE and developed a meta model for the paradigm, which, if instantiated for a particular application domain, unifies the advantages of artefact-based development process models and model-based development. The meta model defines, for example, what an artefact is, namely a definition of structure and content (elements and relations in given description techniques), or how an artefact relates to further process elements like roles or milestones.

Empirical Evidence for Artefact Orientation: In [5], we report on a case study with a street traffic management business unit from Siemens on the application of an artefact-based requirements engineering approach. We discussed the different benefits and shortcomings of that approach, but remained aware that the empirical evidence is limited to the

¹With “replication”, we refer to *empirical generalisation* as introduced in the classification of Gómez et al. [2].

²<http://www.volere.co.uk/template.htm>

Understanding the Impact of Artefact-based RE
- Design of a Replication Study -
Short paper @ ESEM 2013

Case Study Results

- Roles

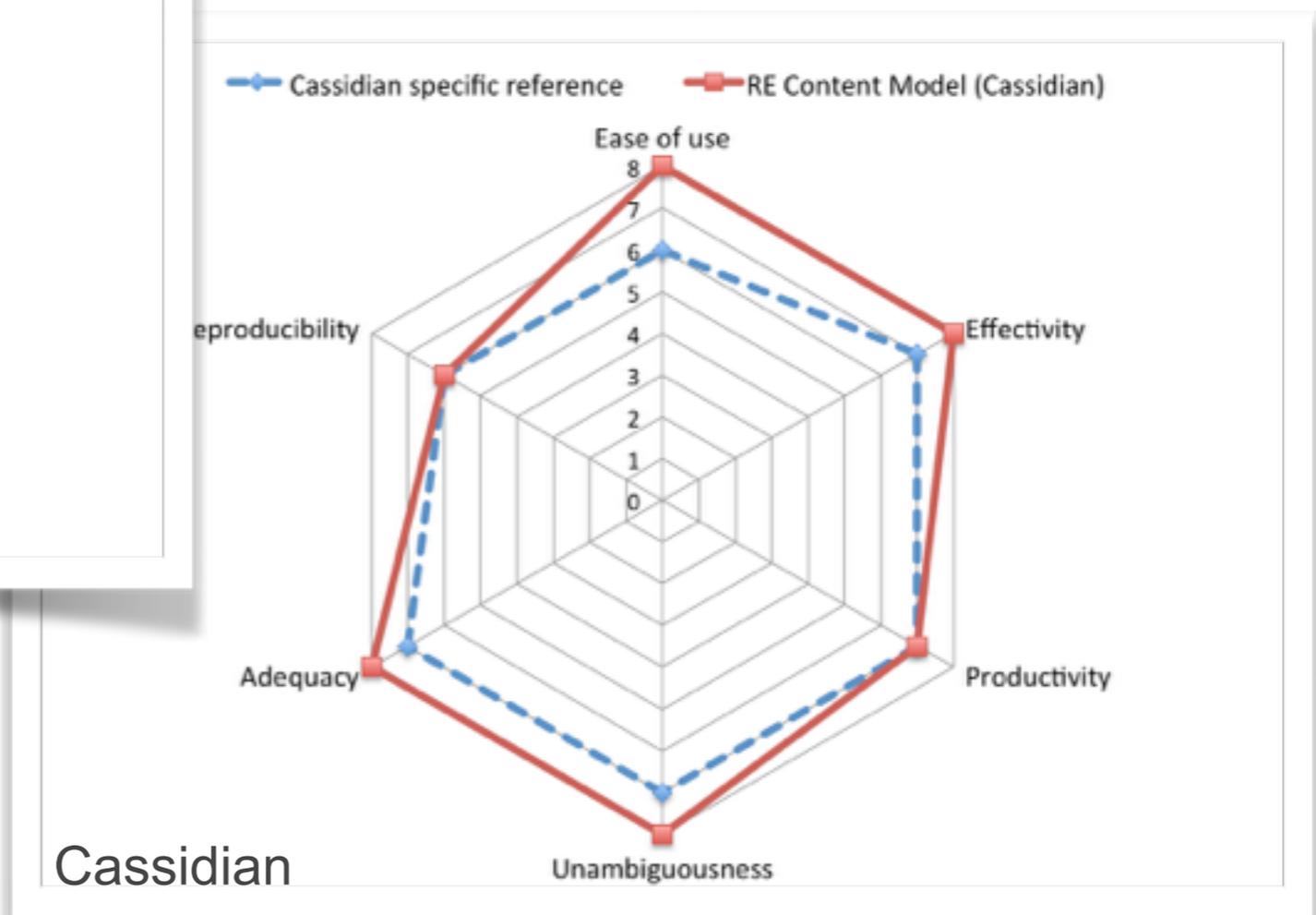
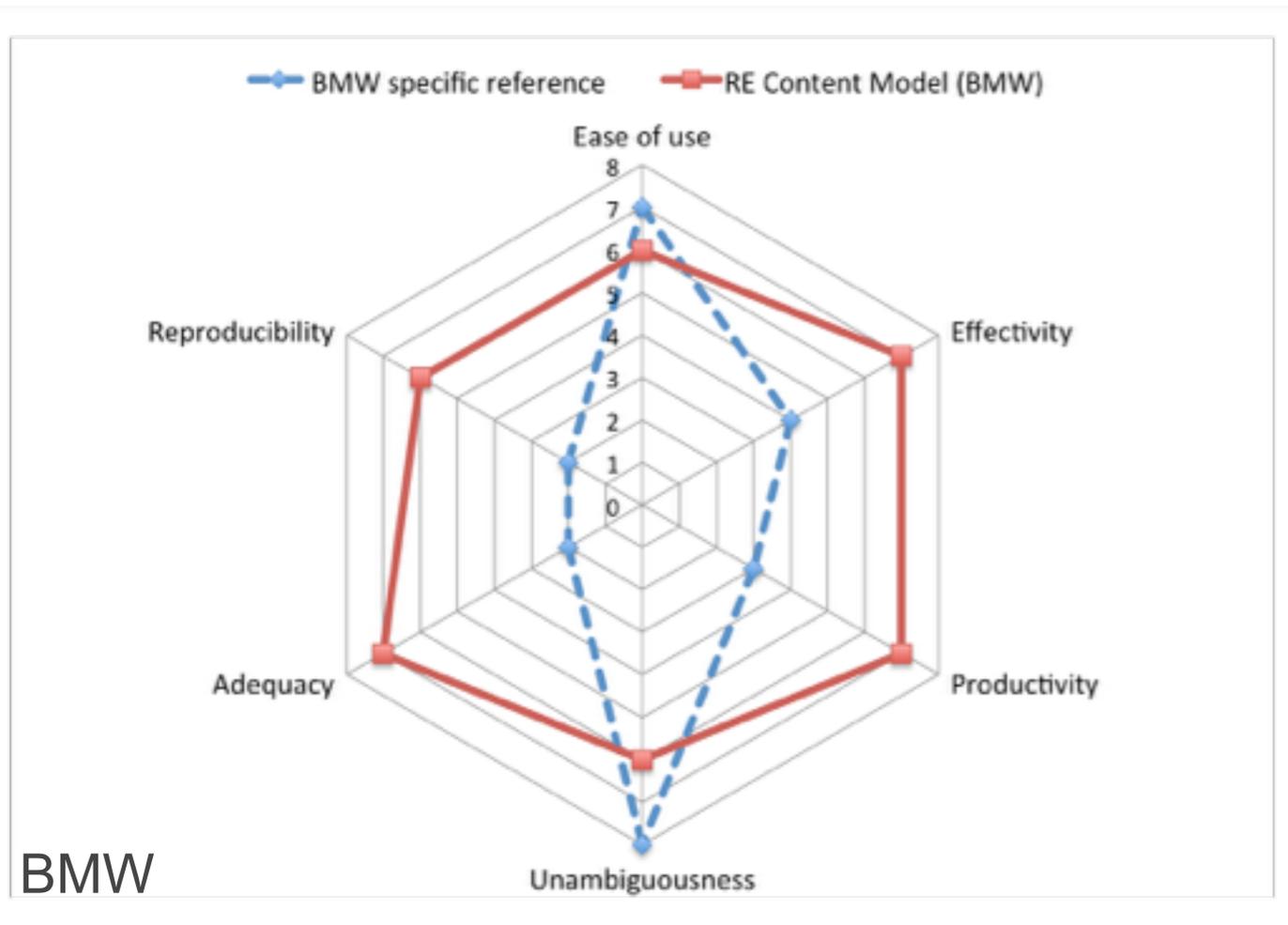
- Automotive: Project Manager from R&D and Developer
- Avionics: Project Manager from R&D and Developer from series development

- Case

- Project ARAMiS: integrated approach for developing and realizing cyber-physical systems (CPS) scenario
- All partners use the ARAMiS artefact model for documenting RE artefacts



Results - RQ1

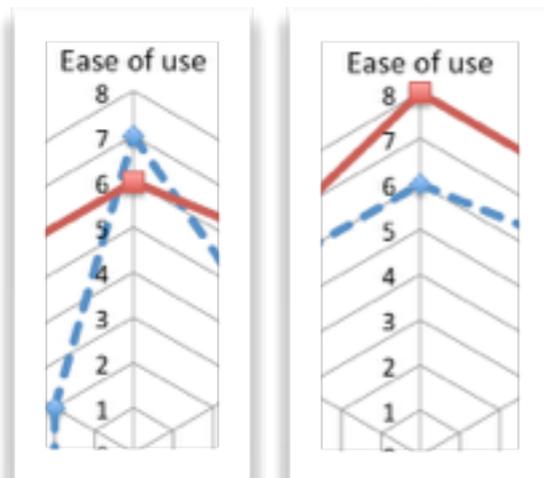


Results - RQ1

Ease of Use: “The reference model is clear and understandable”

BMW

Cassidian

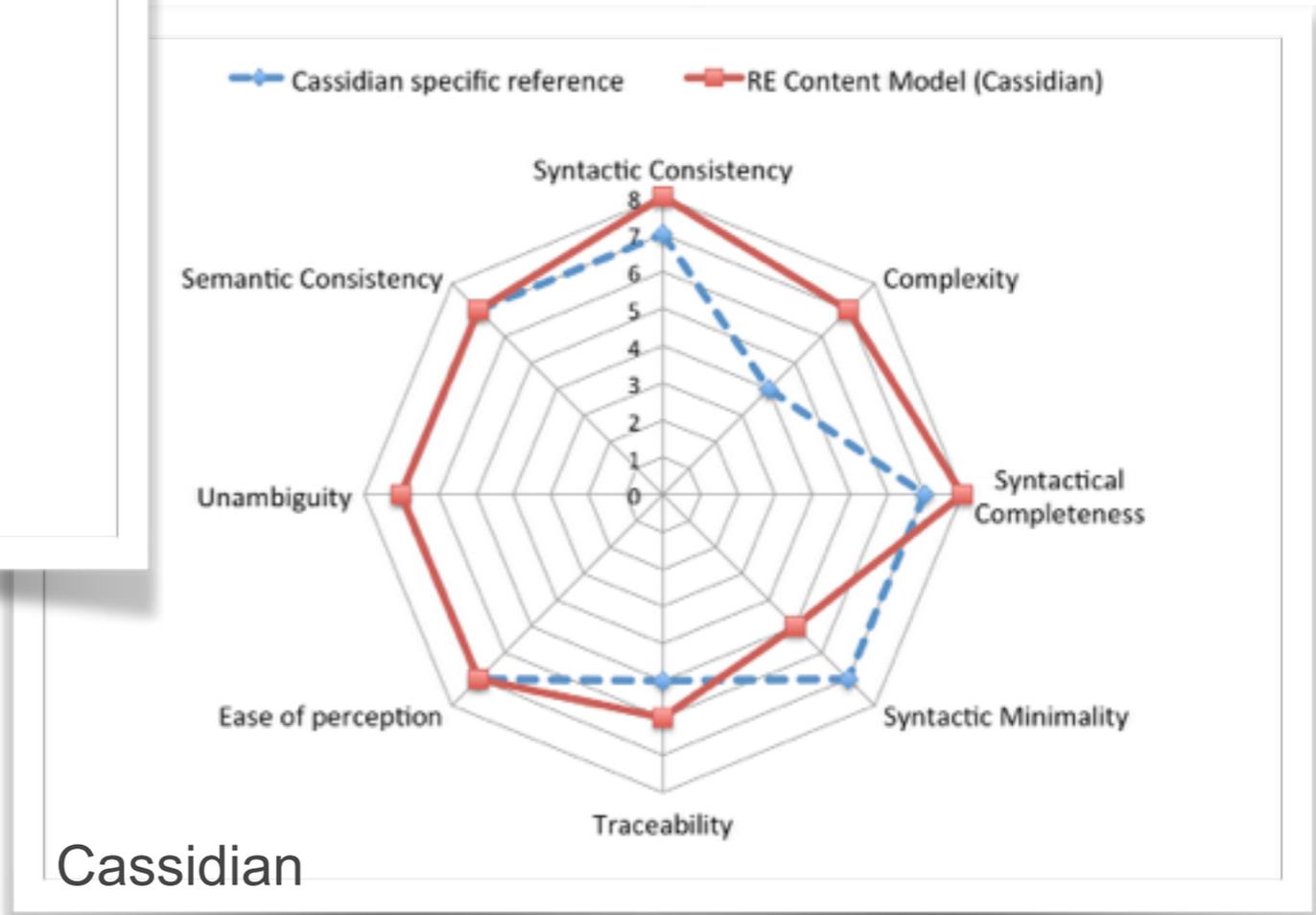
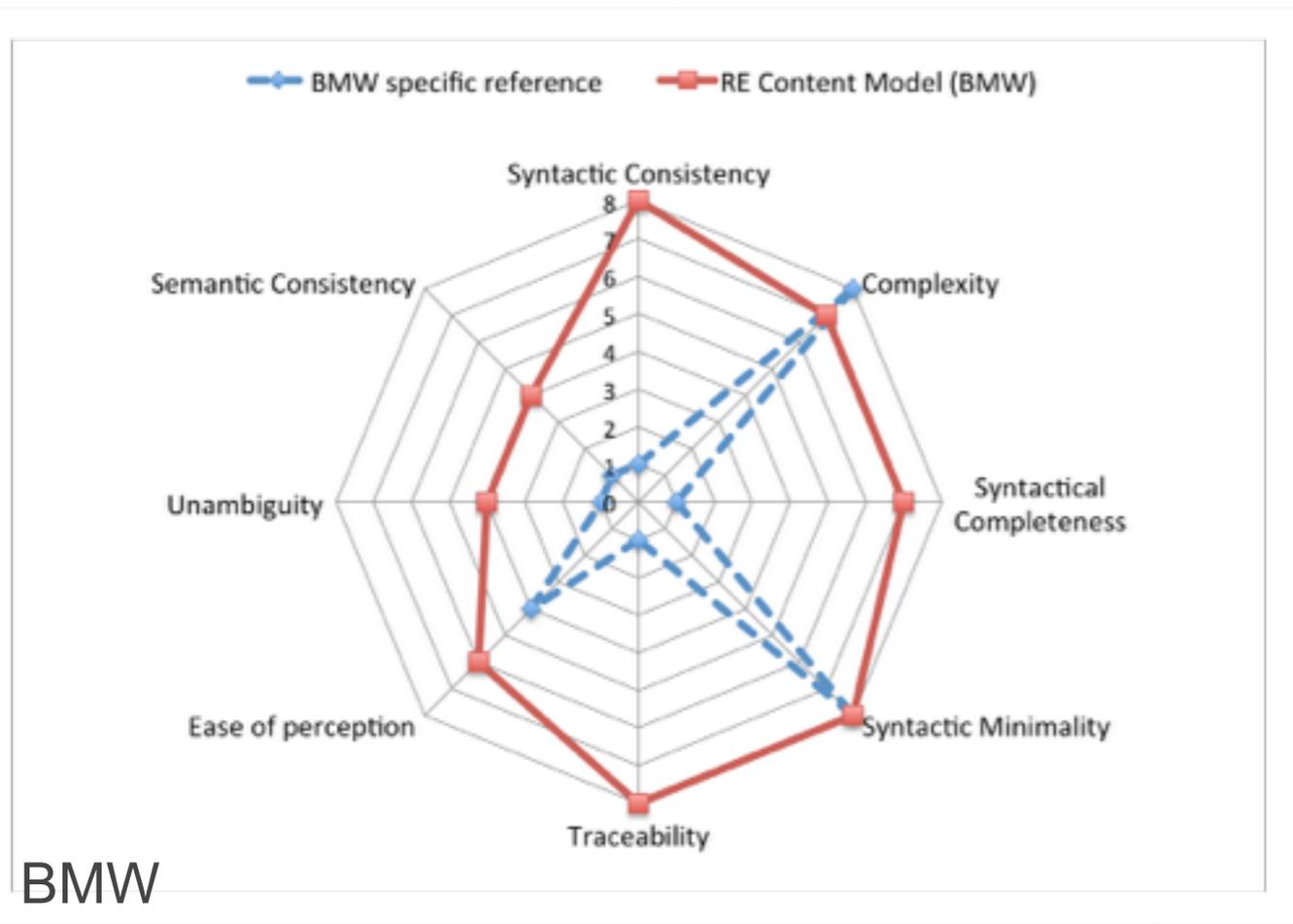


— RE Content Model
- - - reference

1. Ease of use	The reference model is clear and understandable.									
RE content model	I strongly disagree	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	I strongly agree				
BMW-specific reference (DOORS)	I strongly disagree	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	I strongly agree				
Please give a rationale for your rating:										
RECH	<i>Lernprozess = Erarbeitungsprozess, etwas komplizierter aber besser wenn konfiguriert, erstmal mehr Aufwand es zu verstehen</i>									
BMW	<i>einfach, templates, man kommt schnell rein</i>									

1. Ease of use	The reference model is clear and understandable.									
RE content model	I strongly disagree	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	I strongly agree					
Company-specific reference model	I strongly disagree	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	I strongly agree				
Please give a rationale for your rating:										
<i>The Language is easy to understand, all required artefacts are described, some examples would be helpful.</i>										

Results - RQ2 and RQ3

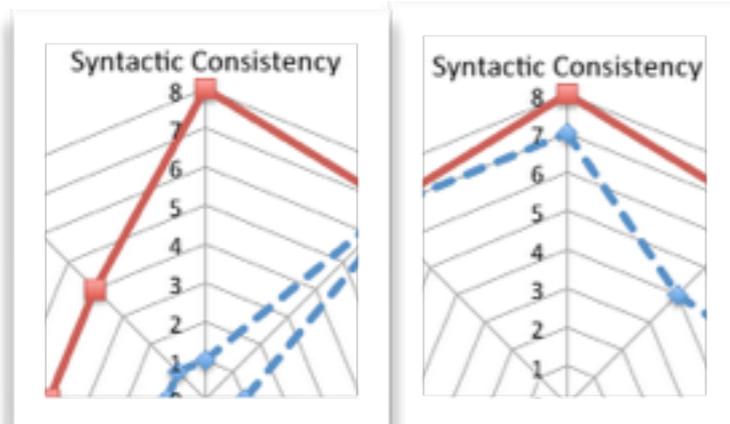


Results - RQ2 and RQ3

Syntactic Consistency: “Elements in the specification are used consistently”

BMW

Cassidian



— RE Content Model
- - - reference

1. Syntactic consistency	The elements in the specifications are used consistently.									
RE content model	I strongly disagree	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	I strongly agree
BMW-specific reference (DOORS)	I strongly disagree	<input checked="" type="checkbox"/>	<input type="checkbox"/>	I strongly agree						
Please give a rationale for your rating:										
<i>RECM</i> ja, wird ja vorgegeben, ich muss die Ebene vorgeben <i>BMW</i> keine Vorgaben, es gibt keine übergreifende Syntax.										

1. Syntactic consistency	The elements in the specifications are used consistently.									
RE content model	I strongly disagree	<input type="checkbox"/>	<input checked="" type="checkbox"/>	I strongly agree						
Company-specific reference model	I strongly disagree	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	I strongly agree					
Please give a rationale for your rating:										
<i>Requirements are in textual form, the content of design notes, giving additional information, depends on the author</i>										

Comparison to the Replication Base

- Both replications:
 - very good ratings in syntactic consistency and completeness
 - high ratings for traceability and ease of perception
- Replication base:
 - Syntactic quality was rated slightly **higher**
 - Ease of use slight **lower**

(Working) Hypotheses

A higher level of detail in an artefact model...

H1: ... increases the syntactic quality in the artefacts

H2: ... decreases the ease of use of the approach

Lessons Learnt

- Diversity of information
 - Many specific expert areas need to be captured by artefact model
 - Different domains result in different challenges and priorities for creating artefacts
- Usability Assessment
 - Usability of an artefact model depends on the acceptance of the requirements engineer
 - Usability and syntactic and semantic consistency depend on the tool



Conclusion

- Two replication studies (Automotive and Avionics)
 - Evaluation of usability and quality of an artefact model (in comparison to a former reference model)
 - Summary of Results:
 - Both companies perceive the artefact model as better than the former reference model
 - Hypothesis confirmed
- ➡ First step towards an empirical repository on artefact-based RE
- ➡ Strengthen out confidence in the general benefits of artefact-orientation

You are cordially invited to join us!

We can provide

- Evaluation sheets
- Models & Tools
- Project data

You can reach us via



ccre@in.tum.de



[@ccre](https://twitter.com/ccre)



<http://www4.in.tum.de/research/requirements/index.shtml>

