Nina Rußkamp, n.russkamp@tk.rwth-aachen.de | Lorena Niebuhr, l.niebuhr@tk.rwth-aachen.de
Human-Computer Interaction Center | Text Linguistics and Technical Communication | RWTH Aachen University

Artificial Intelligence

Involving Users in the Development of AI-Supported CAM Systems by Co-Creation Methods

Computer-Aided Manufacturing

Nina Rußkamp, Lorena Niebuhr, Eva-Maria Jakobs

Textlinguistics & Technical Communication | HCIC - Human-Computer Interaction Center | RWTH AACHEN UNIVERSITY

Nina Rußkamp | Lorena Niebuhr

Affiliation

Research Assistants at RWTH Aachen University
Human-Computer Interaction Center, Department of Text Linguistics and Technical Communication

Research Focus

Co-Creation Approaches •
User Interface Design •
User Acceptance •
Industry 4.0 •

• Technology Acceptance
• Transformation Communication
• Industry 4.0

Background

Technical Communication M. Sc.
Technical Focus: *Computer Science*

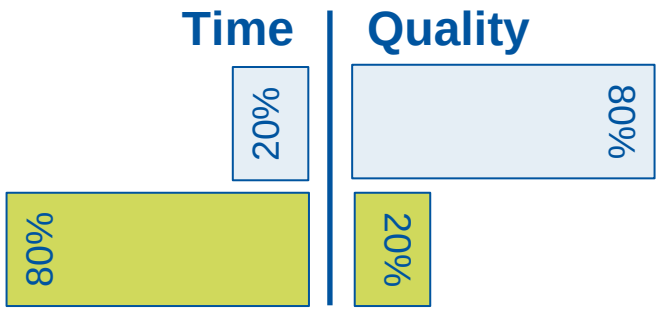
Technical Communication M. Sc.
Technical Focus: *Materials Engineering*

Current CAM-Planning Challenge

Industry 4.0

- Acceleration
- Individualization
- Complexity

- CAM planners spend most of the time on improving the 80% solution by parameter optimization *(Pareto Principle)*
- Now they need to solve complex CAM-planning tasks in increasingly shorter time frames
- This leads to a **lack of time** and thus **inadequate quality** of the CAM process planning



OVERLOAD AND FRUSTRATION OF THE USER

Solution Idea

ENRICH SOFTWARE SYSTEMS WITH NOVEL TECHNOLOGIES TO

(i) improve quality (ii) save time (iii) relieve the user

Project CAM2030

a new generation of CAM systems based on

- Artificial Intelligence
- Cloud Computing
- Evolutionary Algorithms

focusing on

- Automation of CAM-parameter optimization
- User's rethinking, relearning and support needs
- Acceptance and comprehensibility of the system

develops

AN INTERDISCIPLINARY TEAM OF EXPERTS FROM INDUSTRY AND ACADEMIA

IN THIS TALK

- Does the co-creation approach provide indications
  - of potential relearning and support needs
  - and suitable measures to cover them?

applies co-creation to

- Bring actor-specific perspectives together
- Integrate user perspectives
- Close knowledge gaps

State of the Art

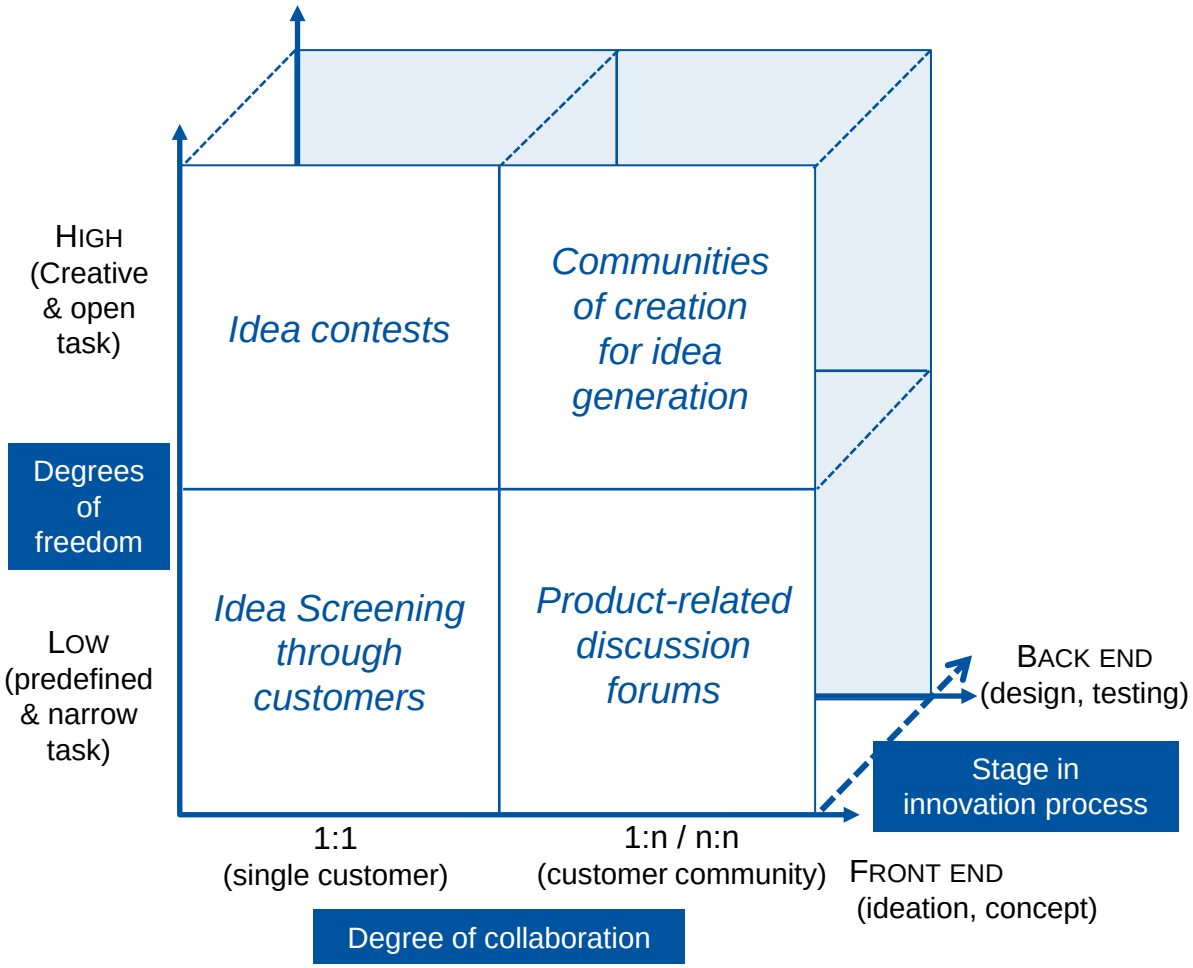
Co-Creation

> “an active, creative and social process, based on collaboration between producers (retailers) and customers (users)” *(Piller et al. 2010)*

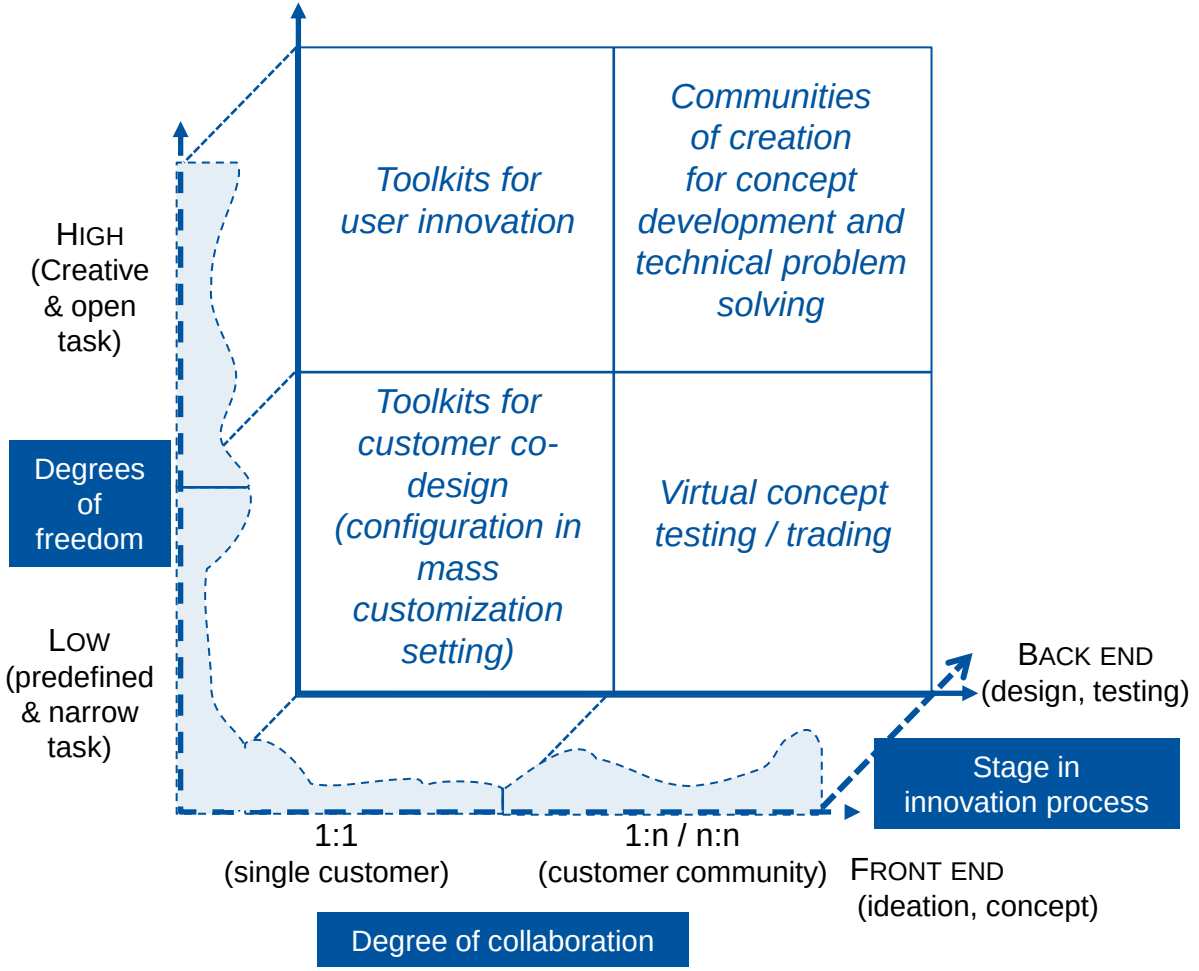
GOALS:

- Reduce uncertainties in the innovation process
- Gain access to need information and solution information
- Create a shared ‘vision’ between actors involved in the innovation process by aligning their perspectives

FRONT-END CO-CREATION *(Piller et al. 2010)*



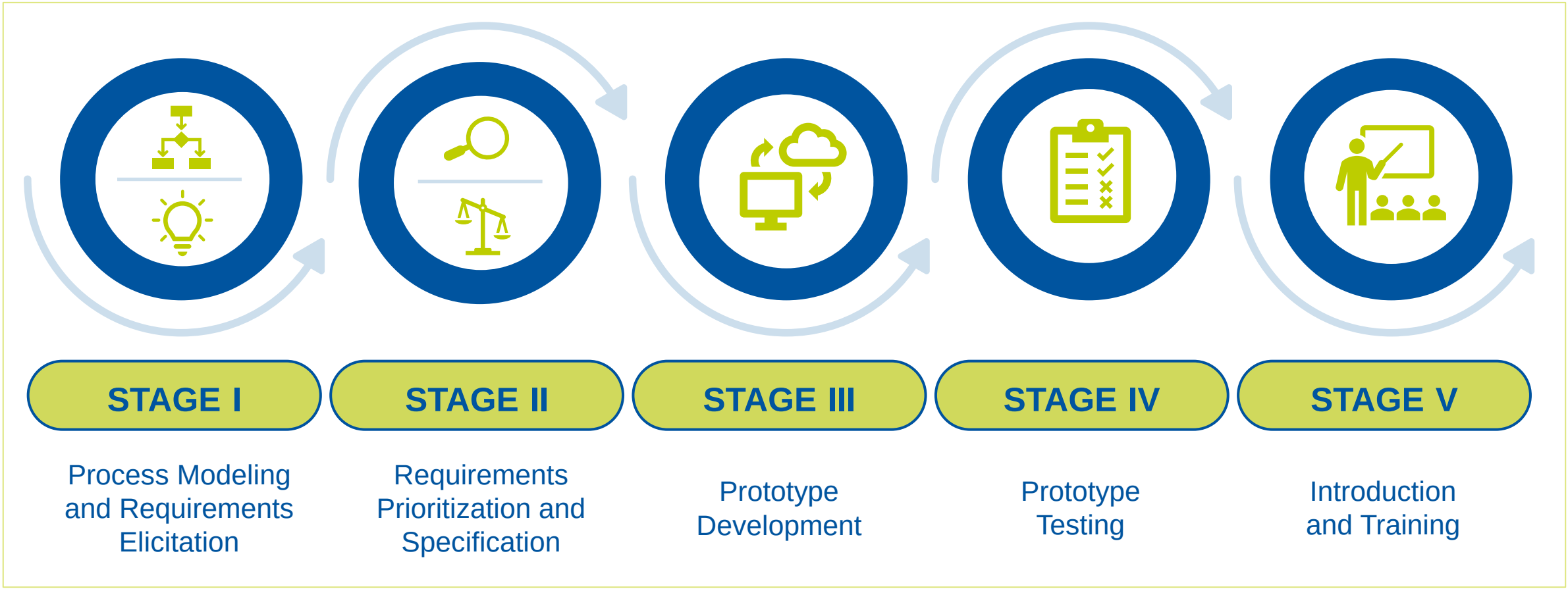
BACK-END CO-CREATION *(Piller et al. 2010)*



Methodology

Co-Creation-Based Framework | Stage-Wise Development of the Framework | Stage IV

Co-Creation-Based Framework



Stage-Wise Development of the Framework

Online Co-Creation Workshop

Workshop Preparation

Participants | Workshop Leader Team

developers | CAM users | human-centered work design experts | technical communication experts

Group Size

single-work tasks vs. group tasks

Tasks

generate ideas | evaluate | discuss

Group Composition

role-related teams
vs. interdisciplinary teams

Tools

Zoom | Google Docs | Google Forms | Mural | Figma | Microsoft Office

Synchrony of User Involvement

synchronous (during workshops)
vs. asynchronous (prior to / after/ inter workshops)

Methods

- front-end vs. back-end co-creation
- combination of co-creation and other methods

Workshop Execution

I. **Introduction**
organization and topic

II. **Main Part**
workshop tasks

III. **Summary**
needs for action

Workshop Analysis

- Consolidation, description and transfer of outcome
- Evaluation of methods

Complementary Formats survey | workshop

STAGE IV
Prototype Testing

ASYNCHRONOUS
prior to the workshop

SYNCHRONOUS
during the
CO-CREATION WORKSHOP

ASYNCHRONOUS
after the workshop

CAM USERS

INTERDISCIPLINARY CONSORTIUM

CAM USERS

User Survey
(single-work task)

- User-specific display of Key Performance Indicators (KPIs)
- Integration of help offers in the user interface

Evaluation of User Interface Prototype *(single-work task)*

- LIVE prototype presentation vs. RECORDED prototype presentation
  - Overall impression of the prototype
  - Evaluation of selected user interface parts
  - Role-related questions (developer vs. user)

Prototype Discussion
(group task)

Discussion of User Feedback *(group task)*

Results and Discussion

Redesign and Relearning Needs | Introduction and Training | Integrated Help Functions

Redesign and Relearning Needs

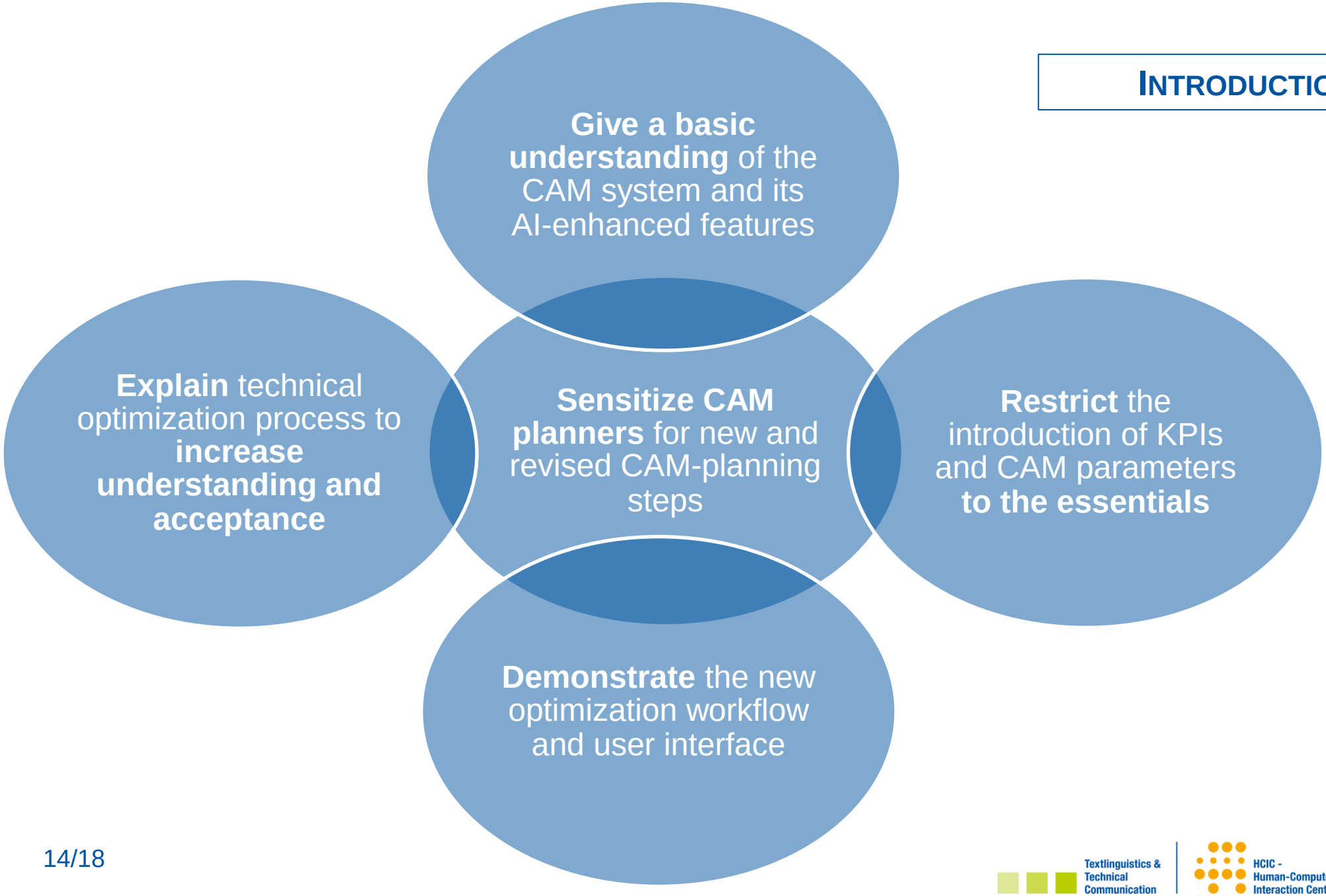
Automation of CAM parameterization

AFFECTS

- CAM-Planning Workflow
- Dealing with Key Performance Indicators (KPIs)
- Design of User Interface
- Requirements for the User

CAM users partly have to rethink and acquire knowledge

KPIs | **CAM Parameter Optimization** | **Artifical Intelligence** | **Trust / Acceptance**


Give a basic understanding of the CAM system and its AI-enhanced features
Explain technical optimization process to increase understanding and acceptance
Sensitize CAM planners for new and revised CAM-planning steps
Restrict the introduction of KPIs and CAM parameters to the essentials
Demonstrate the new optimization workflow and user interface

How useful are descriptions of the KPIs time, quality and costs depending on the target group?

Target Group	Evaluation*	Description of Time	Description of Quality	Description of Costs
Novices	very useful	N=6	N=3	N=7
	useful	N=2	N=4	N=1
	rather useful	N=0	N=1	N=0
Experts	very useful	N=4	N=4	N=7
	useful	N=4	N=4	N=0
	rather useful	N=0	N=0	N=1
All User Groups	very useful	N=4	N=5	N=7
	useful	N=4	N=3	N=0
	rather useful	N=0	N=0	N=1

*the questionnaire additionally offered the answer options *partially*, *rather not useful* and *not useful*; the participants did not select any of these options

How should the KPI descriptions be integrated in the user interface?

Representation as	Description of Time	Description of Quality	Description of Costs
Video	N=0	N=0	N=0
Text	N=1	N=0	N=0
Graphics	N=7	N=0	N=7
Video and Graphics	N=0	N=7	N=0
Text and Graphics	N=0	N=1	N=1

Integrated Help Functions

- **Explain** KPIs and CAM parameters **in detail**
- **Time:**
  - calculate processing time of CAM plans
  - identify and take advantage of the potential for time reduction.
- **Quality:**
  - evaluate component quality prior to final production
- **Costs:**
  - Overview of different types of costs
  - Effects of changes in CAM planning on production costs
  - Total cost

Conclusion

Potential | Limitations | Research Need

Potential

- **CO-CREATION-BASED APPROACHES** are suitable means to integrate the **USER'S PERSPECTIVE** in interdisciplinary innovation processes.
- The user involvement allows for identifying **GENERAL AND SELECTIVE RELEARNING NEEDS**
- Considering these needs in the design and implementation of new software generations **BENEFITS BOTH USERS AND COMPANIES**.
- Early identification of knowledge gaps makes the system introduction **EASIER, FASTER, AND LESS PRONE TO DISRUPTIONS**.

Limitations

- The **END USERS' RELUCTANCE** to advance research at the expense of daily business
- The **RESTRICTION OF AUTOMATION** to one selected CAM-planning step in one specific CAM system
- The **APPLICATION CONTEXT** (well-educated CAM planners in German small and medium-sized enterprises)

Research Need

- How to **ESTABLISH NEW GENERATIONS OF CAM SOFTWARE** (introduction and training of CAM planners) in a **USER-ORIENTED WAY**
- How to transfer the approach to **LARGE-SCALE AUTOMATION** processes in **DIVERSE APPLICATION CONTEXTS**

Thank you for your attention.

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