it's owl

EINSTEIN CENTER Digital Future

ISEM

34th Annual INCOSE international symposium

hybrid event

Dublin, Ireland
July 2 - 6, 2024

Insights from Germany's Mechanical and Plant Engineering Sector

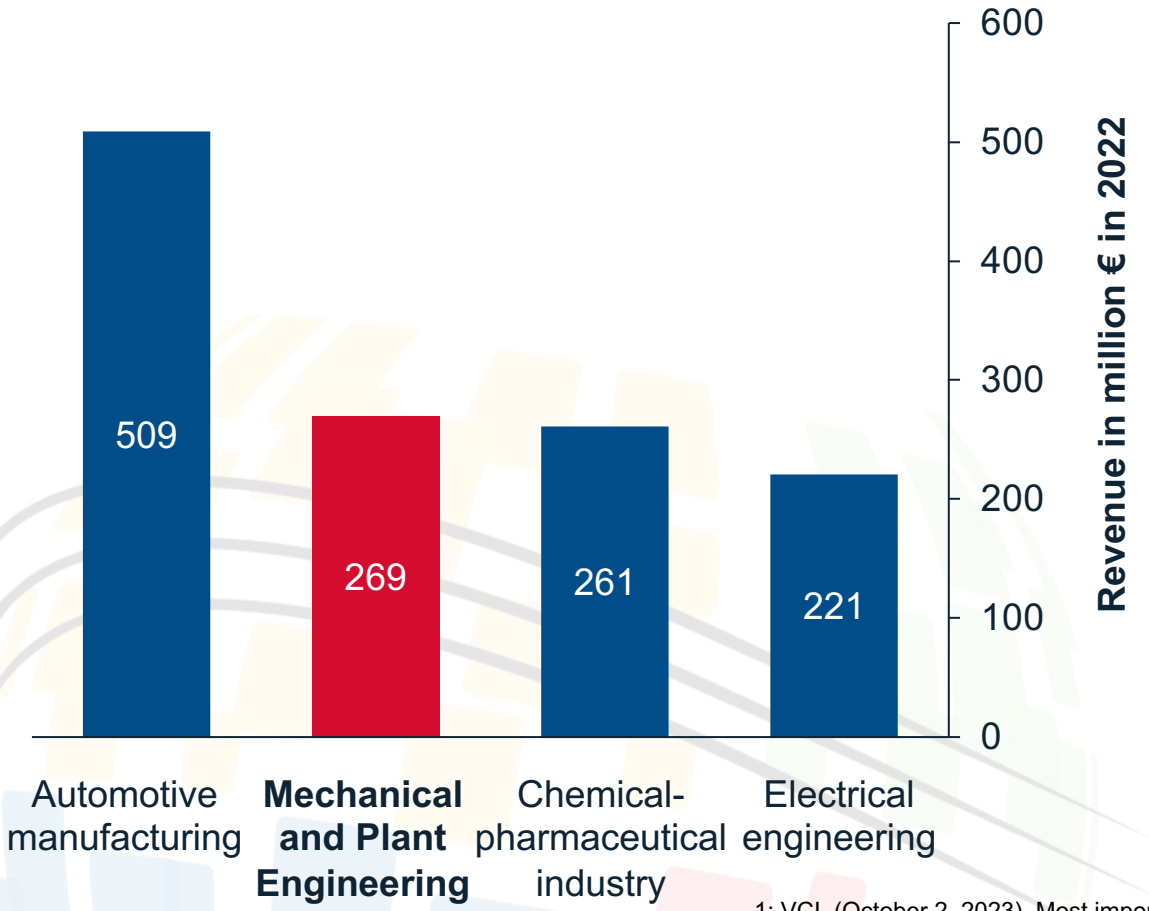
Roles in Systems Engineering

2-6 July 2024

www.incose.org/symp2024 #INCOSEIS

The mechanical and plant engineering sector is the backbone of the German Economy and is driven by change

Industrial sectors by revenue in Germany[1]



Germany-wide and **cross-institute research** initiative.

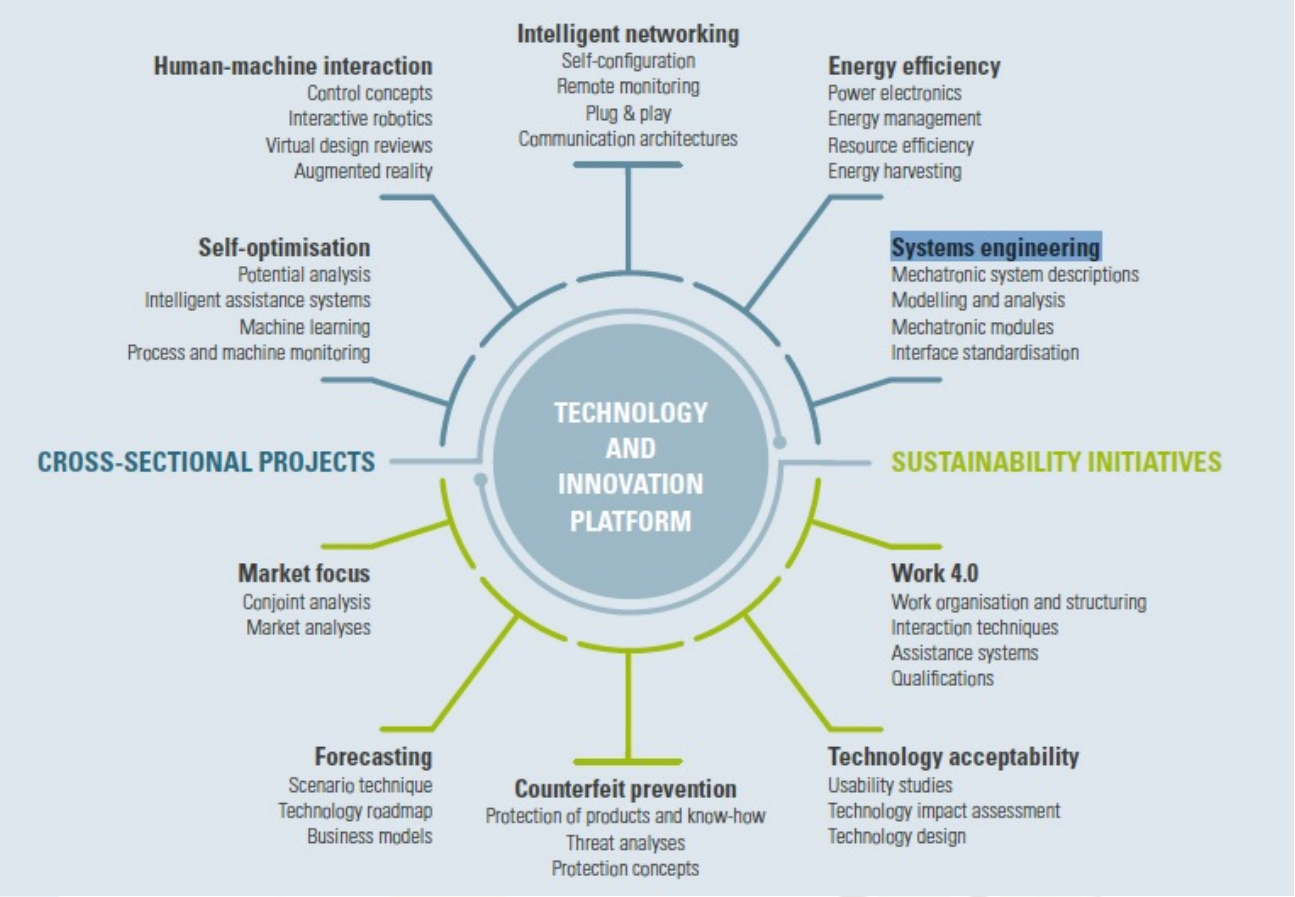
Study on status quo in Germany

- Well-founded basis and orientation framework for further research activities
- Strategic recommendations for the transformation of the value creation

Advanced Systems Engineering

1: VCI. (October 2, 2023). Most important industrial sectors in Germany by turnover in 2022 (in billion euros) [Graph]. In Statista. from https://de.statista.com/statistik/daten/studie/241480/umfrage/umsaetze-der-wichtigsten-industriebranchen-in-deutschland/

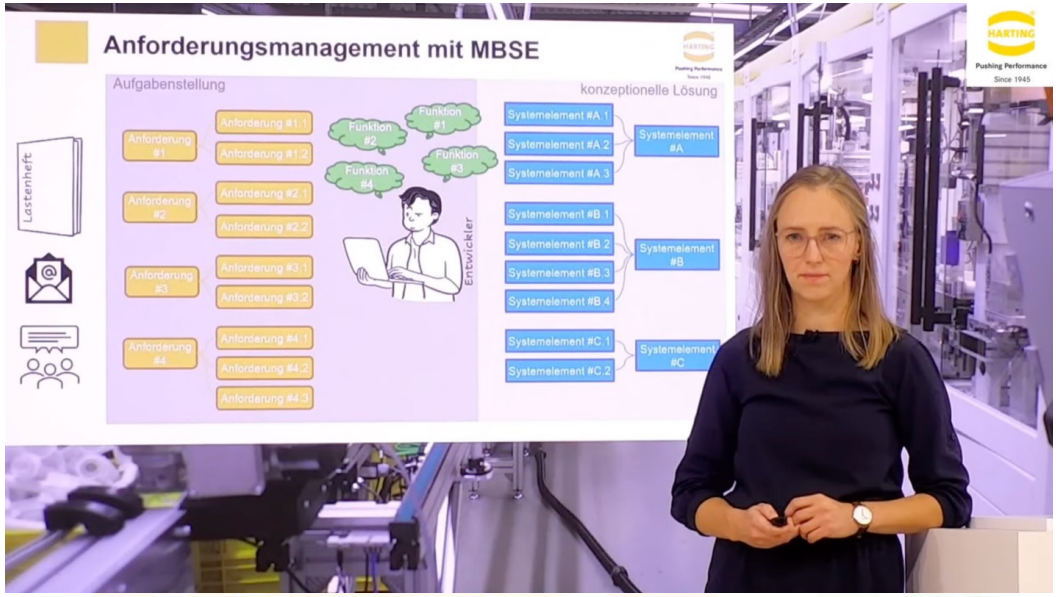
An ecosystem on the transformation of the mechanical and plant engineering industry with systems engineering

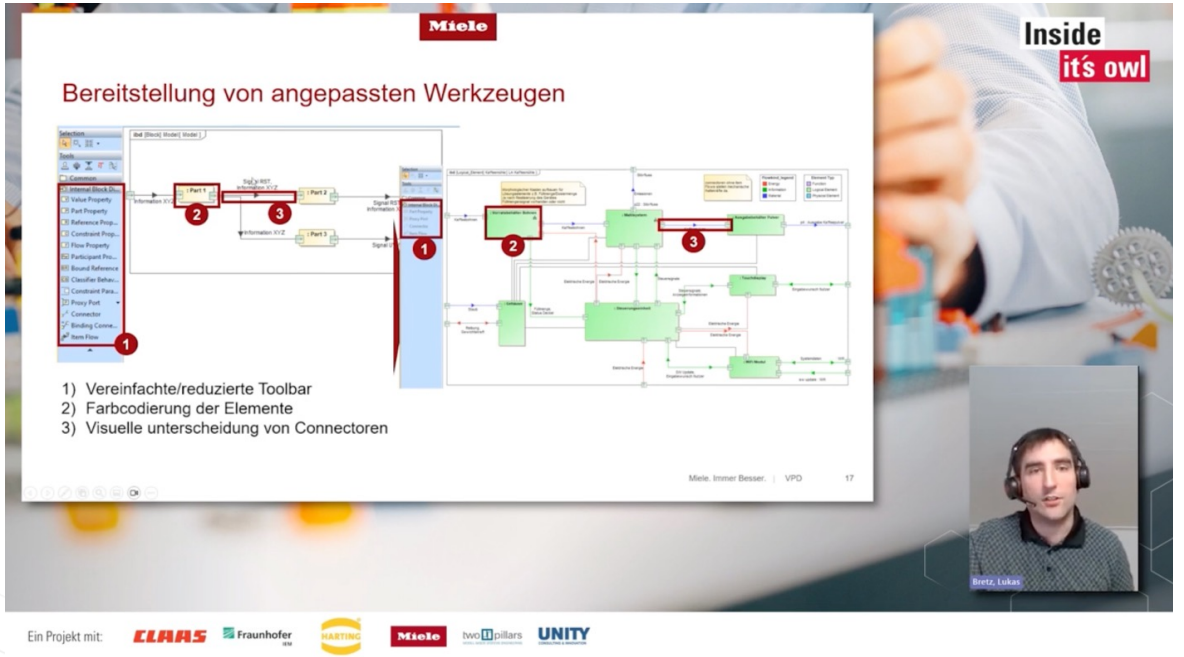


Regional cooperation between companies and science to research on **Intelligent Technical Systems** in West Germany called

it's owl

Implementation of Systems Engineering in the company: What roles and competencies do we need?





Our research is based on three main aspects

How has the understanding of SE roles in international literature changed over time?

What types of SE-Jobs currently exist in the German labor market? What tasks are systems engineers working on?

Which SE role clusters are found in German SMEs?

Our research is based on three main aspects

How has the understanding of SE roles in international literature changed over time?

What types of SE-Jobs currently exist in the German labor market? What tasks are systems engineers working on?

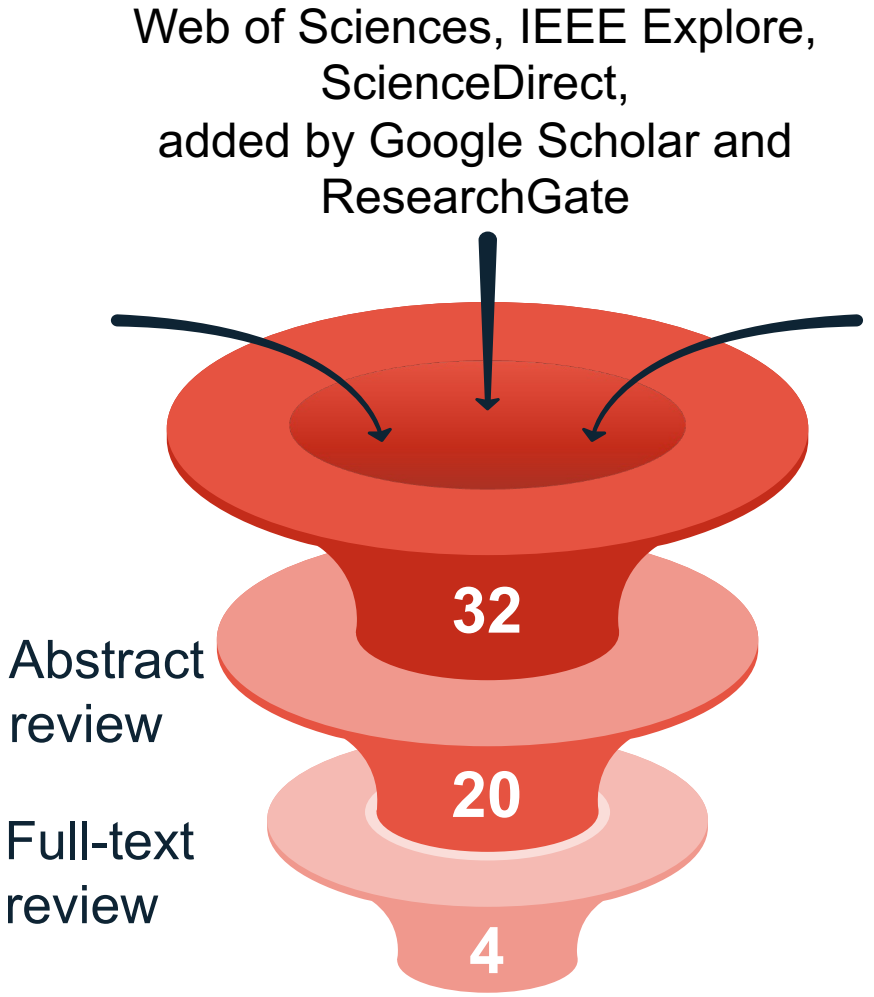
Which SE role clusters are found in German SMEs?

How has the interpretation of roles in international literature changed over time?

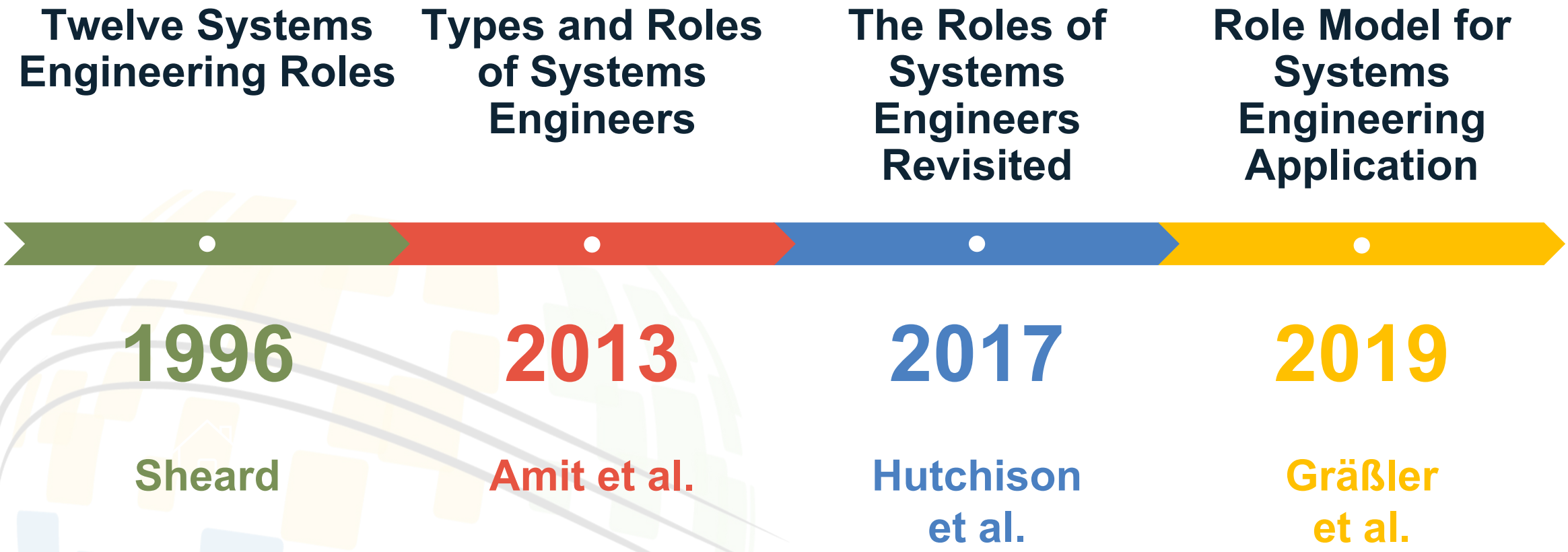
Method:

- Systematic Literature Review for keywords
  - Systems Engineer & Role

- Subsequent classification



Further models were developed based on Sheard's role model from 1996



Creation of a Role Model Matrix

Activities \ Role Model
Requirements
Architecture
Technical Management
V&V
Interface Management
SE process documetation
Stakeholder Management
Information & configuration
Modeling
Coordiation
Ideator
Support & Logistics
Project Management
Teaching & Training
Organizational Management
Life Cycle
System Security

Activities

Creation of a Role Model Matrix

Activities \ Role Model	Sheard (and Amit et al.)	Hutchison et al.	Gräßler et al.
Requirements			
Architecture			
Technical Management			
V&V			
Interface Management			
SE process documetation			
Stakeholder Management			
Information & configuration			
Modeling			
Coordiation			
Ideator			
Support & Logistics			
Project Management			
Teaching & Training			
Organizational Management			
Life Cycle			
System Security			

Role Models

Common activities are filled by all role models

Activities \ Role Model	Sheard (and Amit et al.)	Hutchison et al.	Gräßler et al.
Requirements	✓	✓	✓
Architecture	✓	✓	✓
Technical Management	✓	✓	✓
V&V	✓	✓	✓
Interface Management	✓	✓	✓
SE process documentation	✓	✓	✓
Stakeholder Management	✓	✓	✓
Information & configuration	✓	✓	✓
Modeling	✓	✓	✓
Coordiation	✓	✓	✓

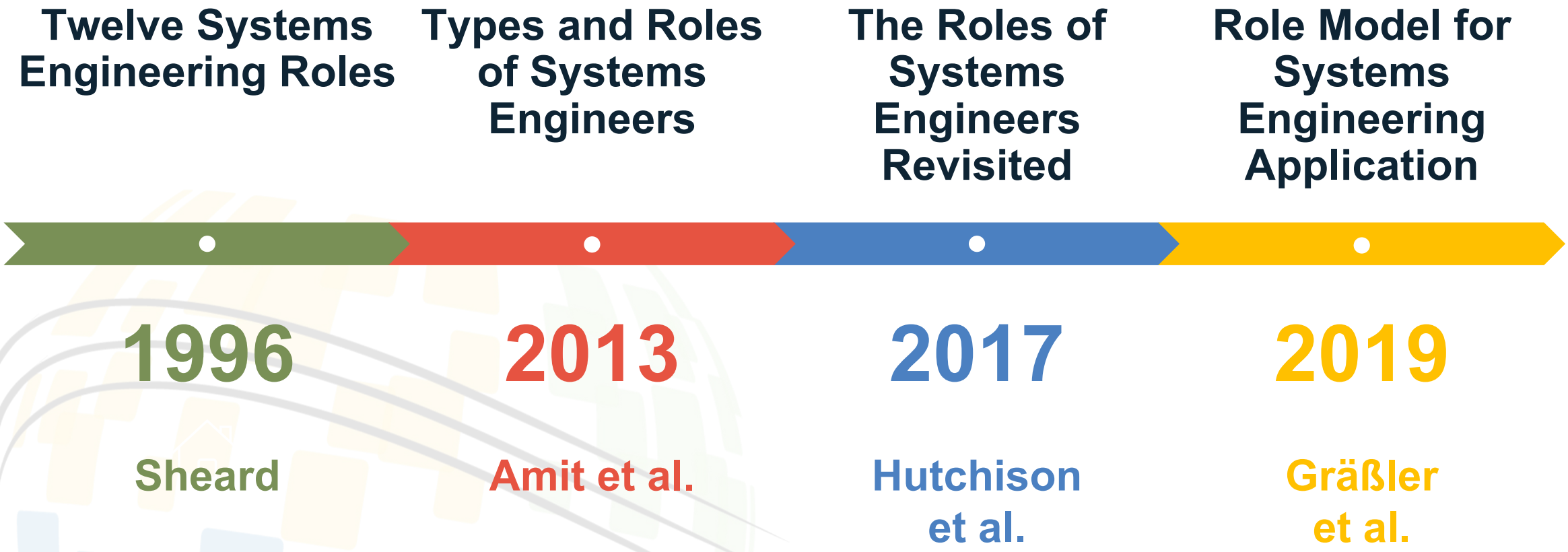
Depending on the model, the roles have different titles or focuses

Role Model / Activities	Sheard *(and Amit et al.)*	Hutchison et al.	Gräßler et al.
Interface Management	Glue	System Integrator	System Interface Manager
Modeling	System Analyst *(/ Architect)*	System Architect	Modeling Engineer

Each role model adds further roles to support different activities

Activities \ Role Model	Sheard (and Amit et al.)	Hutchison et al.	Gräßler et al.
Ideator		✓	✓
Support & Logistics		✓	
Project Management		✓	✓
Teaching & Training		✓	
Organizational Management		✓	
Life Cycle			✓
System Security			✓

Further models were developed based on Sheard's role model from 1996



Our research is based on three main aspects

How has the understanding of SE roles in international literature changed over time?

What types of SE-Jobs currently exist in the German labor market? What tasks are systems engineers working on?

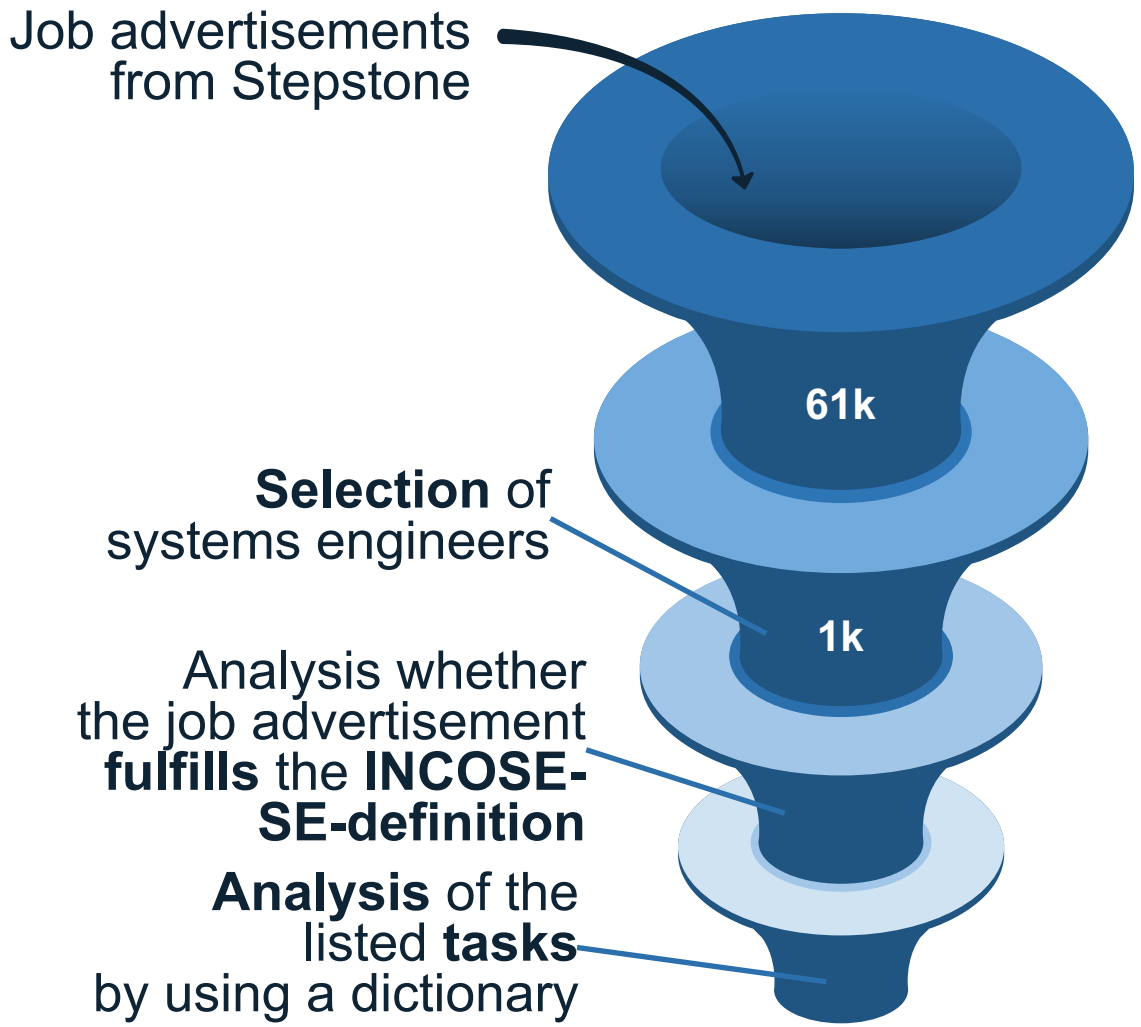
Which SE role clusters are found in German SMEs?

The job title "systems engineer" is understood very heterogeneously in Germany

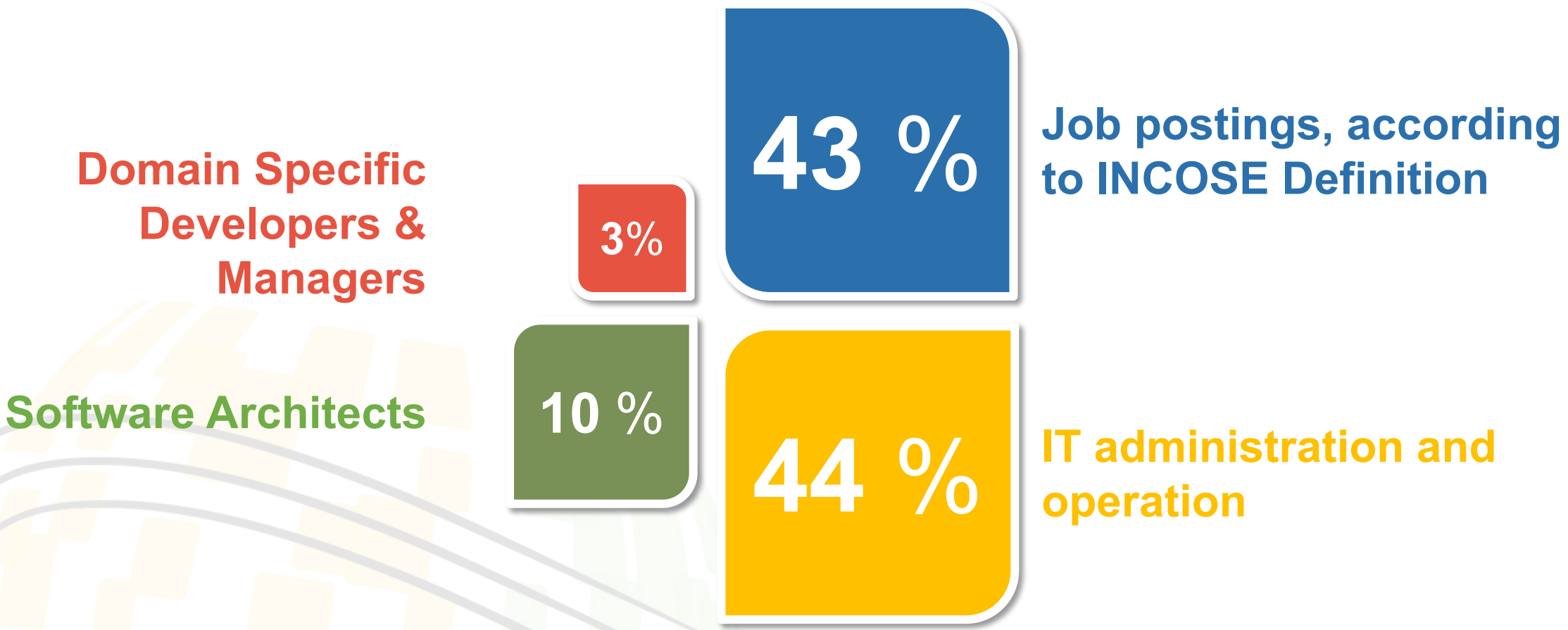
- "**Systems Engineer**" are categorized by the Federal Employment Agency under "**Professions in production planning and control**"
- "**Systemingenieur**" is classified as "**Professions in software development**"

What types of SE-Jobs currently exist in the German labor market? What tasks are German systems engineers working on?

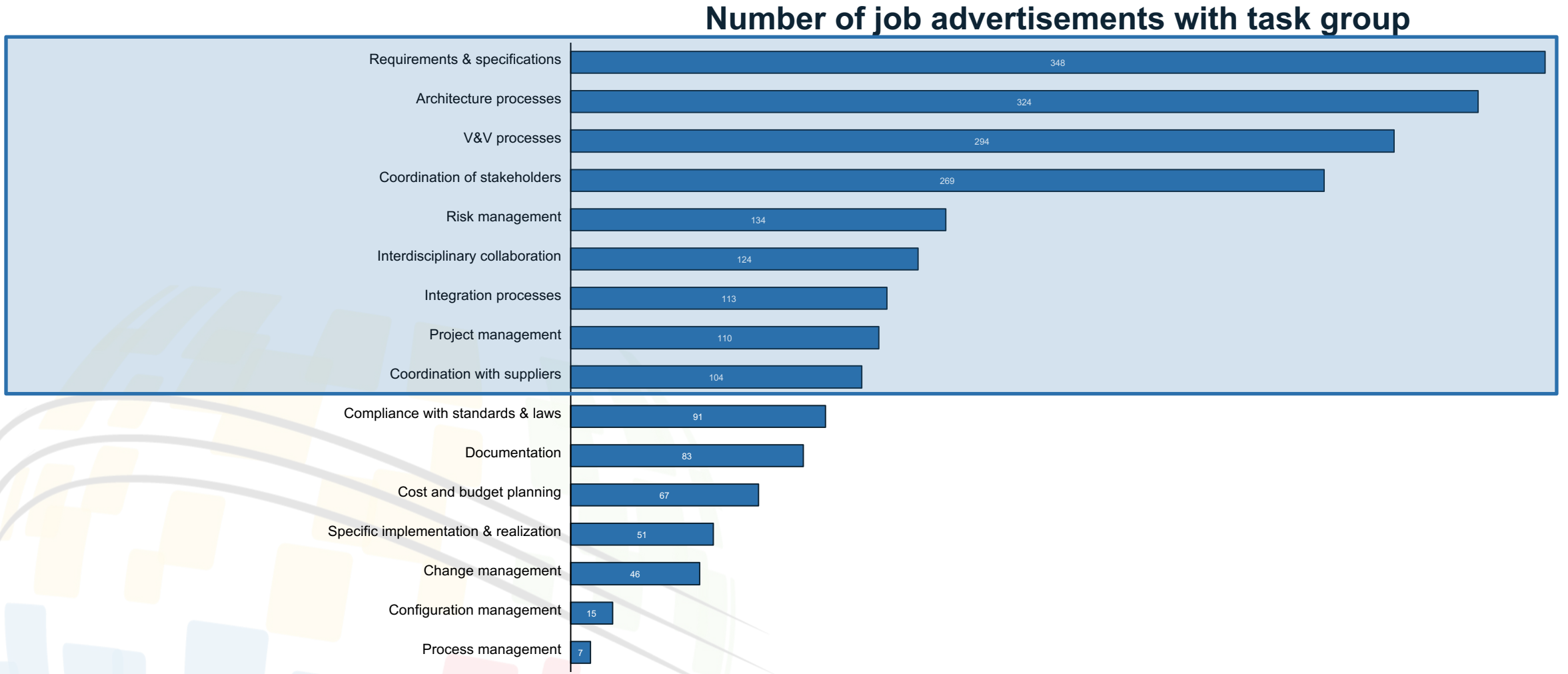
"SE is a **transdisciplinary** and integrative approach to enable the successful **realization**, use, and retirement of **engineered systems**, using systems principles and concepts, and scientific, technological, and management methods."



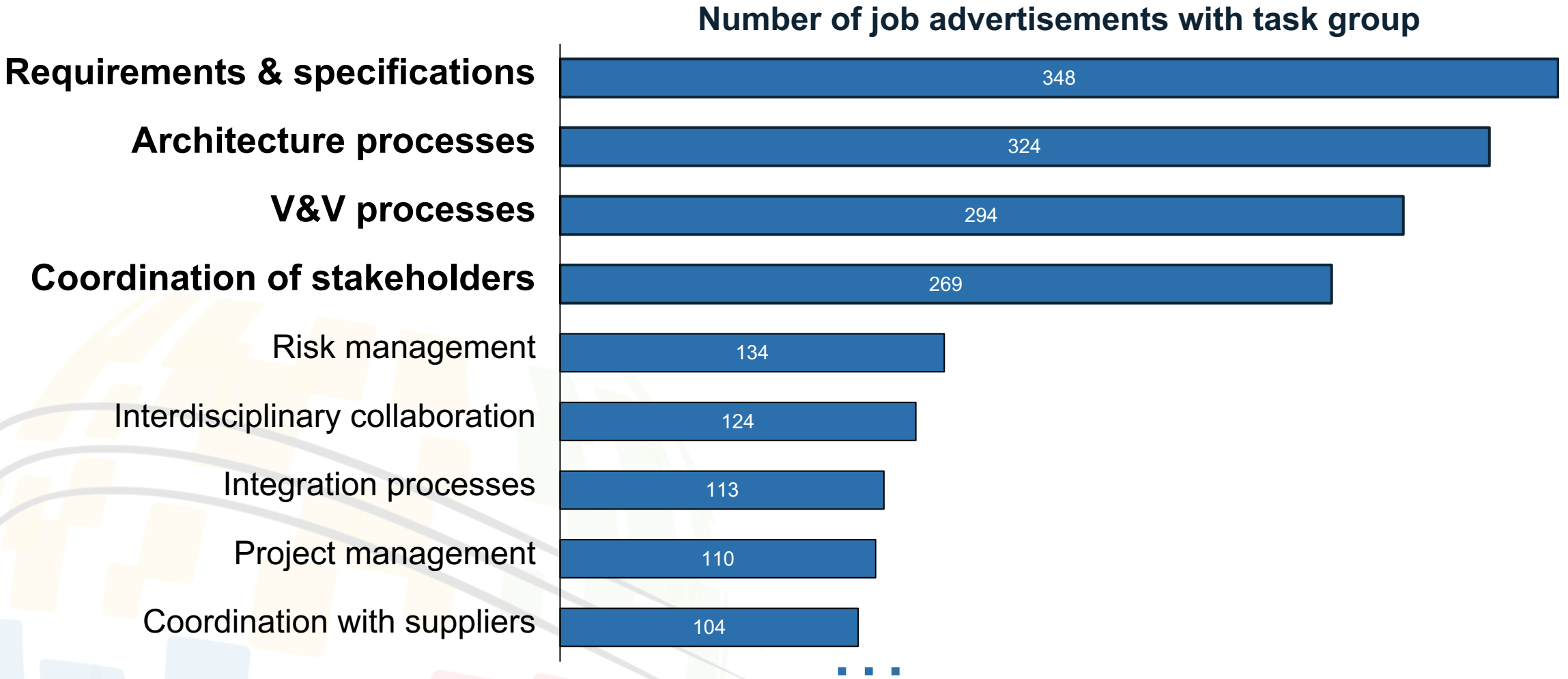
Not even half of job advertisements for systems engineers fulfill the INCOSE SE definition



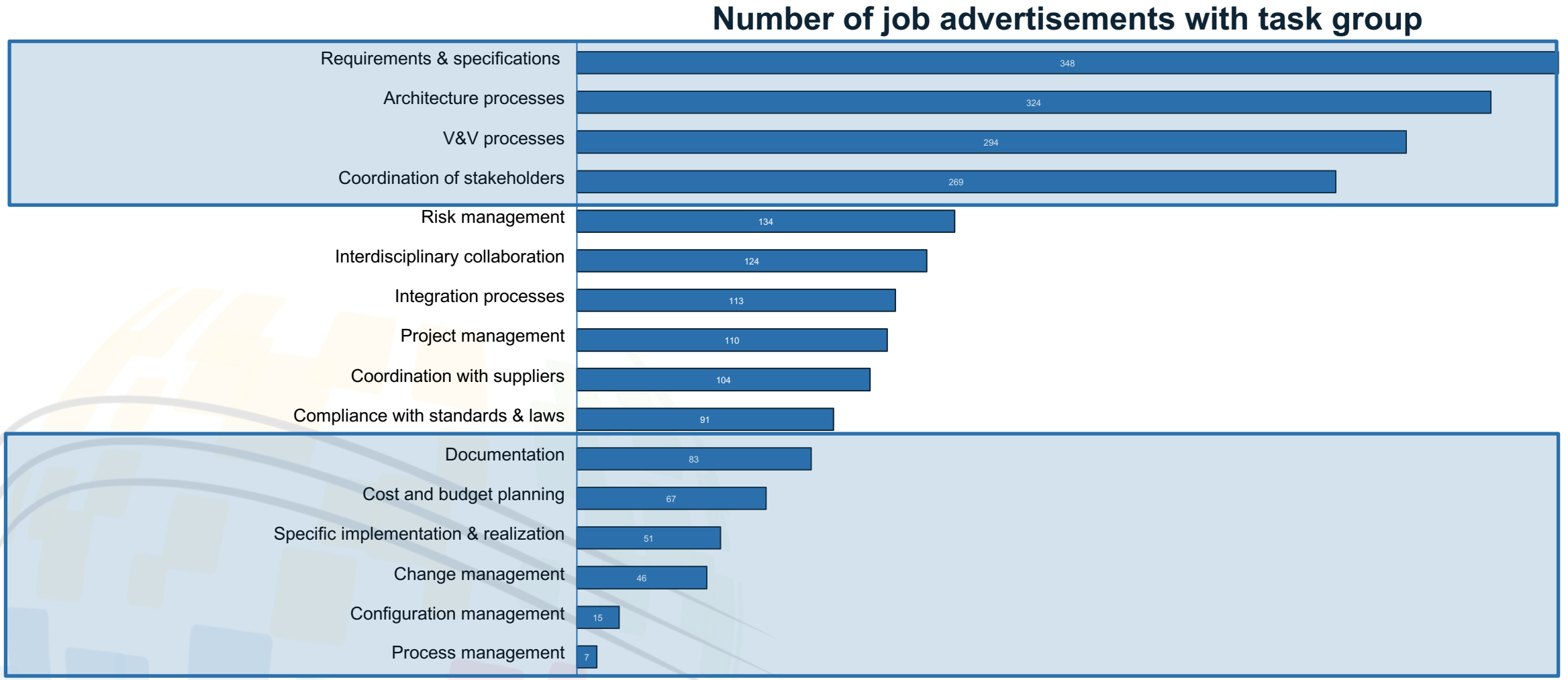
Different task groups appear with different frequency in job advertisements that fulfill the INCOSE definition



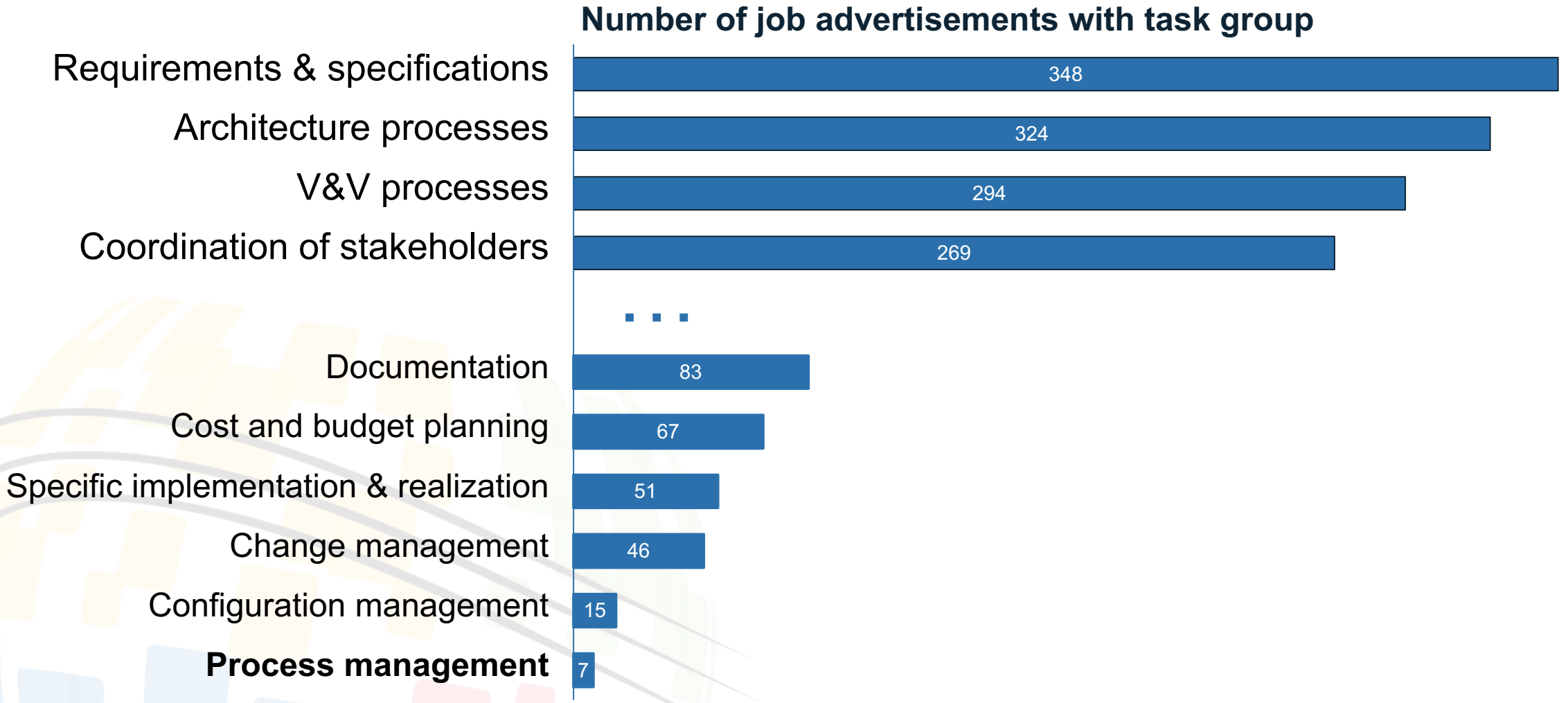
Central task group are made up by requirements, architecture, V&V and coordination processes



Different task groups appear with different frequency in job advertisements that fulfill the INCOSE definition

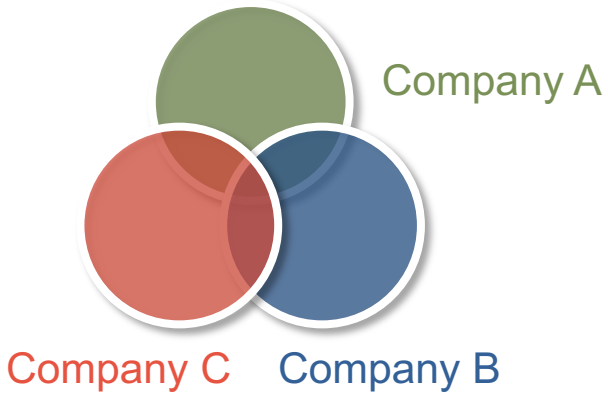


Tasks such as methods or process development and management are hardly present



Approach: Analyze what you know and have

Three companies of it´s OWL – different branches, different sizes



Trend

to give individual roles modern job titles

Challenge

Keeping job descriptions current due to rapid changes

Approach: Role Clusters

1. Analyze and make sure of the same understanding
2. Grouping roles with similar tasks into clusters

14 Role Clusters

forms the interface between the customer and the company. The roles in this cluster form the voice for all customer-relevant information required to the project.

Role Cluster Name	Description
Customer	represents the party that orders or uses a service (= development order). The customer has influence on the design/technical execution of the system.
Customer Representative	forms the interface between the customer and the company. The roles in this cluster form the voice for all customer-relevant information required for the project.
Project manager	is responsible for the planning and coordination on the project side. The roles assume responsibility for achieving the project goals and monitoring the resources (time, costs, personnel) within a time-limited framework and have a moderating role in conflicts and disputes.
System Developer	has the overview from requirements to the decomposition of the system to the interfaces and the associated system elements (external to the system environment and internal between the elements). The system developer is responsible for integration planning and consults with the appropriate subject matter experts.
Specialist Developer	includes the various specialist areas, e.g., software, hardware, etc. They develop new technologies or realize the product/system on the basis of specifications from the system developer cluster.
Production Planner / Coordinator	takes on the preparation of the product realization and the transfer to the customer.
Production Employee	comprises the processes that are to be assigned to the implementation, assembly, and manufacture of the product through to goods issue and shipping. The individual system components are integrated into the overall system and verified with regard to their functionality.
Quality Engineer / Manager	ensures that the company's quality standards are maintained in order to keep customer satisfaction high and ensure long-term competitiveness in the market. Close cooperation with the V&V operator, e.g. for the analysis of customer complaints and identification of the cause.
Verification and Validation (V&V) Operator	covers the topics of system verification & validation. The involvement of this role cluster in the early phases of system development can ensure that the system is verifiable and validatable.
Service Technician	deals with all service-related tasks at the customer's site, i.e. installation, commissioning, professional training of users, as well as classic service tasks such as maintenance and repairs, or the area of after-sales.
Process and Policy Manager	is divided into a strategic and an operational level: On a strategic level, the process owner serves to develop internal guidelines in the development and creation or revision of process flows. On an operational level, the policy owner controls compliance with policies, laws and framework conditions that must be taken into account and fulfilled.
Internal Support	represents the advisory and supporting side during the development process within the project. A distinction is made between: - IT support: IT support provides and maintains the necessary IT infrastructure. - Qualification support: On the one hand, this provides support in the area of mployees is individually e by the HR department, ployees. s separate support with ers assistance in order to
	of products or services,

14 Role Clusters

14 Role Clusters and a mapping with the ISO15288

- For each role cluster typical roles in companies have been allocated
- Each process and task of the ISO 15288 has been allocated to the role clusters

Role-Process-Matrix

0 = None 1 = Support 2 = Responsible		Role			
		Customer representative	System developer	…	V&V operator
Process	Architecture definition	1	2	…	0
	System requirements	2	2	…	1
	….	…	…	…	…
	Validation	1	1	…	2

Role Cluster Name	Description
Customer	represents the party that orders or uses a service (= development order). The customer has influence on the design/technical execution of the system.
Customer Representative	forms the interface between the customer and the company. The roles in this cluster form the voice for all customer-relevant information required for the project.
Project manager	is responsible for the planning and coordination on the project side. The roles assume responsibility for achieving the project goals and monitoring the resources (time, costs, personnel) within a time-limited framework and have a moderating role in conflicts and disputes.
System Developer	has the overview from requirements to the decomposition of the system to the interfaces and the associated system elements (external to the system environment and internal between the elements). The system developer is responsible for integration planning and consults with the appropriate subject matter experts.
Specialist Developer	includes the various specialist areas, e.g., software, hardware, etc. They develop new technologies or realize the product/system on the basis of specifications from the system developer cluster.
Production Planner / Coordinator	takes on the preparation of the product realization and the transfer to the customer.
Production Employee	comprises the processes that are to be assigned to the implementation, assembly, and manufacture of the product through to goods issue and shipping. The individual system components are integrated into the overall system and verified with regard to their functionality.
Quality Engineer / Manager	ensures that the company's quality standards are maintained in order to keep customer satisfaction high and ensure long-term competitiveness in the market. Close cooperation with the V&V operator, e.g. for the analysis of customer complaints and identification of the cause.
Verification and Validation (V&V) Operator	covers the topics of system verification & validation. The involvement of this role cluster in the early phases of system development can ensure that the system is verifiable and validatable.
Service Technician	deals with all service-related tasks at the customer's site, i.e. installation, commissioning, professional training of users, as well as classic service tasks such as maintenance and repairs, or the area of after-sales.
Process and Policy Manager	is divided into a strategic and an operational level: On a strategic level, the process owner serves to develop internal guidelines in the development and creation or revision of process flows. On an operational level, the policy owner controls compliance with policies, laws and framework conditions that must be taken into account and fulfilled.
Internal Support	represents the advisory and supporting side during the development process within the project. A distinction is made between: - IT support: IT support provides and maintains the necessary IT infrastructure. - Qualification support: On the one hand, this provides support in the area of …mployees is individually …e by the HR department, …ployees. …s separate support with …ers assistance in order to
	… of products or services,

14 Role Clusters

Our research is based on three main aspects

How has the understanding of SE roles in international literature changed over time?

What types of SE-Jobs currently exist in the German labor market? What tasks are systems engineers working on?

Which SE role clusters are found in German SMEs?

Conclusion

Historical Evolution:
Roles have evolved since Sheard's 1996 work, with varying titles and adaptations.

Current Job Market Insights:
Job advertisements show that the term "Systems Engineer" and their tasks are interpreted heterogeneous

Role Adaptation for SMEs:
Small and medium-sized companies benefit from empowering existing employees

it's owl

EINSTEIN CENTER Digital Future

ISEM

Insights from Germany's Mechanical and Plant Engineering Sector

Roles in Systems Engineering

2-6 July 2024

www.incose.org/symp2024 #INCOSEIS