Product information representation for assembly processes

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INTRODUCTION

Product development is a collaborative endeavour beginning with identifying customer needs and progressing through product design to final product realization.

Assembly, a fundamental process in discrete product manufacturing, requires meticulous planning for successful execution. Information crucial for assembly planning is generated throughout the product development journey, even in the early stages where the product's geometry is undefined.

However, as the process evolves, there's a tendency for the designer's intent and non-geometrical information to fade, overshadowed by the emphasis on geometric models. This leads to fragmentation of information and redundant efforts, with feature recognition systems often re-creating previously assessed data.

Despite extensive research efforts, there is still no established method to effectively integrate assembly-related information within the product model. Moreover, there is a lack of platforms for early collaboration between stakeholders to communicate ideas, achieve consensus, and incorporate decisions into the final product design.

RESEARCH QUESTIONS

Addressing those challenges requires a concerted effort to bridge the gap between design intent and geometric representation, streamline information flow, and establish inclusive spaces for stakeholder interaction throughout the product development process.

With that aim, five studies were conducted under different research questions, addressing the described issues under a reductionist approach, respectively:

1. How to categorize product requirements to facilitate assembly process planning?
2. How can assembly-related product information be adequately represented to facilitate communication between different stakeholders during the product development process?
3. Are the product functions useful in the assembly process planning? How can these functions and the geometrical model of a product be linked to its assembly process?
4. Could the information behind the physical interface be in assembly process planning? How can this information be reused and archive?
5. How can the design of a product be optimized to facilitate its automatic handling and assembly? Which are the key aspects to consider for this?

METHODS

Due to the wide scope of the proposed questions, different methods were applied to each study, summarized below:

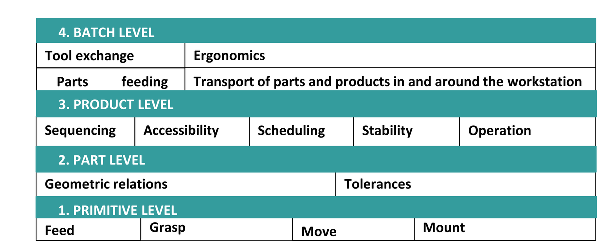
Study No.	Methods	Addressed areas
1	Case study, interviews	Stakeholders, technological information
2	Literature review, Systematic concept analysis, text analysis, scale evaluation	Technological, geometrical, and functional information, stakeholders
3	Functional modelling, case study	Functional and technological information
4	Case study, information modelling	Functional and geometrical information
5	Relational context Analysis, case study	Functional, technological and geometrical information.

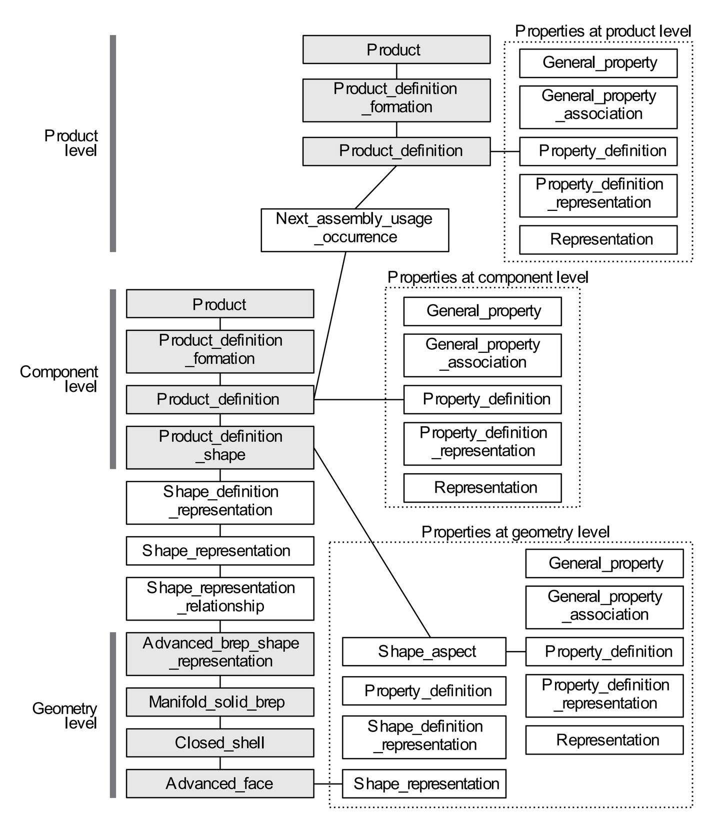
RESULTS

The relevant result of the conducted studies are presented below.

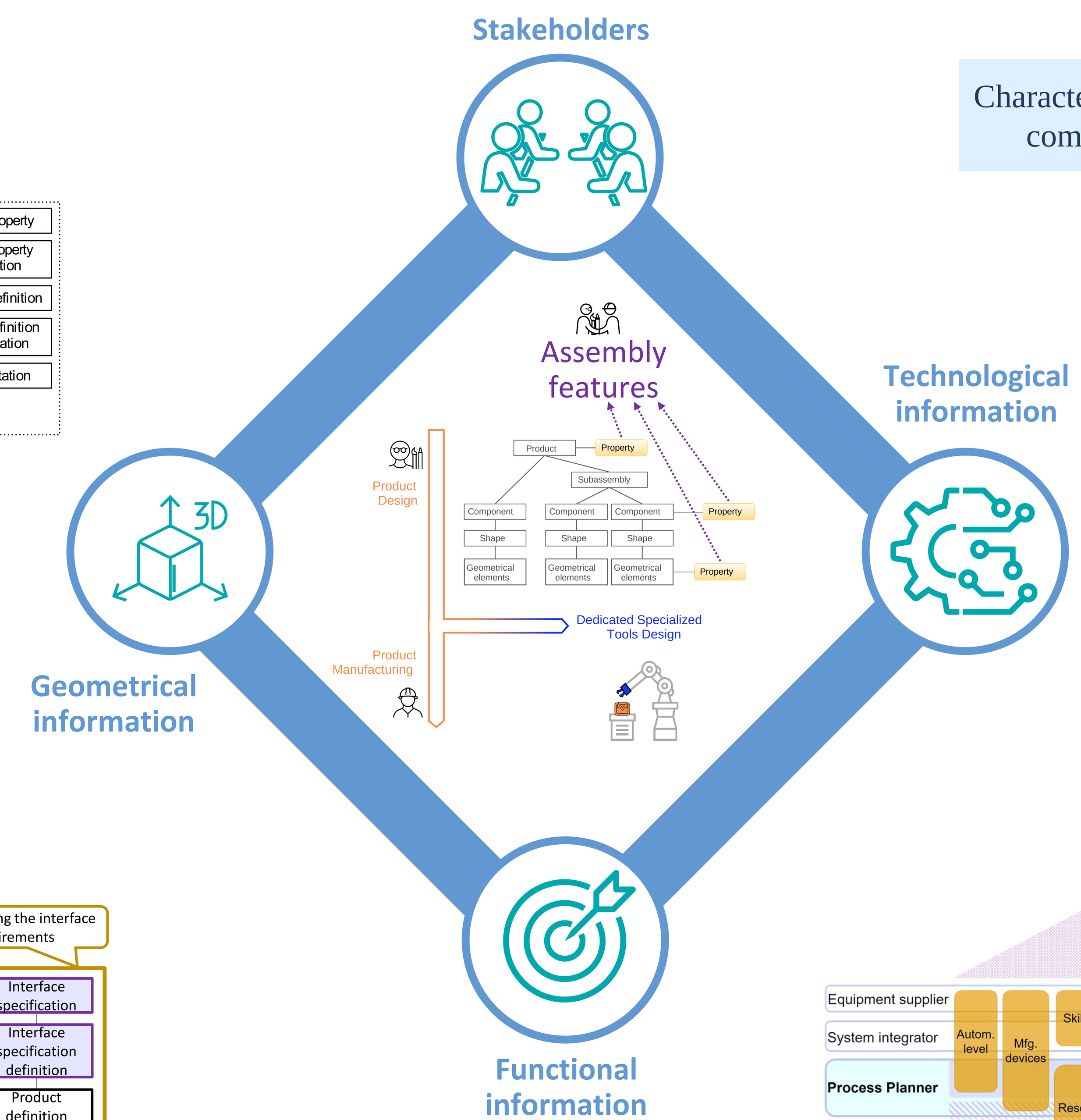
Assembly concepts related to handling considered to enrich the product information model [5]

1 Categorization of assembly requirements [1]

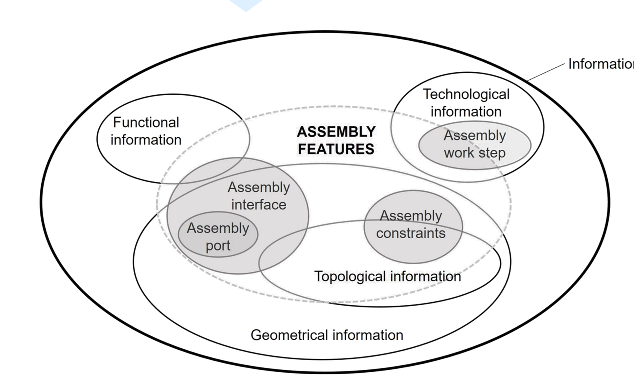




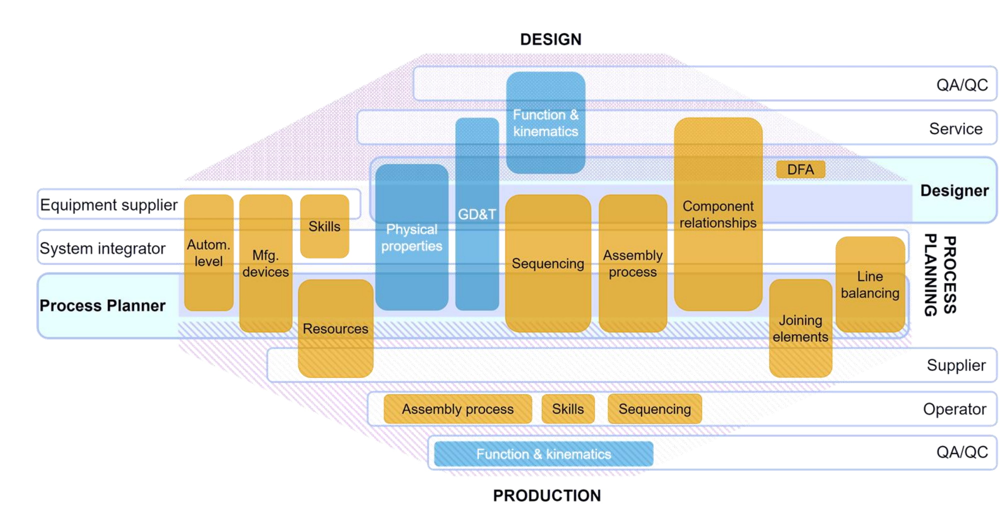
Representing assembly features as user-defined properties within the product model according to ISO 10303 [5] 5

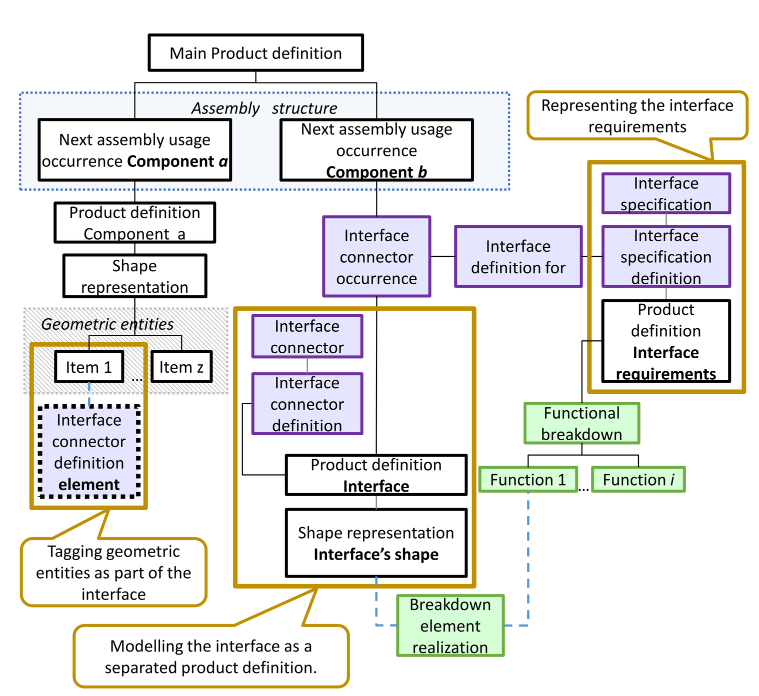


2 Characterization of the assembly feature concept, compared to similar existing concepts [2]

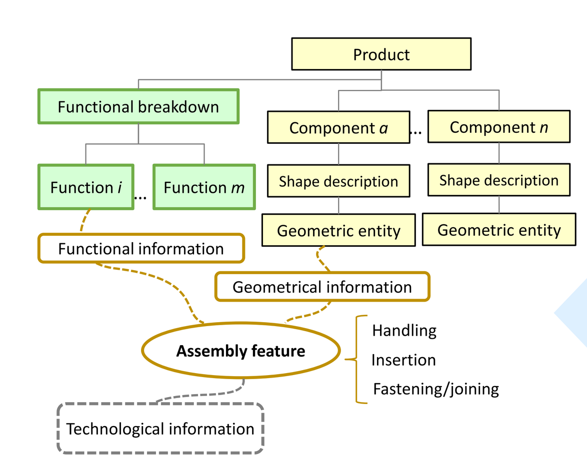


Assembly information and its stakeholders throughout the product development process [2]





A modelling proposal for identifying physical interfaces on the product model based on the ISO 10303 standard [4] 4



Assembly feature as an information carrier [3] 3

CONCLUSIONS

Based on the findings of the conducted studies, several conclusions were derived:

1. A well-defined categorization of assembly requirements facilitates the integration of organizational product design knowledge and stakeholder interactions with technical product specifications. In essence, these categorized requirements can effectively convey the needs of all parties involved, leading to improved comprehension of their impact on the intended domain. Enhanced communication is anticipated to streamline planning processes, thereby reducing product realization timelines.
2. There remains a pressing need to develop a multi-perspective approach centred around a universal core concept for assembly, as this issue remains unresolved. This core concept should encapsulate sufficient information to support the entire product realization process, including during production development phases.
3. The concept of assembly features assumes significance by encompassing functional, geometrical, and technological information. These features serve as carriers of information, facilitating more informed decision-making regarding production planning activities.
4. Clear identification of the product's physical interfaces facilitates information sharing among various stakeholders throughout the product development process, promotes information reuse, and enables the archiving of product designs.
5. A strong correlation exists between product characteristics, handling subprocesses, and the assembly production system. Prompt definition of product characteristics presents opportunities for early design of specialized dedicated equipment.

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ACKNOWLEDGMENTS

The financial support from the H2020-MSCA-ITN DiManD project funded by the European Union's Horizon 2020 under grant agreement No. 814078 is gratefully acknowledged.

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