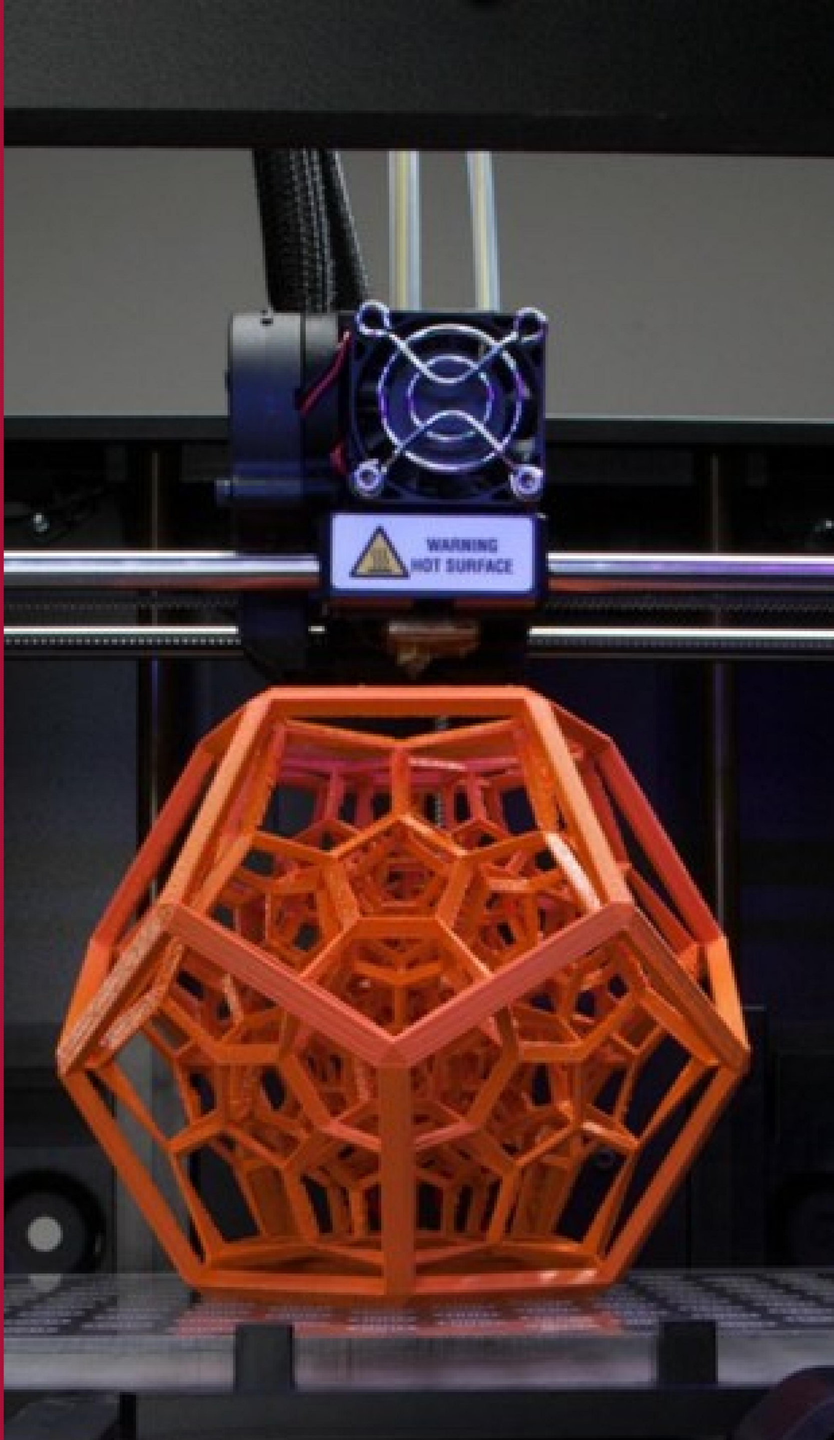
Investigating the Impact of CAD Data Transfer Standards for 3DP-RDM

Malte Ressin, Eujin Pei



Introduction

Malte Ressin, Eujin Pei

College of Engineering, Design and Physical Sciences, Brunel University London

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Problem Statement

3D printing uses digital chain of information

Many of CAD formats extant, only some used for data transfer

No CAD data transfer standard for a 3DP-RDM ecosystem

=> The purpose of this study is to investigate the impact of CAD data transfer standards within the 3DP-RDM landscape.

Research Objectives

Overarching question: What is the impact of CAD data transfer standards in 3DP-RDM landscape?

Addressed by:

1. Literature Review
2. Standards Review
3. Focus Groups / Interviews

1. Literature Review

RQ1: What are the features of 3DP-RDM?

RQ2: What data Interface problems exist with current AM methods?

RQ3: Do different scenarios or situations influence the choice of CAD data transfer standards?

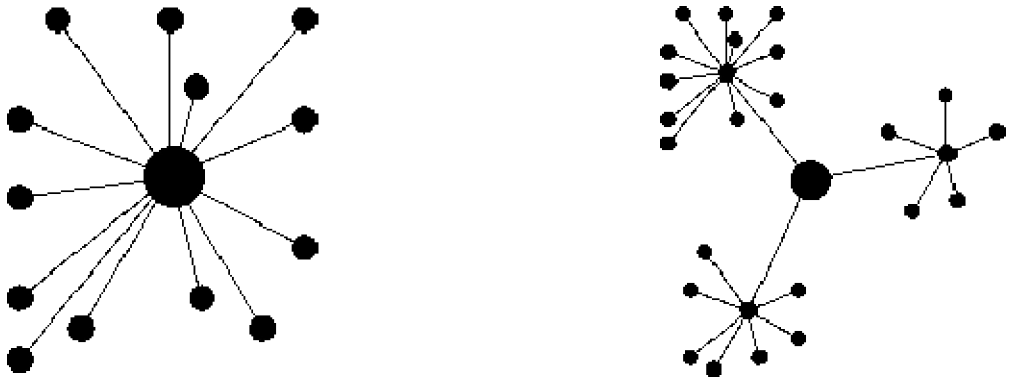
RQ1: Features of 3DP-RDM

Adapted, customer-configured or individualised products

Iterative development

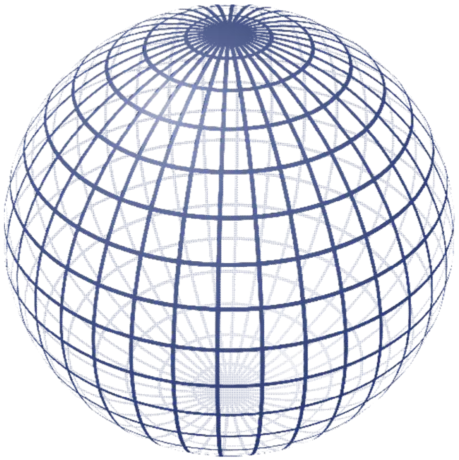
Customer involvement in development and manufacturing

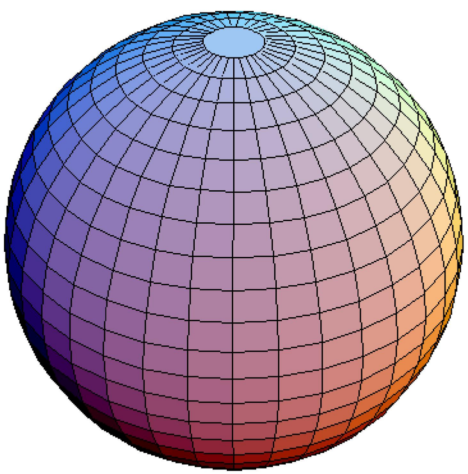
Truly global, de-centralised manufacturing, close to customer location, possibly even at home

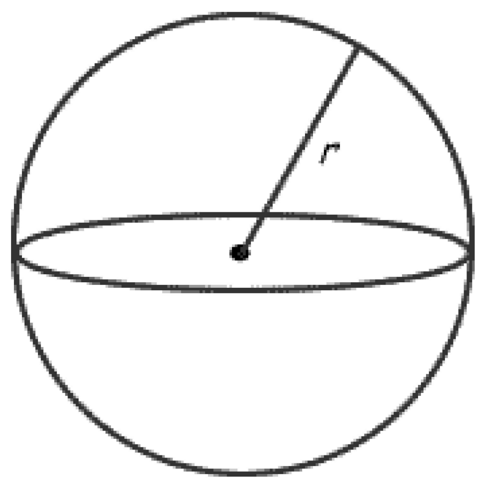


RQ2: What data interface problems exist with current 3DP methods?

1. Surface vs. volume description
2. No established standard
3. Industrial manufacturing data requirements beyond geometry
4. Tessellated vs. geometric models







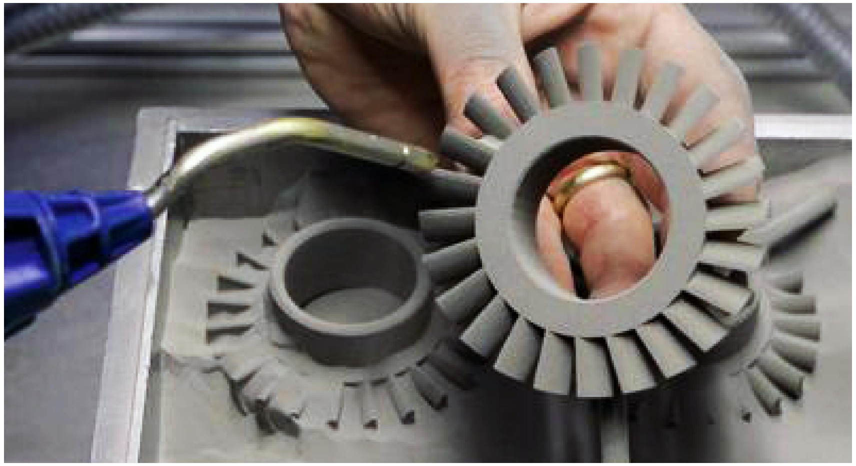
RQ3: Do different scenarios or situations influence the choice of CAD data transfer standards?

Prototyping/"maker" prod.:

- single material
- approximate shapes
- wide tolerances
- reduced functionality

Industrial manufacturing

- multiple materials
- material gradation
- strict tolerances
- functionality



2. Standards Review

RQ4: What are the aims and contributions of AMF, STEP and STEP-NC standards?

RQ5: What are the advantages, disadvantages, similarities and differences of these standards?

RQ6: Which stage of the design or manufacturing process are these standards used?

RQ7: Which standard is most widely used for CAD data transfer and why?

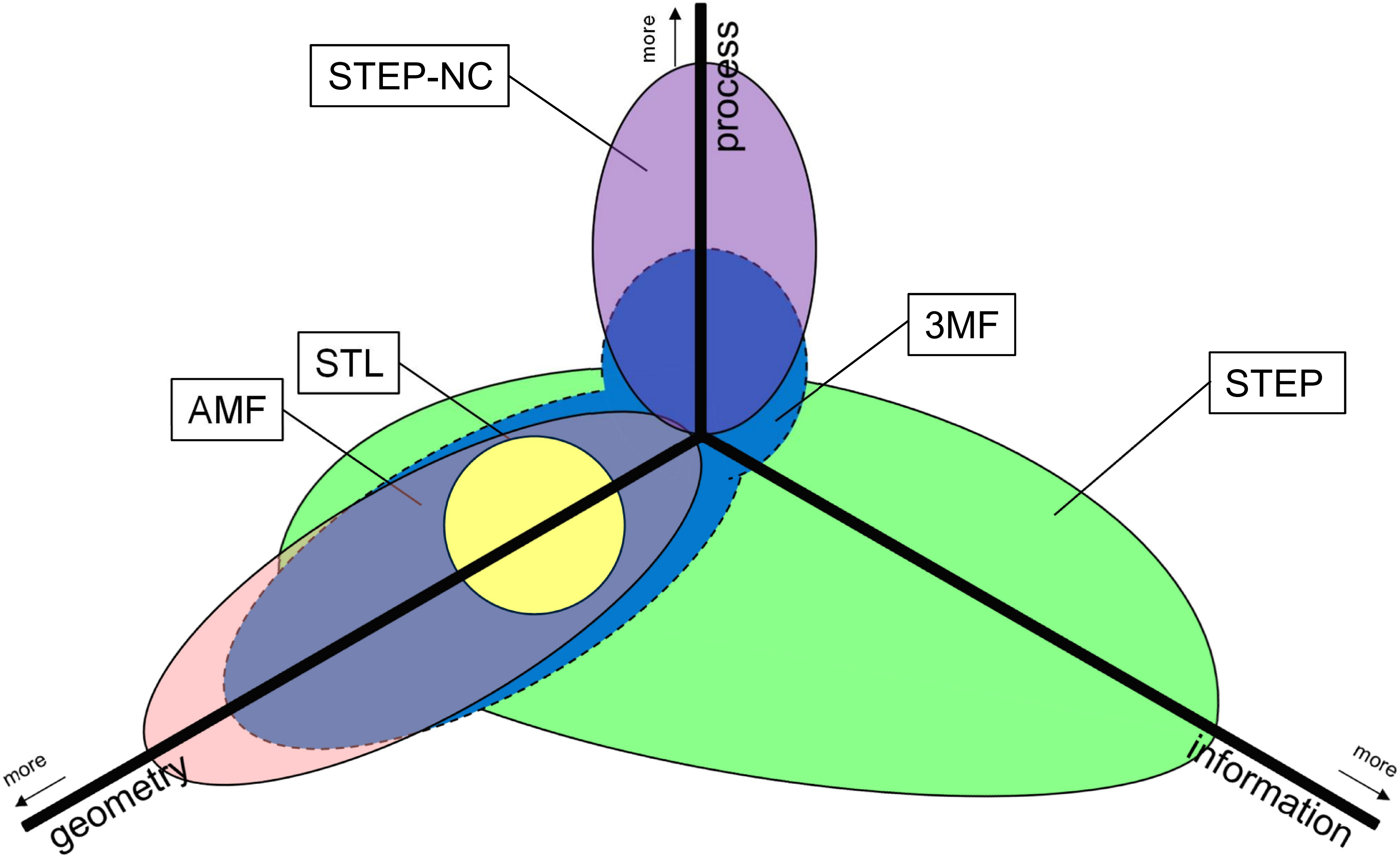
Existing Standards

STL:	proprietary, but de-facto standard through frequent adoption
STEP:	ISO standard ISO 10303 (AP 242)
STEP-NC:	ISO standard, ISO 14649
AMF:	ISO standard, ISO 52915
3MF:	industry consortium including Microsoft, HP, Fit, formLabs, etc.

RQ4: Aims and Contributions of Existing Standards

STL:	Surface geometry description for photosolidification
STEP:	Product data management for information exchange and archiving
STEP-NC:	Device control for manufacturing
AMF:	STL replacement supporting full range of 3DP features
3MF:	STL replacement supporting full range of 3PD features, includes workflow automation

RQ4: Aims and Contributions of Existing Standards

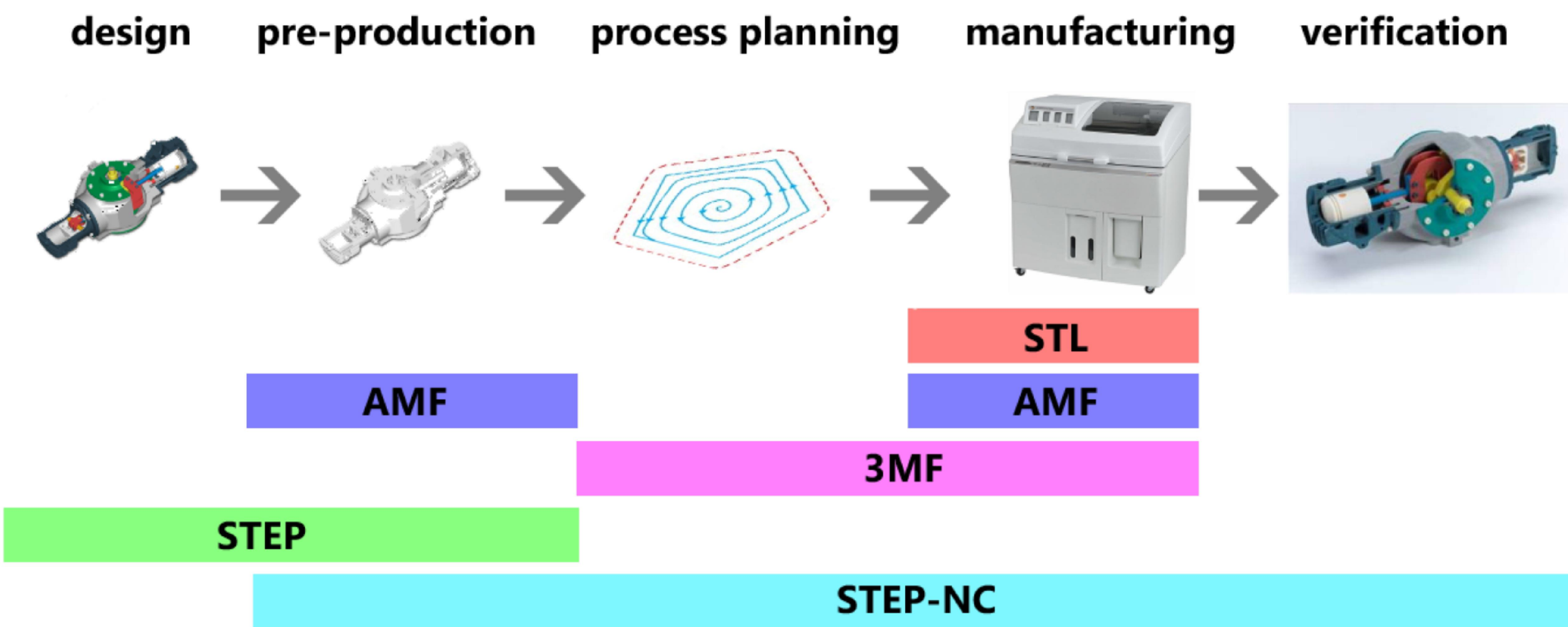


RQ5: What are the advantages, disadvantages, similarities and differences of standards?

	Advantages	Disadvantages
STL	Simplicity	Information redundancy, no support for modern 3DP features
STEP	Multiple representations of 3D model	Complexity
STEP-NC	Precision and tolerance support	No tessellated representation
AMF	Support for modern 3DP features	File size
3MF	Support for modern 3DP features, process automation	File size

RQ6: Which stage of the design or manufacturing process are these standards used?

STL: Manufacturing
STEP: Design and process planning
STEP-NC: Process-planning, pre-production and manufacturing
AMF: Pre-production and manufacturing
3MF: Manufacturing



RQ7: Which standard is most widely used for CAD data transfer and why?

Based on existing literature and informal overviews:

STL de-facto standard supported by wide range of devices

Supported by implication from a large volume of literature discussing drawbacks of STL

None of the replacements discussed here have found widespread traction yet

However, a wide range of alternative proprietary standards in use

3. Data Transfer Standards in 3DP-RDM

RQ8: Who are the users and beneficiaries of 3DP-RDM CAD data transfer standards?

RQ9: Which CAD data transfer standard has greatest competitive advantage for 3DP-RDM landscape?

RQ10: What impact could CAD data transfer standards have on a 3DP-RDM landscape?

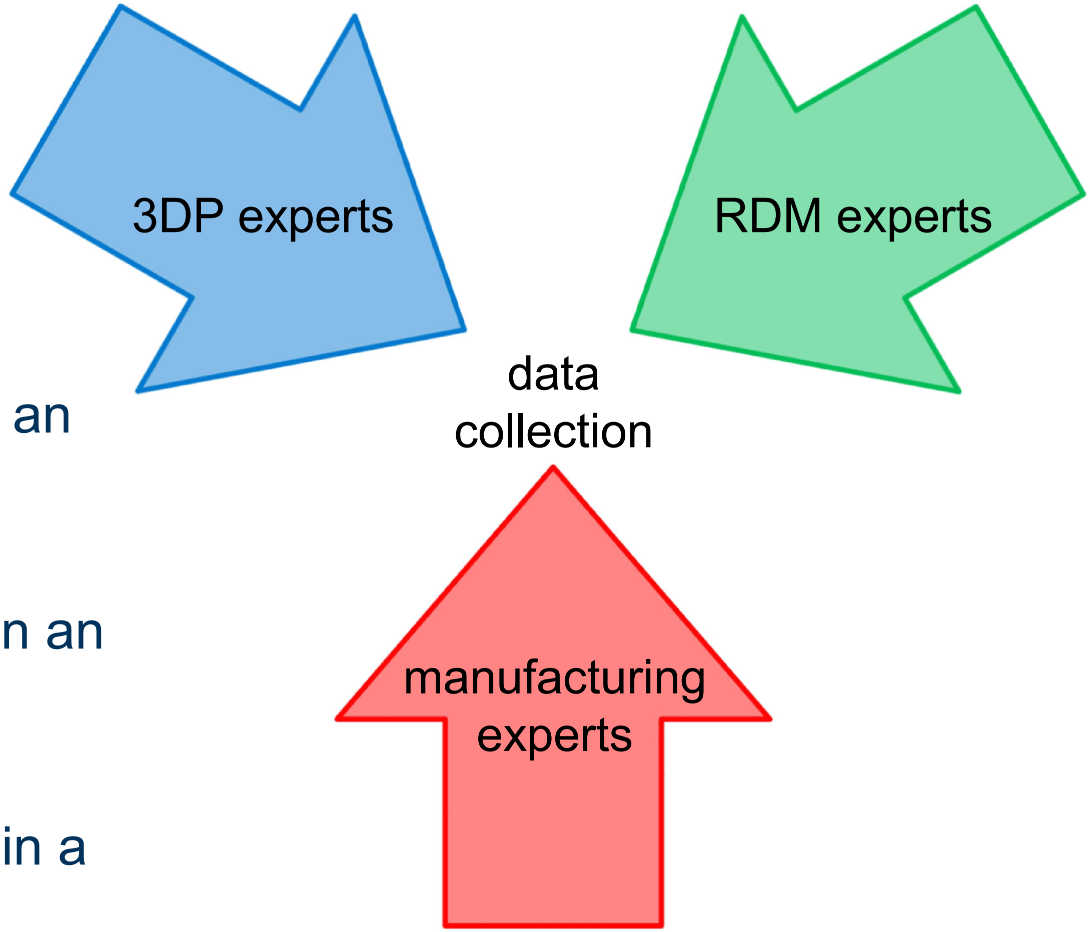
RQ11: Are there opportunities for an open architecture 3DP-RDM CAD data transfer standard?

RQ12: What characteristics are required to manage and utilise 3DP RDM CAD data transfer standards?

Data Collection and Recruitment

Obtain views of experts from different areas on requirements and limitations:

- How might 3DP fit into an RDM scenario?
- What are the data requirements on 3DP in an RDM scenario?
- What 3DP data format features are desirable in a 3DP-RDM scenario?



Research Methods

Focus groups with RDM specialists:

- Discuss the role of 3DP in RDM

Focus Groups with 3DP/manufacturing industry specialists:

- Discuss the role of data exchange standards for 3DP and their desired features in the context of 3DP-RDM.

Analysis: thematic (questions)

Research Methods

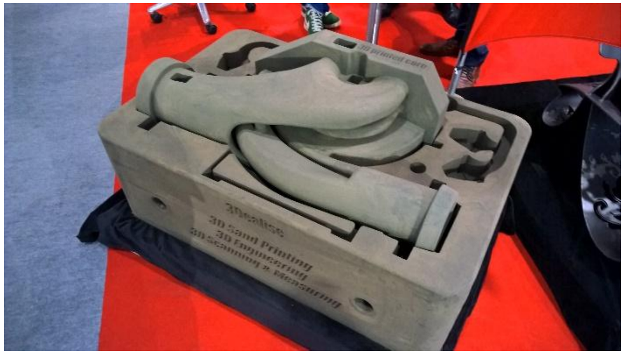
Structured interview/questionnaire with 3DP manufacturing/industry specialists:

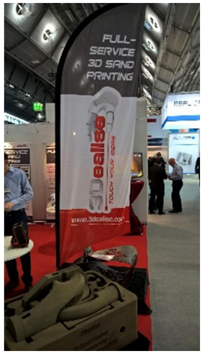
- Open questions on standards for 3DP processes and industry
- Vote on importance of support for various 3DP features, e.g.:
  - Compression, units, copyright information, print queues, tool paths, metadata, open architecture, curvature/voxel/geometric representation, multiuser editing

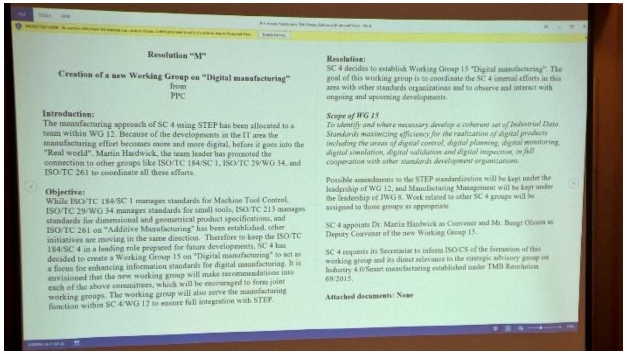
Analysis: descriptive-statistical (voting)

Groundwork, Recruitment, Feedback

Oct. 2015:	ISO TC184/SC4 STEP-NC meeting, Baltim.
Nov. 2015:	FormNext 3DP industry fair, Frankfurt
	Disruptive Innovation Festival, online
Dec. 2015:	RDM|RSC workshop, Exeter
Jan. 2016:	3DP-RDM workshop, Cambridge
	ISO TC 261 (AMF) meeting, Philadelphia







Resolution "M"

Creation of a new Working Group on "Digital manufacturing"
from
PPC

Introduction:
The manufacturing approach of SC 4 using STEP has been allocated to a team within WG 12. Because of the developments in the IT area the manufacturing effort becomes more and more digital, before it goes into the "Real world". Martin Hardwick, the team leader has promoted the connection to other groups like ISO/TC 184/SC 1, ISO/TC 29/WG 34, and ISO/TC 261 to coordinate all these efforts.

Objective:
While ISO/TC 184/SC 1 manages standards for Machine Tool Control, ISO/TC 29/WG 34 manages standards for small tools, ISO/TC 213 manages standards for dimensional and geometrical product specifications, and ISO/TC 261 on "Additive Manufacturing" has been established, other initiatives are moving in the same direction. Therefore to keep the ISO/TC 184/SC 4 in a leading role prepared for future developments, SC 4 has decided to create a Working Group 15 on "Digital manufacturing" to act as a focus for enhancing information standards for digital manufacturing. It is envisioned that the new working group will make recommendations into each of the above committees, which will be encouraged to form joint working groups. The working group will also serve the manufacturing function within SC 4/WG 12 to ensure full integration with STEP.

Resolution:
SC 4 decides to establish Working Group 15 "Digital manufacturing". The goal of this working group is to coordinate the SC 4 internal efforts in this area with other standards organizations and to observe and interact with ongoing and upcoming developments.

Scope of WG 15
To identify and where necessary develop a coherent set of Industrial Data Standards maximizing efficiency for the realization of digital products including the areas of digital control, digital planning, digital monitoring, digital simulation, digital validation and digital inspection, in full cooperation with other standards development organizations.

Possible amendments to the STEP standardization will be kept under the leadership of WG 12, and Manufacturing Management will be kept under the leadership of JWG 8. Work related to other SC 4 groups will be assigned to those groups as appropriate.

SC 4 appoints Dr. Martin Hardwick as Convener and Mr. Bengt Olsson as Deputy Convener of the new Working Group 15.

SC 4 requests its Secretariat to inform ISO/CS of the formation of this working group and its direct relevance to the strategic advisory group on Industry 4.0/Smart manufacturing established under TMB Resolution 69/2015.

Attached documents: None

The End

Any questions?