



Prof. Dr. F. Neumann

Applying 3D PDF within shape-based similarity search

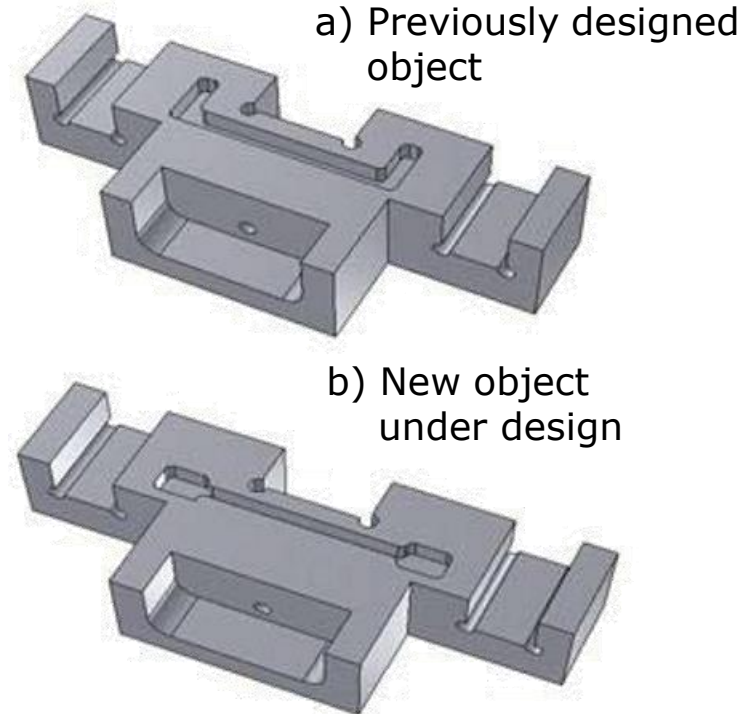
15.05.2017

Overview

- Why similarity search in product development?
- The conventional approach
- The shape-based approach(es)
- How can 3D PDF support similarity search?
- Experiences, results and outlook

Why similarity search in product development?

1. Rule in product development:
Keep the **variety of components** used in a product and in the whole company as low as possible.
 2. **Estimate costs** based on similar components
- Search and rank **similar components** used within the same product or in previous products



Source: Cardone et al. (2003)

The conventional approach - overview

- **Classification** of components into **groups** (e.g. springs, bearings, resistors, capacitors) based on geometrical, functional and physical characteristics
- Each group is characterized by a distinct set of **attributes** (e.g. geometry, material, and performance).
- In Germany: *Sachmerkmaleisten* according to DIN 4000

Sachmerkmaleistensystem		
SML-Gruppe AW - 89		
Durchm.	Länge	Abs
122,5	235,8	15,
65,5	122,0	18,
65,5	122,5	8,
90,0	145,2	22,
135,0	220,8	64,
72,0	165,2	45,
88,2	180,0	30,
//IA> Suchhierarchie <U O> Ur		

Source: Eigner et al. (2014)

The conventional approach - example

Classification based on tabular layouts of article characteristics (TLAC)

1 von 1	Sachmerkmaleiste DIN 4000					
	für Flachrundschraube mit Vierkantansatz DIN 603					
Merkmalkennung	nd	dk	k	c	f	v
Merkmalsbezeichnung	Nenn Durchmesser	Kopfdurchmesser	Kopfhöhe	Kopfstärke	Vierkant-höhe	Vierkant-breite
Einheit	mm	mm	mm	mm	mm	mm
M5	5	13	3	0.5	3.5	5
M6	6	16	3.5	0.5	4	6
M8	8	20	4.5	0.8	5	8
M10	10	24	5	1	6	10
M12	12	30	6.5	1	8	12
M16	16	38	8.5	1.2	12	16
M20	20	46	10.5	1.5	15	20

Source: Jahn (2000)

The conventional approach - disadvantages

- Setup of classification system
 - Recurrening effort for the manual classification when adding new or updating changed components
 - Initial training for the users on the used groups and their attributes
- Does not benefit from the general availability of **3D models**

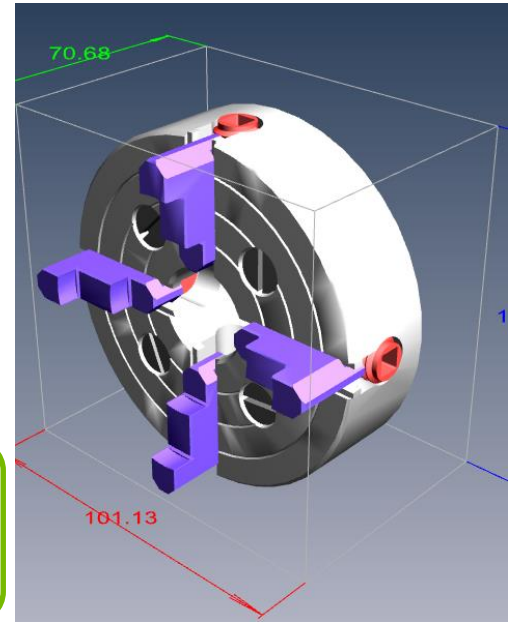
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Source: Eigner et al. (2014)

The shape-based approach(es) – ideas

- **Today:**
General availability of **3D models** in product development
- **Ideas:**
 1. Automatic classification based on shape (e.g. simus systems)
 2. Similarity search based on 3D models w/o classification (e.g. Geolus Search)



Source: PDF3D (2016)

The shape-based approach(es) – Shape matching constituents

Shape Descriptor

- Ideal **representation** of the characteristics of a 3D model
- **Measure** for the **similarity** of 3D models, i.e. if two models are identical, they must have the same shape descriptor

Distance between 2 Shape Descriptors

- **Function** representing the similarity between two 3D models
- In general: **Positive** number
- For **identical shapes**: 0

The shape-based approach(es) – Shape retrieval queries

Similarity Search based on Text

- Use keywords describing the content

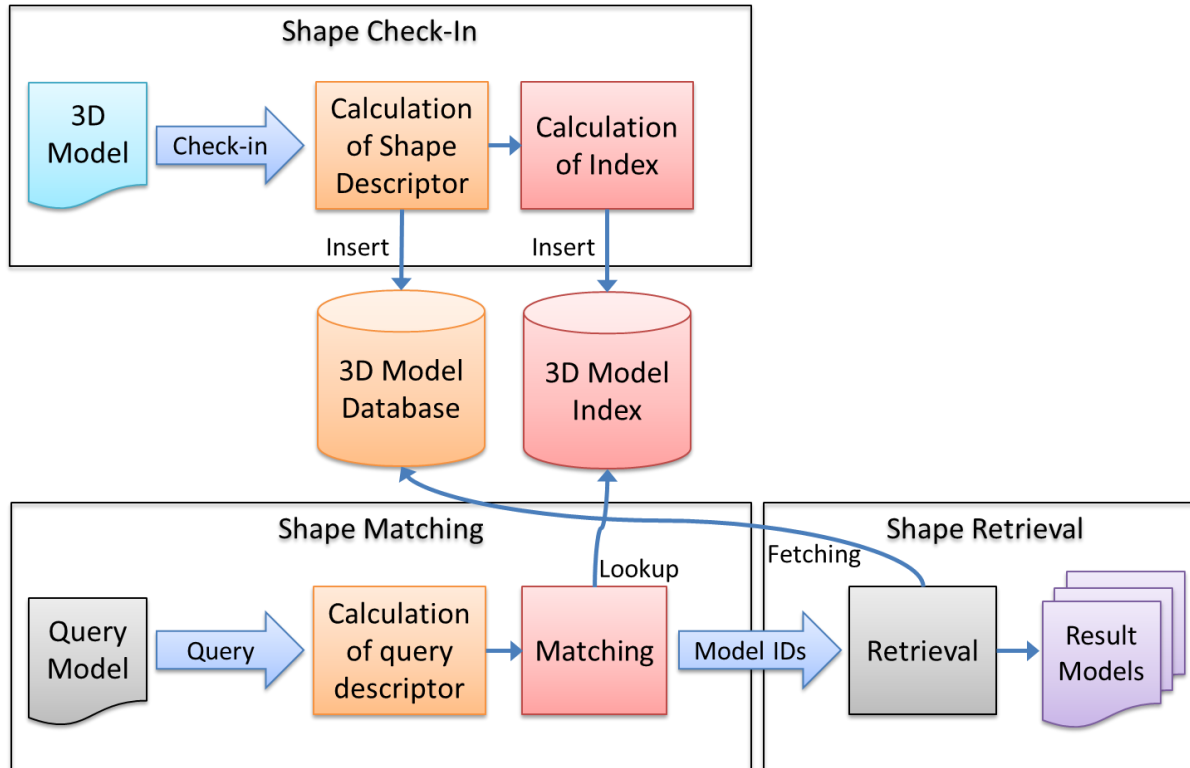
Similarity Search based on 2D Sketch



Similarity Search based on 3D Model



The shape-based approach(es) – Check-in, matching and retrieval

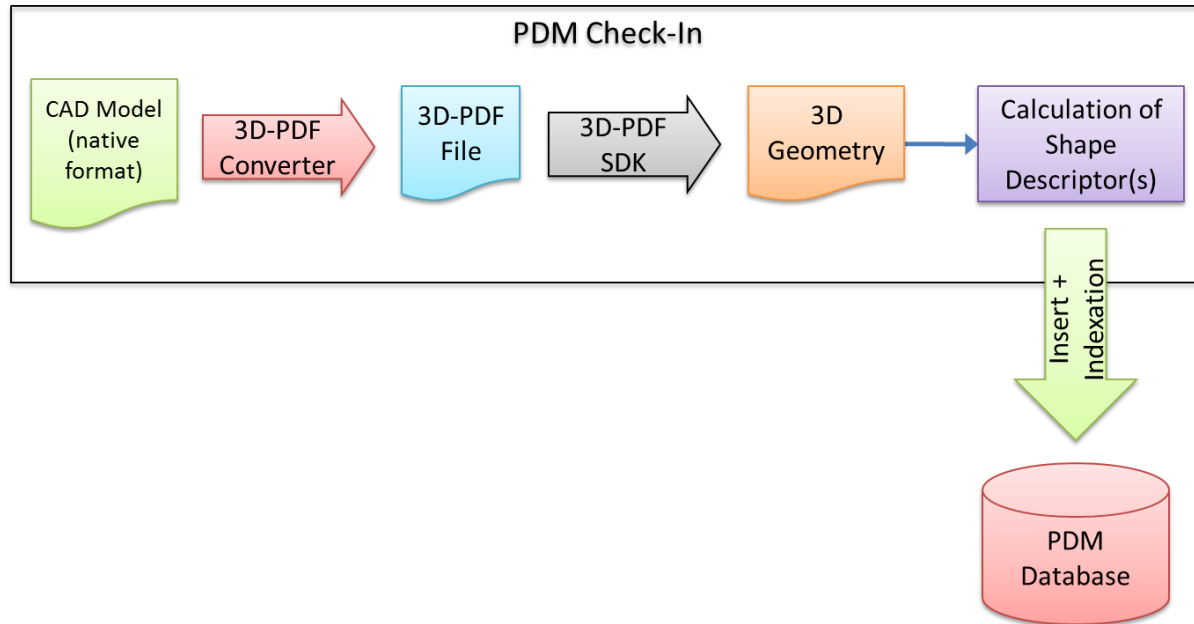


How can 3D PDF support similarity search?

In PDM/PLM systems:

- 3D PDF representation for model from broad range of 3D-CAD systems generated upon **check-in** (cf. Aras presentation)
- Tessellated data stored in the 3D PDF file provides the **input format** for calculation of shape descriptors.
- 3D PDF may serve as input for the similarity search for both **parts** and **assemblies**.
- Calculation of **shape descriptor** as part of the post-processing chain upon check-in

How can 3D PDF support similarity search?



Experiences, results and outlook

- Adoption of 3D PDF format significantly **reduces** the **implementation efforts** for of shape based similarity search involving **multiple CAD systems**
- HOOPS Exchange Toolkit allows for an implementation of a 3D PDF reader in approx. **500 lines** of client code
- Future research:
 - Efficient **indexing** for the selected shape descriptor
 - 3D PDF as basis for **B-Rep graph** based methods

The screenshot shows a web browser window titled 'http://192.168.130.131 - CAD Document - BA-042 (read only) - Mozilla Firefox'. The main content area is titled 'CAD Document' and displays the following information:

- Document Number: BA-042
- Revision: A
- State: Preliminary
- Name: Hohler Zylinder
- Created By: Innovator Admin
- Created On: 8/29/2016
- Modified By: Innovator Admin
- Modified On: 9/6/2016
- Locked By:
- Major Rev: A
- Release Date:
- Effective Date:
- Generation: 1
- State: Preliminary

Below the metadata, there are checkboxes for 'Changes Pending', 'Standard', and 'Template'. At the bottom, there is a '3D Retrieval' tab with a table of results:

Place	Document Number	Name	Result
1	BA-049	Hohler Zylinder 6	178
2	BA-045	Hohler Zylinder 4	238
3	BA-043	Hohler Zylinder 2	389
4	BA-044	Hohler Zylinder 3	515
5	BA-046	Hohler Zylinder 5	567
6	BA-034	Zylinder hohl 2	658
7	BA-037	Extruder	691
8	BA-002	Zylinder	749
9	BA-002'	Zylinder-Kopie	749

Source: Atten (2016)

***Thank you for your attention.
Any questions?***