JÖNKÖPING UNIVERSITY

Integration of manufacturers' product data in BIM platforms using semantic web technologies

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- *Title: Integration of manufacturers' product data in BIM platforms using semantic web technologies*
  - Semantic Web
  - Manufacturers Product Data

Published in the journal of automation in construction (https://doi.org/10.1016/j.autcon.2022.104630)

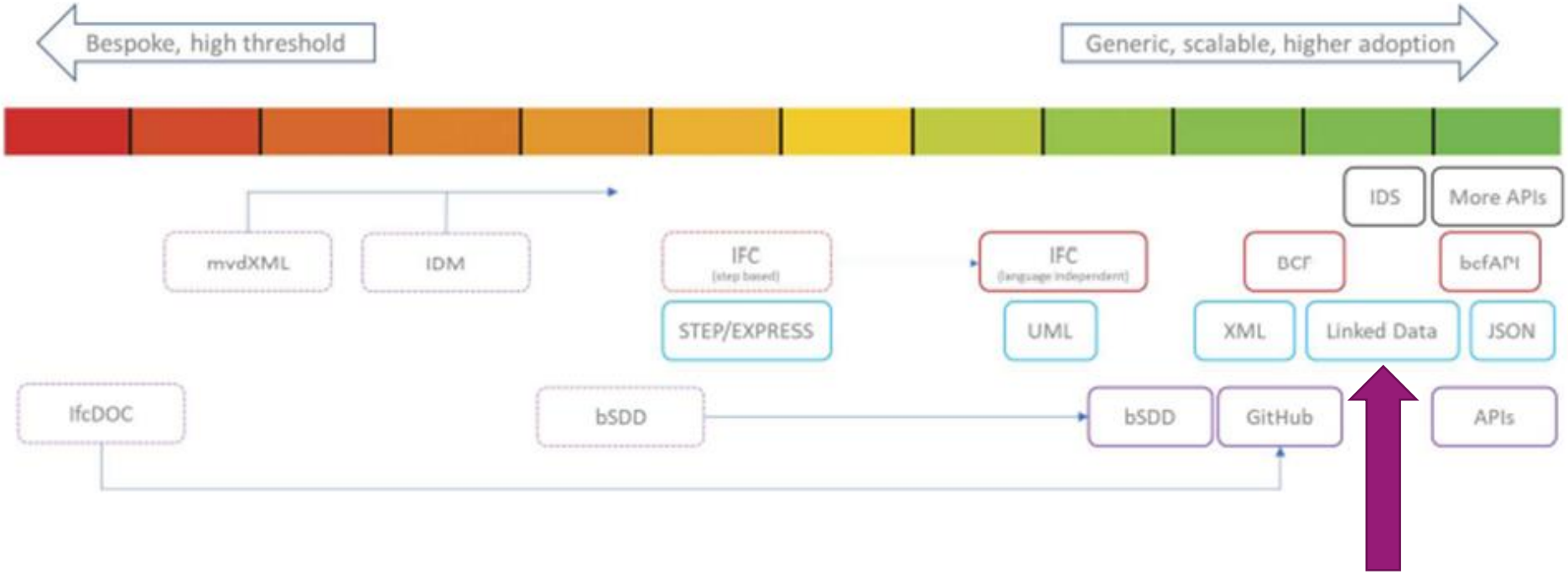
PRESENTATION OUTLINE

1. Research Problem
2. Research Motivation
3. Research Purpose
4. Research Workflow
5. Current Research
6. Questions and feedback

1. RESEARCH PROBLEM

- Manufacturers are required to distribute their **product data** in **digital** form
- Currently **BIM objects** and **PDF** documents are mostly widely used
- These formats do not support **flexible data integration** and **product search** based on semantics
- time-consuming and error-prone process of **manually** entering product data into BIM software

2. RESEARCH MOTIVATION



(*BuildingSMART Technical Roadmap, 2020)*

2. RESEARCH MOTIVATION

Title: Semantic web technologies for information exchange between the building and manufacturing industries: a literature review

- Benefits of SW technologies
- Limitations of SW technologies
- Limitation of openBIM standards for information exchange
- Recommendations to the application of SW in the building industry


SEMANTIC WEB FOR INFORMATION EXCHANGE BETWEEN THE BUILDING AND MANUFACTURING INDUSTRIES: A LITERATURE REVIEW

Published in proceedings with the 37th CIB W78 Information Technology for Construction Conference (CIB W78)

(http://dx.doi.org/10.46421/2706-6568.37.2020.paper018)

2. RESEARCH MOTIVATION

Recommendations:

- Studies suggest the application of semantic web in **combination** with the existing technologies due to:
  - the wide industry adoption and support of the existing technologies by various BIM software applications
  - several involved actors such as engineers, designers, and manufacturers use different software applications and have their own way of representing their knowledge

2. RESEARCH MOTIVATION

- Autodesk Revit and Dynamo
- Dynamo is a widely used visual programming language (VPL) for BIM processes. It is integrated with Revit and can be easily deployed using Dynamo Player or plugins like Nonica
- Users can **extend** Dynamo's functionalities using custom nodes and packages
- Using a **well-established** tool like Dynamo coupled with the **emerging** Semantic Web technologies will bring the application of Semantic Web technologies close to users as well as increase the applicability of the method introduced in this research
- Modeling the non-geometric (semantic) data of products

2. RESEARCH MOTIVATION – LD + DYNAMO

- Generative design / Genetic algorithm (Future Research)

- Empower designers with the ability to **compare** products and **optimize** their product choices considering different factors, such as energy efficiency, cost, aesthetic appeal, and light level requirements

- Federated SPARQL queries – retrieve data from distributed RDF databases or data sources and perform the generative design process

2. RESEARCH APPROACH

Approach -

M. Bonduel, M. Vergauwen, R. Klein, M.H. Rasmussen, P. Pauwels, A novel workflow to combine BIM and linked data for existing buildings, eWork and eBusiness in Architecture, Engineering and Construction, CRC Press, 2018, pp. 347-354, https://doi.org/10.1201/9780429506215-43

Evaluation -

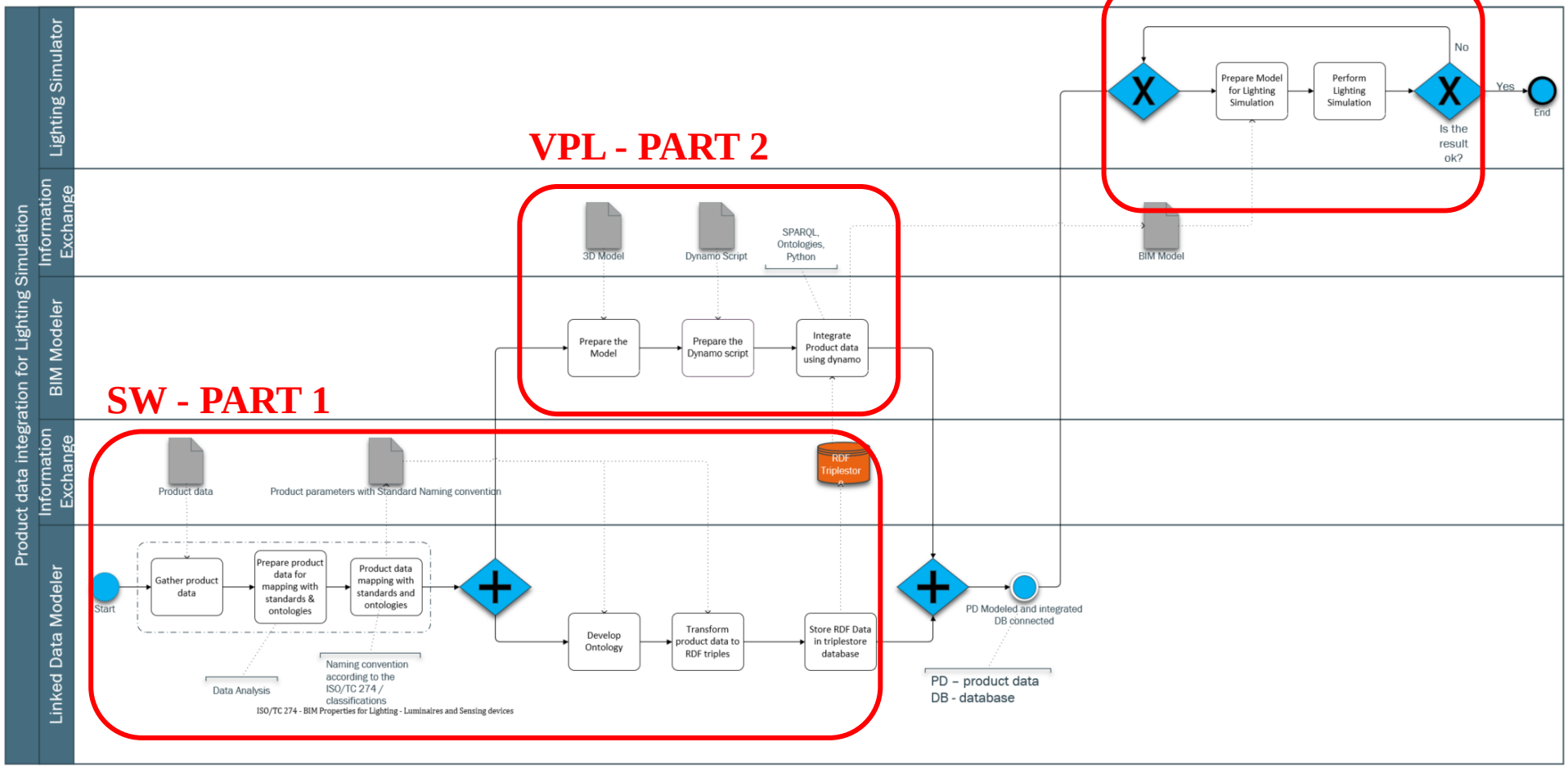
- Lighting simulation
- Testing - with the company representatives
- Informed argument - use of information from relevant research to build a convincing argument for the applicability of implemented method

A. Wagner, W. Sprenger, C. Maurer, T.E. Kuhn, U. Rüppel, Building product ontology: Core ontology for Linked Building Product Data, Automation in Construction 133 (2022), https://doi.org/10.1016/j.autcon.2021.103927

3. RESEARCH PURPOSE

To introduce a method to support the integration of manufacturers' product data in BIM software using Semantic Web technologies and Visual Programming Language

4. RESEARCH WORKFLOW



PART 1 & PART 2 – BUILDING THE METHOD

PART 3 – EVALUATING THE METHOD

4. RESEARCH WORKFLOW

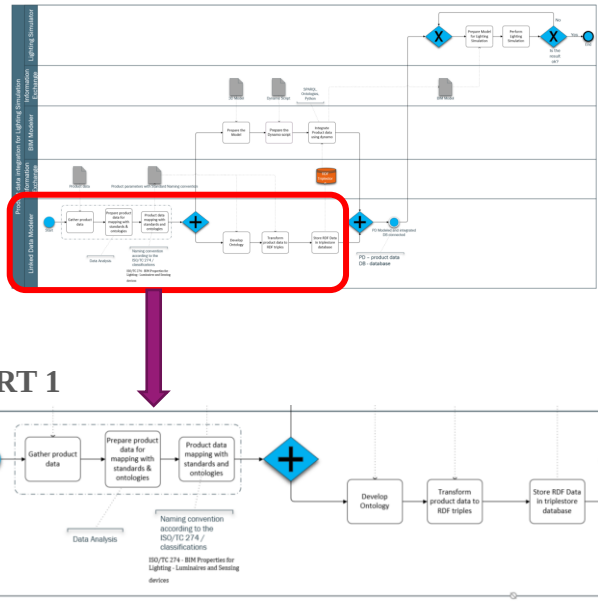
4.1. SEMANTIC WEB APPLICATION – PART 1

OBJECTIVE:

- Promote the use of **standards** for product descriptions to improve cross-domain data **interoperability** between digital tools and involved actors
- Standards play major role to share **common understanding** of product data
- Many standards are written in natural language text and formatted for human consumption
- Standards should be supported by explicit semantics & **data formats** that are machine-understandable and enable seamless machine processing
- Assist humans in various activities: automation, easy access, search & sharing of data

4. RESEARCH WORKFLOW

4.1. SEMANTIC WEB APPLICATION – PART 1



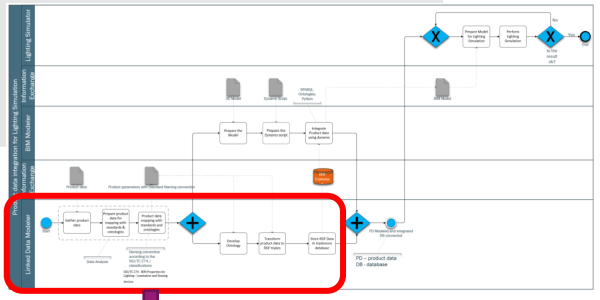
MAIN STEPS

1. Product data - excel - **map** with the SIS-CEN/TS 17623:2021 standard

    - CEN/TS 17623:2021 standard – BIM Properties for lighting – Luminaires and sensing devices
    - refers to the ISO 23386:2020
    - Light products
    - Understandable by users globally
    - Manufacturers keep their way of representing data

4. RESEARCH WORKFLOW

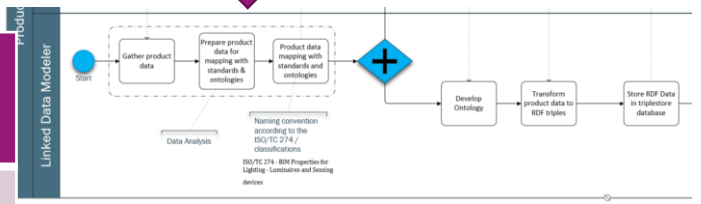
4.1. SEMANTIC WEB APPLICATION – PART 1



MAIN STEPS

2. CEN/TS 17623:2021 ontology
    - Orignial format – PDF ==> OWL
3. Product ontology

PART 1



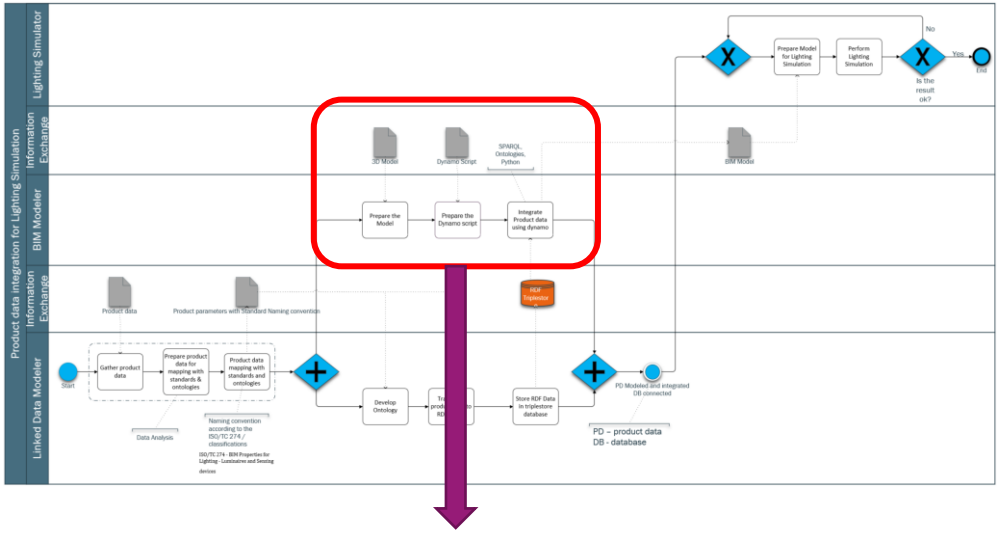
Product data model in the studied case	Product ontology
Family	Class
Properties	Object properties /Relations
Instances /Items	Individuals

- Linked it with the CEN/TS 17623:2021 ontology
- In this ontology, product data is described by both the manufacturer and a standard format

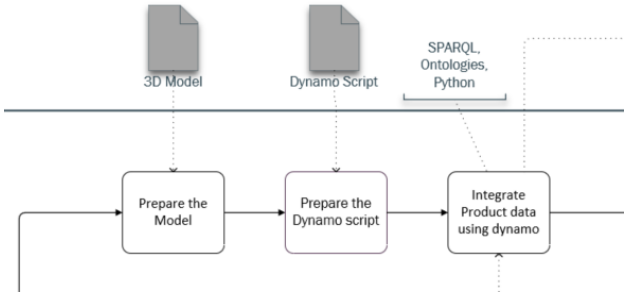
4. Product data transformed into RDF
5. Store/Access/Update/Retrieve data – SPARQL

4. RESEARCH WORKFLOW

4.2. VISUAL PROGRAMMING APPLICATION – PART 2



PART 2



4. RESEARCH WORKFLOW

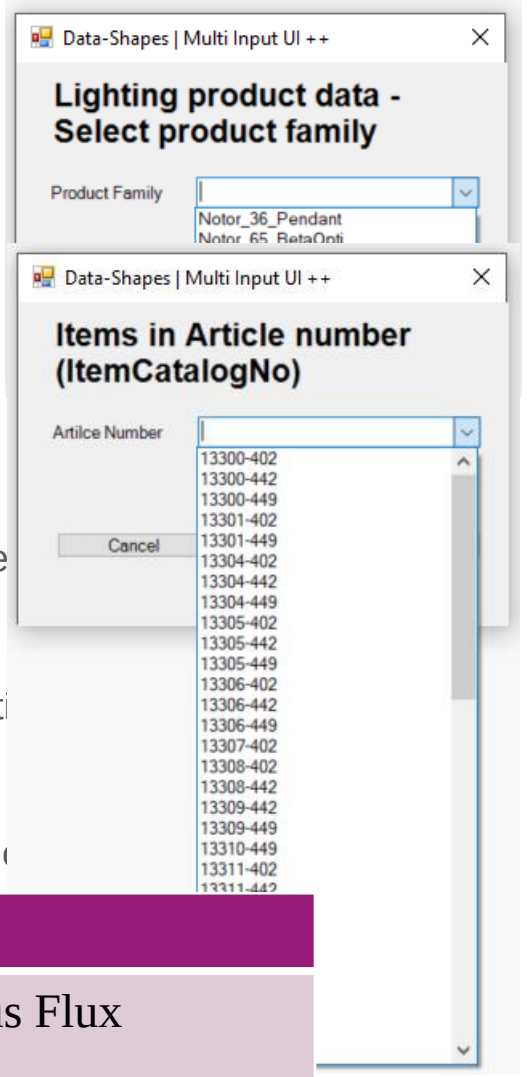
4.2. VISUAL PROGRAMMING APPLICATION – PART 2

MAIN COMPONENTS/ STEPS

1. Connect to database - local or remote
2. Select Product Family - user interface
3. Run a SPARQL query to retrieve all instances of the product family
4. Select Product instance - user interface
5. Run SPARQL query to retrieve product data for the product instance according to the manufacturer's representation

Run SPARQL query to translate the manufacturer's product descripti 17623:2021 standard

Run python script to translate with the Revit convention of product d



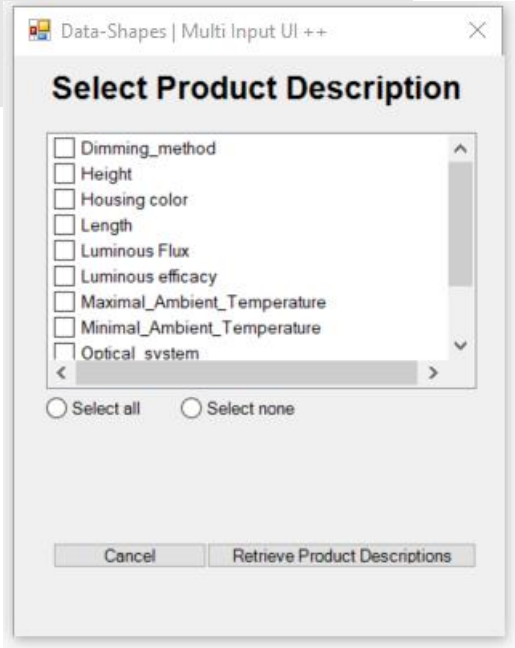
Manufacturer	CEN/TS 17623:2021	Revit
Lumen output	Rated Luminous Flux of the luminaire	Luminous Flux

4. RESEARCH WORKFLOW

4.2. VISUAL PROGRAMMING APPLICATION – PART 2

MAIN COMPONENTS/ STEPS

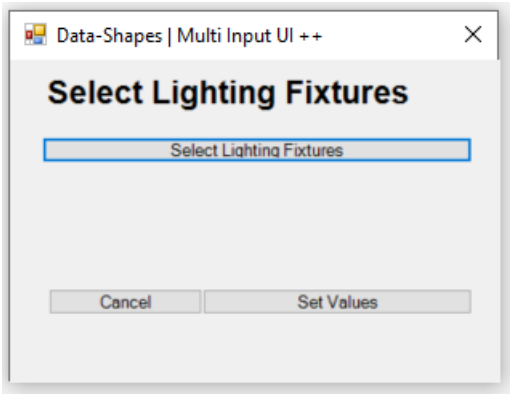
6. Select product descriptions – user interface



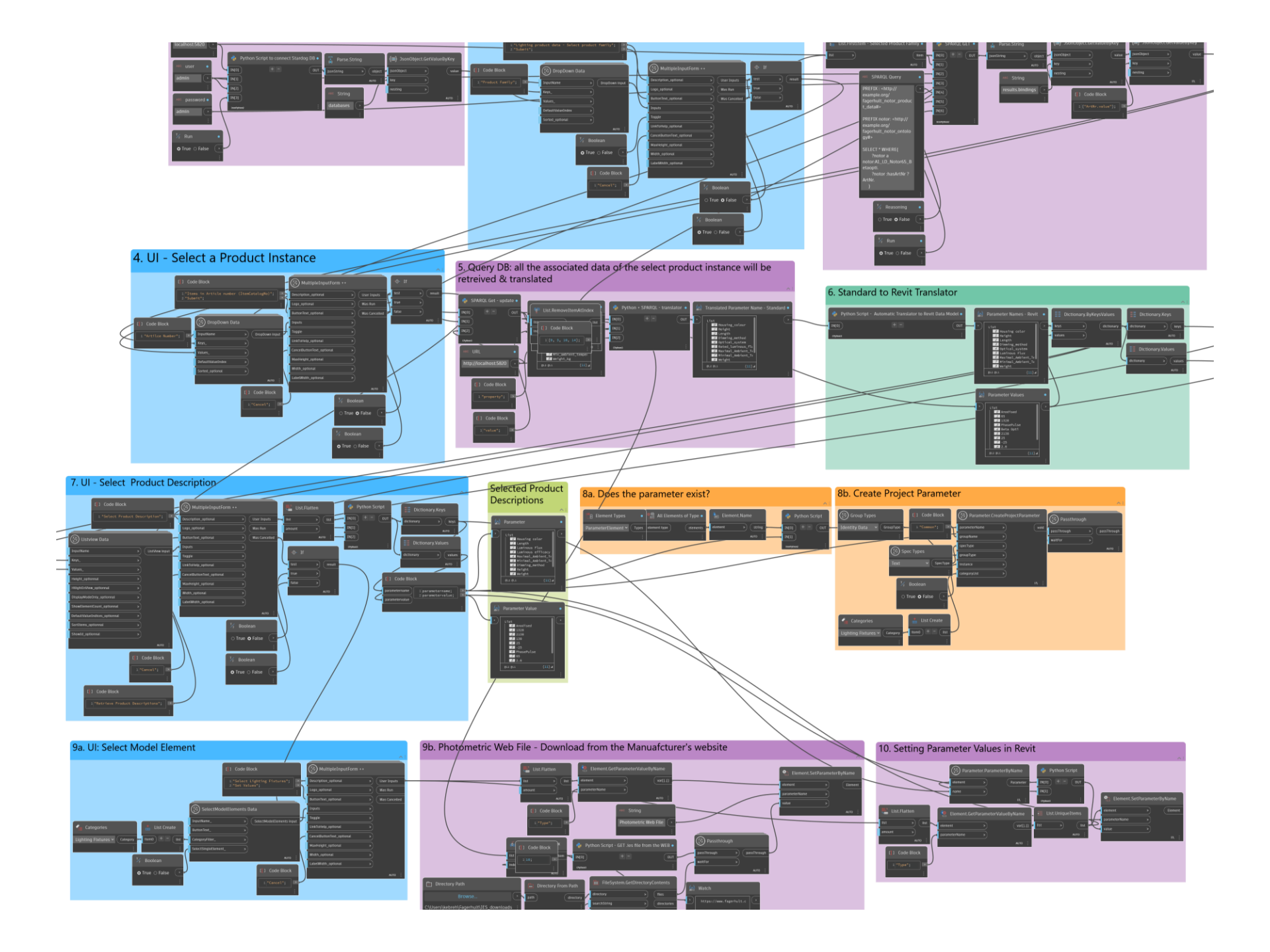
7. Run python script to check if the retrieved data as parameter name is present in Revit

8. Parameters will be created for data that is not present in Revit

9. Select an object in Revit model to integrate the retrieved data - user interface



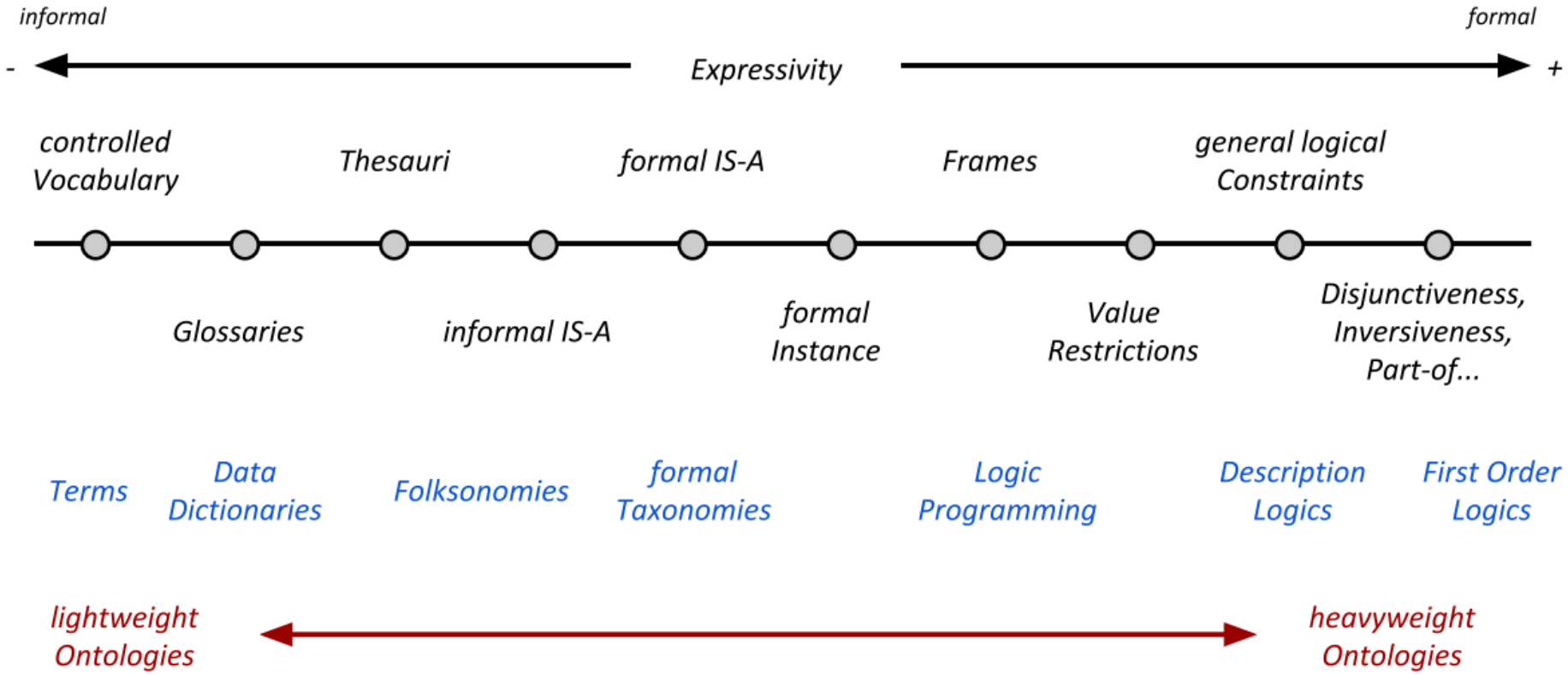
10. Integrated product data in Revit the selected object with product data


4. UI - Select a Product Instance
5. Query DB: all the associated data of the select product instance will be retreived & translated
6. Standard to Revit Translator
7. UI - Select Product Description
Selected Product Descriptions
8a. Does the parameter exist?
8b. Create Project Parameter
9a. UI: Select Model Element
9b. Photometric Web File - Download from the Manufacturer's website
10. Setting Parameter Values in Revit

5. CURRENT RESEARCH

DEVELOP PRODUCT ONTOLOGY

- **CoClass** classification - Swedish classification system for the construction industry, developed and maintained by the Swedish Construction Federation (Svenska Byggtjänst)
- buildingSMART Data Dictionary (**bsDD**)



(according to Guarino: Formal Ontology in Information Systems, 1998)

(according to Lassila and McGuiness:The Role of Frame-Based Representation on the Semantic Web, 2001

5. CURRENT RESEARCH

DEVELOPING DIGITAL PRODUCT PASSPORTS (DPP) USING KNOWLEDGE GRAPHS FOR LIGHTING PRODUCTS

- DPPs are digital representation of products that containing information about the composition, origin, environmental impact and lifecycle of a product
- Collects data from various actors across all phases of the product lifecycle, from production to end-of-life
- Information requirements:
  - Material composition
  - Lifecycle information
  - Design assembly information
  - Maintenance and repair
  - End-of-life management

5. CURRENT RESEARCH

DEVELOPING DIGITAL PRODUCT PASSPORT USING KNOWLEDGE GRAPHS – LIGHTING PRODUCTS

- Developing an ontology is a difficult task as representing complex and diverse information in a strict ontology can be challenging and inflexible

- Knowledge Graphs offer a more flexible and scalable approach,
  - allowing for seamless integration of diverse data sources
  - can be constructed and updated incrementally from large volumes of textual data without the need for extensive restructuring

6. QUESTIONS AND FEEDBACK

- Do you have any questions or comments about this presentation?
- How can we further improve our framework to implement Digital Product Passports using knowledge graphs?
- What challenges do you foresee in implementing knowledge graphs for Digital Product Passports?
- Can you share any experiences or insights from your domain that could enhance the use of knowledge graphs in Digital Product Passports or other related use cases?

Thank You!