National BIM Standard - United States®
an initiative of the National Institute of Building Sciences buildingSMARTalliance®

National BIM Standard - United States® Version 3

2 Reference Standards

2.5 International Framework for Dictionaries Library / buildingSMART Data Dictionary – Revised May 2012

CONTENTS

2.5.1 Scope

This section of the standard provides background information on the buildingSMART International (bSI) standard – the *buildingSMART Data Dictionary (bSDD)*, also known as the International Framework for Dictionaries (IFD) Library. Information about the *bSDD* is provided for reference in this version of the. National BIM Standard-United States® (NBIMS-US™). The goal of bSI and its chapters is to use the *bSDD* to store, make available for linking to and extension by others, translate and, ultimately, to manage the property sets in the buildingSMART reference model (IFC).

Another goal is to use the *bSDD* as a library of all entities and types in the IFC model so that they can be reference and used worldwide by others in the building industry that are identifying objects in models. Realizing this goal is a work-in-progress as the *bSDD* is maturing, but one that is coming closer to fruition with the recent release of a new Version 3.0 of the *bSDD* application programming interface (API), addition of classification as a relationship, the merger of the Dutch lexicon content, and the harmonization and rationalization of terms already in the *bSDD*.

Looking to the day when it will be populated with the IFC entities, types, and properties and when it will begin to be used as an open, neutral, third-party source of shared terminology that can be explicitly identified, this section is provided as background with the intent that exchanges and other components of the NBIMS-US™ will use the *bSDD* as a core part of content structure to support interoperability. The NBIMS-US terminology committee plans to explore implementation of *bSDD* in the next version of the standard.

Note: IFD Library, IFD, and *buildingSMART Data Dictionary (bSDD)* are used interchangeably throughout the document, as the transition to the new name was being initiated when this document was prepared. Future references will be to *buildingSMART Data Dictionary*.

2.5.2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. The *bSDD* is based on the following:

- ISO 12006-3, *Framework for Object-oriented Information Exchange*, developed by committee TC59/SC13/WG6

2.5.3 Terms, definitions, symbols, units and abbreviated terms

For the purposes of this document, the following terms, definitions, symbols, units and abbreviated terms apply.

2.5.3.1
characteristic (property)
concepts that cannot be defined using other concepts; meaning is provided through a description; characteristics are distinguished into the following types (in alphabetic order): behavior, environmental influence, function, measure, property, and unit

2.5.3.2
classification
hierarchical organization of related information

2.5.3.3
concept
described both by a set of names and definitions in multiple languages and also with relating a concept to other concepts

2.5.3.4
context
grouping of relationships that exists between concepts

2.5.3.5
dictionary
construction terminology defines the use of a particular 'name' (type, property, etc.) in a consistent manner

2.5.3.6
global unique identifier
GUID
unique identification number generated and assigned by a computer

2.5.3.7
schema
structure of information

2.5.3.8
subject
a subject is distinguished as an object (tangible or intangible), where objects are defined by formal characteristics

2.5.4 IFD Library/buildingSMART Data Dictionary – Revised May 2012

2.5.4.1 Introduction

The construction industry is increasingly applying building information modeling methods to the process of design, procurement, construction, operation and maintenance of facilities. In order for building information models to share data, they employ schemas that define the structure for the information that they process.

A schema requires a consistent set of ‘names’ of the entities it is organizing, in order to work. Names could refer to a particular construction (e.g. wall type 1), system (e.g. low voltage electrical supply), material, property set or individual property, for example. Each of these names should have a controlled definition that describes what it means and the units in which it may be expressed. Having a controlled vocabulary of construction terminology is essential to support interpretable data exchange.

Perhaps even more importantly, 'names' of things may be used more widely to support knowledge application and management in connection with BIM. For instance, building codes also refer to items by name (both in terms of a concept, and attributes or properties that a concept may possess). Specifications, product data sheets, costing schedules, and reference standards are all examples of data which could be better integrated with a common vocabulary.

A ‘*Dictionary*’ is used to define names. A *Dictionary* of construction terminology defines the use of a particular ‘name’ (type, property etc.) in a consistent manner, regardless of who is using the schema and where it may be used. Since construction is a global industry, terminology dictionaries need to accommodate different languages; that is, different names for the same things. Within a language, there are also often regional differences in the names of things within the same language. A primary role of the buildingSMART Data Dictionary is to address this need.

2.5.4.2 Background

At ISO meetings in Vancouver in 1999, a variety of organizations developing IT standards for the building industry (leading to what we are today calling BIM) agreed that some sort of standardized global terminology was necessary and that its structure must be useful for computers to reliably exchange data

irrespective of language. As a result, the ISO committee TC59/SC13/WG6 was formed to develop the standard now known as *ISO 12006-3 – Framework for Object-oriented Information Exchange*.

Once ISO 12006-3 was published, *STABU LexiCon* in Holland and *BARBi* in Norway, two independent efforts to develop dictionaries (more precisely called "terminology libraries") underway at the time, each focused their development of terminology databases to be compatible with the standard. In January 2006, the organizations signed an agreement that they would combine their separate efforts into the ***IFD Library,*** to produce a single terminology database that they would share between themselves for mutual benefit.

Following the IAI buildingSMART conference held September 2006 in Lisbon, Portugal that included a two day workshop on *IFD*, the Construction Specifications Institute, Construction Specifications Canada, buildingSMART Norway, and the STABU Foundation (the Netherlands) established a partnership to share unified terminology libraries, developed under ISO 12006-3, as a structure for a multi-national, controlled *Dictionary* of construction terminology.

In 2009, the Partners approached buildingSMART International (bSI) and requested that the *IFD Library* become a part of the bSI organization. At the bSI meeting in London, the Executive Committee (EC) accepted the request and recognized the *IFD Library* Group as a Group within the bSI reporting to the EC. Since this time, integration of *IFD Library* into bSI has progressed with plans underway to transfer the *IFD Library* Intellectual Property to bSI and establish bSI as the principal in agreements to embed *IFD* in applications. At its September 2010 meeting the bSI EC proposed the renaming of *IFD Library* to *buildingSMART Data Dictionary* to fit in with the renaming of the *IFC* standard to *buildingSMART Data Model*, and the *IDM* standard to *buildingSMART Processes*. Integration of IFD financials, websites, IP and Agreements to bSI is scheduled to be completed by the end of 2011.

Establishing bSI as a home for the *Data Dictionary* is seen as a critical step by the founding Partners and one that will encourage widespread adoption and use of the *Dictionary* both as a result of its integration with the other buildingSMART standards and through the stability its inclusion within buildingSMART International represents to firms that would commit to its use in applications and databases.

Note*: Throughout this document, IFD, IFD Library, buildingSMART Data Dictionary and Data Dictionary are used interchangeably.*

2.5.4.3 Relevance to users

In order for a real free flow of information to occur, three factors need to be in place:

1. The format for information exchange (Digital Storage Model),
2. A specification of which information to exchange and when to exchange the information (Process Model), and
3. A standardized understanding of what the information you exchange actually is (Terminology Library).

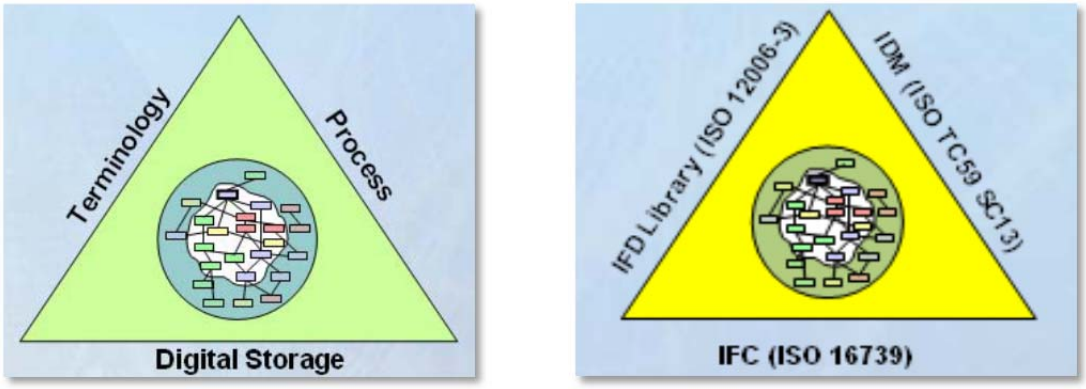

Figure 2.5-1 – Interoperability through Standards, courtesy Jotne EPM Technology AS

Having these three fundamental components in place allows for a true computerized interoperability between two or more information exchanging parties. This approach has been used with success in other industries, most notably the oil and gas industry, to support application and data interoperability.

2.5.4.4 Relationship between IFC, IFD, IDM and MVD

The open international *IFC* (*buildingSMART Data Model*) standard defines an exchange format for information related to a building and its surroundings. The up-coming release of version 2x4 of the *IFC* standard will include facilities to exchange GIS (Geographic Information System) data, (e.g. where the building is located and information about surrounding buildings) and facilities to tag all information with a globally unique identifier (GUID). With this added functionality the *IFC* will provide a computer understandable format in which all relevant building information can be exchanged between two parties. The *IFC* allows various data to be exchanged in various ways. If a receiver of information wants to be sure they can utilize the information received, the sender and receiver need to agree on exactly which information to exchange, and using the *IFC* model to structure exchanges provides a common platform for establishing this agreement.

The aim of the Information Delivery Manual (IDM) (buildingSMART Processes) and Model View Definition (MVD) is to specify exactly which information is to be exchanged in each exchange scenario and how to relate it to the IFC model. For example an architect designing a building needs to be sure that they receive information from the structural engineer about which walls and columns are load bearing and which are not. At the same time the structural engineer needs to know the function of each of the spaces in the building in order to calculate the right design loads for the structure. IDM along with MVD explains the exchange scenario in plain text for human readability, as well as in a computer interpretable way to enable implementation of automatic checks and validations in computer applications. Continuing the example, the engineer can run a quick test through a computer based on the requirements established in the *IDM*/MVD to verify that the architect has sent enough information to get started on the work.

In order to automatically verify the information in an exchange process (as described above) the information often needs to be detailed further than the general level of detail available in the *IFC* model. For example, if an architect wanted to supply information about the type of materials in the beams and columns this would be done in *IFC* using a plain text string. Even if all of words are spelled correctly there is no guarantee that the receiving application will understand exactly what this text string means. And if a different language, dialect or form of the word is used there is no reliable way to achieve verification. Ideally the computer should be able to understand even this type of information in the *IFC* formatted information received. This is typically the scenario addressed in semantic searches on the web but in order to automatically interpret the semantics, the semantic needs to be described first. The International Framework for Dictionaries (*IFD*) (ISO 12006-3) buildingSMART *Data Dictionary*) together with the upcoming version of the *IFC* standard, 2x4, provides a means to make this possible. In this way *IFD* is a supplement to *IFC*.

IFD is an open terminology standard, where concepts and terms are semantically described and given a unique identification number. This allows all the information contained in an *IFC* exchange format to be tagged with a Globally Unique ID (GUID). The architect can then input the materials in any language supported by *IFD*, while the receiver can view the data in the same or any other language supported by *IFD*. Both the creator and the viewer have confidence that the name is accurate and appropriate to their language. Likewise, a synonym or plural form of a name of a material can be correctly understood by the receiving application, as long as the correct GUID is given. While strings like names and descriptions are exchanged in textual form and used by humans, the underlying GUID is used by the computers.

2.5.4.5 IFD Library and international standards

IFD Library, (IFD is an acronym for the International Framework for Dictionaries), is, in simple terms, a standard for a terminology database. The concept for the *IFD Library* is derived from internationally-accepted standards that have been developed by the International Organization for Standardization (ISO) and the International Construction Information Society (ICIS) subcommittees and workgroups from the early-1990s to the present. The ISO committee TC59/SC13/WG6 developed the standard now known as *ISO 12006-3 – Framework for Object oriented Information Exchange* upon which *IFD Library* is based.

2.5.4.5.1 ISO 12006-2 and OmniClass™

The related standard was set out in International Organization for Standardization (ISO) Technical Report 14177 - Classification of information in the construction industry, July 1994. This document was later established as a standard in ISO 12006-2: Organization of Information about Construction Works - Part 2: Framework for Classification of Information. This standard is the basis for OmniClass™, the comprehensive classification system being developed in North America by CSI/CSC and industry working groups. *OmniClass*™ consists of 15 tables classifying the built environment and processes used to create it. Individual *OmniClass*™ tables have been approved as a part of the National BIM Standard-United States®.

In the building industry, material suppliers, specification writers, cost engineers and many others recognize the formats, terminology, and concepts included within *OmniClass*™. As a result, these names and the corresponding numbering from these tables are already being used in many cases to organize the systems and databases that store, retrieve, and analyze all manner of facility related information. Use of all of the *OmniClass*™ tables is anticipated to grow with the demand for structured access to and reports containing BIM information. But classification has some limitations when it is used exclusively as a system to organize (store) data. Classification is hierarchical, and as a result is difficult to extend in a consistent way that is discoverable by others. In addition, classification also has no explicit rules for implementation, so that systems and users can implement it in different ways. Reliance on matching the name or numbers can be problematic if any errors are introduced through input or by differences in use.

IFD Library working with classification systems (such as OmniClass™) can address these limitations by assigning each concept a unique GUID, and defining which classifications apply to the concepts. Because each term has a GUID in *IFD*, it can be referenced and understood unambiguously by computer applications. *IFD* exists as a web service and has classification included as part of the definition of terms, as a result, the terms, relationships and corresponding GUIDs can be accessed in a consistent way by all users. Thus, *IFD* along with a 12006-2 based classification system like *OmniClass*™, enables users to continue accessing and viewing data using familiar classifications, while ensuring that the data can be reliably associated with processes and documents commonly used and understood in practice.

2.5.4.5.2 ISO 12006-3 and ICIS

ICIS (International Construction Information Society) members are organizations that specialize in the delivery of 'data' for the construction industry around the world.

Early in the 1990s, ICIS members attempted to standardize on classifications that could become a world standard. These discussions led to the formation of the ISO 12006-2 standard, upon which Uniclass (UK) and OmniClass™ (North America) classifications are based.

ICIS members later realized that classification in itself did not sufficiently guarantee that data could be reliably exchanged, especially for things which could be classified in two or more ways. Solving this problem led to a focus on the 'names' of things and on the ability to store and retrieve those names in computers without dependence on classification. This realization occurred shortly before the landmark 1999 ISO meeting with other organizations that were also realizing the importance of terminology to the reliable exchange of information.

ICIS members with experience developing their own terminology databases, and experience in the depth of detail required to store and organize construction data, participated in the working group that developed the ISO 12006-3 standard.

2.5.4.5.3 ISO 12006-3 and ISO 15926 (EPISTLE)

EPISTLE is a *Dictionary* development used in the oil and gas industry that has a similar top level structure to ISO 12006-3. While *IFD* and EPISTLE share much of the same concepts and have the same core structure, the initiatives are different. Where *IFD* only defines types of things, EPISTLE also stores instances or individuals of things. Entries in *IFD* would be types of doors, while an instance of a door in a particular building project would be established using *IFC*. *IFD* does not aim to hold such individual records. *IFD* will hold all *classes* or *types of concepts* that in turn can be used to identify individuals. In other words *IFD* holds the templates while *IFC* (or other standards and compliant databases) are used to fill them.

2.5.4.6 Relevance to the National BIM Standard-United States®

The National BIM Standard-United States® (NBIMS-US™) will require terminology and classification agreement to support model interoperation. *OmniClass*™ is the recommended classification system for use in identifying information types in exchanges standardized in NBIMS-US™. *IFD Library* complements OmniClass™ by providing definitions and relationships for the items classified and a mechanism to make them explicit and persistent through the application of a GUID for all terms. Entries in the *OmniClass*™ tables can be explicitly defined in the *IFD Library* once, and reused widely enabling reliable automated communications between applications – a primary goal of NBIMS-US™.

To provide this potential benefit, the *IFD Library* will need to become an integral part of exchange standards within NBIMS-US™. To demonstrate the potential, a pilot project in conjunction with one of the previously developed or developing exchange standards needs to be conducted. The search is underway for a candidate project. The cumulative effect of using *IFD Library* will be a comprehensive shared and openly available *Data Dictionary* to support semantic interoperability in North America and other regions, as the *Dictionary* is adopted by other buildingSMART chapters around the world. The NBIMS Terminology committee will work with the North American *Data Dictionary* members, CSI and CSC, to achieve this vision over subsequent versions of NBIMS-US™.

2.5.4.5.7 Data Dictionary development

Development of the *IFD Library* is in two primary areas - content and technology. With the recent release of the *IFD* API 3.0, the technology platform is solid and the efforts of the *IFD Library* Group are shifting to Content development.

2.5.4.7.1 Data Dictionary status - content

Content within *the Data Dictionary* are of two basic types of Concepts:

1. Subjects (Terms) – something that can be distinguished from other things and that can be recognized as such, and is represented by a name. In the *bSDD, a* subject is distinguished as an object (tangible or intangible), where objects are defined by formal characteristics.

2. Characteristics (Properties) - concepts that cannot be defined using other concepts; their meaning is provided through a description. Characteristics are distinguished into the following types (in alphabetic order): Behavior, Environmental influence, Function, Measure, Property and Unit.

Concepts are related to other concepts through objectified relationships. Relationships are collected into contexts based on how they came into the library and where they came from. Concepts can relate to other concepts in multiple contexts. For example, the concept Door might have the following relationships to other concepts depending on the context in which it is being viewed.

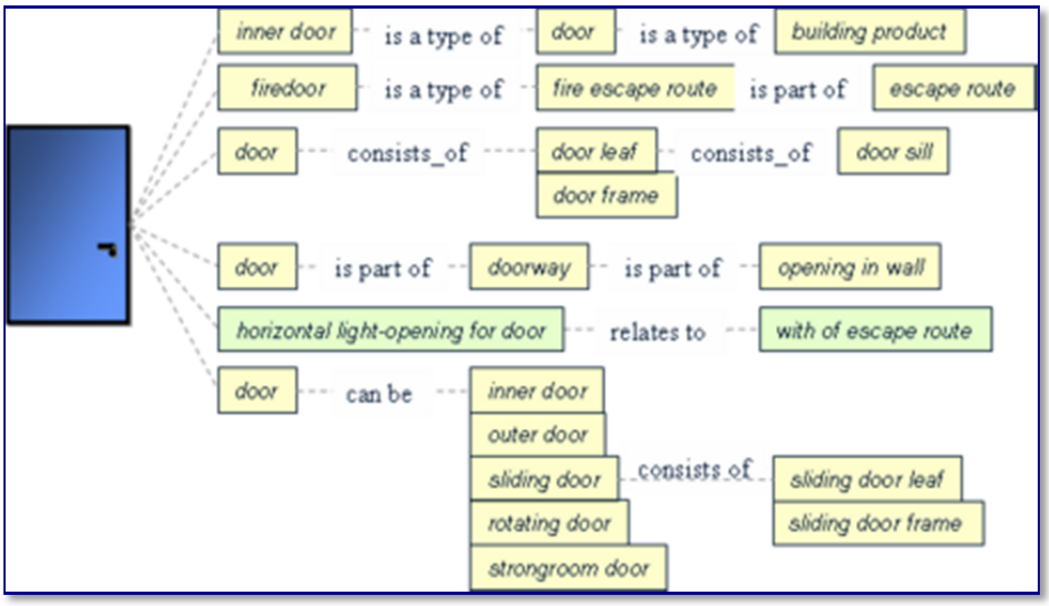

Figure 2.5-2 – Concepts and Relationships, courtesy Lars Bjørkhaug and Håvard Bell, *IFD in a Nutshell*, *IFD* Developers wiki, www.*IFD*-library.org

All concepts are assigned a Global Unique Identifier (GUID) by the *Data Dictionary to* allow them to be readily identified and reused by applications. One goal of the *Data Dictionary* is to resolve duplicates so that multiple entries with the same or similar meaning are not created. Processes and procedures for achieving the common use of terms across multiple contexts are in place and continually being refined to help those using the *bSDD* to efficiently search for similar terms already in the library.

The following graphic illustrates how a subject (window) can be described by a set of characteristics in *bSDD*. The relationship between a concept and its characteristic can also be captured in a context allowing the relationship between the particular use of a subject and its properties in that use to be captured.

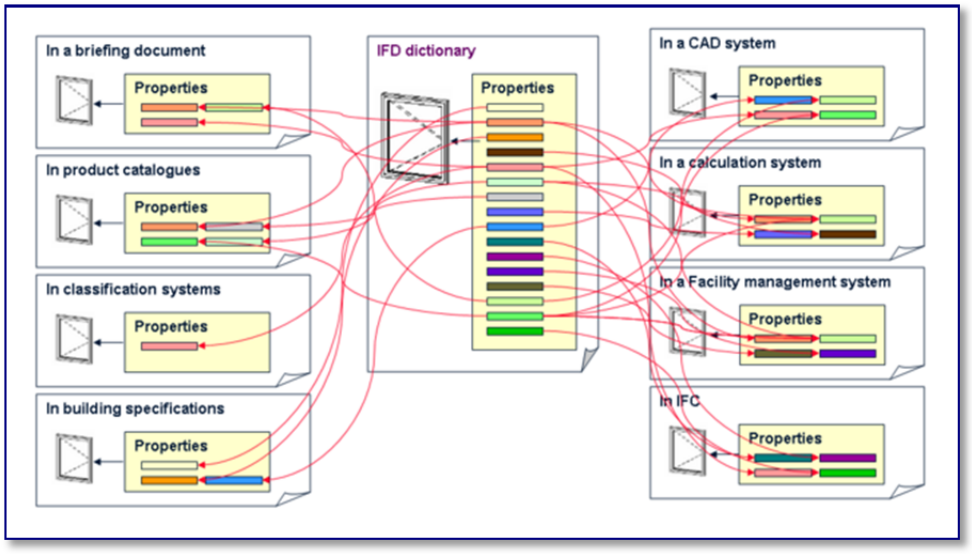

Figure 2.5-3 – *IFD* as a Mapping Mechanism: courtesy Lars Bjørkhaug and Håvard Bell*, IFD in a Nutshell*, *IFD* Developers wiki, www.*IFD*-library.org

As stated earlier, it is important to note that the *Data Dictionary* is a database of names, and not a database of individual items. The *Data Dictionary* defines the names for types of objects and the properties that describe them. It does not hold data about those objects like a product database might. This is illustrated by Figure 2.5-4.

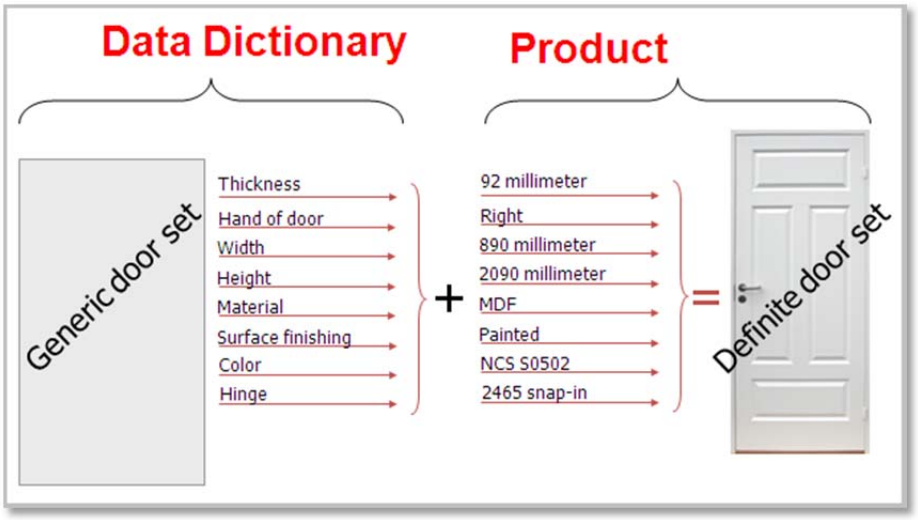

Figure 2.5-4 – *IFD* as a Type Library, courtesy Lars Bjørkhaug and Håvard Bell*, IFD in a Nutshell*, *IFD* Developers wiki, www.IFD-library.org

In application, *Data Dictionary* would be used to establish the term *door set* and what it means once, through a description and a set of relationships to properties that describe its characteristics. To utilize

the *Dictionary,* a product manufacturer or application developer looking to provide or use information about a door could reference the GUID for door set. This reference would give that user access to the associated properties defined in the *Data Dictionary*. By both parties referencing this agreed metadata

(the data provider and the user), the application and the product database could locate and exchange information with semantic agreement in place.

Currently both the Norwegians and Dutch have created terminology in the *Data Dictionary*. The Dutch are leading a project to harmonize the existing terms in the Dutch and Norwegian contexts. As new projects are initiated the goal is to expand the content available while at the same time making use of terms already in the *Data Dictionary* to the greatest extent possible so that a shared global and multilingual *Dictionary* can be created. The Group members have agreed that any terms entered into the *Data Dictionary* must be accompanied by an international English translation to facilitate connection to equivalent concepts in other languages.

Product	Status
Timber	Completed
Insulation	Completed
Sheeting	Completed
Flooring/Floor covering	Completed
Windows	Completed
Doors	Completed
Roofing and cladding	In Process
Steel	In Process
Aluminum	In Process
Masonry	In Process
Roofing membrane	In Process
Foil	In Process
Concrete	In Process
Stairs	In Process
Fireplace	In Process
Cupboards, closets etc.	In Process
Equipment and hardware accessories	In Process
Others	In Process

Norwegian content development is focused on what is required to exchange building product information between manufacturers, product data providers and applications. Thus far they have prepared product type and property data for 6 domains and are working on another 10. CSC is beginning a project to adapt these to fit construction practices in North America and make them available for use here. The domains that Norway is working on that will eventually be adapted for use in North America are:

In North America, plans are to assign classification to all entries being added to or used from the *Data Dictionary* using *OmniClass*™. This will identify and relate concepts that have been assigned a persistent definition, to the classification systems commonly used to structure documents and applications.

2.4.5.7.2 Data Dictionary status - technology

The core of the *Data Dictionary* system is an object oriented database, written in the EXPRESS data modeling language and hosted on EPM Technology's EDM Server™. Although the EDM Server is a proprietary product and thus requires payment of licensing fees for its use to EPM, all data are stored and manipulated using the ISO originated EXPRESS standard (ISO STEP 10303-11). The database currently

resides on one physical server in a well-guarded and maintained datacenter. The *IFD* MG has agreements in place with EPM that include payment for use of EDM Server. As *Data Dictionary* is used,

these costs will be passed on to licensees through a licensing fee for applications that embed use of *Data Dictionary* in their processes. More information about this is available in the *IFD Library* business plan available through http://buildingsmart.com/standards/ifd/.

A standard web service based approach is utilized to communicate with the library independent of the actual technology chosen for the database in a way more suited for application developers. A set of software objects and methods that use the objects enabling software to pass information to and from the database are defined. These objects and methods fit into a normal object oriented programming setting and can thus be easily utilized from within an application. The Application Programming Interface (API) is clearly versioned through its access point, so newer versions of the API can be provided in parallel with the old.

An offline option will also be available where the entire library will be located on the local disk of the application. The data will be accessible through the same objects and methods as for the Web Service. In addition, it will be possible for the application, when online, to download the latest version of the library, and thus stay up to date as often as needed.

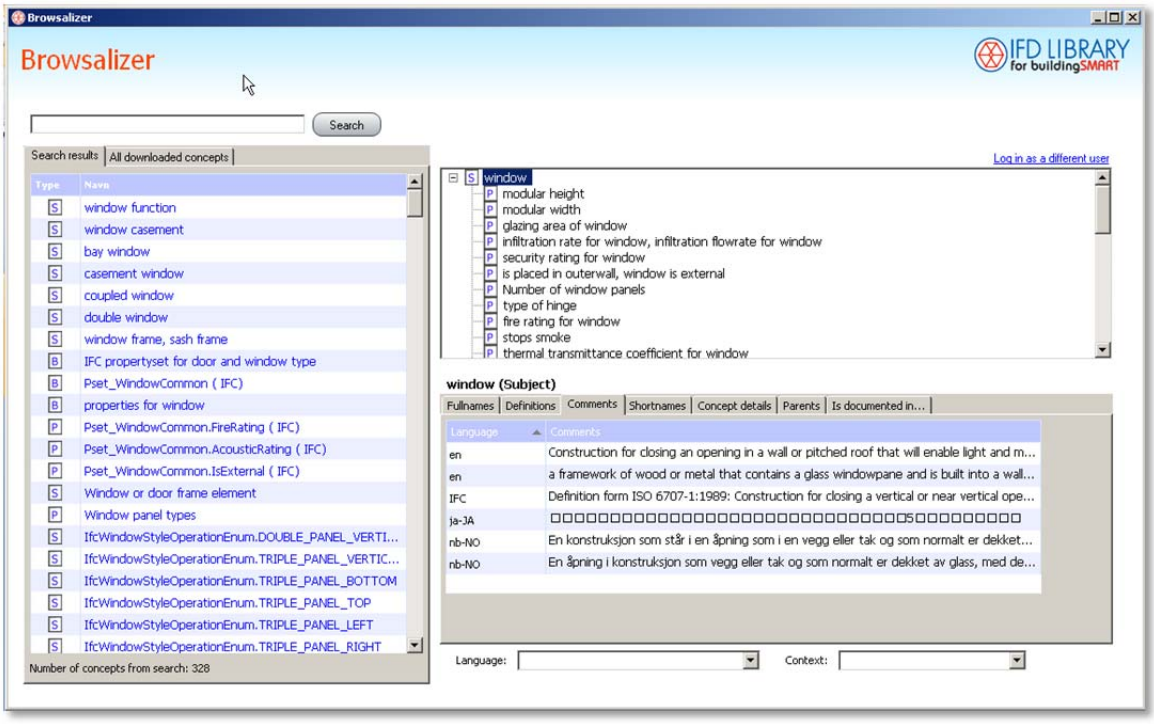

Figure 2.5-5 – *IFD Library* Content Browser – Browsalizer, available at www.buildingsmart.com/standards/*IFD*

The web service API and offline API will enable any application to access the library. The set of objects and methods defined in the API, greatly simplify accessibility to the database. The web service API is in its third release and is accessible at www.buildingsmart.com/standards/*ifd*. Applications that use the API, input tools (Batch Input Manager and Propertylizer) and a browser (Browsalizer, Figure 2.5-5), have been developed and are available from the *Data Dictionary* website. The tools have been developed in the .Net framework and a .Net toolkit that encapsulates many of the common functions needed to access and implement queries on the Library is also available. More information and access to the tools is available

on the *Data Dictionary* website. In addition, Catenda, a Norwegian technology consulting firm and STABU the Dutch MG member have also developed tools that access the API for their own uses.

2.4.5.7.3 Data Dictionary status - projects

The *Data Dictionary* MG members and Affiliate organizations have a number of projects underway that are starting to address working with the *buildingSMART Data Dictionary* and integrating it with the *IFC* model to support interoperability. Projects are underway in North America, Netherlands and Norway that are focused on expanding content and implementing the *bSDD*.

Content expansion projects are focused on:

- Identifying building products and their properties (Norway)
- Introducing a comprehensive construction ontology (Netherlands)
- Developing controlled *Dictionary* of terms used in designs and specifications (North America)
- *Adapting* terms developed in another country (North America)

Implementation projects currently underway are focused on:

- Searching for products to match design model requirements (Norway)
- Searching reference data (Norway)
- Mapping BIM objects to cost data (Norway)
- Mapping BIM objects to specifications (Norway and Canada).

More information about projects and the organizations pursuing them can be found on the *Dictionary* web site. Information about initiating a project using the *Dictionary* is also available there.

2.5.4.8 References and links

Additional information about the IFDLibrary/buildingSMART Data Dictionary and access to the developer's wiki can be found at www.buildingsmart.com/ifd or by contacting Roger Grant, IFD Group Secretary (rogerjgrant@gmail.com or rgrant@csinet.org).

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2.5.5 Bibliography

1. Construction Specifications Institute/Construction Specifications Canada; *UniFormat*™; Alexandria, VA and Toronto, Ontario, Canada: CSI/CSC, 2010.