
# Knowledge taxonomies

## A literature review

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# Abbreviations

| | |
|---|---|
| ADB | Asian Development Bank |
| EC | European Commission |
| ICANN | Internet Corporation for Assigned Names and Numbers |
| IT | Information Technology |
| ODI | Overseas Development Institute |
| PRINCE2 | Project in Controlled Environment methodology |
| R&D | Research and Development |

# Executive summary

Taxonomies are part of our daily life and this is particularly apparent today. The explosion in the volume of information and knowledge available though information technology and especially through the internet today has made it more urgent than ever to adopt systems, processes, and technology to organise this information.

This literature review was carried out as part of a study of the Asian Development Bank's knowledge taxonomy conducted by the Overseas Development Institute (ODI) between October 2010 and January 2011. The results of the literature review informed the semi-structured questionnaire used to interview ADB staff at the bank's headquarters and in Resident Missions, as well as staff from other development organisations, which were used as comparators.

While one of the first large organised catalogues was created by Callimachus at the library in Alexandria in Egypt, during the 3rd to 1st centuries BC (Malafsky, 2008), modern taxonomies were the result of the dispute between two biologists. On the one hand Carl Linnaeus who was in favour of analysis and a controlled nomenclature of living organisms, on the other hand George Louis Leclerc Compte de Buffon who advocated for an analysis of the environmental context of living organisms.

In its basic definition, a taxonomy is a structured set of names and descriptions used to organise information and documents in a consistent way (Lambe, 2007). A knowledge taxonomy, focuses on enabling the efficient retrieval and sharing of knowledge, information and data across an organisation by building the taxonomy around workflows and knowledge needs in an intuitive structure (Lambe, 2007; Malafsky, 2008).

Taxonomies are crucial for the management of organisations. Pincher (2010) argues that, without a taxonomy designed for storage and management, or one that supports better searching, all types of management systems in an organisation are nearly useless. Nevertheless, there is still reluctance among organisations to commit the necessary resources to the design and maintenance of taxonomies. There is reluctance may be linked to an insufficient understanding of what taxonomies are and what can they do for an organisations.

Taxonomies can contribute to making explicit knowledge embedded in documents available at the point of need. They also help the mapping and categorisation of tacit knowledge embedded in staff expertise. They promote collaboration and sharing between units and departments of an organisations by mapping and coordinating the sharing. They also help putting knowledge into practice by making sense of the knowledge of the organisation and creating a common vocabulary and a common way of working.

Taxonomies have therefore to be treated as an integral part of the knowledge management strategy of the organisation and when the strategy is implemented as a project, taxonomies are a key task that needs to be planned and implemented by teams equipped with the necessary knowledge and skills.

# 1 Introduction

It is not necessary to be a biologist to be familiar with taxonomies. In fact, most of us use taxonomies every day. Every time we enter a modern supermarket, we navigate a carefully studied taxonomy of goods and products located along its aisles. When we switch on our computers, we enter various personal taxonomies: the folders structure in our document libraries, the tags we have attached to our pictures, the categories we have created for our blog entries, the tree structure of our email inbox folder.

Moreover, every time we browse the internet, we navigate a taxonomy of familiar suffixes, such as .net, .com and .org, which is governed by an international body, the Internet Corporation for Assigned Names and Numbers (ICANN) (The Economist, 2010). ICANN ensures that the internet remains one worldwide address book that is valid for all: when someone types, for example, www.adb.org, whatever the browser or part of the world, that unique address will bring up the website of the Asian Development Bank (ADB). Life would be much more complicated without taxonomies.

This literature review is part of a study conducted by the Overseas Development Institute (ODI) of the knowledge taxonomy of the ADB between October 2010 and January 2011. The results of the literature review informed the semi-structured questionnaire used to interview ADB staff at headquarters and in Resident Missions, as well as staff from other development organisations, which were used as comparators.

The search for references focused on publications that look at taxonomies from the point of view of linkages with knowledge and organisational change. Sources and references for this literature review include specialised books and articles, blogs and information technology magazine articles.

The paper is organised as follows: Section 2 looks briefly at the emergence of taxonomies as a way to organise knowledge and this historical perspective holds some useful insights into modern taxonomies. Section 3 presents some key definitions. Section 4 details the problems taxonomies can help solve. Section 5 looks into some of the risks and limitations associated with taxonomies. Section 6 looks at the different taxonomies for different purposes. Section 7 lists the key steps for planning and implementing a taxonomy project. Section 8 touches briefly on the future directions of the taxonomy field.

# 2 The emergence of taxonomies: looking at the past to understand the present

Information and knowledge have been classified for centuries. One of the first large organised catalogues was in the library in Alexandria in Egypt, during the 3rd to 1st centuries BC (Malafsky, 2008). Callimachus, its first bibliographer, compiled a 120-volume subject catalogue of all the library's books, and is considered the founding father of librarians, as he not only listed the books but also included the author, data on the text and comments on authenticity to guide users and readers. In ancient Greece, Aristotle (384-322 BC) developed the first large biological catalogue, grouping animals with similar characteristics into *genera* and then distinguishing the *species* within the *genera*.[1]

From Callimachus until the 1730s, classification, arrangement and taxonomy were all considered synonymous (Lambe, 2007). With time, the field of biology contributed to the development of taxonomy as an activity in its own right. This was a result of the work of two biologists with different ideas on how to order and arrange the rapidly growing knowledge base on species: George Louis Leclerc Compte de Buffon and Carl Linnaeus (ibid). Linnaeus was in favour of analysis and a controlled nomenclature of living organisms. De Buffon, on the other hand, advocated for an analysis of their environmental context.

Linnaeus's argument emerged as the winning one in the end. In his *Systema Natura* of 1735, he introduced a simpler way to distinguish species based on their anatomy. In his *Critica Botanica* of 1737, he proposed a binomial Latin naming system for different species. He adopted a hierarchical and nested tree structure to express genealogical relationships, which contributed to the development and acceptance of evolutionary theories of the late 18th century and early 19th century. Overall, this new system created a common language that greatly enhanced coordination and collaboration among botanists and biologists (Lambe, 2007). It simplified classification by imposing rigid rules and standardised approaches and is still used today in biology. The system has also influenced the management of information and knowledge in enterprises and organisations, as the next sections show.

But what about de Buffon? While he may have lost the intellectual battle, his criticism of the system Linnaeus developed provides us with important lessons for the management of knowledge and information. De Buffon's argument was that Linnaeus's system did not capture the complexity of the biological. In his opinion, organisms could be classified in many different ways: by their environment, by their adaptations, by their functions, by their similarities in behaviours, etc.: the anatomy principle was only one way to classify creatures. By suggesting this multiple classification approach, he inadvertently created the basis for the faceted classification that is now applied widely in information systems. Lambe (2007) argues that the system Linnaeus developed highlighted the importance of simplicity and standardisation, which contributed to its wide acceptance. On the other hand, de Buffon's greatest legacy relates to the many possible ways there are to organise the same things, with every arrangement telling a different story.

The development of cataloguing systems continued to expand to different knowledge domains. One of the most influential classification systems has been the Dewey Decimal System, which was introduced in 1876 as the general catalogue system for libraries and which is still employed today (Hunter, ND; Malafsky and Newman, 2009).

[1] Aristotle divided the animals into two types: those with red blood and those without red blood. This corresponds closely with our distinction between vertebrates and invertebrates. Blooded animals included: viviparous quadrupeds (mammals), birds, oviparous quadrupeds (reptiles and amphibians), fishes and whales (which Aristotle did not realise were mammals). Bloodless animals included: cephalopods (e.g. the octopus), crustaceans, insects (including spiders, scorpions and centipedes as well as what we now define as insects), shelled animals (e.g. most molluscs) and zoophytes ('plant animals,' which resembled plants in form). www.ucmp.berkeley.edu/history/aristotle.html.

## Figure 1: Dewey Decimal System

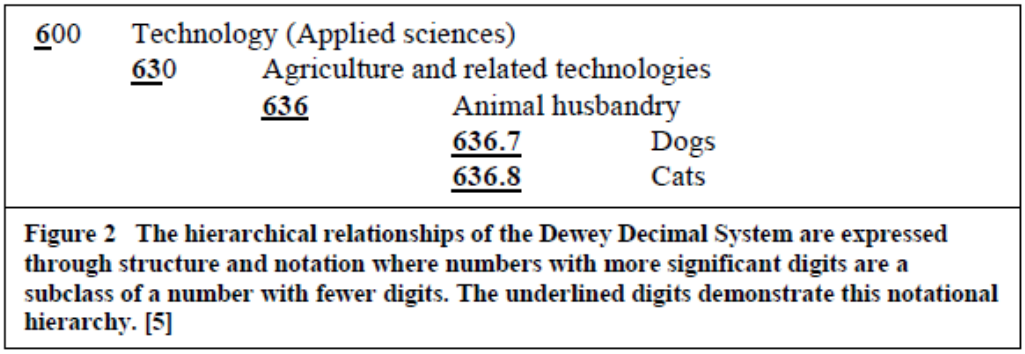



**Figure 2 The hierarchical relationships of the Dewey Decimal System are expressed through structure and notation where numbers with more significant digits are a subclass of a number with fewer digits. The underlined digits demonstrate this notational hierarchy. [5]**

*Source*: Malafsky and Newman (2009).

Another famous taxonomy is the Bloom Taxonomy, which was first presented in 1956 by B.S. Bloom. This taxonomy is considered essential within the education community. It classifies different objectives that educators set for students (i.e. learning objectives): affective, psychomotor and cognitive. Within each, the higher level is dependent on a student having attained the knowledge and skills at lower levels (Bloom, 1956).

The massive expansion of computing during the 1980s helped push information into digital formats, thus making it possible to distribute it on a much larger scale (Hedden, 2010). The advent of the internet in the 1990s then contributed to a further explosion of information dissemination and highlighted the need to develop new tools and skills to organise and retrieve such information (ibid). In this context, taxonomies have become necessary. But what is a taxonomy and how can it be defined?

# 3 Some definitions

The literature on taxonomy suggests various definitions of the term, and also introduces other terms, which may create some confusion. The terms 'taxonomy,' 'ontology' and 'folksonomy' all belong to the field of knowledge management.

Ontology is derived from philosophy and represents the study of being or existence (Lambe, 2007). However, ontology in knowledge management has a different connotation and refers to 'a data model that describes a set of concepts and their relationships to each other' (ibid: 238). Ontologies can be defined as broad conceptual categories or domains that can be used to organise knowledge and information (Malafsky and Newman, 2009), or the broad conceptual frameworks that people use. They provide the meaning associated with specific categories (Denham, 2006a) and can be extremely useful in companies, when it comes to search engines and the construction of navigation aids, as they allow for faster and more relevant retrieval, more effective communication and reduced training costs (ibid). An inherent problem with ontologies is that they are often 'machine-friendly' and less good at enabling shared understanding on a more human level. Malafsky and Newman (ibid) provide the following example of a machine-readable ontology which requires computer language to define the concepts and associated relationships (ibid: 3):

The OWL Web Ontology Language is a standard language that was developed by the World Wide Web Consortium (W3C). An short example an OWL ontology is:

<owl:Class rdf:ID="WineGrape">

<rdfs:subClassOf rdf:resource="&food;Grape"/>

</owl:Class> <WineGrape rdf:ID="CabernetSauvignonGrape"/>

This example defines a class of items (WineGrape) and specifies that it is a type of another class of items (food:Grape) and then defines a single type of the new class (CabernetSauvignonGrape is a type of WineGrape).

An ontology can be better understood as the main domains that need to be broken by means of a structured set of terms, which is where taxonomies and folksonomies come into the picture.

In its basic definition, a taxonomy is a structured set of names and descriptions used to organise information and documents in a consistent way (Lambe, 2007). The origin of the word is in the Greek *taxis*, which means 'order' and 'arrangement' (Hunter, ND; Lambe, 2007). Whittaker and Breininger (2008) define a taxonomy as a controlled vocabulary, in which each term usually has hierarchical relationships, which means that a taxonomy imposes a topical structure on information. It uses a logical arrangement and does not usually account for users' specific decision-making and action-taking needs (Malafsky, 2008).

As described in further detail in Section 6, a knowledge taxonomy focuses on enabling the efficient retrieval and sharing of knowledge, information and data across an organisation by building the taxonomy around workflows and knowledge needs in an intuitive structure (Lambe, 2007; Malafsky, 2008). By providing a controlled and carefully considered vocabulary to describe knowledge and information, it acts like a map of the knowledge domains of the organisation (Lambe, 2007).

A folksonomy can be defined as a classification system that maximises the opportunities provided by the new web technology associated with web 2.0 and cloud computing (Lambe, 2007). The term was coined in 2004 in an attempt to define the process through which users owned and tagged the content of social networking websites such as Facebook with their own words, rather than website hosts deciding categories. A folksonomy therefore refers to the act of tagging documents, or pictures, for example in Flickr or Picasa, blog entries in Blogger or

Wordpress, videos in Vimeo or YouTube or individual tags in delicious.com, etc; in other words, when it is left to individuals and not associated with a predetermined classification and the formal rules that go with a traditional taxonomy (ibid). It entails, as Denham (2006b) notes, the advantage of individual recall.

## Figure 2: An example of bookmarks tags in delicious.com

| All Tags | 22 |
|---|---|
| consulting | 4 |
| decentralisation | 1 |
| development | 1 |
| donor | 21 |
| economy | 1 |
| education | 1 |
| evaluation | 1 |
| governance | 5 |
| internet | 3 |
| intranet | 1 |
| jobs | 13 |
| knowledge | 19 |
| management | 1 |
| ngo | 3 |
| participation | 3 |
| policy | 2 |
| radio | 1 |
| research | 21 |
| running | 1 |
| taxonomy | 9 |
| training | 2 |
| visa | 3 |
| Untagged bookmarks | 2 |

Lambe (2007) notes that folksonomies tend to be more context-specific, and linked to individuals' or teams' ways of working. For example, Unilever, a consumer products multinational, decided in 2000 to reduce its portfolio of 1,600 brands down to the 400 that provided 90% of its revenues. In doing so, it simplified its taxonomy into three industries, (Home Care, Personal Care and Foods), 13 categories and 400 brands. At the same time, a large number of Unilever's research and development (R&D) projects were suffering from the rigid knowledge taxonomy associated with the business. Consequently, in 2001 the head of knowledge management introduced a more pragmatic 'just-in-time' approach, whereby taxonomies were created for a specific task or project and then disposed of once this was completed. The freedom given to teams to decide their specific taxonomies has resulted in greater collaboration and sharing, which is an essential ingredient of Unilever's R&D effort. (Dale, 2001; Lambe, 2007).

The next section looks at the main benefits associated with taxonomies by highlighting the importance of the various purposes they have.

# 4 Advantages and purposes of taxonomies

In today's information age, individuals have to cope with a huge amount of data, and it is almost impossible for anyone except those who have stored information to be able to retrieve it. The advent of the internet, while contributing to the dramatic increase of available data and information, has also generated an increased interest in using taxonomies to structure information for easier management and retrieval (Hunter, ND; Lambe, 2007). In the corporate world, knowledge workers spend between 11 and 13 hours a week searching for and analysing information (Whittaker and Breininger, 2008). Larger and larger repositories of digital data and information require more ways to help individuals retrieve exactly what they need at any given moment (Malafsky, 2008). A key benefit of a taxonomy is that, when information is well-organised and consistent across an organisation, staff will spend less time searching and browsing, with the result that they enrich their research experience and leverage their expertise (Serrat, 2010).

Pincher (2010) posits that, without a taxonomy designed for storage and management, or one that supports better searching, all types of management systems in an organisation are nearly useless. Nevertheless, many organisations are not willing to commit the necessary resources to the design of taxonomies. When they do, they often limit their investment to information technologies, with inadequate investment in the appropriate categorisation of information and data.

Lambe (2007) identifies four main knowledge domains operating within organisations. For each of these, taxonomies provide specific benefits and have a specific purpose that supports the overall knowledge management of the organisation.

### Table 1: Knowledge domains and the benefits of taxonomies

| | **Knowledge domain** | **Benefit of a taxonomy** |
|---|---|---|
| Information | Refers to the implementation of information management and supplying the right information when it is needed. Mainly explicit knowledge. | Contributes to making explicit knowledge embedded in documents available at the point of need. |
| Expertise and learning | Refers to the expertise and experience individuals within the organisation acquire. Associated with tacit knowledge. | Contributes to mapping and categorisation of tacit knowledge embedded in staff expertise. |
| Collaboration | Refers to the social aspects of knowledge and sharing within an organisation. | Mapping and coordination of sharing. |
| Culture of the organisation | Enables sharing and allows for the putting of knowledge into practice. | Helps with making sense of the knowledge of the organisation and creating a common vocabulary and a common way of working. |

*Source*: Lambe (2007).

The knowledge domains and benefits associated with taxonomies show that the latter are limited to the content of documents and databases, but can support collaborative ways of working that activate the tacit knowledge that resides within people (Lambe, 2007). In other words, 'to limit the purpose of a taxonomy simply to the findability of information and documents is to limit the potential of the taxonomy to contribute to a broader vision of knowledge management and identify different ways for the organisation staff to work together' (ibid: 107).

However, despite these advantages, organisations seem to be reluctant to invest the time and resources required in developing a taxonomy of their own knowledge and information, as we have already seen (Denham, 2006b; Lambe, 2007). Moreover, when organisations decide to develop a taxonomy, they do so without a clear plan and by assigning staff who show some familiarity with IT and computers but who do not have adequate taxonomy training, defined by Hedden (2010) as the 'accidental taxonomists.'

For Lambe (2007), the reasons for this underinvestment are related to insufficient understanding of the different purposes taxonomies can serve and of the requirements of a

taxonomy project. Denham (2006b) argues that the problem is that it is hard to quantify the advantages associated with taxonomies: the management of an enterprise has to simply have faith that investment in a taxonomy will contribute to greater synergies, better personal connections, increased dialogue and heightened idea exchange. It is important to accept that the real power of a taxonomy does not arise from the elegance of classification and organisation but is a by-product of the connections.

The next section describes risks associated with taxonomies.

# 5 Risks associated with taxonomies

A common risk with taxonomies is that they are introduced too quickly or prematurely without adequate testing (Lambe, 2007). In large organisations structured around departments and units working in different parts of the world, when local taxonomies are not linked to the corporate one, this can reinforce isolation and a silo mentality (ibid). Taxonomies should be designed to nurture diversity not only of tasks but also of interests and knowledge specialisations. Therefore, overly homogenised language and categories can severely prejudice the collaboration that can be achieved by linking teams and units within an organisation.

Another risk commonly associated with taxonomies is that they do not have the flexibility required to adapt to changes within the organisation. This issue can arise when the key roles and responsibilities necessary to develop and maintain the taxonomies are not defined carefully when a taxonomy is planned (Hedden, 2010).

There are also risks linked to the decision to develop a corporate taxonomy, in both large and small organisations (Hedden, 2010; Lambe, 2007). Management should consider carefully whether to design a single rigid taxonomy or several taxonomies that cover different areas of work and associated knowledge. The aim is to avoid excessive rigidity, which will undermine cooperation and sharing. Hunter (ND) argues that, when several taxonomies coexist, they organise different areas of knowledge and lead to creative improvements in the organisation.

Given the risks described here, rather than aiming at absolute consistency, standardisation and tidiness, taxonomists should seek the consistency and standardisation necessary for effective sharing and retrieval of data and information (Lambe, NDb). Keeping in mind that flexibility is an important characteristic of taxonomies, the next section illustrates how different types of taxonomies are defined by different purposes.

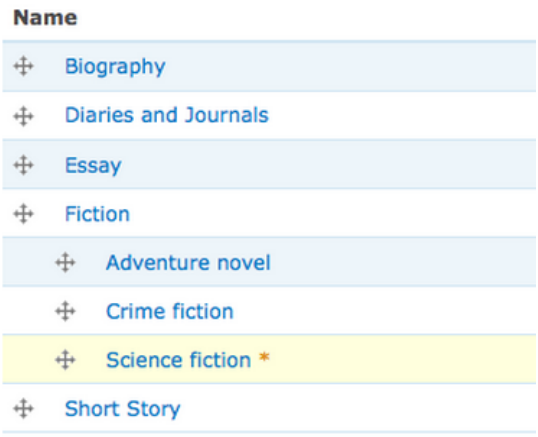
# 6 Different taxonomies for different purposes

According to Lambe (NDa), taxonomies should be defined more by their purpose and use than by the structural form they happen to take. He describes the following taxonomies and specific purposes (Lambe 2007).

## 6.1 Lists

Lists are the most basic form of taxonomy, and are good for non-complex issues. A list is also a first step towards certain more complex taxonomies, whereby sub-categories are added to the main elements of the list. Ideally, a list should contain between 12 and 15 elements. When it becomes longer or more complicated, it is advisable to adopt a different taxonomy form, such as a tree structure. In most cases, then, although the development of one or more taxonomies will start with a list, this may not be the best type for complex classifications. Lists have to be thought out properly if they are to remain consistent and relevant.

**Figure 3: List (literary genres)**

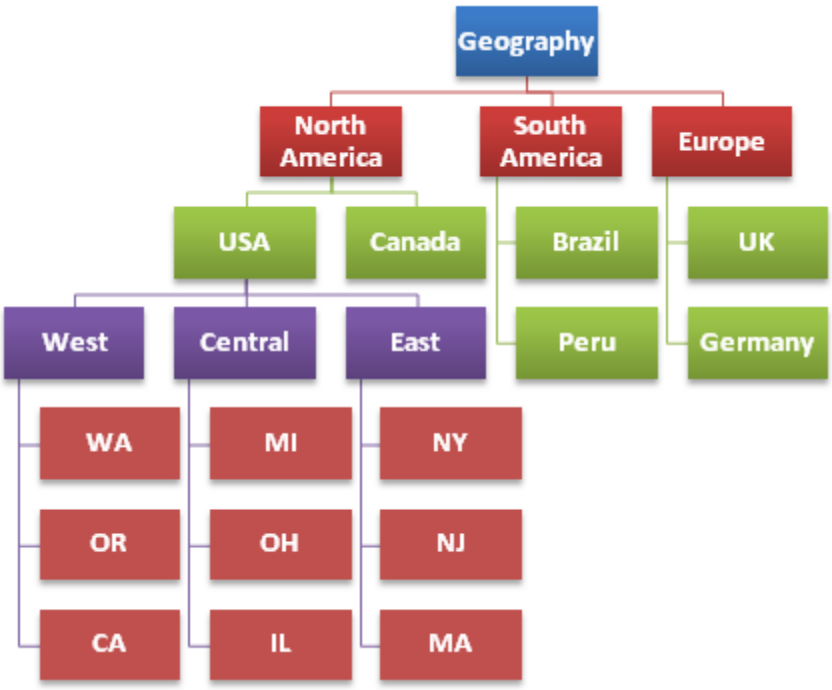



*Source*: http://blog.adyax.com/2009/03/english-drupal-tutorial-node-auto-term-taxonomy-tips-and-jquery-menu-api-in-use/.

## 6.2 Tree structures

Tree structures reflect the way we think. The different branches of the tree hierarchy allow us to distinguish basic broad categories and also more specific ones, and are powerful in that they display cause-effect relationships in the taxonomy. They show hierarchical relationships as well as horizontal ones. Tree structures are the most used taxonomies in enterprises. They are particularly useful when lists grow too long and when concepts need to be divided into sub-categories based on well-understood and agreed principles. They must be predictable, and must be managed so they adapt to changes and therefore remain relevant. Tree structures do not work well when different communities use different categories and principles for classifying data and information.

### Figure 4: Tree structure (organisational chart)




*Source*: http://www.projectserverhelp.com/Lists/Posts/Post.aspx?List=f884b43f-61db-4c4e-94a3-38f21a8efdad&ID=60.

## 6.3 Hierarchies

Hierarchies are a specific kind of tree structure. They can be represented as pyramidal structures, where the transition from one level to the next is predictable and consistent. Hierarchies work well in biology, but can create misunderstandings by giving the impression that taxonomies need to have a certain hierarchy in order to be valid. In an organisation, this usually brings about tensions and discussions on which terms, sectors or departments need to be represented at the top of the hierarchy. Hierarchies are also often too rigid to incorporate the complexity of an organisation.

### Figure 5: Hierarchy structure (biological classification)

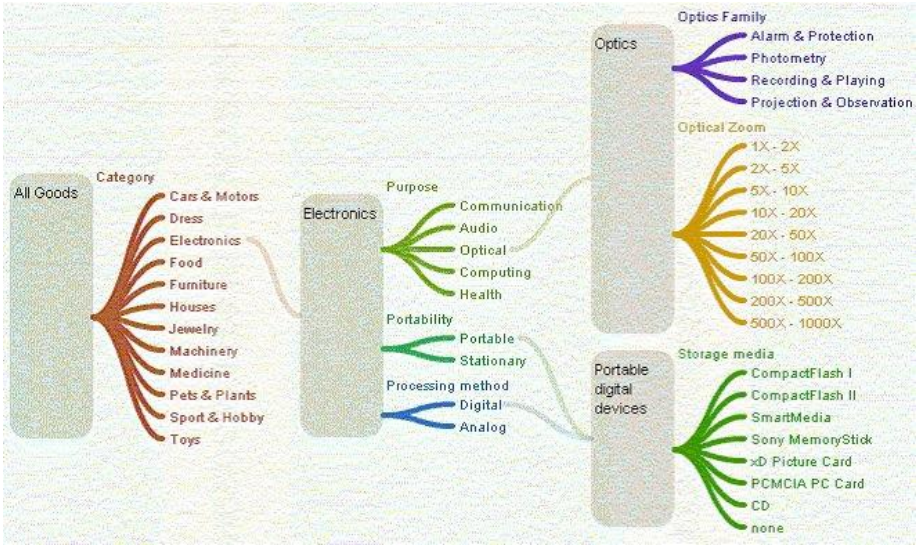
| Main taxonomic ranks | | | |
|---|---|---|---|
| Latin | | English | |
| Regio | | Domain | |
| Regnum | | Kingdom | |
| Phylum | Divisio | Phylum (in zoology) | Division (in Botany) |
| Classis | | Class | |
| ordo | | Order | |
| Familia | | family | |
| Genus | | Genus | |
| Species | | Species | |

Source: http://en.wikipedia.org/wiki/Taxonomic_rank.

## 6.4 Polyhierarchies

Polyhierarchies are an attempt to deal with the fact that, in an ambiguous world, it is difficult to generate a tidy hierarchical structure. As de Button noted in the 1730s, items usually belong to more than one class. Polyhierarchies thus accommodate topics that belong to different categories and that may not fit in tree structures or hierarchies. They are complex visual representations, as they often entail many connections between categories and words. They work well when hyperlinks allow for jumping between categories and cross-references. When the cross-references become too many, matrix and facets taxonomies are better (see below).

### Figure 6: Polyhierarchy (purchasing selection)




*Source*: www.quasinewtonian.com/popular.html.

## 6.5 Matrices

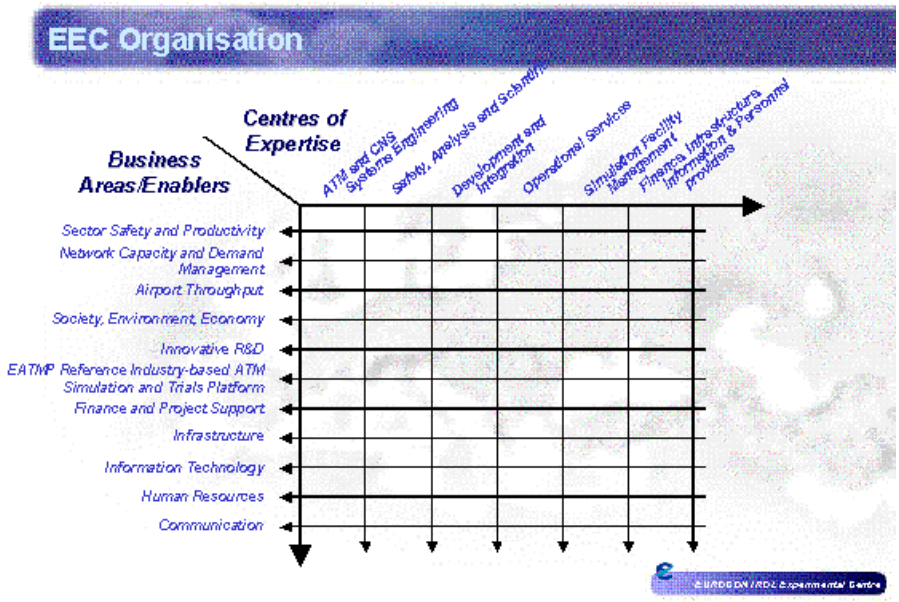
Matrices work best with a well-defined body of knowledge that can be organised along two or three dimensions. They can help make sense of categories and highlight gaps or missing categories once they are laid out. If there are more than three dimensions, matrices do not function well. One of the best-known two-dimensional matrices is the Mendelev periodic table of the elements (Figure 7). Two-dimensional matrices can also be applied to business, as in the case of the European Commission (EC) organisation matrix (Figure 8).

### Figure 7: Two-dimensional matrix structure (periodic table)

| Group | 1 | 2 | | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Period | | | | | | | | | | | | | | | | | | | |
| 1 | 1 H | | | | | | | | | | | | | | | | | | 2 He |
| 2 | 3 Li | 4 Be | | | | | | | | | | | | 5 B | 6 C | 7 N | 8 O | 9 F | 10 Ne |
| 3 | 11 Na | 12 Mg | | | | | | | | | | | | 13 Al | 14 Si | 15 P | 16 S | 17 Cl | 18 Ar |
| 4 | 19 K | 20 Ca | | 21 Sc | 22 Ti | 23 V | 24 Cr | 25 Mn | 26 Fe | 27 Co | 28 Ni | 29 Cu | 30 Zn | 31 Ga | 32 Ge | 33 As | 34 Se | 35 Br | 36 Kr |
| 5 | 37 Rb | 38 Sr | | 39 Y | 40 Zr | 41 Nb | 42 Mo | 43 Tc | 44 Ru | 45 Rh | 46 Pd | 47 Ag | 48 Cd | 49 In | 50 Sn | 51 Sb | 52 Te | 53 I | 54 Xe |
| 6 | 55 Cs | 56 Ba | * | 71 Lu | 72 Hf | 73 Ta | 74 W | 75 Re | 76 Os | 77 Ir | 78 Pt | 79 Au | 80 Hg | 81 Tl | 82 Pb | 83 Bi | 84 Po | 85 At | 86 Rn |
| 7 | 87 Fr | 88 Ra | ** | 103 Lr | 104 Rf | 105 Db | 106 Sg | 107 Bh | 108 Hs | 109 Mt | 110 Ds | 111 Rg | 112 Uub | 113 Uut | 114 Uuq | 115 Uup | 116 Uuh | 117 Uus | 118 Uuo |
| *Lanthanoids | | | * | 57 La | 58 Ce | 59 Pr | 60 Nd | 61 Pm | 62 Sm | 63 Eu | 64 Gd | 65 Tb | 66 Dy | 67 Ho | 68 Er | 69 Tm | 70 Yb | | |
| **Actinoids | | | ** | 89 Ac | 90 Th | 91 Pa | 92 U | 93 Np | 94 Pu | 95 Am | 96 Cm | 97 Bk | 98 Cf | 99 Es | 100 Fm | 101 Md | 102 No | | |

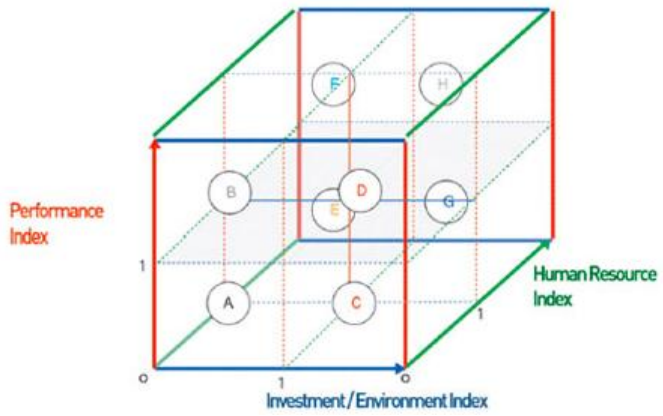
*Source*: www.meta-synthesis.com/webbook/35_pt/pt_database.php?Button=Data+Mapping.

## Figure 8: Two-dimensional matrix structure (EC)




Source: www.eurocontrol.fr/Newsletter/2003/March/Reorganisation/Matrix_organisation/Matrix_Organisation_at_the_Experimental_Centre_v0_2.htm.

## Figure 9: Three-dimensional matrix structure (Design Competitiveness Evaluation Tool)



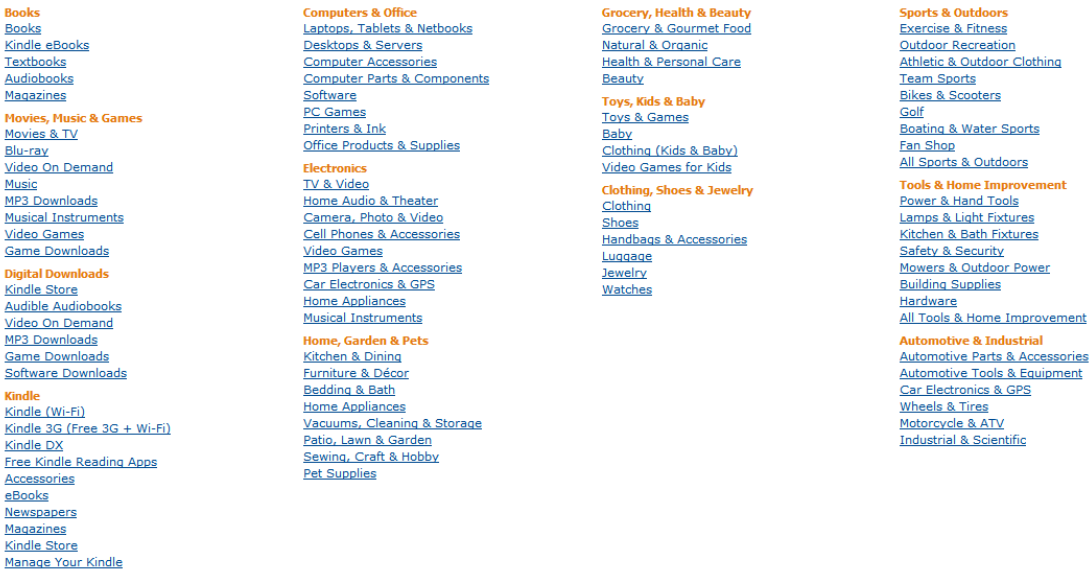

*Source*: http://inventorspot.com/articles/it_takes_country_support_its_designers_2008_rankings_country_22111.

# 6.6 Facets

Facets were introduced in 1932 by Indian librarian S.R. Ranganathan, who had decided to find an alternative to the Dewey Decimal System for classifying books. Traditionally, books were classified so readers could find a certain book on a certain shelf. Ranganathan found this approach limiting and, in line with de Button's principles, argued that one book could actually belong to different sections of a library. His system allowed books to be classified according to five different categories, which he called *facets*: main topic; things the book talks about; action discussed in the book; localisation in the book; and chronology covered in the book. Each book is therefore classified according to five mini taxonomies, and can be identified from different searching points. Search engines and software adopt the same principle today. The outcome is that hierarchies in taxonomies are no longer necessary.

A taxonomy that consists of multiple smaller hierarchies (or facets) and that can be searched in combination is called a 'faceted taxonomy.' Typical facets might be people, organisations, topics, products, locations or activities (Hedden, 2008). Facets work well when there is a large content, and are the best type of taxonomy where there is frequent use of metadata and tags on digital documents (Lambe, 2007). They are particularly useful when tree structures have become too large and complex. Facets are not a map, and they do not have the clear representation of a map. They also require a certain maturity among users: novices in an organisation may find it difficult to understand the categories being used, and searches may return empty results. E-commerce organisations and organisations with large publication libraries make use of facet classification so customers can access specific resources from different directions. The search function on www.amazon.com, for example, allows the user to find a book by searching through books, audio books, authors, themes, editors, etc.

**Figure 10: Faceted taxonomy (www.amazon.com)**

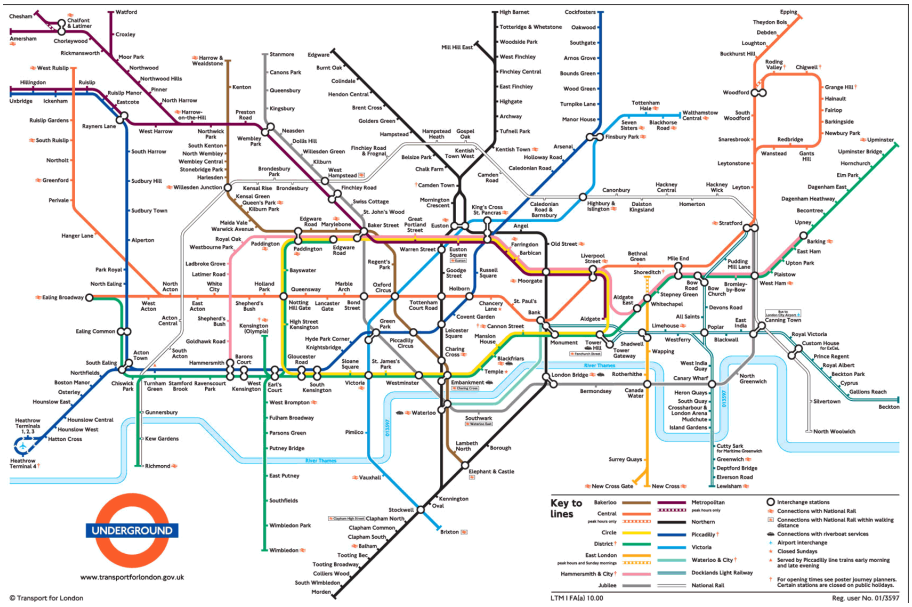



Source: www.amazon.com/gp/site-directory/ref=topnav_sad.

## 6.7 System maps

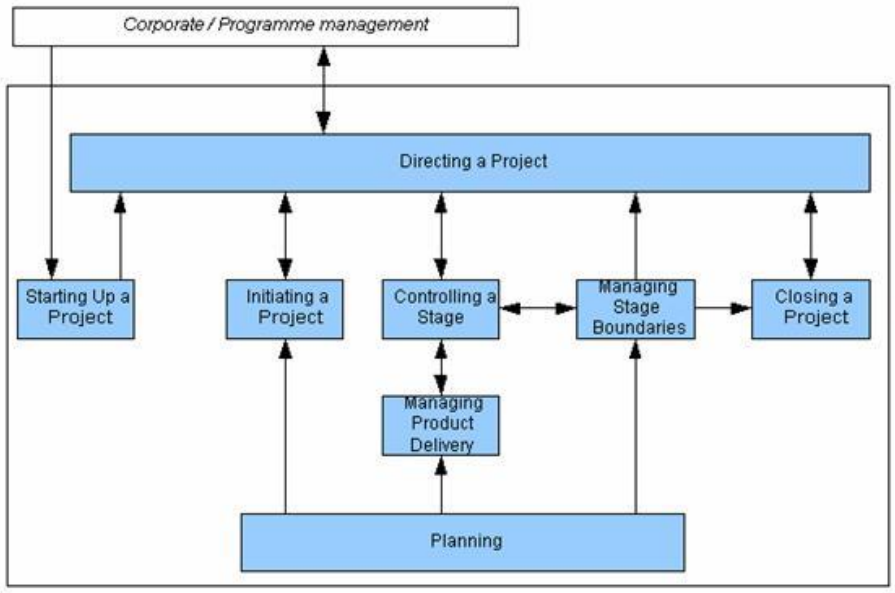
System maps are visual representations of a knowledge domain, in which proximity and connection between categories, as well as real world relationships, are expressed. They are useful when there is a coherent system of knowledge that can be communicated visually. They are similar to mind maps, and provide a highly visual way to show relationships between core ideas (Denham, 2006a). Business process taxonomies, for example, are often described as system maps. When they become overly complex, faceted taxonomies work better.

## Figure 11: System map (tube map of London)




*Source*: www.walking-uk.com/tubemap.htm.

## Figure 12: System map (project management process under Project in Controlled Environment methodology (PRINCE2))




Source: www.emeraldinsight.com.

To conclude, the purpose of the taxonomy is key to determining the type of taxonomy that suits the objective the organisation has set (Lambe, 2007). The next section presents the main steps required to implement a taxonomy project.

# 7 A taxonomy project

The literature reviewed in this paper highlights the importance of treating the design and development of taxonomies as structured projects. This applies to both small and large organisations, the only difference being that large organisations usually need to develop several taxonomies to capture all their knowledge domains and ways of working (Lambe, 2007; Whittaker and Breininger, 2008).

Treating the development of a taxonomy as a structured project with clear stages and activity plans increases the chances of reaching an internal agreement around common principles that allow for better sharing of knowledge and resources. This is particularly important if the main purpose of the taxonomy project is, in addition to improving storage and retrieval of data and information, to enable greater social coordination and interaction within the organisation. Lambe (2007) suggests some basic principles to guide the implementation of a taxonomy project:

- Know why you are doing it;
- Involve taxonomy users;
- Negotiate a common understanding;
- Have a clear idea of how it will be implemented;
- Don't be too attached to it.

Ultimately, taxonomies need to reflect the working environment and culture of the organisation for which they are created. Since working environments change continuously, taxonomies should also be flexible and adapt to the changing environment.

It is also important to highlight what taxonomy is not, in other words to dispel some myths that surround the development of taxonomies within organisations (Montague Institute Review, 2002):

- A taxonomy can be expressed only as a hierarchical list of topics.
- There is only one right taxonomy for each organisation.
- You can shortcut the taxonomy development process through wholesale adoption of someone else's taxonomy.
- Taxonomy applications (i.e. what the user sees) must conform to the same rules as the underlying taxonomy structure (i.e. how the data are stored in computers).
- A corporate taxonomy should be derived solely from the content in the document repositories.
- Personal and departmental taxonomies do not need to be integrated with other corporate taxonomies.
- Taxonomies should always be tightly integrated and computerised to achieve maximum efficiency.
- Taxonomies should be funded and managed by a centralised IT function.

These misconceptions need to be cleared up at an early stage to reflect a correct understanding of the nature of a taxonomy project, that is, a participatory effort that aims to categorise information and knowledge as well as enhance collaboration and sharing within the organisation.

The basic processes of a taxonomy project described here are derived from Hedden (2010), Lambe (2007), Pincher (2010) and Whittaker and Breininger (2008), unless stated otherwise.

## 7.1 Get a mandate from senior management

A taxonomy project has to receive support and adequate resources from the senior management of an organisation. In the absence of this mandate, the risk is that the taxonomy effort will be left to the initiative of individuals, or Hedden (2010)'s accidental taxonomists.[2]

The next step, after the mandate is obtained, is the analysis and scoping of needs and existing taxonomies within the organisation.

## 7.2 Analysis and scoping

Analysis helps gather the information necessary to design the taxonomy project, including on: the taxonomy(ies) required and their purpose; the benefits sought; the roles and responsibilities of main stakeholders; the risks; and the budget required. This will help senior management make an informed decision as to whether or not to continue with the taxonomy project. The results can also help in confirming, during the life of the project, whether the benefits are realised or whether the taxonomy requires change and adaptation. Areas that should be studied during the scoping exercise include:

- **Stakeholders:** In large organisations, a stakeholder map helps generate an understanding of the relationships between departments and units, as well as of the boundaries the taxonomy may help overcome. It may also the key stakeholders in the development of the taxonomies (Lambe, 2007). Stakeholder analysis will also help in identifying the key roles required across the organisation in implementing and maintaining the taxonomies.
- **Skills and capacity:** The analysis can help in assessing whether the necessary skills and capacity to design, introduce and maintain the taxonomies exist within the organisation, or whether they should be developed through training or procured externally.
- **Organisational needs:** The scoping exercise must look at specific organisational needs and suggest taxonomies that best suit these. Interviews and meetings can help highlight the organisation's way of working and its underlying needs (Lambe, 2007). Results and suggestions generated by the analysis can help in reaching a common ground before entering the implementation process of the taxonomy project.

## 7.3 Design of the taxonomy

This is a key stage in the development of the taxonomy. First off, how complex does the taxonomy need to be? Lambe (2007) puts forth the following key decision factors that need to be considered:

- **Internal or external use?** If the taxonomy is for internal use only, it will require its own vocabulary or set of categories. If the taxonomy is to be shared with external partners, the internal language needs to be harmonised with that used externally. The taxonomy should help to negotiate a common vocabulary and organising principles between external and internal knowledge. Tree structures are usually used here, as well as polyhierarchies.
- **Homogenous or heterogeneous taxonomy?** If the content covered by the taxonomy is homogenous and consistent, the taxonomy project is straightforward

[2] Hedden (2010) posits that the growing interest in taxonomies means the people being asked to create them may not have done such work before, may not have sufficient training and/or may not even have thought of pursuing such work before they were asked to.

and refers to formalising the organising principles. If it is heterogeneous, covering many different types of information and purposes, then the project will be complex and data gathering and negotiation will be wide ranging. The taxonomy should help to negotiate a common vocabulary. Tree structures are usually used here, as well as polyhierarchies.

- **Disciplined or undisciplined environment?** In a disciplined knowledge environment, where documents are tagged, metadata are applied and a common vocabulary is used consistently, the taxonomy project is straightforward. It can be developed by reusing existing vocabularies that support routine work, and taxonomies can be large and complex. Matrices and faceted taxonomies work usually well. On the other hand, in an organisation where shared folders are very messy and staff are used to working in their own way, it will be very hard to locate information. It is usually fastest to ask the person responsible for what cannot be found. Here, the taxonomy should help to negotiate inconsistencies and harmonise vocabularies. Tree structures are usually used here, as well as polyhierarchies. The project will have to be developed through a phased approach. Multiple revisions and adaptations will be required, as the taxonomies need to be tested. Stakeholder participation is required to increase ownership.
- **Explicit or implicit knowledge?** If the taxonomy content covers documents and databases, definition of the common vocabularies and organising principles is easier. When the taxonomy covers content that is not captured in documents but rather is embedded in the common practices and knowledge of individuals, then data collection will be more interactive and participatory, often involving group work.
- **Common or specialised taxonomies?** When a common enterprise taxonomy replaces separate ones, the taxonomy project can require the merging of existing taxonomies. This is the case when units and departments within an organisation are merged, for example. Merging works best when it is possible to identify a common primary taxonomy that will incorporate the specialised ones. The primary taxonomy should be broad and shallow: multiple and at times disposable taxonomies can then be used for specific purposes. A common taxonomy helps an enterprise understand the information it holds as well as that which is missing. It allows for the use of related information that was previously divided into separate areas of management.
- **Taxonomy or folksonomy?** Folksonomies and taxonomies are not mutually exclusive. Taxonomies can contain folksonomies when, for example, teams working on a specific task create their own disposable classifications through tags on online sharing platforms. Tag clouds, as in Figure 13, show key terms in different sizes, determined by how many times the word has been used. This encourages users to reuse words rather than always inventing new terms, and contributes to the emergence of a new language associated with specific areas of knowledge (Robles, ND).

### Figure 13: Folksonomy (tag cloud)


Source: Author's blog.

Folksonomies and taxonomies deliver their benefits in different ways and in different situations, and can therefore coexist. Folksonomies are thus not an alternative to taxonomies: they are powerful and innovative tools that complement taxonomies and help reduce the latter's rigidity. When content and communities are small and relatively homogeneous, formal taxonomies deliver benefits. Folksonomies are not very good for retrieval of documents. However, while social tagging may seem outside the scope of the work of taxonomists, it can actually help in identifying new terms and categories and in adapting and changing existing taxonomies. Meanwhile, when communities and collections grow, social tagging becomes a valuable complement to strained navigation aids. For example, IBM has adopted folksonomies for its global intranet, serving 300,000 staff. Folksonomies also contribute to innovation and creativity and prevent structured taxonomies from being perceived as too top-down and from smelling too much like project management (Denham, 2007). They help enhance agility, awareness, shared understanding and meaning linked to social network and web2.0 technologies and ultimately allow for greater informal learning. Andrews (2005) mentions that it is better to combine many simple tags than dream up complicated new ones. Moreover, it is best to adopt good tagging habits early, because it is hard to go back later and retag bookmarks.

## 7.4 Governance structure: roles and responsibilities

Implementation of the taxonomy project and delivery of project outputs need to be managed by a team with the necessary skills and expertise as well as access to key stakeholders. The project team should analyse the needs and perspectives of all users from the beginning of the project. The project team should also consider its future transition into a centralised unit in charge of maintaining the corporate taxonomy and coordinating the various specialised taxonomies within the organisation. Depending on the complexity of the taxonomy project and the size of the organisation, the team should have between 6 and 12 members, with various expertise areas (Pincher, 2010). A key criterion for selection is sufficient seniority to access senior management for key decisions and approvals (ibid). Hedden (2010) suggests the following key skills are required in a taxonomy team:

- Analytical skills to understand what principles and concepts should make up the taxonomy;
- Organisation and categorisation skills to determine how concepts, subjects or entities are to be classified and categorised along hierarchies;
- Language skills, as all taxonomists deal with words and phrases;
- Research skills to search for specific meanings and usages of terms and to understand whether these terms are a proper choice or not;
- Familiarity with basic and advanced features of online search and search engines;
- Understanding of different software and their functionality, tagging, metadata, etc.;
- Attention to detail, as taxonomies require accuracy and consistency;
- Attention to users' needs, as well as expectations and online behaviours;
- Ability to work independently, as taxonomists may have to make decisions alone;
- Ability to work with a range of people, such as software developers, webmasters, interface designers, project managers, users, etc.

## 7.5 Build a communication plan

Taxonomies can change working habits by, for example, requiring all staff to tag documents uploaded onto the internal intranet system or to conform to a certain vocabulary. These changes often encounter resistance, which needs to be managed through a communication

strategy. This needs to pay attention to key audiences, as different messages need to be communicated to senior management, project teams and users. The aim is to keep all stakeholders informed as to the purpose of the taxonomies, the approach adopted, progress and what is expected from the audience. In order to engage the interest of the staff, it is also important to find a simple and interesting message. Lambe (2007) suggests adopting concise, timely and context-specific messages to demonstrate the benefits of the taxonomy in the daily work of the staff. Face-to-face interaction and small group discussions work best, as they give staff the opportunity to ask questions and raise concerns. They can also help in collecting stories that will engage the interest of the staff and contribute to changing the working culture. Stories of change, as highlighted by Heath and Heath (2009) in relation to the knowledge management approach at the World Bank (Annex 1), are very important in changing perceptions and attitudes.

## 7.6 Deliver and test the taxonomy

The taxonomy will be developed through a series of deliverables and activities, such as mapping of working processes, analysis of IT systems, analysis of key terminology, consolidation of vocabularies, etc. Once the taxonomy has been drafted, it is important to test it with selected users. Testing helps in gathering evidence as to whether the taxonomy is easy to navigate and reflects the way of working of the organisation or department. It also helps in checking whether users can find what they are searching for and whether research returns empty results or not. Users' validation helps generate an understanding of whether the categories and sub-categories and topic terms enable users to predict the kind of content they will find.

## 7.7 Maintain the taxonomy

Taxonomies have to be flexible and adaptable to change within the organisation. Therefore, the taxonomy delivered by the taxonomy project will never really be final, but will need to be updated over time. Robust taxonomies usually require only small audits of their effectiveness conducted at regular intervals, for example every year or so. This allows the taxonomy to remain relevant over time by adapting to new work processes and roles within the organisation or enterprise. Large enterprises usually have a central unit tasked with ensuring that taxonomies remain relevant.

The project team must therefore be equipped with a series of guidelines on adding and changing terms and categories in the taxonomy; the estimated costs of making changes in the taxonomy; the kind of information required to adopt changes; the approval process required; and the approach to communication of changes and user feedback. Maintenance of the taxonomy has to be part of any taxonomy project, regardless of whether it is implemented internally by a team or through external contractors.

# 8 The future of taxonomies

Although taxonomy as an area of expertise in biology seemed to be fading (according to Mayfield, 2002, there are only about 10,000 active taxonomists in the world), the advent of the internet has provided opportunities that would have been unimaginable for Linnaeus and de Buffon. For example, the All Species Inventory Project aims at discovering, naming and classifying every living species on Earth within 25 years, thus closing the gap between the 2 million species that taxonomists have identified so far and the 10-to-100 million that may exist on the planet (Mayfield, 2002; Wolf, 2008).

Social networking has based its success on the freedom the internet provides, and is generating opportunities for new ways of creating and managing taxonomies. Coates (2005), for example, mentions an experimental service at the BBC which allows for bookmarking, tagging and rating of songs heard on the radio through a mobile phone. Tagging and social bookmarking seem to be the way taxonomy is moving forward, as technology now allows for the management of tags by automatically aggregating them and creating free metadata on a whole range of concepts (ibid).

Some companies and organisations, however, still think social media are 'kids' stuff,' and seem to be in denial of the new opportunities they provide (Robles, ND). However, the new social media and associated taxonomy approaches are attacking the culture of the old economic paradigm. For Robles (ibid), whoever knows the new language is powerful, whoever does not is vulnerable.

Lambe (2010) argues that, even though social networking taxonomies are the future, the traditional types of taxonomy reviewed in this paper are still an essential element in enhancing the effectiveness of enterprises and organisations. In line with Lambe, Sterling (2009) mentions that, while there are studies showing that folksonomy destroys the need for any solid taxonomy, he does not believe that the damage is that strong. Taxonomies are still required; now, it is more a matter of the correct balance.

The decision on how complex the taxonomy needs to be has to take into consideration the balance between the consistency imposed by a taxonomy and the degree of competition among different taxonomies or alternate knowledge organisation tools. Lambe (NDb) argues that this balance has to be determined by the overall performance objectives of an organisation, where it wants to go, what it wants to achieve and how it defines its effectiveness (ibid). To overcome stagnant knowledge silos and improve cross-organisation coordination, competing mechanisms should always be allowed to coexist with a taxonomy: allowing them to die out completely would kill the value that a taxonomy brings. Lambe (ibid) posits that a taxonomy thrives in the bed of the 'Babel instinct' of fragmentation within organisations, and that the whole essence of taxonomy work is to constantly repair the fragmentation caused by different ways of working, different languages and different vocabularies.

Therefore the future lies not in the choice between taxonomy or folksonomy, but rather in their integration to maximise the opportunities they both provide. Lambe (2007) recalls what Jane Jacobs (1992) once wrote in relation to cities:

> 'The ubiquitous principle is the need of cities for a most intricate and close-grained diversity of uses that give each other constant and mutual support […] The components of this diversity can differ enormously, but they must supplement each other in certain concrete ways' (p. 14).

In a knowledge environment, characterised by a diversity of subjects, areas and expertises, taxonomies, in their various forms and with their various purposes, represent a key element to build these concrete ways.

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# Annex 1: The importance of a story – knowledge management at the World Bank

Chip and Dan Heath (2008), in their book *Make it Stick*, tell an interesting story about the emergence of knowledge management at the World Bank. The story is about Stephen Denning, who in 1996 was managing the World Bank's work in Africa. At one point, he was asked to step down from his position and look into the area of information and knowledge management. Denning was uncertain: the task was unattractive and daunting at the same time. One the one hand, the World Bank knew a great deal about how to achieve results in developing nations; on the other, this information was scattered about the organisation. In the World Bank centralised bureaucracy, each project was an own universe; as Denning remembers, a water expert in Zambia would be unlikely to have an opportunity to share knowledge with a water expert in Bangladesh. Neither manager would know of each other's existence unless they happened to be in the same circle of friends or former colleagues.

One month after the new assignment started, Denning had lunch with a colleague who had just returned from working on a project to improve health care, particularly for mothers and children, in Zambia. He had met a health worker in Kamana, a small town 360 miles from Lusaka, who was struggling to fight malaria in the community and was trying to find information on how to combat the disease. Denning remembers that the worker had found a way to log onto the internet to discover the answers he needed on the website of the Centers for Disease Control and Prevention in Atlanta in the US. Denning did not pay too much attention to this story at that time, considering it more an interesting anecdote. Later on, though, he realised the Zambia story was a perfect example of the power of knowledge management. Someone in charge of a vital operation needed information. He went looking for it, found it and, as a result, was able to act more effectively. This is the vision of knowledge management.

Denning began to use this story in conversation with colleagues, stressing why the World Bank ought to make knowledge management a serious priority. Weeks later, he had an opportunity to speak to a senior management committee. He had just 10 minutes on the agenda to introduce a new organisational strategy and win the group's approval. In this 10 minutes, he set out the problem: the World Bank's difficulty in pooling its knowledge and the sorry state of the information system. Then he told the Zambia story. Immediately after the presentation, knowledge management became a priority at the World Bank.

This story, illustrated by Chip and Dan Heath, shows the importance of organising and managing knowledge to improve the design and implementation of development strategies and plans and, at the same time, highlights the dangers of scattered information within an organisation.

Moreover, Chip and Dan Heath highlight the 'curse of knowledge' argument, which states that

> 'Message compactness is unworthy. Becoming an expert in an area means that we become more fascinated by nuances and complexity [...] and we start to forget what it's like *not* to know what we know. Thus the importance of knowledge management should not be undermined by the complexity in communication about lessons' learned, success stories, stories of change.'

# Annex 2: Taxonomy web resources

| | |
|---|---|
| Collaboration and Findability, blog by Lee Romero | http://blog.leeromero.org/ |
| Consulting and Training in Taxonomies and Indexing, by Heather Hedden | www.hedden-information.com/index.htm |
| Earley and Associated Blog | www.earley.com/blog |
| EncycloZine Content Classification | http://encyclozine.com/Reference/Library/Classification |
| Green Chameleon, blog by Patrick Lambe | www.greenchamelon.com |
| Montague Institute | www.montague.com/ |
| Taxonomies & Controlled Vocabularies Special Interest Group | www.taxonomies-sig.org/ |
| Taxonomy Boot Camp | www.taxonomybootcamp.com/2010/ |
| Taxonomy Community of Practice Wikispace | http://taxocop.wikispaces.com/ |
| Taxonomy Community of Practice Yahoo Group | http://finance.groups.yahoo.com/group/TaxoCoP/ |
| Taxonomy Strategies | www.taxonomystrategies.com/html/library |
| Taxonomy Warehouse | www.taxonomywarehouse.com/ |
| Taxonomy Watch, by Linda Farmer | www.taxonomy2watch.blogspot.com |
| The Taxonomy Blog, by Marlene Rockmore | www.thetaxonomyblog.wordpress.com |
| Willpower Information Thesaurus principles and practice | www.willpower.demon.co.uk/thesprin.htm |