Granularisation

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Chapter 2
Granularisation

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"Granularisation" is a clumsy word for an elegant concept. It refers to the size of learning objects. Granularisation is a necessary condition for learning objects to be shared and reused. Reuse is necessary to gain economic benefits from educational technology. Economic issues cannot be ignored. It may be possible for a single, well-funded project to produce superb, interactive, absorbing online learning material but the wide-spread use of such high-quality resources cannot depend on project funding. It must depend on a form of " learning object economy" in which trading (sharing) occurs so that each contributor has access to a much larger pool of resources than they can use and reuse. The effort and cost of production is then balanced by the benefit to a large number of implementers.

Before considering the details of granularisation it is necessary to establish a working definition of a “learning object”. Many definitions are already in use but one of the most general is that of the IEEE Learning Technology Standards Committee which defines a “learning object” as being “any entity, digital or non-digital, that may be used for learning, education or training” (IEEE LTSC, 2002). This has been refined by others such as Wiley who describes a learning object as being “any digital resource that can be reused to support learning” (Wiley, 2000) and by Koper who states that “A fundamental idea is that a learning object can stand on its own and may be re-used.” (Koper, 2001). The notion of reusability is regularly associated with learning objects.

Anyone familiar with the way educational technology was used in the 1990s will point out that this view of reusable, shareable learning objects does not match reality. Why not? In the early 1990s courses were delivered on CD-ROM. They were large and indivisible, and could usually be used only in the context for which they were designed. Later, web-based courses appeared but they also followed the monolithic model. There were several reasons for this approach:

- **Economic:** Commercial products could demand a higher price if they were all-encompassing. Project-based products could be justified only if they produced substantial courses.
- **Expertise:** Producers were few and they were forced to assume that the users of their material would have little expertise.

- **Technology:** An absence of standards for joining different products together meant that each product had to produce everything that might be needed for its educational use without the option of using different products for different purposes in a common educational context.

The " learning object economy" has become possible because these "drivers" have not only disappeared but been reversed. We now see:

- **Economic:** Customers are unwilling to buy large monolithic courses when they only want to use part of them. In many cases customers also want to extract parts from their given context and use them in new and different contexts. The requirement is now for collections of small, reusable learning objects.
- **Expertise:** Many more teachers and learners are familiar with educational technology. There is an awareness of which tools are best for which jobs and an ability to use them.
- **Technology:** Standards have now been established to enable interoperability between different applications. Exchange of learning objects and learner information is now possible between different learning environments, management databases, digital repositories, authoring tools and quiz systems. These standards rely on a common "information model" for exchange between applications using their own internal formats.

From a technological point of view the key element enabling a learning object economy is the way the objects are linked to work together. This is discussed in more detail in Chapter 4, along with other factors.

Metaphors Galore

To convey the idea of breaking learning resources into granular objects and rebuilding them into different resources many people search for metaphors. The process of disaggregation and aggregation is common in a number of fields. From the world of publishing we can consider the granularity of a book. When visiting a bookshop the customer is not forced to buy the entire catalogue from a publisher rather than the single, selected book. However, it might be even better if is was possible to remove some chapters or even pages from the book and replace them with others from a different book. In some cases one might want to use a single illustration from a book as an overhead transparency in a talk. This process of disaggregation is already common practice among many teachers, though few carry it further and produce new books by aggregating parts of others - for sound, legal reasons.

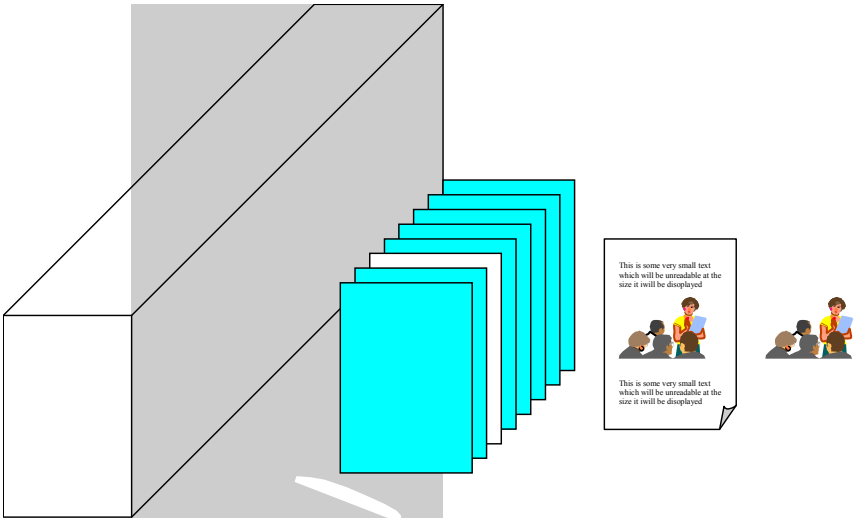

Figure 1: Disaggregation of a book, into chapters, pages and paragraphs and figures on the page.

Another useful metaphor that includes aggregation is that of Lego bricks. These come in many shapes and sizes and have illustrations on the box showing what can be made from the contents. However, the bricks are sufficiently reusable that the constructions are only limited to the availability of suitable bricks. Lego works because it has a very well defined "interface". The way one brick fits into another is obvious and requires no special skill. More sophisticated versions of Lego now break this basic rule by using specialist objects that cannot fit into any other Lego object. The rate of reuse of these non-conformant Lego elements is very low.

The atomic/molecular model is yet another useful metaphor. Different atoms have nuclei composed of the same basic particles. These atoms also all have electrons in common but in different configurations. The atoms themselves can build into molecules with one class of atom able to be used in many different types of molecule. This highlights the fact that the building blocks can be reused at different levels of granularity. It also shows that although there is considerable versatility in the way objects can fit together there may only be certain configurations that will work.

Levels of Granularity

Although the principle of granularisation of learning objects is easy to define it is much more difficult to find agreement on describing the various levels of disaggregation. Many bodies have tried to define levels of granularity or levels of aggregation with varying degrees of success. This is discussed in more detail in chapter 4 which explores "Engaging with the Learning Object Economy".

The different approaches to defining aggregation include:

- Educational terms (course, module, unit): Although the terms are familiar they have a wide variety of meanings which are highly entrenched in their communities and are not suitable for conveying common concepts.

- Purpose terms (asset, reusable learning object): The definition usually includes the amount of associated information (metadata). This indicates if the object is ready for use in an education context or if it needs to have that context specified.
- Size terms (number of pages, duration to complete): These are immediately understandable but do not give any information about the way in which objects might be used.

In summary, the levels of aggregation defined by purpose are the most useful for those who have to perform the aggregation and disaggregation. There are three levels of purpose: raw media assets, collections of assets which include structure but not educational context, and those which include the educational context and support for educational activities. Several alternative approaches to defining granularity are given in Wiley (2000)

At the basic level an asset will normally be a single file. It could be an image, some text, a video or audio clip, an interaction, or animation. Each raw asset might be used in many different settings. These settings may be educational but that is not a requirement. Any metadata (related information) associated with these objects will only describe the object and not the purpose to which it may be put since a multitude of different purposes is possible. An important component of the metadata is the “classification” which can have a high degree of multiplicity, in other words, one objects can be classified into many different contexts. For example, a logic gate object might be classified as Computer Science / Computer Architecture but also as Electronic Engineering / Digital Principles. Objects with many different classifications are inherently ripe for reuse. In terms of granularisation these basic objects are the most fundamental building blocks. All other objects will be composed largely of these elements. The next section will consider what is required to make these basic objects interoperable.

Assuming that these raw objects can be assembled into aggregations and that these aggregations can be given some structure we can consider this aggregation to be an information object. By bringing raw elements together they have been given some context. An image of the Van Gogh's Sunflowers might be accompanied by a brief description of the artist's life and some discussion of the historical period in which he worked. At this stage the aggregated object has no educational purpose. It might just as easily be used in an art gallery or auction house catalogue as in a course on art history. The metadata associated with this object describes it but need not include any educational information. On the other hand, it might be possible to define a learning objective which this object could help achieve, for example "to understand the historical context of post-impressionism". It might also be possible to define the target audience since the text may be written for those who are already expert in the subject and familiar with the jargon. Once this degree of additional metadata is provided it is clear that the object is intended for education and it might be referred to as a learning object rather than an information object. It is unlikely that a single object could achieve the ambitious learning objective defined above but it is also possible that this objective could be met if the Van Gogh object is aggregated with other similar objects to form a larger learning object which is an aggregate of aggregations. At this level, it is possible to add structured learning objects

together to form a new structure, possibly with a more extended learning objective, and this process could be repeated again and again to produce very substantial learning objects. These objects all have the same basic nature but some are more complex than others. In this discussion no distinction is made between these objects although some might refer to the various sizes as topics, units or modules. In technological terms the aggregation of objects is achieved through “content packaging” (IMS-CP (2001), ADL (2001)).

No matter how large a learning object becomes it normally requires more to achieve effective learning. It requires some activities and these often need to involve working with other people, learners and teachers, as well as discovering and using other resources. The way the activities are formed will influence the effectiveness of the learning. A single learning object may be used in more than one educational activity. Generally, the more complex the aggregation the less likely it is that it can be reused without modifying the learning object. At this level the objects need more than just metadata - they need a means of defining pedagogical strategies and the services to support them. This is the highest level of aggregation and the most complex. Emerging standards to describe pedagogy and educational support are often described as “learning design” or “educational modelling” (IMS-LD (2002), Koper (2001)).

If granularisation is to be effective it must be easy to take a learning object, disaggregate it and replace some media elements with others, rebuild the learning object and then aggregate it with others. The assembled resources then need to be incorporated into a "lesson plan" and made available to all the participants with appropriate support for a variety of activities and services. All of these component parts should be removable and reusable in different contexts.

Properties of a reusable object

What makes an object interoperable? The terms “reusable information object" (RIO) and “reusable learning object" (RLO) are in common use (particularly following Cisco (2001)). In this book the term “learning object” (LO) is used and it is assumed that such objects are reusable. But learning objects themselves are not interoperable. It is the software applications that support interoperability of objects that meet certain specifications. Those same applications may not support interoperability of objects that meet other specifications. The challenge for educational technology is to ensure that software applications can interoperate with all objects at all levels of granularity. This is a demanding task, but is not impossible. There are several ways in which it can be achieved:

- One company could totally dominate the market for educational technology and everyone would use the standard that company defines. This would allow the dominant company to dictate the direction and pace of future developments.
- Software vendors could agree on interfaces between their products that allow them to exchange objects with each other. If each vendor agreed an interface with every other vendor there would be very many interfaces and this would present serious barriers for new vendors entering the market.

- Purchasers could buy a complete suite of tools from a single vendor that promises all the components of their suite will interoperate. This can be effective so long as the vendor remains a market leader and the purchaser is willing to tie itself to that vendor for a long period and then expend significant effort when moving to a new vendor in the future.
- All vendors can agree on file formats that they will be able to import and export. This approach puts a great degree of power in purchaser's hands as they can choose from several vendors as long as enough support these file formats. This also means that purchasers can change their software from one vendor to another that supports the same format with little or no transition effort.

The last of these options closely matches the work of specifications bodies such as ADL (2001), IEEE (2002), IMS-CP (2001) and CEN/ISSS (2002). These bodies support device independent "information models" as a format for exchanging objects. Raw media objects are already supported by most software applications. Once they are brought together into a structured information or learning object, however, the information on the structure and location of the components needs to be stored in a form that other applications understand. This becomes more complex as educational metadata is added in the form of learning objectives and prerequisites. Once these learning objects are aggregated the information about the structure of the aggregate must be standardised. Finally when a pedagogical strategy and supporting services are defined they need to be specified in a form that can be understood by different applications which might deliver the supporting services in slightly different forms but for the same education effect.

Later chapters show that these specifications are in place or are planned, so that genuine granularisation is now possible and reuse and sharing of learning objects in an object economy is possible. Those responsible for commissioning substantial sets of learning objects have an important role to play in ensuring they only commission *reusable* learning objects. Now that the technological barriers to an object economy are crumbling it will be interesting to see if human influences act as barriers or as drivers for the development of an object economy.

A final word

The discussion above concentrates on the economic and practical advantages of reuse and learning through granular learning objects. We should also consider if it makes sense from an educational standpoint (for more detail see the chapters on “Keeping the Learning in Learning Objects” and “Pedagogical designs for scaleable and sustainable online learning”). It could be argued that the best courses display strong coherence and detailed cross-referencing to build links from concept to concept and from conceptual knowledge to the application of that knowledge. Since granular learning objects are designed for reuse they cannot include these linkages. They must be able to stand on their own under different uses. However, when we compare this situation with the way other resources are used in constructing coherent courses we find that textbooks, diagrams and research papers, videos, computer models and many other "learning objects" are also free-standing. It is not the objects that form a coherent course but the skill of the teacher in supplying a structure, a set of activities and occasional course specific material that act

as the "glue" to tie together the entire course. Many believe granularisation enables good teachers to continue what they have always done: create stimulating courses for students. Others take the view that granularisation and automatic course creation will, to some extent, change the role of the teacher. This is discussed at length in chapter 3.

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