Size and quality measures for multimedia and web-site production

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ABSTRACT. In the context of multimedia and web-site development, size and quality measures are needed for modelling the project costs and schedule, for optimising the design and test plans, for contractual negotiations, and for studying and teaching the nature of multimedia development processes. A distinction must be maintained between internal and external measures, with aggregate measures and cost models separated from these. A focus on product characteristics is recommended because the process characteristics are unstable, and are likely to evolve continually over the next 10-20 years.

Introduction

This paper addresses two questions: Can we model the effort and duration of multimedia development? And if Yes, how do we go about it? To answer the questions, methods are taken from existing materials and compared against the personal observations of the author.

The paper begins with an exploration of the scope of the problem, and identifies the main influences that make multimedia different from software. Three approaches to cost modelling are then explored, and their advantages and disadvantages considered. In order for these cost models to be built, measures of size will be needed – these are discussed in the next section. It is followed by a description of other product characteristics, relating to quality. As a conclusion, the paper addresses the problem of how to cope with a future that is not an extrapolation of the past.

(1) What is multimedia?

This paper uses the word “multimedia” repeatedly to cover interactive computer-based transactions that involve two or more of the following media components: text, pictures, video, sound, 3D objects and environments, motion, smell and physiological effect. The mechanism by which this is delivered is irrelevant to the scope, although it is noted that the need for interactivity and personalisation is currently resulting in domination of the area by applications that use Internet, intranets and extranets. The use of multimedia technology for broadcast-only is excluded by the lack of significant “interactive transactions” between the broadcaster and audience.
To understand what is currently happening in multimedia, it helps to think of four separate influences. These are each summarised in the paragraphs below.

**Historic context**

Multimedia represents a new phase in computing technology, but it follows from a sequence that began 120 years ago.

The first computers were entirely calculating devices, initially mechanical, and later with electrical components. The market for such devices was severely limited.

The inclusion of software allowed machines to be developed that had many more uses. The total expenditure on hardware increased, but the expenditure on software increased even faster.

The inclusion of spreadsheets allowed users to develop applications for their business and personal uses. Like the first use of software in the 1960's, the growth of user-applications was initially modest. However the new multimedia technologies provide major commercial and personal opportunities. The total expenditure on user-applications already exceeds “professional” software, and it continues to expand. Ultimately all the information industries (and perhaps much of the medical and defence industries) will redesign their businesses to be focussed on information – the entire set of e-based industries will dominate the international economy. The software engineers will be critical, but can not aspire to impose their own values and behaviour on the entire economy.

**Layered structure**

As illustrated in figure 1, the multimedia community exists at 4 levels: hardware infrastructure, software infrastructure, development and application/content.

- The infrastructure is provided by telecomms companies, software developers (such as Microsoft) and hardware manufacturers. At the infrastructure level the technologies are converging as fast as the companies can achieve it. Since the motive for this is financial, it is likely to continue.

- The development layer includes the web-site and multimedia development companies and departments. There is some convergence of look-and-feel between these companies, and the multimedia development tools also enforce some standardisation, however the companies differ substantially according to the industries of the clients.

- The application/content layer is represented by existing industries. They provide content which is used by the multimedia developers. It is common for half the total project costs to be incurred by the industries. Inevitably the working relationship between the content providers and developers must be very close if it is to be effective. This substantially influences the way in which the multimedia development companies work – they must fit with their clients processes, rather than enforce alien processes.

In the infrastructure layer, the emphasis is on convergence. However in the content layer, the emphasis appears to be on divergence, as each company wishes to find new market opportunities. This effects the multimedia developers, who must elucidate and implement these wishes.
There is no multimedia industry

The term “multimedia industry” is often used by the press and in journals, but without explaining whether it refers to the infrastructure layer or the development layer.

Professional multimedia developers tend to avoid the phrase, because there are “multimedia industries” but no homogenous multimedia industry (singular). Indeed, the whole nature of multi-media is to achieve close collaboration between different industries, not to replace them.

Evolution

Each of the layers shown in Figure 1 is undergoing a period of rapid change, resulting from new opportunities and competitive threat.

In the infrastructure layer, the combination of technical convergence and huge investment in cabling/etc, creates major new opportunities.

The multimedia developers receive major annual upgrades to their main development tools, sometimes providing major new features that dramatically change the way applications are developed. (Such as in Macromedia Flash 1 and Flash 4.) Also, advanced technologies are becoming accessible at low price (as in 3D modelling), allowing completely new opportunities.

The application/content layer is effected by the need to re-engineer their business – 21st century businesses must become e-centred rather than merely e-users. Typically this is the most dramatic change of an entire organisation’s history, and many will fail. The effect on the multimedia developers is unstable clients, and many who must be entirely avoided.

The combined effect of rapid evolution in all three layers, is that work processes have to be changed frequently, often using best-guesses. The use of statistically-controlled process change would take so long for many projects, that the company would become completely uncompetitive within 2-3 years.
(2) What cost models?

Currently, there are no published "cost models" for the multimedia industry. Occasionally variants of existing software cost-estimation models are proposed, but these typically address only the software component of the project[1]. This is not sufficient, since except on e-commerce and database sites, software typically represents less than 10% of the project costs.

Three different strategies could be adopted: a generic approach, the creation of a set of micro-models, and the use of advanced data-driven models. The paragraphs below consider each of these in turn. In the context of the author's research, the focus is on the first two of these because they have different purposes and providing complimentary viewpoints.

Generic models

The classic generic models in software development are the COCOMO family for effort estimation. To achieve the same thing within multimedia, it is essential to find generic measures of size and product characteristics that can replace lines-of-code and product quality features. (Some examples are given in section (3) below.)

Also attempts to build a COCOMO-like model will need to address diverse development processes, resulting from the inclusion of different industries (graphics, animation, technical writing, etc). The challenge of building models of this kind has steps: first the basic processes and features have to be identified, second a basic model has to be created using expert opinion, thirdly data is collected to calibrate it. The examples of COQUALMO, CORADMO and COCOTSMO, show how these models can be useful from the moment they achieve the second step, because Step 2, they provide sufficient information to support management decisions, and for teaching managers about the influences within projects. To achieve Step 3, a network of players is required (like the COCOMO affiliates) and the resources are needed for statistical analysis. Unfortunately, for multimedia modelling, we are currently trying to achieve the Step 1.

Sets of micro-models

An alternative strategy is to focus on creating small and simple models for each major activity within the multimedia development process. (For example, graphics production, technical authoring, video editing, software production, etc.) In some cases, different versions of the model would exist for fundamentally different ways of working. (For example, conventional drawing tools are widely used within video editing, but the process is heavily automated.)

An advantage of micro-models is that they can use "internal" product data. Not only does this make data collection easier, but it also allows the model to describe the design and testing decisions made within the activity.

Another advantage of creating micro-models is that they can be developed at different speeds, depending on motivation, the stability of the process and the availability of data. If there is collaboration between the micro-model builders, then some uniformity of data-collection could also be achieved.
Advanced data-driven estimation methods

The software industry has used advanced methods for cost estimation, including multivariate regression analysis, neural nets and genetic algorithms. Each claims high success rates, when used on data collected for homogenous sets of projects.

In multimedia development, processes are unstable and data is non-existent. This could change, and some of these advanced methods may then become applicable.

(3) What measures of size?

The quantity of product that is delivered affects the cost and delivery time, and possibly also the product reliability. These are typically referred to as the “size driver(s)”. In addition, measures of the quantity of product are also important in negotiation with clients (especially when they change their minds) and when studying the trade-off between quantity and market value. To support these different needs, different types of measure are required: internal, external and aggregate.

Internal measures

Internal measures provide meaningful descriptions of the size of each asset. They can often be precisely and consistently measured, and some can be measured very easily. The internal measures are useful for supporting design decisions.

<table>
<thead>
<tr>
<th>Example of internal size measures: 2-D bitmap images</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pixels.</strong> The dimension of the bitmap in pixels gives an indication of how much work will be needed to create a detailed picture. (The pixel dimensions are available on all picture editing software with exact precision.)</td>
</tr>
<tr>
<td><strong>Special effects.</strong> The number of special effects applied to an original bitmap, gives an indication of how the picture was built. However it is not possible to define counting rules that are suited to all versions of all graphics tools, and the data collection would be expensive and unreliable.</td>
</tr>
<tr>
<td><strong>Objects and symbols.</strong> These are the discrete items from which a photograph is composed. It is time-consuming to count them, but it can be achieved with precision and consistency.</td>
</tr>
<tr>
<td><strong>Layers.</strong> Bitmaps are typically composed of a set of layers, each of which adds one or more images or text, which may interact with the layers below. Complex images require more layers. Layers can be counted easily, with total precision and consistency. Layers are also useful when describing animation sequences, because tweening is applied to an individual layer (using a path over several frames).</td>
</tr>
</tbody>
</table>

RECOMMENDATION: Always count the Pixels and Layers. In systems requiring high maintainability, it is useful also to count the number of objects/symbols. (Corel Photopaint 9 users can automate the process using VisualBasic programs.)

External measures

External measures are obvious to users and could be counted by someone presented with the completed product. (In practice, there are so many paths through most multimedia, that the actual counting occurs using the design or file structures.) External measures are useful for generic models and for negotiations with the client.
Object counts are good external measures for products such as web-pages. (For example, the number of pictures, the number of pages, and the number of paths.) Duration is more appropriate for multimedia based on video, sound or animation, since the costs are directly proportional to total duration of all assets.

Function counts (and similar measures) are appropriate for e-commerce sites and searchable on-line databases.

**Aggregate measures**

Function Point Analysis is the most popular aggregate measure for software development. It is widely used as a way of describing the total delivered size, for comparing productivity rates, and as the basis for negotiating the cost of changes. (It is also widely used in cost-estimation, although better sizing methods exist for that purpose.)

If Multimedia Points are to achieve the same success as Function Points, there are some basic requirements they must achieve:

1. They must be unaffected by how or when the product is implemented. (For example, duration and object counts are good, but layer-counts are application-dependent.)
2. They must be suitable for sizing contract changes.
3. They must be available early in the project, following detailed specification or prototyping.
4. They must be cheap, consistent, and precise.
5. There must be a simple logic behind the way they are aggregated.

(4) **What measures of quality?**

As with size, quality can be expressed with internal, external and aggregate measures. However there is a further distinction, because in many multimedia developments, some quality features are to be maximised within available constraints, while other quality features are required only to meet a specific performance level[2].

**Comment on web-site specifications.**

Some clients specify the nature and content of the web-site with great precision, following “good practice” for specifying software products. They are invariably deeply disappointed with the results[3]. Often the only way to achieve a good site is by repeated experimentation and by establishing a very close working relationship between the client and the creative people in the multimedia developers.

**Internal indicators of quality**

Experienced multimedia developers are familiar with the different asset-types and the features that make them good or bad in a specific context. Many of these quality features are inherited from the traditional media industries that contribute to multi-media, and which continue to share some common development tools. However new measures are needed for new digital forms (especially concerning moving images), and in some cases quality features that had originally been ignored are now important.
Internal measures of the product provide indicators of the quality that is seen by users, but there is no such thing as “internal quality” (except concerning conformance to standards and requirements), and it is easy to become overly focussed on internal measures and loose the big picture that is painted by external features and reward.

<table>
<thead>
<tr>
<th>Example of quality features for Narrative assets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal indicators of quality: Spelling, Grammar, Linguistic simplicity, Tone of voice, Compactness, Quantity per section, Logical structure, Text layout.</td>
</tr>
<tr>
<td>Related size measures: Words, Abstract concepts, Concrete concepts, Analogies, Stories, Characters.</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Example of quality features for 2D-Images</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal indicators of quality: Quantity, Compression, Contrast, Smooth tonal transition (&quot;gradation&quot;), Edge sharpening, Use of colour, Colour detail (&quot;colour mode&quot;), Colour fidelity, Printing accuracy (Gamma), Colour vibrancy, Harmony with main scheme, Composition.</td>
</tr>
<tr>
<td>Note that applications often have reversed priorities – i.e. a high value may be good or bad, depending on the context.</td>
</tr>
</tbody>
</table>

External features of the system
The external features are those that are easily visible to users, and with which they are readily familiar. This makes them especially useful for requirements definition and contractual negotiations.

In some cases, measures of external quality features match exactly onto internal measures, however usually they take an entirely different perspective. Since neither external nor internal views are fully representative, the use of both views builds a more complete picture. The ISO/IEC 9126.1 & .2 characterisation scheme[4] is useful in that it is exhaustive, and can be adapted to describe content as well as functionality [5].

Unfortunately, despite the obvious benefits of this classification scheme, very few of the concepts are familiar either to multimedia developers or to users. (Indeed, users often express themselves using internal measures rather than external features.) Consequently, a slow uptake is anticipated for the use of external quality features, other than those concerning usability).

Reward features – “attractiveness”
The 9126 definition of usability includes a loosely defined sub-characteristic of “attractiveness”, which appears to have been added specifically for multimedia products. For multimedia in generally, and especially for web-site developers, this is so significant in commercial terms that it needs to be considered by itself.

Good multimedia and web design results in massive positive feedback to encourage continued use. Current discussions in the multimedia industry refer to “interaction”, “personalisation” and “participation”, but this is only a partial view and is distorted towards specific solutions. The full nature of this feedback comes from a combination of novelty, supplementary learning, participation, emotional involvement and comfort [2]. Different users respond to different combinations of stimuli. Since the
attendance at each web-site is very diverse, web-site designers provide a combination of stimuli to appeal to as broad an audience as possible.

There is an important exception to the need for positive feedback. Negative emotional feedback can be very effective. Especially anger, fear, jealousy and lust, are to aggravate common medical conditions such as depression, neurosis and addiction. For example, the traditional news industry uses these so extensively that sometimes they are given higher priority than the reliability and completeness of the data transfer ("news").

Aggregate measures
Internal measures of multimedia quality are typically too specific for use in requirements elicitation, contracts and system evaluation. It would be very convenient to have aggregate measures that addressed high-level concepts. Various uses of aggregate are likely to emerge as a result of low-level measures of size and quality. Specifically:

1. **Indexes which indicate specific properties.** (An example is the Fog Index, which combines sentence length and the number of long words to give an indication of readability.) These can provide useful feedback within the authoring, development and testing process.

2. **Aggregation of quality sub-characteristics into quality characteristics.** This is mathematically trivial, but the selection of which weightings is highly debatable. Never-the-less the convenience of a single number, means that it will be widely used. (Also inevitably, people will combine all sub-characteristics into a single dimensionless expression of "total quality", which could only be meaningful relative to other similar types of product in an environment of stable user requirements.)

3. **Prediction of external quality features** based on internal measures. The advantage of doing this is obvious, however it has proven especially difficult within the software industry (e.g. predictions of reliability from defect detection) and multimedia is even more diverse than software.

4. **Quantitative alternatives to abstract concepts.** This combines various quality measures with perceptions of good or bad practice. (An example, is the stereotyped approach common to judging photographic competitions.) Unfortunately such aggregate measures are difficult to calibrate, because the abstract concept can itself not measured except by opinion polling.

Only the first of these is likely to produce results that will widely accepted as good practice by the academic community.

(5) What future?
Creating cost models for multimedia development is not easy.
- The productivity increases being achieved by multimedia developers are considerable, and the rate of change greatly exceeds that experienced within the software industry.
- The different combinations of what can be done for users, increases exponentially with the number of different combinations of these effects.
- The distinction between client and multimedia developer is becoming blurred in some areas.

There is evidence that these problems will remain for decades:
- There are no near-term limits on development of the technologies and service infrastructure.
- The amount of available money increases as the benefits contribute to the quality of life. Future integration between computing and medical science has enormous potential to support improvements in health, work and recreation.
- There are potentially external factors (such as environmental concerns) which will force mankind to resort to putting more emphasis on "virtual" pass-times.

To what extent organisations enforce process stability will depend on the benefits of stability compared to that of evolution. However, while the technical and business environment changes, rapid evolution is inevitable.

This paper has shown that cost models could potentially be built to support multimedia development, despite these problems. Initially the models would be useful as decision support aids and for training, but not for precise forecasting. The existence of size and quality measures will also have benefits for contract negotiation and for design & test planning.

Challenges exist in obtaining funding for the research work, building a network of multimedia organisations who will contribute, and selling the benefits of the methods to the broader community which is continually bombarded with exciting new tools which make productivity improvements of 20-100% as well as major (commercial) advances for some quality features.

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Further information
Lists of multimedia quality and size (as well as various teaching aids) are maintained at

http://www.mmhq.co.uk/

These are updates as new information becomes available.


