SPECIFICATION-ORIENTATED PROCESSING: INTEGRATING AND SUSTAINING WHAT?

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ABSTRACT

This paper argues that basic terms, including specification, product, contract and asset are inadequately defined by the International Organisation for Standardisation (ISO). Inconsistent identification and representation of decision-making information results, hindering the development of integrated computer handling of information. An improved definition of specification and contract is proposed for a specification-orientated approach to integrated information handling, using definitions of product and asset proposed previously. Inconsistent definitions found in British Standard BSO are discussed to illustrate the problem. Some requirements of a specification-orientated task controller are presented to handle specifications, as defined in the paper, in an integrated and sustainable manner. Limitations met when trying to handle a proliferation of standards are considered. The different requirements of adding-value in production, sustainable production and the regulation of productive activity are outlined. The paper concludes that a review of basic terms should provide a formal definition of the category of information used for decision-making. The term specification is considered to be appropriate.

KEYWORDS specification-orientated, computer-integration, specification, product, asset, contract, standard, sustainable.

1 INTRODUCTION

Construction activity can be described as a sequence of productive tasks. In everyday language, it can be said that each task is specified prior to being undertaken. Information handling is considered to involve the repeated creation and use of specifications [Toms 1995]. A contract binds parties to conform to a specification, which must comply with relevant regulations. In these terms any bit of construction information can be associated with a particular task specification used to specify and represent a productive or regulatory activity, which may be adopted as a project standard. To be able to describe information in this way requires an appropriate definition of specification. This paper considers a definition of specification given by the ISO to be conceptually inadequate and proposes an improved definition.

The possible scope of computer integration of construction information handling is then considered. A standard for exchange of data describing the form of a product only provides a limited scope for integrated handling of information. To use information in decision-making requires appropriate representation, which should be regarded as an aspect of integration [Toms 1994]. The problem of integration is considered to be specification representation rather than modelling of building products [Toms 1995]. Integration is not only a matter of systems, previously it has been argued that only certain aspects of a product specification can

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be handled by computer in terms of objects [Toms 1996]. A specification-orientated task controller has been proposed as the basis of integration, rather than a product model [Toms 1995].

The term specification is used to describe the category of information used to take decisions about a product, that is "specify" in the sense outlined above. To elaborate a specification-orientated approach requires appropriate definitions of product, specification and contract. An improved definition of product has been proposed previously [Toms 1993]. The conceptual approach adopted previously to define a product is extended here to consideration of a specification. This involves consideration of both the process of specification creation and its product, a document. The proposed definition is intended to make consistent identification and representation of tasks common to any decision-making process easier, to facilitate integrated computer handling of specifications.

This paper commences by considering the definition of specification using the previously-presented definition of a product. It argues that a definition of "specification" given by the ISO has conceptual inconsistencies [ISO 1991]. The definition states that a specification "prescribes technical requirements". This papers argues that a contract "prescribes", whilst a specification only "represents". Some consequences and problems for information handling arising from the use of the ISO definition are discussed, including some definitions found in BS0: A standard for standards [BS0 1991]. Improved definitions of specification and contract, consistent with a definition of product presented previously are presented. These definitions are intended to enable any decision-making task to be analysed consistently and facilitate integrated computer handling of specifications. They take account of the needs of both the design process and product representation.

Having presented an improved definition of a specification, the following factors which determine the extent to which specifications can be handled in an integrated way by computer are considered

- enterprises create and use different standard specifications to gain market advantage
- the need to interpret a standard
- the historic proliferation of standards.

Finally, the need for an integrated and sustainable approach to take account of the characteristics of different types of decision is considered. A specification-orientated approach has to facilitate

- implementation of value-added processes that exploit new standards
- sustainable development
- regulation of productive activity.

Having identified some of the different information requirements for decisions concerning these objectives, the paper proposes a conceptual basis for sustainable integration handling.

2 DEFINITION OF PRODUCT

An improved definition of product as "a thing specified in association with a process" has been proposed previously [Toms 1993]. The definition explicitly acknowledges specification of a thing with respect to a process. It was proposed as an improvement to inadequate definitions proposed for STEP. A product is the outcome of a process defined using specifications.

A product should not be confused with an asset. At any time an asset is a specific owned product, as material, space or compatible process [Toms 1991, 1988]. It is often made up of other product. An asset changes over time, maybe due to ongoing maintenance where new material is added (paint) to maintain original performance, or due to alteration (an additional

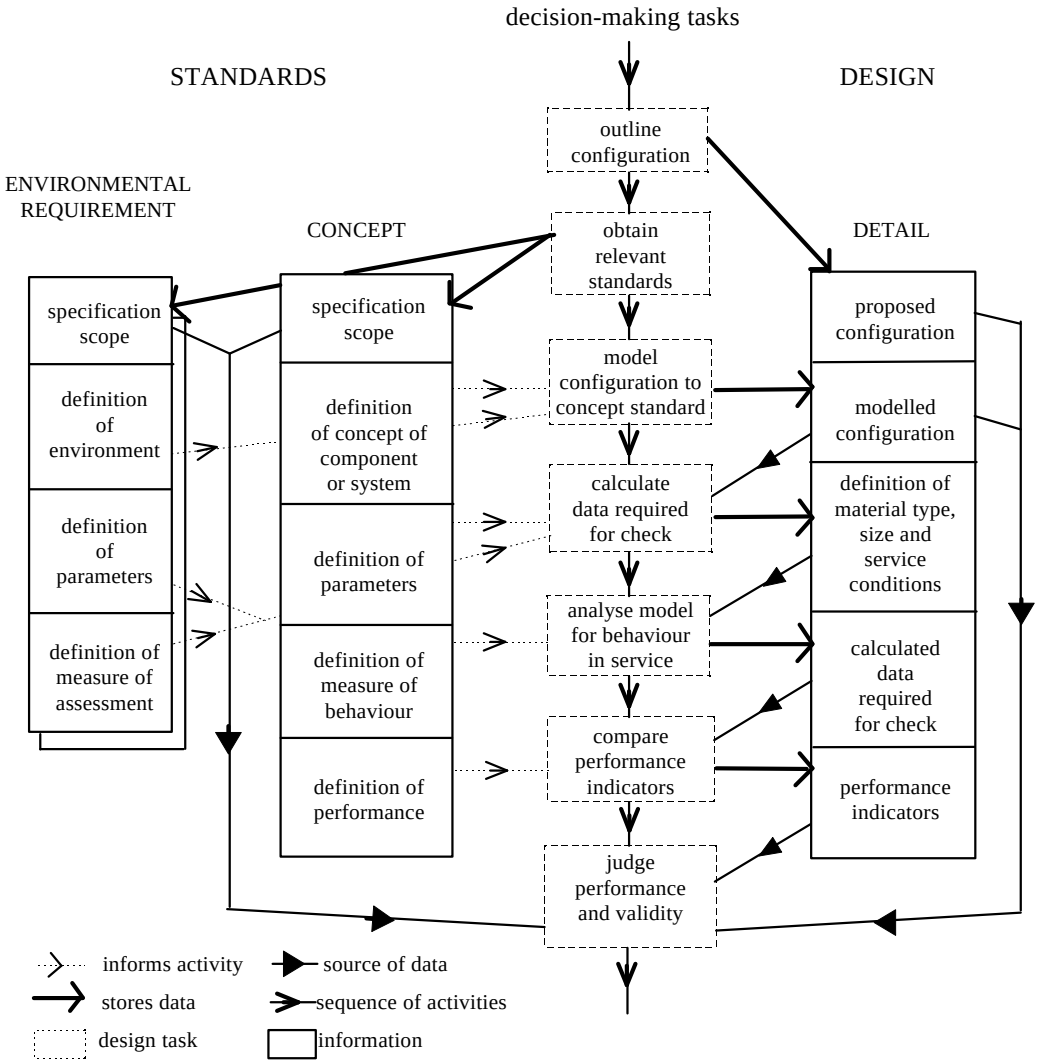


Figure 1. Activities and information involved in decision-making.

door opening) to create new performance. An asset changes its form, maybe simply degrading, over a useful lifetime.

3 DEFINITION OF SPECIFICATION

An ISO definition of a specification is: "a document that prescribes technical requirements to be fulfilled by a product, process or service" [ISO 1983]. This definition is considered to be inadequate. Some consequences of using this definition are discussed below.

One problem with this definition is the use of the word "requirement". It is defined by ISO as "a provision that conveys criteria to be fulfilled". Use of the term "requirement" relates to the product of a process only. Previously, it has been argued that a specification is used for both decision-making and product representation [Toms 1992]. It is not sufficient to define a specification only in terms of product "technical requirements", that is product criteria.

A second problem is use of the word "prescribe". Prescribing requirements is a contractual matter. Thirdly, the word product is used in a loose manner. Using the definition of product given above "a thing specified in association with a process", a process and a service are both types of product. The ISO definition does not take account of the way specifications are used to decide on the configuration of a product; it only concerns the description of the product, in terms of requirements. A product is a specification for a subsequent process [Toms 1996]. As the product of a decision-making process, a specification may be used in a product representation for a subsequent process, or be retained and declared to be a standard specification for future repetitive use.

This paper proposes a definition of specification as "a document available for perusal comprising a set of specifications representing the product of a process". A specification, maybe adopted as a standard, is the product of a process of investigation, maybe involving tests and analysis of results. Essentially, it represents and contains the results of that process. To understand what information is in a specification requires definition of the word "represent". How does a specification "represent" a product? By providing the following categories of information (figure 1) [Toms 1988]:

- a title
- specification scope
- definition of concepts
- definition of parameters
- definition of measures of behaviour or performance
- definition of performance.

The content of a specification contains different types of information (see figure 1). For a specification of environmental requirements (say wind loads) four types of information must be provided; for a specification of performance, five types of information must be declared.

The word "requirement" does not appear in the definition of a specification (say, for the strength of brickwork), proposed in this paper. As discussed, prescribing requirements is a contractual matter. So, a contract can be defined as "a document that prescribes requirements in accordance with specifications agreed by parties promoting and undertaking an activity". Specification, product and contract are defined in this paper in a consistent and integral manner.

Why define a specification in terms of specifications? A specification represents a product which is a specification for a subsequent process, repeated endlessly in industrial production. The definition of a specification should acknowledge that a specification is devised and used to define other specifications, when the product of the application of the specification is consumed. In another context, software programming techniques, object-orientated techniques are based on the principle that one object may be defined in terms of other objects [Gray 1992].

4 CONSEQUENCES OF USING AN INADEQUATE DEFINITION

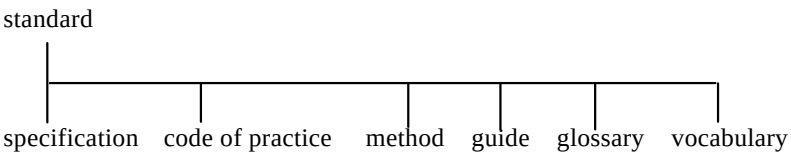
Use of an inadequate definition of specification appears to be a factor in the inconsistent and inadequate definition and categorisation of types of standard given by British Standards.

For example, BS0 Part 3 section 8.1.1 defines the term specification [BS0 1991]
"A specification is a detailed statement of a set of requirements to be satisfied by a product, a material or process and the procedures for checking conformity to these requirements" (a current draft of a revised version of BS0 proposes only minor changes). Strictly, "material or process" are both types of product, so the additional use of these terms in section 8.1.1 is superfluous.

This definition does not comply with the definition of specification in ISO/IEC Guide 2, which defines a specification in a restricted sense of "technical requirements" only [ISO 1991]. This restricted definition of specification may have contributed to the incorporation of inconsistent definitions into BS0.

The word "technical" appears to have been used to restrict the scope of the concept of "specification". The inadequate definition concerns the product only, the process of specification is not acknowledged in the definition.

As a consequence there is no convenient term to describe the category of information used to take decisions, which in everyday language is "specification", hence "to specify". BS0 tries to use the word "standard" as a substitute, and gives a hierarchy of concepts, viz



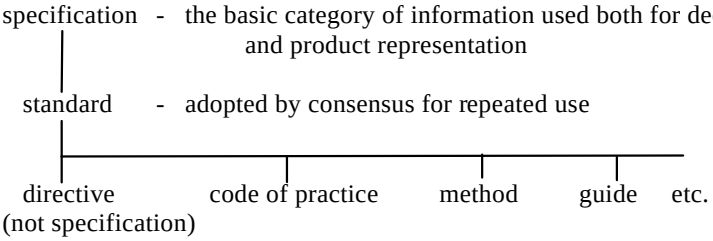
The word standard was historically shorthand for standard specification, and this change is clearly inadequate. The "looser concept" of specification was dropped in 1981 from BS0 in favour of replacing "standard specifications" by "standard" [BSI 1996].

Standardisation is defined in BSO part 1 section 2.1 in terms of "repetitive application" of a document. By emphasising this aspect of the use of standards, the oversimplified hierarchy of types of document can be justified more easily. However, this is done at the expense of losing sight of the use of a standard as an aid to decision-making, by emphasising a standard as a product.

Methods, code of practice, guide, glossary and vocabulary are all types of specification, using the term “specification” as defined in BSO Part 3 section 8.1.1. These documents are all the results of decision-making processes, and detail requirements for subsequent productive activities. As a product is the outcome of a productive process, including a decision-making process

- a specification is the outcome of a decision-making process
- specifications are also part of the information input into a decision-making process.

A more consistent hierarchy of concepts, which should be adopted, is



When the content of methods, glossaries, guides and vocabularies, etc. are analysed in terms of the productive activity in which they are used, the categories of information comprising a standard specification (listed above) can be identified in each one. In many cases information categorisation is trivial. For example, when using a vocabulary the performance indicators would concern the “fit” of a word to the contents. It would either be exact or not-at-all. Nevertheless, the ability to categorise any specification information consistently would make it easier to define software to handle information in a specified manner.

The present inadequate definition of specification has resulted in

- lack of a formal definition of the category of information used for decision-making (called a specification in this paper)
- difficulties identifying specification information in different product representations as being of the same type, for consistent computer handling.

For STEP (ISO 10303) a new category of information “application protocol” has been invented, a category of information used for decision-making [Toms 1993]. It would be more consistent to revert to “specification”, with an improved definition. There may be “persuasive arguments” for reviewing the international terms and definitions, most of which are unchanged since 1986 [BSI 1996].

5 USING STANDARDS

To what extent can specifications, understood as defined in this paper, be handled in an integrated manner? Some characteristics of the use of specifications are now considered. Enterprises create and use different specifications, as standards in particular projects, to gain market advantage.

- When a new standard is introduced into the market, it cannot always be understood without explanation from its originator.
- An enterprise may keep certain information confidential from competitors and the market.

Having adopted a standard, an enterprise wants its use integrated in both project and overall management to achieve increased value-added activity. To ensure safe activities and to maintain viable economic activity, some standards are imposed by regulation.

6 PROLIFERATION OF STANDARDS

The proliferation of standards also determines the possible scope of integration. As discussed previously, standards proliferate: “overall, the number and variety of standards increases” [Toms 1985]. Whilst the aim of standardisation is reduction in the variety of standards and simplification of the design process”, this applies only to the promotion of economy in the production and use of one type of product through variety reduction. For a product comprising compatible processes (such as a building containing more than one component, as described previously [Toms 1988]), the opposite tendency is everyday experience.

Increase in the complexity of design codes is not dependent solely on changes in the type and range of material. Before a decision can be made by an enterprise to invest in production, prediction of likely return on capital has to be made. Increased predictability of return on investment in a given product, perhaps a steel frame, is sought through improved prediction of performance, achieved through standardising and rationalising its fabrication and use. To make identification of a particular type of performance easier, the variety of functions performed by a given component can be reduced. For ease of fabrication, configuration can

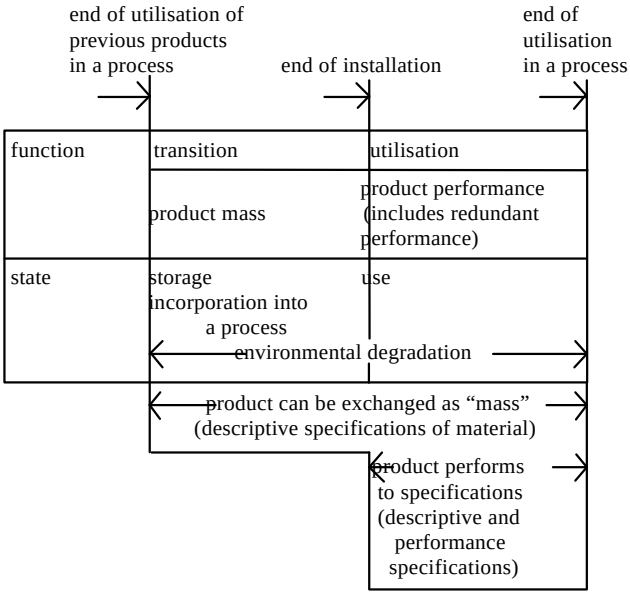


Figure 2. A product: transition and utilisation.

be kept as simple as possible. However, to increase the predictability of performance it is necessary to identify additional parameters of behaviour for measurement. So, although the number and type of components incorporated into a structure tends to be minimal, and the form simple, the number of parameters to be considered to improve assessment of performance tends to increase.

Typically, for a building product, an increasing range of performance requirements have to be considered in design. Improved economy contributes to an increase in production of all goods with an associated greater variety of all standard specifications. Integrated handling techniques have to take account of the tendency for the production of standards to proliferate, both quantitatively and in complexity.

7 A STANDARD SPECIFICATION AS A PRODUCT

A specification-orientated task controller should make available information handling processes common to the use of any type of specification. These processes concern two aspects of the use of any standard specification as a product, transition and utilisation, as discussed previously (figure 2) [Toms 1994].

To make a standard specification available for use (transition), a task controller is required to assist the decision-maker

- handle standards containing unique concepts, which cannot be handled automatically
- handle a proliferation of standards where only certain aspects can be handled logically
- find a relevant standard
- access out-of-date standards (for example, applicable to old buildings or software).

To assist in the use of a specification as an aid to decision-making (utilisation), a task controller is required to

- handle an increasing number and complexity of standards
- permit the creation of unique interfaces and interpreters to handle new concepts.

Improved communication techniques provide better access to standards and explanatory text, but not necessarily better understanding of their application, which depends on the skill and experience of the decision-maker. A decision-maker does not have the experience to understand and use every standard. Whilst integration could provide consistent handling techniques, this does not mean open access in practice, in the sense that information can be understood. The availability of extensive information access and exchange does not necessarily make a decision-maker more effective. For practical reasons, much information will not be of use to a decision-maker (consider the amount of information on the Internet).

8 DECISION-MAKING REQUIREMENTS

Processing the content and representation of specifications in an integrated manner has to take account of different decision-making requirements. Each of the following tasks involve different processing requirements: implementing value-added processes that exploit new standards; determining the requirements of sustainable production and regulation of productive activity.

8.1 Adding value

Implementing value-added processes that exploit new standards in the market involves automated information handling wherever possible. Some information may be confidential, to maintain competitiveness.

8.2 Determining requirements of sustainable production

The requirements of sustainable production are not well understood. Sustainable development is in many respects undefined. Advocates of sustainability have identified the need to recycle resources to conserve limited supplies, reduce energy consumption and limit the use of hazardous materials. Though the type of economic growth is altered by pursuing these objectives, the basis of a long-term sustainable alternative to the present unsustainable growth economy needs to be elaborated.

A computer cannot assess how a selected specification contributes to sustainable development, without the criteria of judgement being contained in the specification or another one. Where decision-making criteria concerning sustainability can be defined by a standard, integrated computer handling of information can be described in specification-orientated terms. Assessment of unique site factors involving non-standard considerations requires interactive computer access to information.

In addition to requirements of the process of specifying a product, the sustainability of the integration process itself has to be considered. The integration process must be sustainable throughout the duration of a project. But there are limits to the extent that a proliferation of standards can be handled that determine the scope of integration, as discussed below.

8.3 Regulation of productive activity

Productive activities now have global consequences. Third parties, addition to the two parties to a construction contract, are involved in the review of environmental impact, health and safety issues and economic consequemces. Regulation of productive activity requires open interactive access to certain information.

9 INTEGRATING AND SUSTAINING WHAT?

As all the tasks involved in handling specification information cannot be managed automatically, what are the essential characteristics of a specification-orientated approach to integration? It should be based on the requirements to manage contracts and regulations. Processing facilities for the different decision-making objectives referred to above need to be incorporated. Though the variety of standard specifications in use is growing at present, it should be recognised that a single decision-maker cannot handle an indefinite number of additional standards.

What then can sustainable information processing be based on? A decision-maker cannot use an ever-increasing number of standards in an integral way. A sustainable process can facilitate the effective use of a selection of standards only. A specification-orientated task processor should provide for access to, creation and use of a selection of available specifications to represent and regulate productive activities. This means that a specification-processor cannot be regarded as being able to effectively access every standard previously created.

Integrated information handling should be based on the functional requirements of specification processing, including representation for decision-making, which is not limited to the exchange of specific data. Though some symbols and interpretation processes may be common to different applications, many will not be [Toms 1996]. Instead of having symbols in common, common functionality can form the links between software packages, permitting different symbols and combination of symbols to be devised and processed. For text this is already provided for by word processors, likewise graphic packages handle any combination

of geometric entities. A word processor provides functionality, it cannot understand or check the spelling of a new word, it can only recognise the symbols as a word and facilitate their manipulation. Standards for word processing and graphics should be selected and adopted for a project. In a similar way, specification processors will have to recognise symbols (maybe text or geometric) as particular types of specification information and handle them accordingly, using appropriate classifications of specification content and representation, as discussed previously [Toms 1993, 1996].

10 CONCLUSIONS

The following consistent and integral definitions are proposed to assist in the elaboration of a specification-orientated approach to integrated information handling

- product: a thing specified in association with a process (the outcome of an activity)
- specification: a document available for perusal comprising a set of specifications representing the product of a process (this definition means directives, codes of practice, methods, etc. are all specifications)
- contract: a document that prescribes requirements in accordance with specifications agreed by parties promoting and undertaking an activity
- asset: a specific owned product which can be changed over time into another product.

The present inadequate definition of specification has resulted in

- lack of a formal definition of the category of information used for decision-making (called a specification in this paper)
- difficulties identifying specification information in different product representations as being of the same type, for consistent computer handling.

Inadequate definitions found in BS0 and STEP (ISO 10303) appear to be related to inadequate ISO definitions. Inadequate ISO definitions should be reviewed [STEP 1991].

A specification-orientated approach to integrated information handling should be based on the functional requirements of specification processing for decision-making. This includes specification representation for decision-making with provision for the creation of specifications. It should not be limited to the exchange of product data.

Handling an increasing proliferation of standards, both quantitatively and in complexity, is not possible. As regards the proliferation of standards

- only certain aspects of specification processing can be integrated
- the needs of a single decision-maker are not necessarily met by the technical potential for extensive information access and exchange
- a specification-orientated task controller should assist a decision-maker process a selection of specifications to represent and regulate productive activities.

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