

**The Conceptual Structure of
Product Semantic Models**

A thesis submitted for the degree of Doctor of Philosophy

by

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Abstract

The study is concerned with the conceptual structure and content of the framework for characterising user-product interaction, proposed under the title - 'Product Semantics'. The sources for the critique of design, from which the framework is derived, are identified and analysed, and the substantive theoretical and methodological content given initial consideration in terms of the deployment of the central concept of 'meaning', and the principal theoretical approaches adopted in the analysis of meaning and semantic concepts generally. The commitment to a cognitive and experiential approach to user-interaction is established and the concepts central to the framework, and requiring more detailed analysis, are identified. The core of the study consists in an analysis of the sequence of concepts and contexts that are chiefly used in the theoretical articulation of the framework, including - function, affordance, categorisation, artefacts, meaning and expression - of which the concept of affordance is central to the structure.

On the basis of the initial consideration of the structure and content of the scheme, and in the light of the analysis of concepts, the explanatory structure of the framework is established. It is argued that the core commitment to an experiential and cognitive account, and the form of the explanatory structure, are jointly incompatible with the conceptual content of the framework, particularly in respect of the pivotal role of the concept of affordance. Proposals are advanced for an alternative interpretation which addresses the central issues of consistency and coherence, and which suggests an alternative approach to the conceptual characterisation of the framework and the form of the explanatory hierarchy. The implications of the framework, and the proposed alternative interpretation, are considered in respect of their application in shaping approaches to the development of design theory and methodology, and the experiential aspect of semantics and cognition.

The Conceptual Structure of Product Semantic Models

| Contents | | Page |
|------------------|--|-----------|
| Part A | Stagesetting | |
| Section 1 | Nature and Scope of the Study | 1 |
| 1.1 | Nature, Scope and Significance of the Study | 1 |
| 1.2 | Definitions | 4 |
| | <i>Products and Product Design</i> | 4 |
| | <i>Semantics</i> | 5 |
| 1.3 | Philosophical Orientation | 7 |
| 1.4 | Methodological Issues | 9 |
| | <i>Consistency and Polemical Form</i> | 9 |
| | <i>Frameworks, Theories, Models</i> | 12 |
| | <i>Framing Frameworks</i> | 21 |
| 1.5 | Statement of the Thesis | 23 |
| 1.6 | Strategy and Structure of the Dissertation | 24 |
| Section 2 | Product Semantics | 25 |
| 2.1 | Historical and Critical Context | 25 |
| 2.2 | Product Semantic Frameworks | 35 |
| 2.3 | Principal Theoretical Approaches | 40 |
| 2.4 | Product Semantics and Meaning | 47 |
| | <i>Cognitive/Contextual Approach</i> | 47 |
| | <i>Semiotic Approach</i> | 58 |
| 2.5 | Structure and Content of the Analysis | 64 |
| Part B | Analysis | |
| Section 3 | Function | 65 |
| 3.1 | Function, Purpose and Teleological Explanation | 65 |
| 3.2 | Function in Artefacts | 72 |
| 3.3 | Artefact Function - An Analysis | 80 |
| 3.4 | Role of Function in Design Discourses | 93 |
| 3.5 | Function, Intentionality and Meaning | 96 |

| | | |
|------------------|---|------------|
| Section 4 | Affordance | 99 |
| 4.1 | The Concept of Affordance | 99 |
| 4.2 | Affordance in Product Semantics | 111 |
| 4.3 | An Analysis of Affordance | 119 |
| 4.4 | Affordance and Semantics | 125 |
| | <i>Affordance, Function and Teleological Semantics</i> | 125 |
| 4.5 | Affordance and Cognitive Models | 130 |
| 4.6 | Role of Affordance in Design Discourses | 136 |
| | | |
| Section 5 | Categorisation | 138 |
| 5.1 | Categorisation in Product Semantics | 138 |
| 5.2 | Categorisation, Concepts and Kinds | 148 |
| 5.3 | Prototype Theory vs Theory Theory | 159 |
| 5.4 | Abstract Concepts and Schemas | 164 |
| 5.5 | Categorisation and Product Semantics | 168 |
| | | |
| Section 6 | Artefacts | 173 |
| 6.1 | Objects, Artefacts, Products | 173 |
| 6.2 | Product Models | 178 |
| | <i>Place Marker Models (Socio-Cultural)</i> | 178 |
| | <i>Place Marker Models (Individual)</i> | 182 |
| | <i>Place Marker Models (Composite)</i> | 185 |
| | <i>Feature/Structure Models (Collective)</i> | 187 |
| | <i>Feature/Structure Models (Individual)</i> | 190 |
| | <i>Overview</i> | 191 |
| 6.3 | Product Models in Product Semantics | 193 |
| 6.4 | Product Content | 197 |
| 6.5 | Role of 'Artefacts' and 'Products' in Design Discourses | 202 |
| | | |
| Section 7 | Meaning | 204 |
| 7.1 | Language and Meaning | 204 |
| | <i>Referential Theory</i> | 204 |
| | <i>Ideational Theories</i> | 206 |
| | <i>'Behavioural' Theories</i> | 207 |
| | <i>Truth-Conditional Theories</i> | 211 |
| | <i>Intentional Theories</i> | 213 |
| 7.2 | Meaning and Cognition | 219 |

| | | |
|------------------|---|------------|
| 7.3 | Objects and Meaning | 222 |
| | <i>Meaningful and Meaningless</i> | 226 |
| | <i>Significance</i> | 228 |
| 7.4 | Signification, Semiotics and Meaning | 230 |
| 7.5 | Symbol Systems and Exemplification | 242 |
| 7.6 | Folk Psychologies and Meaning | 247 |
| | <i>Narrative Structures and Schemas</i> | 252 |
| 7.7 | Meaning in Product Semantics | 257 |
| Section 8 | Expression | 260 |
| 8.1 | Expression, Affordance and Meaning | 260 |
| 8.2 | Expression and Content in Product Semantics | 263 |
| | <i>Affective Attribution</i> | 268 |
| | <i>Emotion and Mood</i> | 270 |
| | <i>Expression, Affect and Representation</i> | 272 |
| 8.3 | Metaphor | 275 |
| | <i>Theories of Metaphor</i> | 276 |
| | <i>Visual Metaphor/Artefact Metaphor</i> | 282 |
| 8.4 | Metaphor and Expression in Product Semantics | 285 |
| Part C | Synthesis | |
| Section 9 | Concepts and Relations in the Framework | 287 |
| 9.1 | Introduction | 287 |
| 9.2 | The Product Semantic Framework | 289 |
| | <i>Product Legibility</i> | 289 |
| | <i>User Perspective</i> | 290 |
| | <i>User Models and Affordance</i> | 292 |
| | <i>The Semantic Order</i> | 293 |
| | <i>Meaning Contexts</i> | 294 |
| | <i>The Cognitive Order</i> | 295 |
| 9.3 | Summary - The Product Semantic Framework | 296 |
| 9.4 | Concepts and Conceptual Relations | 298 |
| | <i>Function</i> | 298 |
| | <i>Communication, Meaning and Understanding</i> | 301 |
| | <i>Significance</i> | 302 |
| | <i>Meaning and Cognition</i> | 303 |
| | <i>Affordance</i> | 304 |

| | | |
|-------------------|---|------------|
| | <i>Meaning Contexts</i> | 305 |
| | <i>Meaning</i> | 309 |
| | <i>Meaning and Categorisation</i> | 310 |
| | <i>Meaning and Identity</i> | 311 |
| | <i>Meaning and Extension</i> | 314 |
| | <i>Affordance and the Directness of Meaning</i> | 316 |
| | <i>Context Dependence</i> | 317 |
| | <i>Function</i> | 318 |
| | <i>Theory of Meaning in Product Semantics</i> | 318 |
| | <i>Experiential Content</i> | 321 |
| 9.5 | Summary - Concepts and Conceptual Relations | 322 |
| Section 10 | Reconciliation | 324 |
| 10.1 | Introduction | 324 |
| 10.2 | Conceptual Re-Orientation | 325 |
| | <i>Individualism and Context</i> | 325 |
| | <i>Representation</i> | 329 |
| | <i>Representational Content , Concepts and Identity</i> | 334 |
| | <i>Concepts, Categories and Representations</i> | 336 |
| | <i>Meaning and Representation</i> | 338 |
| | <i>Explanatory Contexts, Meaning and Affordance</i> | 340 |
| 10.3 | Summary - Conceptual Re-Orientation | 342 |
| 10.4 | Experiential Content | 344 |
| | <i>Knowing How and Knowing That</i> | 344 |
| | <i>Reasoning and Judgement</i> | 348 |
| | <i>Affective Representation</i> | 351 |
| 10.5 | Summary - Experiential Content | 352 |
| Section 11 | Implications | 353 |
| 11.1 | Introduction | 353 |
| 11.2 | Design Theory and Methodology | 354 |
| | <i>Theoretical Orientation</i> | 354 |
| | <i>User Interaction and the Design Process</i> | 355 |
| | <i>Design Model</i> | 356 |
| | <i>Meaning</i> | 359 |
| | <i>Offers, Expectations, Perceive-Affordances</i> | 360 |
| | <i>Affordance and Meaning Contexts</i> | 362 |
| | <i>Affordance and Explanatory Levels</i> | 364 |
| | <i>Holism as Strategy</i> | 365 |

| | | |
|-------------------|---|------------|
| | <i>Levels and Relations</i> | 366 |
| | <i>Reconciliation</i> | 369 |
| | <i>Affordance and Product Ecology</i> | 372 |
| | <i>Tacit Knowledge and Experiential Content</i> | 373 |
| | <i>User Interaction and Design</i> | 374 |
| 11.3 | Summary - Design Theory and Methodology | 377 |
| 11.4 | Semantic Theory and Cognition | 379 |
| | <i>Post-Fregean Semantics</i> | 380 |
| | <i>Non-Conceptual Content</i> | 382 |
| | <i>Abilities to Act - Affordances</i> | 384 |
| | <i>Cognition Based in Experience</i> | 386 |
| | <i>Experience, Awareness and Concepts</i> | 389 |
| | <i>Possible Implementation</i> | 391 |
| 11.5 | Summary - Semantic Theory and Cognition | 393 |
| Section 12 | Conclusion | 394 |
| 12.1 | Conclusion | 394 |
| | <i>Stagesetting</i> | 394 |
| | <i>Analysis</i> | 395 |
| | <i>Synthesis</i> | 398 |
| | <i>Summary</i> | 405 |
| 12.2 | Limits of the Study | 406 |
| | <i>Limits of Context</i> | 406 |
| | <i>Limits of Content</i> | 407 |
| | <i>Methodological Limits</i> | 408 |
| 12.3 | Directions for Further Research | 409 |
| | <i>Semantic Theory and Cognition</i> | 409 |
| | <i>Design Theory and Methodology</i> | 410 |
| | Appendices | 411 |
| A | Framework Models | 411 |
| B | Theories of Emotion and Affective State | 428 |
| C | Mapping Affordance and Meaning | 447 |
| D | A Methodological Implementation | 471 |
| E | Belief and Acceptance | 482 |
| | Bibliography | 486 |

Part A Stagesetting

Section 1 Nature and Scope of the Study

| | |
|---|----|
| 1.1 Nature, Scope and Significance of the Study | 1 |
| 1.2 Definitions | 4 |
| <i>Products and Product Design</i> | 4 |
| <i>Semantics</i> | 5 |
| 1.3 Philosophical Orientation | 7 |
| 1.4 Methodological Issues | 9 |
| <i>Consistency and Polemical Form</i> | 9 |
| <i>Frameworks, Theories, Models</i> | 12 |
| <i>Framing Frameworks</i> | 21 |
| 1.5 Statement of the Thesis | 23 |
| 1.6 Strategy and Structure of the Dissertation | 24 |

1.1 Nature, Scope and Significance of the Study.

The nature of recent design theory has been shaped by the dominant influence of two major classes of models - problem-solving models and process models.¹ In addition to these a substantial input into design theory has come from the consideration of the nature of design reasoning in the form of a variety of inference models.² The thrust of such models overall is to give emphasis to those aspects of the design process which are concerned with the 'functional' elements of design and the organisation and management of the design process - the description and analysis of technical content and the characterisation of patterns of reasoning and knowledge claims that attend on these perspectives on the design process. The bulk of the theoretical work and the majority of empirical studies and research undertaken has consequently been concerned with aspects of the production of products as represented in the design process, rather than consumption.³

Although design theory and practice have been substantially advanced both by the philosophical and methodological underpinning, and the development of substantive methods, provided by such models, they have tended to create an imbalance in the characterisation of the design process. Whereas in the field of engineering design the core of the design process could be argued to lie squarely in those areas of theory which have been the focus for attention, in the case of product design the core activities, responsibilities and concerns of the designer have remained marginal. These core activities might be summarily caricatured as the designers' prime concern with the product both as interface with users and their practices, and as an element of material culture.

Whilst these concerns have remained central to product design practice, theoretical attention to such issues has generally been given piecemeal and through the application of models and methodologies drawn from other disciplines, notably ergonomics and the social sciences. In addition, substantial though less formal theoretical input has arrived via the development and formalisation of related practice, such as that seen in the fields of

¹ Problem solving approaches are represented in the idea and definition of needs and their relations and the substructure of 'fitting' to need [for example Alexander 1963, 1964; Alexander and Poyner 1984; Papanek 1972] and the characterisation of problem types and frameworks for their analysis [Simon 1969, 1984; Rittel and Webber 1984]. Process models typically include critical path and decision network models [Archer 1965, 1970] decision support frameworks [Jones 1984] and formalisations of applied decision theory [Tribus 1969]. The integration of model types has been addressed in terms of criteria framing [Portillo and Dohr 1994] and in terms of the mediating idea of 'roles' [Dias and Blockley 1994].

² For example March 1976; Eekels 1982; Goel 1988; Roozenburg 1993; Galle 1996, 1997.

³ Consumption models and theories (also termed 'reception' theories) [Holub 1984; Walker 1989] have assumed an increasing importance in the history of design and cultural studies, particularly in the wake of marxist and neo-marxist analyses of commodity aesthetics such as those of Haug [Haug 1986], and particularly in the context of phenomena loosely associated with 'mass culture'. [Miller 1987; Tilley 1990] and taste or value [Lloyd Jones 1991; Thompson 1979].

market research, marketing, mediation and management and business studies. Whilst work in these fields has informed the development of product design practice, and to some extent related theory, a systematic theoretical framework which properly articulates the role of the product designer and the nature of the product design process has yet to be developed.

It has been argued that some form of theoretical systematisation might be achieved via the approaches grouped under the title Product Semantics, which focus on the interaction between products and users, and which articulate design theory in terms of the concepts of affordance, significance and meaning rather than function. The application of such concepts shifts the centre of gravity of design theory towards a more explicitly cognitive framework which is applied both in understanding the nature of the relationship between user and product, and in the prospective characterisation of the design process itself, drawing in models and the results of empirical studies from work in fields such as semiotics, psychology, linguistics and cognitive science.

The core task of the present study is to explore the conceptual structure of the group of 'meaning-centred' models which comprise the essential features of the product semantic approach to the characterisation of user-interaction; to identify, analyse and develop the core concepts in terms of which these models are articulated; to identify and clarify the overall theoretical framework in which they are explicitly or implicitly embedded; and to evaluate the theoretical and systematic potential of the approach.

Product Semantics has secured a significant niche within product design, both as a broad framework for the articulation of design theory and as an approach to design practice. It has been particularly influential as a model in design education,⁴ and in a number of key areas of professional practice.⁵ In addition it has been influential in shaping the nature of research programmes, particularly in the qualitative aspects of user-product interaction and in the development of related support systems for systematic design judgement.⁶

⁴ This is particularly evident in the educational model and work in product design at Cranbrook [Cranbrook Academy 1990], at the University of Industrial Arts, Helsinki, where it is represented both in a semiotic and product semantic approach to product design and in its focus as a centre for international conferences where the product semantic idea has been addressed and developed [Vihma 1987, 1990] and in the interaction between research in product semantics and product design education at Ohio State University [Butter 1989; Dorsa 1986]. More generally the idea of product semantics and meaning has influenced most courses in product design in recent years, in respect of product identity and visual significance and its articulation in terms of visual metaphor.

⁵ In the professional sphere the adoption of a product semantic approach is explicit in the work at Phillips [Blaich 1989, 1990], in the context of corporate design strategy at ERCO [Kutchinski-Schuster 1990], and the product design practice of Richardson-Smith, for example in work for Rank-Xerox [Rheinfrank 1984, 1989].

⁶ Recent examples include the general development of approaches to semantic analysis and related computer aided support [Hsiao 1994; Hsiao and Cheng 1996, 1997; Chen 1997; Hsiao and Wang 1998], quality databases and typological approaches to style [Muller and Pasman 1996; Smets and Overbeeke 1995; Chen and Owen 1997] and in the relation of properties and attributes to product character [Janlert 1987; Janlert and Stolterman 1997].

In large measure its acceptance and use in these areas stems from broad assumptions made about the theoretical content of the framework that it proposes, and a recognition of the consonance of its central concepts with the unframed intuitions and unanalysed practices conceived as essential to the pragmatics of professional practice.⁷ It is not the purpose of this study to examine the relationship between product semantics as presented and the perceptions that drive its use in these areas. Nevertheless the significance of the study, beyond its intrinsic value as an analysis and reconstruction of a prospective theoretical framework, does rest on the contention that in so far as product semantics does invite a broad range of interpretations and applications, its use will benefit from a deeper understanding of the conceptual basis and structure of the theoretical framework it proposes or embodies.

⁷ For example in the perceived parallel between the idea of a more formal analysis of semantic content, and the informal methods typically used by designers such as 'mood boards' and similar forms of user profiling [see Hasdogan 1993 for a review], and in the relation between the product semantic categorisation model and the visual aspects of product positioning.

1.2 Definitions

Products and Product Design

This study is concerned with the nature and characteristics of a particular conception of user-product interaction framed by the title 'Product Semantics' and its associated definitions and rubrics. In addressing these, a number of definitions and assumptions are made at the outset for the purposes of initiating the discussion, which are taken up and challenged where necessary in subsequent sections and in the conclusions.

It is assumed that products constitute a particular class of objects forming part of a nested hierarchy of inclusive categories roughly captured by the series 'things', 'artefacts', 'products'. One aspect of distinguishing between kinds of things in the world consists in the distinction between those things that are man-made and those that are not, and the term artefact is reserved for the former. It is further assumed that a large and significant subclass of man made things is constituted by those artefacts which are made in recognition of their context in human affairs more generally - their participation in social and cultural transactions - and these are termed products. The term product is not intrinsically restricted to material objects, and might thus include number systems and social institutions for example, but it is assumed for the purposes of this study that the core model does consist in a reference to material objects and that the extension of the concepts in the hierarchy to less tangible and more abstract 'objects' operates through analogical or metaphorical reference to material objects, or via some other relation.⁸

Product Design as a discipline and a profession is presumed to be concerned with the design of products so defined. Whilst both artefacts and products might be arrived at and made in many ways, it is assumed that only some of these necessarily involve a process of design. At the outset it will be assumed that the core model of design consists in a process which is intended to arrive at a specification for a product. No restriction is placed on the nature of that specification or the nature of the process involved, but it is assumed that there is some measure of independence between the framing of a specification for a product and its existence as a product.

A design, as opposed to the process of design is the specification arrived at following a process of design, and distinguished from any particular type or token of existing

⁸ What Austin referred to in identifying the preferred philosophical exemplars as 'medium sized dry goods' [no reference - anecdotal]. The question as to whether the core model can be construed as concrete and physical, and the assumption of analogical status for more abstract 'objects' is taken up generally in the course of subsequent analysis. It is recognised in the discussion that the distinction may not in any case be clear cut - an insurance policy might be classed as a product, but the question of just what constitutes the product in this case is by no means either a clear or a trivial matter.

product. The form taken by such a design or specification can vary dramatically. In the case of a mechanical product it might take the form of a detailed set of working drawings, in the case of fashion - a sketch, and in the case of an insurance policy - a set of rules, conditions and commitments. In all cases it will be apparent that any specification can only make sense within a broader context which does not form part of the specification, but which must necessarily be assumed in framing the specification.⁹ Since products as distinct from artefacts are defined in terms of their role in what might broadly be classed as social interactions, product design can only be understood in terms of such contextual framing, in respect of its objects, specifications and processes.

Semantics

Broadly speaking the term semantics embraces as its subject matter, questions of 'meaning', among which the question 'what is meaning?' might be regarded as the most fundamental. It is used to refer to those aspects of natural and formal languages and other systems of expression and communication which concern the nature and function of, and conditions for, meaningfulness. In terms of its use in the title 'Product Semantics', it signals the view that products can be characterised in terms of meaning relations.

Traditionally, semantics has found its natural home in the context of the linguistic and philosophical analysis of natural language, where it has been the focus for intense debate, both in respect of its status vis a vis other recognised components of language (syntax, phonetics etc)¹⁰, and more fundamentally, in respect of whether it even constitutes a substantive element of language or is in some sense eliminable in the face of the deployment of other concepts such as truth and reference, for example.¹¹ Whilst this ambience has framed one set of debates regarding meaning, and has fuelled the analogical extension of key terms in the idea of a 'language of products', alternative conceptions of semantics have been driven on models of signification in the semiotic analysis of culture, and on the basis of the nature of cognitive strategies in categorisation, for example. The use of the term semantics within product semantics is indifferent to the resulting distinctions, at least at the level at which 'meaning' is presented as the core concept replacing 'function'.

⁹ This is in effect an informal generalisation of Godel's formal point regarding the necessary constraints on the possibility of demonstrating consistency within the confines of any given rule structure. [Nagel and Newman 1959]

¹⁰ For example in respect of its logical or extra-logical status [Katz 1972].

¹¹ The two principal ways in which the role of meaning is called into question are in respect of the argument that it is a heuristic which is eliminable in an account of the constitution of relations in formal languages (and by extension, natural languages) which can be characterised in terms of reference and truth [Davidson 1967; Platts 1979] and the contention that 'meaning' is the most general social cluster term ('a coarse net over language') for a range of relations [Putnam 1978].

In the context of product semantics, 'semantics' expresses the general framework of meaning concepts and relations that underpin the analysis of user-product interactions and which thus form the basis of design processes for the specification of products. Whilst the general sense that can be given to semantics and meaning is assumed to be sufficiently clear intuitively to act as a primitive in characterising the basis of the approach, 'meaning' is ultimately articulated in terms of its role in three principal contexts - in relation to the ecological concept of affordance; in relation to processes of categorisation; and in relation to significance and the variously described processes of signification. The relationship between these senses or contexts is not unequivocally established within product semantics, but the link between them can be argued to subsist in their common relation to the concept of 'understanding', and the idea that meaning is a mental construct. This underlying commonality reinforces the sense that the models deployed within the framework are essentially cognitive models.

In the context of cognitive theory generally, 'semantics' is linked to the idea of 'representation' and 'content'. If an informal sense of the idea of semantic content might be expressed in terms of the property of 'aboutness' (the fact that a word or sentence has content and meaning, because it has an extension or a topic), then in cognitive contexts this is equated with the idea that mental constructs are representational in having content which is referentially linked to something external to those constructs. Similarly in the case of expressions of the idea of meaning which are centred on intentionality (the idea that there are states termed 'psychological attitudes' such as 'believing', 'desiring' 'intending' etc), meaning or semantic content is equated with the object or content of an attitude (a belief 'that it is raining', a desire 'for riches beyond the dreams of avarice').

In addition product semantics deploys the core idea that meaning is operational (it is a function of use). In terms of the more general run of approaches to semantics, these affiliations would seem to place the product semantic conception of semantics roughly in the sphere of 'functional role' or 'conceptual role' semantics.¹² But since the implications of the different bases for the articulation of meaning, and their interrelation, constitutes one of the core strands of this study, any sharper resolution of the sense of 'semantics', must wait on further discussion of these topics. For present purposes sufficient purchase can be gained from the association of semantics with the intuitive senses of 'meaning', to comprehend the thrust of the product semantic approach.

¹² Using the commonly accepted terminology [see for example Cummins1989]. The idea is roughly that given that it is mental states (constructs) that have meaning, the meaning that they have is dependent on the role that they have in the overall operation of cognition, whether this is conceived along the lines of their causal or computational role ('functional role semantics') or in terms of their role in cognitive activities such as inference ('conceptual role semantics').

1.3 Philosophical Orientation

Whilst I hold no brief for the advancement of any particular philosophical stance, it would as is always the case, be untrue to say that I have no views and prejudices regarding the enterprise. Philosophical and logical theories, as is the case with theory generally, provide frameworks which help us to locate and make sense of the particulars that we encounter. In doing so there is both gain and loss. We may well gain perspective at the risk of the richness of the encounter. Generally speaking we can balance these in practice, by tempering our idealisations with the empirical. In philosophy and conceptual analysis however, where the grand abstraction and the sheer generality of themes looms so large, there is a particular danger that the drive to the general and the all encompassing reduces particulars to the status of marginal examples falling short of the ideal, and the *ceteris* that are *ever paribus*. This remains so in spite of the influence of Wittgenstein and linguistic philosophy generally, which has alerted us to these dangers, and assisted in the relocation of much of philosophy and conceptual analysis within the contexts that hitherto it had been conceived to stand, in loco parentis, as a higher level metadiscipline.

To take an example from my own previous studies in scientific explanation.¹³ It became clear that the various accounts and analyses provided of this concept had suffered from a number of familiar and general problems. In the first place the raw material from which the various authors generalised were in all cases partial, giving weight to particular formulations, and thus failing in a true generality across the concept of scientific explanation. Secondly although buried deep in all the analyses examined was some lingering sense that explanation is something that is given by someone to someone else in communication, the idea of explanation quickly becomes reified in the abstract in such a way that this sense is lost, with the concomittant result that systematisation of the grand concepts - knowledge, understanding, explanation, meaning, truth takes on a remote and self realising air. This is a programmatic problem in philosophy, which is reflected in the underlying desire to find a single all or nothing account, which will settle the question once and for all. Meaning is this, truth is that. Thirdly, and closely related is the sense that the drive to abstraction and generality, imperceptably fuels the transition from realism to nominalism, and from rooted discussion of intellectual themes to a kind of linguistic meta-epistemology that is only located within philosophy and not in the world.

In the case of semantics, for example, the role of meaning has fluctuated markedly over time. Whilst classical accounts and their derivatives give meaning a central place, the difficulty in achieving a generality over cases, led to a gradual restriction in the field of enquiry. This strategy of avoiding seemingly intractable problems in favour of more

¹³ Hughes 1976.

manageable ones, has in many respects been a successful research strategy in science, but can lead to a field of study becoming determined not by the inherent features of its subject, but by the susceptibility of certain kinds of problem to available methods of analysis. In linguistics, the perceived central problem of explaining the consequence relations of sentences on the basis of the meaning of their constituents, gave way to a narrower conception of logical form derived from the construction of artificial or formal languages. In these the elements of natural language which had given rise to the difficulty encountered in the relation between logical form and meaning, were definitionally ironed out. Whilst this strategy enabled major advances to be made in logic and linguistics, the re-introduction of meaning as a necessary consequence of the need to find a non-arbitrary distinction between form and content, occurred in a radically restricted conceptual environment, which placed tight artificial constraints on the nature of an acceptable semantics. Ultimately the problem of meaning could only be re-addressed by a determined return to the messy but real context of language in use.

The upshot of these observations should reveal an underlying commitment to some form of realism, and a conception of analysis in which the philosophical is allowed, or even encouraged, to be contaminated with the empirical. In respect of the former, my sense is that the underlying idea that there is a reality that is independent from human perception and representation is inescapable, and is resistant to arguments from cultural relativity, or epistemic conceptions of perspective. This is so because realism is essentially an ontological commitment, and one which need make no commitment to the particular form of the reality that it asserts exists.¹⁴ In respect of the latter, I would argue that in the critical areas related to the issues at the heart of this study, which occur at and across the boundaries of philosophy of mind, philosophy of language, psychology, cognitive science and semiotics, recent advances have been made precisely because these disciplines have been recognised as being mutually informative rather than operating in closed domains. This is not to say that there is no distinction between a philosophical and a psychological question, but rather that each discipline can and does inform the other, and it is a matter of some importance to ascertain when a philosophical question enters the realm of the empirical, and when empirical matters are in need of conceptual analysis. This is either a very old or a very recent view, depending on whether one takes 'natural philosophy' or say 'cognitive science' as a working example.

In this study these elements of a philosophical stance at times assume some importance, particularly in respect of the use of a realist distinction between kinds of facts, and in the deployment of empirical evidence to support or counter broad conceptual positions.

¹⁴ Searle has presented a series of arguments which I believe conclusively supports a view of this kind, and refutes the key counter-arguments that have been advanced [Searle 1995, pp149-197].

1.4 Methodological Issues

Consistency and Polemical Form

Product Semantics proposes a new conceptual framework with which to approach questions relating to the theory and practice of product design. It is based on the contention that the existing conceptual framework, particularly in so far as it provides the basis for the articulation of theory, is both mislocated and insufficiently flexible to account for the key interactions that characterise the discipline. The wrong concepts are given a central place in the framework of design, principally because conceptually and philosophically the nature of design as a discipline is misconceived. The results of this misconception have created a disjunction between theory and practice, and a view of design that can be shown historically, to have been incapable of providing a meaningful picture that can be applied in the solution of problems within the discipline. The perceived consequences for design practice have been to allow the succession of styles to gain the ascendance over principled and well founded decision making. In response to these observations an alternative framework is proposed which foregrounds a different set of core concepts through which the theoretical, methodological and practical ground of product design can be more effectively and accurately established.

The purpose of this study is to examine the substantive proposal (rather than the background argument), and in particular to establish as clearly as possible the nature of the product semantic framework and to evaluate it as a conceptual scheme. This is problematic in a number of respects. In the first place product semantics does not exist as a single or fully articulated position, but rather as a concatenation of conceptual, theoretical and methodological approaches held together under the broad umbrella of its title and through the relations that these individual elements bear to each other and to a small number of core concepts. The strategy in establishing the nature of the product semantic framework will therefore be to identify the core concepts and to assemble the more detailed material systematically into a whole in which the relations between the elements is made as clear as the material will allow. This process is viable for two principal reasons. The first is the consistency with which such material is individually related to the core concepts, which are usually explicitly identified. The second is that a systematic and philosophically driven overview of the framework of product semantics has been articulated by one of the leading proponents,¹⁵ which although ultimately expressing a univocal expression of the position, can serve as a frame of reference for the interpretation and location of concepts and related material.

¹⁵ Krippendorff 1989, 1990.

The second problem, which in its consideration gives rise to a third, concerns the extent to which the material constituting the corpus of product semantics embodies an ideological stance. Since product semantics arises in response to a critique of recent historical practice in design, it is probably inevitable that the presentation of an alternative conceptual and theoretical position will in some cases take the form of injunctions that design practice 'ought' to be carried out in a certain way. This is a problem that is not unique to design, nor to the particular context of what has been described as a practical and productive, rather than a theoretical discipline. In fact it is a problem that has been at the centre of debates in a number of disciplines, including the austere example of the relationship of the philosophy of science to scientific theory and practice.

In one sense the ideological content can be viewed as a form of expression which has a substantive empirical and theoretical content, which is subject to the same standards of assessment as the empirical and theoretical content of statements expressed in some other form. To the extent that this is the case there is no problem specific to this form that does not arise for all other forms of expression. If what is embodied in the empirical and theoretical content can be argued to justify a change in the practice of a discipline, then it is perhaps natural that this should be expressed in terms of an injunction as to how that practice ought to be conducted, given the empirical and theoretical background provided.

However there is a further and more deeply embedded question which relates to the extent to which the 'ought' is underpinned by matters which are external to the framework of analysis. In the philosophy of science, for example, the extent to which the programme of analysis was itself conceived as re-theoretised description of scientific practice, a philosophical critique of existing scientific practice demonstrating the limits of rationality given the form of its practice, or an injunction that science ought routinely to be conducted in a different way, became a matter of intense debate.¹⁶ In reply I would contend that the elevation of a sound logical point concerning the relationship between a theoretical statement and its supporting evidence, to the status of criterion for scientific rationality and thence to an injunction concerning the nature of scientific practice, is to limit the perceived relationship between theory and practice to an unacceptably narrow view. One might as well conclude, on the basis of Hume's logical arguments concerning constant conjunction and induction, that scientific practice should be discontinued since it can supply no answer to the logically sound and critical sceptical case presented.

¹⁶ See for example the debates surrounding the relationship between Kuhn's account of the nature of science as represented through the idea of 'paradigms' [Kuhn 1970] the logic of science articulated in terms of Popper's criterion of 'falsifiability' [Popper 1963] and Feyarabend's liberal adversarial view which rejects naive falsificationism and the rigidity and incommensurability of paradigms [Feyarabend 1970]. The arguments are usefully rehearsed in a collection of papers which includes those of the major combatants and additional commentary [Lakatos and Musgrave 1970].

The issues here are subtle ones and lend different perspectives to both practice and rationality, but there does appear to be an in-principle limit, in the sense that one cannot simply stipulate that the purpose of design should be other than it is, any more than one can argue that the purpose of science should be other than it is. This is not because one cannot disagree about the nature and morality of what is done, but rather that there is not necessarily a simple sense that can be given to the idea of a discipline having a purpose that one can choose. It would probably be more accurate to say that a discipline operates in respect of a certain domain, in accordance with certain principles, and that the outcomes of the activity are put to a variety of purposes, and it is by no means clear that one can single out a 'one true aim'. In the case of science for instance, it has been equally fiercely argued that its underlying aim is the systematic explanation of phenomena, or alternatively prediction and control. Although it is clear that the concepts are related in the overall framework of science, neither is definitively prior to or dependent on the other. From a historical perspective it is probably true to say that these have vied (with others) for dominance in the field, with the instrumental view taking turns with the explanatory in holding court for a period. In more abstract terms it might be possible to set principled limits on the domain of investigation of a discipline, and elect a concept or concepts in terms of which methodological constraints can be defined, relative to a standard of acceptability which may or may not be expressed in terms of a purpose. But, however the domain is defined or the constraints set, the discipline will ultimately be shaped by its practice, independantly from the purposes to which it is claimed it ought or ought not primarily to be put.

The situation is similar in the case of design, in that one cannot decree that its aims should only be such and such. It represents a set of practices operating in a domain, whose aims though interconnected and central to its conception, cannot wholly define or constrain the discipline itself. The claims made in product semantics to the effect that it represents, in addition to the exposition of a conceptual framework, a purification of practice from the pernicious influence of marketing and mediation, cannot be made good. Generally speaking the polemic is kept separate from the substantive proposal in expositions, which allows the substance to be presented without particular comment. There is however one exception. It does seem to be an incontrovertible fact, for good or ill, that part of the constitution of the significance of products for people derives from processes of mediation. The assumption that is sometimes made in the presentation of product semantics that this aspect of significance could be bypassed if we had the right kind of conceptual framework and methodology, seems to run seriously adrift of the general view being advanced.¹⁷ Social and commercial mediation is an integral part of the way in which we make things meaningful, and as such cannot be excised by decree, from a semantic

¹⁷ Krippendorff 1990, p a4.

account of the user-product relationship in design.

In the case of a so called 'productive' discipline such as design, one can hold distinct views regarding its nature which if expressed as absolutes will give rise to undecidable conflicts.¹⁸ This is no different from the position of science, except in so far as the latter can more easily shelter behind a non-instrumental self-conception. It is difficult for design to do this since, qua practice, it is located and generally conceived in terms of the satisfaction or attainment of tangible outcomes. Although it is possible through theorisation to conclude, for example, that design when generalised represents a fundamental expression of the idea of practical reasoning and planning, (which is instantiated professionally in particular contexts with particular constraints), are we then to conclude that all the reasoned action in which we engage is design. Distinctions at the level of practice are as significant as the generalisations at a theoretical level, and the relationship between context, commonsense expression and theoretical abstraction together constitute indispensable elements of a conceptual framework.

Frameworks, Theories, Models

Product Semantics offers a semantic characterisation of the design process, in terms of a semantic account of the user-product relationship. It is not strictly a theory, since it does not offer an axiomatisation, a formal abstraction or a partial formal abstraction, but rather a broad conceptual framework in terms of which a formal theory could in principle be developed. Neither is it strictly a model, in the sense that regards models as particular instantiations of theories. Clearly however the use of the terms 'framework', 'theory', 'model' can hardly be taken to have an agreed interpretation or range of application, given that they stand at the centre of conceptual debate in most domains of enquiry.¹⁹

The most consistently held view of theories is that they are explanatory. They provide the basis for explanations which account for the nature and occurrence of things and events. In the most attenuated account of theories as explanatory, one could summarise the position with the definition that a theory is :

'... anything which is, or can be, articulated in the form of a statement or set of statements which purport to offer, or which can be taken as offering, an explanation of something.'²⁰

¹⁸ For instance in juxtaposing the ideas that 'design is meeting needs', 'design is solving problems', 'design is giving shape to products' as basic formulations from which broad process descriptions are derived.

¹⁹ Freudenthal 1961.

²⁰ Gaukroger 1978, p 3.

As a rule, less attenuated explanatory definitions invoke the need for systematicity and generalisation to overcome the sense that there is more to theories than is captured in a definition in which each explanation offered is prospectively individual and isolated.²¹ Distinct accounts of theories and explanation are generally differentiable in terms of which particular features are asserted to be the sources of explanatory power. In positivist and empiricist accounts, explanatory power is generally held to derive from the form of logical inference characterising patterns of explanation. In deductive-nomological accounts, for example, the explanatory power of an explanation derives from the fact that taken together with a law, it can be used to deduce the thing or event to be explained.²² In contrast, realist accounts stress that explanatory power derives from the applicability of models of 'mechanisms' judged to be generatively competent, in respect of the things or events to be explained.²³ A further alternative is represented in accounts which locate explanatory power in the coherence of explanatory statements with other relevant statements in the total network of a framework of discourse.²⁴

The common frame of reference within the various distinct accounts of theory and explanation, can be expressed in terms of the idea of a 'formal language system'. Using the analogy with a natural language, we can approximate to the idea that a language consists of a vocabulary and a set of rules which govern the allowable combinations and permutations of the elements of the vocabulary. The totality of the language can be generated by sifting the allowable from the possible, using the rule structure. If we construe language on this model then it will be clear that it depends on a specifiable and stable vocabulary, a specifiable and stable rule system, and the implicit assumption that effective use is dependent only on these specifications. In fact in the case of natural languages neither the vocabulary or rule system has these characteristics, nor is it the case that language can be used without some additional interpretation of elements which fixes the reference of terms.

A purely formal language system, given that its terms and rule structure are stipulatively defined, can be mechanically derived through the exhaustive interaction between terms and rules. In order for the system to have any internal dynamic, however, it is necessary to express relations between some of the allowable combinations of terms. In axiomatic systems this involves selecting a subset of allowable combinations (called axioms), and

²¹ Nevertheless the definition offered by Gaukroger reflects some aspects of common usage of the terms 'theory' and 'theoretical', in which one might for example distinguish between theory and practice in the case of individual instances. Gaukroger develops his account in the context of the idea of theoretical discourses in which individual explanations or theories rely, for their explanatory power, on the frameworks in which they are embedded [Gaukroger 1978, and see below Appendix A 'Framework Models'].

²² Hempel and Oppenheim 1948; Hempel 1965.

²³ Harre 1970; Harre and Madden 1975.

²⁴ Hesse 1974.

formulating rules whose application to the axioms results in the derivation of some of the remaining allowable combinations (termed theorems). Generalising, a formal system with structure will have three kinds of rules - formation rules, which determine allowable combinations of terms; definitional rules, which designate primitive allowable combinations and substitutions; and transformation rules, which determine legitimate derivations of allowable combinations from designated primitives.

A formal system of this kind, in which none of the terms is interpreted, and which consists only in the formal or syntactic relations between its elements is termed a calculus. In order to put a calculus to explanatory, or any other use, it must be interpreted. Interpretation involves designating sense or reference to the terms and expressions of the calculus, and in turn establishing conditions of truth or falsity for expressions and their combinations. In principle, the semantical rules that establish the conventions of interpretation could be arbitrarily applied, but for a system to be coherent, complete and consistent there must be some constraint on interpretation. The constraints on interpretation can be expressed generally in terms of the preservation of truth conditions. Deductive systems, for example, can be characterised in terms of the fact that for every possible interpretation of the calculus in which the axioms are true, every derived theorem will also be true.

In its strictest formulation a theory can be defined as a deductive system - an interpreted formal system all of whose possible interpretations are axiomatically truth preserving. This formulation expresses the ideal of deductive rigour lying behind logical-empiricist accounts of scientific theory.²⁵ Nonetheless, it is an ideal that it is acknowledged is seldom if ever achieved. This is in large measure due to the recalcitrance of problems relating to the designation of crucial primitive terms, and the conditions for the introduction of concepts in a developing theory. The former cluster of problems are typified by the difficulty associated with a distinction between observational or experimental terms and the apparently unavoidable and logically elusive dispositional and theoretical terms. In practice, positivist perceptual primitives prove hard to pin down as genuine observation terms, and operationist procedures only interpretable in theoretical terms if procedural rules are to be underpinned. The latter group of problems concern the commensurability of theories in cases where the introduction of a concept cannot be implemented in terms of definitional equivalents to combinations of existing elements of the system, which can themselves be primitively defined.

To a large extent the prevalence of the concept of a 'model' in the context of theory definition represents a response to the problems of formal characterisation, although it is

²⁵ Hempel 1965.

also one form of reflection of dissatisfaction with logical-positivist accounts of scientific theory and explanation.²⁶ In terms of the formal position outlined above, a model is one of a pair of isomorphic interpretations.²⁷ There is no structural difference between a model and its subject, but simply the case that one interpretation is used to model the other. The general assumption in empiricist accounts of theory is that models are independent from, and not necessary to, interpretation, but have a heuristic function in the development and formalisation of theory. However, realist theories give central place to the concept of a model and the modelling relation, and ultimately define theories in terms of models.²⁸

In respect of the various candidates for the source of explanatory power, the concept of a model plays a central role. Ultimately, in empiricist accounts, the deductive logical relation models causality through the concept of constant conjunction and universal laws. The expression of the possibility of a systematic ordering of concepts in a theoretical framework depends on the intelligibility of both logical and empirical isomorphisms, although the logical relation is given priority. Realist frameworks, on the other hand, which are grounded in an ontology of 'particulars with powers', give priority to empirical isomorphism, whilst network theories emphasise the isomorphism of structural relations. In each case priority is established with respect to the perceived role of theory - as a systematic set of logical relations structuring knowledge, as a non-arbitrary system of causal powers, as a dynamic pattern of relations in a conceptual framework, respectively.

These distinct approaches to the characterisation of theory can be viewed as different facets of the necessary context for theory, rather than as competing accounts. Whilst the theoretical ideal might justifiably appeal to axiomatisation and complete interpretation, these do not exhaust the conceptual content of theories, neither do they constitute the bottom line in standards for rationality.²⁹ In broad terms, a theory is

'....a body of assertions whose terms refer to individuals and properties, and which is transmitted and evolves in accordance with the intention that it assert the truth about them. A theory need not be stated or statable by any single person. It need not be precise. Nor need everyone who subscribes to it know quite what his subscription commits him to. But one must use the theory as if those one had obtained it from intended its terms to refer to objective realities, and the changes one makes in the theory, by removing existing beliefs or adding new ones, must

²⁶ Harre 1970, pp 8-10.

²⁷ Harre 1970, pp 31-60.

²⁸ See Freudenthal 1961 for an overview of the role of models in mathematics and the natural and social sciences. Some take the view that models are inessential [Braithwaite 1953; Carnap 1956] some that although they may have a heuristic function, they are eliminable [Duhem 1954] and others, that they are essential and ineliminable [Black 1962; Hesse 1963; Achinstein 1969; Harre 1970].

²⁹ Hughes 1976. Where I argue for the co-extensivity of explanatory models across scientific disciplines. The particular emphasis given in individual cases results from the pragmatic demands and methodological constraints evident in these cases, reflected in the different accounts given by philosophers of science. These are underpinned by a minimal principle of rationality which is essentially based on the idea of 'parity of explanation'.

be made with the intention of increasing the proportion of true to false assertions about those realities.³⁰

Although Morton's general definition can clearly be challenged in many respects,³¹ it does capture informally a number of the key broader features of theories. In the first place a theory is a body of assertions. But not just any collection of assertions will do - a theory is a collection of assertions which are systematically linked through their common terms of reference, and by their conformity to an overarching commitment to maximising (or optimising) truth. The definition does not say what truth is, but indicates that whatever criteria are adopted, systematisation demands a consistent commitment to them. Some sense of the sorts of criteria that might be implied is carried by the idea that a theory is separable from particular persons, both in the sense that no one person need have it all, and in the sense that the agreed terms of reference establish conventions for the relations between what is referred to, the ways in which reference is made, and the forms that assertions can take.

A given theory is a communally owned working tool, with the built-in expectation that it will be patched up or replaced when it no longer adequately serves its users. It is an interactive and responsive tool in the sense that it will change and grow with use. It is a tool which is designed for certain kinds of tasks in a restricted domain, but which can be compared with other tools designed for the same or similar tasks, and with quite different tools serving other tasks in other domains. Ultimately though, tasks are not discrete and isolated activities but cohere in the overall concerns and activities of a given community. It is possible to capture these broader expressions of commitment and task relations, in ways other than simply putting the tools that we have into a box. We can, for example, get some indication of the range of tools that we might need, in terms of an analysis of what seems to be implied by that broader commitment, and the tasks that are perceived to comprise it. A 'framework' is an expression of this kind.

Although it is possible in principle to develop an independent analysis in terms of commitments and tasks, it is difficult both theoretically and pragmatically to isolate tools from tasks in conceptual domains. In practice they are interdefining, and the sense of what constitutes a task is as much a function of what we are prepared to recognise as a tool, as a tool is characterised relative to a task.³² The development of frameworks and the framing of theories both arise from the operation of, and interaction between, top-down

³⁰ Morton 1980 p5.

³¹ Morton argues (I believe rightly) that this informal presentation, when unpacked more formally is congruent with the basic idea of the autonomy of theory, and captures the main elements of a number of the core treatments including the logical empiricist tradition [Hempel 1965] and more recent developments relating the nature of theories to reference and meaning [Putnam 1973, 1975; Field 1973].

³² Parallel to the idea of the relativity of properties to methods of measurement for example [Hempel 1966].

and bottom-up procedures, and these in turn can only be set in motion using concepts and working methods that are already in place. It is this factor more than any other which places the 'model' concept at the centre of theoretical and meta-theoretical development.

A model is one of a pair of isomorphic interpretations of a theory. In the case of fully axiomatised and interpreted theories, this fact is of relatively little interest in contexts other than the formal comparison of such theories. However, given that this level of theoretical formalisation is so rare, the role of models can be seen to be crucial to the possibility of theoretical development. If the independent characterisation of a framework, or the framing of a theory, is like arriving at a specification for a tool or range of tools from first principles, then the development of theories and frameworks using models, is akin to using existing tools to perform tasks while we develop specifications through an analysis of the ways in which they fit or fail to fit those tasks.³³

The nature and types of modelling relation have been thoroughly analysed by a number of authors,³⁴ and it is not my intention to rehearse the issue here, other than to give an indication of matters relevant to the present discussion. In slightly less informal terms than the tool analogy, we could say that the use of a model in the development of a theory consists in an assumption of isomorphism between the chosen model, which is read as the interpretation or partial interpretation of some other theory, and which is used to generate an interpreted analogue model as a temporary form for the theory that we are seeking to express. The choice of model will in part be guided by availability, parallel or overlapping referential structure, and the degree of theoretical development represented in the model qua interpretation.³⁵ The process will be a dynamic one, involving creative interchange and interpretation of the positive and negative elements of the assumed isomorphism, as the theory is established independently and interpreted in terms of its own model.

In the case of frameworks, the roles for models are of two kinds. In one respect the modelling relation mirrors that between model and theory in the sense that the range of models characterises the broad compass of theoretical commitment, in the same way that

³³ The debate over the question of whether models are an essential feature of theories, a useful heuristic in theoretical development, or an inessential epiphenomenon of the use of interpreted theories, can be viewed in this light as facets of the state of theoretical completion in a given domain. However I would argue that since a theory is always work in progress, and in principle never known to be complete, models are a necessary feature of theories. In addition, given the formal difficulties associated with transparency of reference, models are essential to the semantic disambiguation of interpretations.

³⁴ Harre 1970; Freudenthal 1961; Black 1962; Hesse 1963.

³⁵ Clearly we can only use models of which we are aware. In addition, although we may not be sufficiently clear about the developing theory to feel confident about what might be sufficiently isomorphic to an interpretation of it, we will at least need to identify some parallel relations between the referential terms of the two theories. Thirdly, little benefit is likely to accrue in theoretical development in using a model which interprets a theory that is as undeveloped as the target theory.

the range of related theories would. This is akin to characterising the overall thrust of a domain in terms of collecting together the tools in a box. However, in another respect, there is clearly no bar to the use of a meta-model as an assumed interpretation of the meta-theory that can in principle be seen as the formal expression of the framework. In the case of product semantics, which I would characterise as a framework since it sets a broad agenda for the framing of concepts and theories, the two kinds of role for models is evident. At the meta-theoretical level it is expressed as a semantic model - design is to be understood in terms of meaning. At the theoretical level, problems relating to the user-product interface and their role in shaping the design process are expressed in terms of a series of concepts in which the general and unanalysed notion of meaning is unpacked in the form of different models of possible meaning relations.

Although, in some respects, positioning the modelling relation at the centre of characterisations of 'theory' and 'framework' points up the joint operation of logical, ontological and epistemological factors in the articulation of these concepts, and captures something of their scope and range of application, there is a further factor which may be perceived to be at issue in respect of their use in relation to design.

In stark terms this could be stated as follows. Whilst the majority of disciplines to which the terms 'framework' and 'theory' are generally applied fall under the broad heading of science and share a significant core of methodological assumptions, there are equally important spheres of human activity which might reasonably claim to have frameworks and theories, but which do not sit easily under that heading. Broadly speaking one might distinguish between 'productive' disciplines and 'explanatory' disciplines, and include design, engineering, music, and sculpture for example in the former category, and physics, biology, sociology and history in the latter.³⁶ The basis for the distinction is that some disciplines take the phenomena and furniture of the world as a given, and aim to arrive at rational and systematic accounts of the nature of their existence, genesis and persistence, whilst others aim at the production of new world furniture or phenomena on the basis of the principles of existence, genesis and persistence.

Although the above sketch presents the distinction in terms of the same elements, differing only in their functional roles relative to productive or explanatory activities, it could be argued that this obscures the degree to which the distinction is fundamental. This is evident even in cases where the parallel is accepted, for example in the attempts to articulate differences in the structure of inference in design as against science.³⁷ In that case the general conclusion has been that whilst explanatory activities are typified by the

³⁶ Broadbent, for example, makes a distinction of this kind [Broadbent 1984].

³⁷ Bunge 1967; March 1976; Coyne 1988; Coyne et al 1990; Eekels and Roozenburg 1991; Roosenburg 1993.

use of deduction and induction as the basic modes of inference, productive activities are typified by the use of abductive and productive modes of reasoning. This notion of the core differences between productive and explanatory disciplines has been extended to the other aspects of the characterisation of theory noted above, for example in the distinction between kinds of knowledge claims, and the structure of conceptual relations.³⁸

On the other hand, given the sense of what we have indicated might be implied by 'theory' it is possible to take another tack. Essentially this consists in a refusal to draw a-priori distinctions between disciplines, and to re-examine the comparisons between the conceptual and pragmatic content of activities across disciplines. On this basis it is equally possible to conclude that there is an underlying consistency in the cognitive structure of human thought and action, which is evident in all activities. This is not to say that there is no distinction to be made between physics and ballet, but rather that the distinction cannot necessarily be made good in terms of differences in inferential structure or the form of knowledge at the cognitive level, for example. Ultimately the dominance of deductive systems in physics, and their total absence in dance, can be attributed to other factors.

There is a strong sense in which science generally can equally be regarded as a productive discipline. Science is productive both in the sense that it creatively postulates the existence of entities and mechanisms, and in the sense that it arranges performances with purposes. Far from conforming to a picture of the detached collection of the knowledge waiting to be plucked from the existent, science actively designs and creates interventions in the world, on the basis of expectations that the world will respond in particular ways, and articulates its future plans in the light of the results. In a parallel way, design plans and creates interventions in the world in the expectation of certain outcomes, and articulates further processes on the basis of this experience. The degree to which distinctions between them can usefully be made in terms of modes of inference, for example, is further called into question when one compares the evident richness and variety in modes of inference in the practice of both of these disciplines. The allure of a simple distinction is largely based on flawed comparisons. Design as an activity is compared with science as the formalised outcome of a process, rather than design processes being compared with scientific processes.

Nonetheless there does still seem to be a distinction to be made if one compares the formalised outcomes of science, with the formalised outcomes of design (if they are to be found). What is it about these activities that leads one discipline to bodies of formalised knowledge, networks of relatively well-defined and located concepts, and partial axiomatisations, which are almost entirely lacking in the other? In one respect the answer

³⁸ For example Broadbent 1984.

could be seen to lie in the kernel of truth found in the crude commonsense view of science noted above. Although science does not consist in collecting bagfuls of knowledge, the underlying assumption of scientific disciplines is that there is an independent reality with which we interact and which in some sense we can come to know. One way of expressing this might be to say that there are aspects of the world whose existence is independent of our perception or representation of them. The commonsense view is roughly that the physical reality (whatever it is) that constitutes that piece of the world that we refer to as 'Mount Everest', would be the same if we referred to it as 'Henry', if we did not refer to it at all, or if human beings had never existed. In contrast there are other aspects of the world which have a reality that we recognise, for example in the phrase 'my driving license has expired', but whose recognition is ultimately dependent, not on the persistence of its physical reality, but on the existence of social institutions. I would argue that the distinction in kinds of discipline and kinds of theory rests on this contrast between different kinds of facts. The subject matter of design is essentially concerned with facts dependent on social institutions and representations, whilst the subject matter of science essentially comprises facts that are not so dependent.³⁹ The particular form of theories in these areas is not a function of whether they are productive or explanatory, but rather a function of the extent to which the facts that they encompass are institutional facts.⁴⁰ It is not important at this stage for this distinction or its implications to be accepted, and it is not assumed in what follows.

In terms of the broad and approximate distinctions introduced above, product semantics is a framework rather than a theory. It suggests that the characterisation of design be approached from a particular perspective, and that given this perspective design theories can be framed and appropriate methods defined. Although it is a framework, whose structure is made most explicit in Krippendorff's key papers,⁴¹ the elements of the framework are generally presented in terms of the core concepts associated with partial and relatively independent models.

³⁹ One objection to this kind of distinction is roughly equivalent to the idea that both 'Mount Everest' and 'My driving license' are socially constituted, since they are both expressions in language which is in itself a social construction. But although in order to state any fact at all we need the institution of language, it is essential to distinguish between the fact stated and the statement of the fact. Whilst the fact stated in the case of Mount Everest is independent of the statement of the fact, this is not the case in respect of my driving license. See Searle 1995 for an extended treatment of the relation between realist and relativist treatments of these kinds of cases.

⁴⁰ This distinction is evident in a different form in Kerner's treatment of categorial frameworks [Kerner 1970] In Kerner's account a distinction is made in terms of the contrasts between 'factual' and 'constructive' thinking and between 'commonsense' and 'theoretical' thinking which are jointly reflected in differences in argument form which parallel the distinction between institution dependent and institution independent facts. [See Appendix A, 'Framework Models'].

⁴¹ Krippendorff 1989,1990.

Framing Frameworks

Product Semantics is not design theory per se, but a complex framework of thinking composed of conceptual, empirical, practical, professional and polemical elements which are collectively used to motivate a re-articulation of both theory and methodology and to promote change in design practice. As such it is both partial and incomplete, and lacks a systematic coherence and consistency in the explicit unpacking of its central elements. Nevertheless sufficient shape can be given to many of the principles involved, to make it possible to infer or postulate a number of the key presuppositions and consequences lying on either side of such principles, and thus inhering in the framework, and to develop and assess their conceptual status. Inevitably this must to a large extent be carried out on a piecemeal basis, given the nature of the material, although with as much interanimation between the separate subjects of conceptual analysis as the matter and form will allow.

In so far as one can assert that product semantics represents a unitary framework, there are three distinct perspectives from which the shape of the whole might be approached. The first is the explicit presentation by Krippendorff of product semantics as a new paradigm, in direct contrast to his characterisation of traditional approaches to design.⁴² The second is the articulation of product semantic concepts through the framework of product categorisation proposed by Athavankar.⁴³ The third is the semiotic basis for product semantic analysis, developed by Vihma.⁴⁴ These will be given direct consideration.

In addition it is possible to view product semantics from the perspective of the collective of separately articulated concepts that are perceived to constitute its core. Although this is problematic since it involves inferring relationships between elements that have not always been explicitly stated, it is possible because there is an implicit prioritisation of concepts in the use of a product semantics approach, that is exemplified in most of the treatments to be found in the literature, and inherent in reported practice. Thus it is possible to argue for example that the concept of 'meaning' in the context of products is central to the framework, and to be articulated in terms of the concepts of 'affordance', 'significance', 'understanding' and so on, with which it is interdefined. Similarly the concept of an 'interface' provides the locus through which the theoretical terms of the product semantic discourse find general application.

But whereas individual elements can be the subject of logical and conceptual analysis, and the relations between them established, using a range of familiar analytical tools, it is by

⁴² Krippendorff 1990, 1989, 1984.

⁴³ Athavankar 1990, 1989.

⁴⁴ Vihma 1995, 1990.

no means clear that this would in itself constitute a sufficient characterisation of the framework as a whole. Product semantics can be viewed as a distinctive conceptual framework or paradigm for design, and has been presented as an alternative to an existing paradigm.⁴⁵ The evaluation of a framework or paradigm is clearly a different matter from the evaluation of a particular theory or theoretical statement relative to its empirical referents and evidence, and the broader theoretical network of which it forms a part. What is the appropriate frame of reference for the evaluation of a conceptual framework, which operates at a meta-level in respect of theoretical content and the workings of practice ?

There are of course some measures that can be applied, but which are essentially internal, such as measures of coherence and consistency in respect of the concepts that constitute the framework, but beyond these there appears to be very little in the way of apparatus which is preadapted to the purpose. The principal way in which it is possible to gain some purchase on this question is to evaluate the extent to which the approach overall is coherent philosophically or metaphysically. This is particularly problematic in the case of product semantics, since at this level of analysis it is radically eclectic and there is little attempt at systematisation, and it is therefore necessary to adopt a reconstructive approach to the analysis of concepts and their relations.

Nevertheless certain broad but distinct framework conceptions are evident in the construction of the product semantic account (the most general of which might be described as 'categorical', 'paradigmatic' and 'socio-linguistic'), which are consonant with a range of independent framework characterisations offering different but related perspectives on the nature and constitution of theoretical and conceptual frameworks generally. These analyses, which have been the subject of detailed independent treatment, can be viewed as representing a continuum of analytic framework types, and provide a background against which aspects of the product semantic framework can be clarified.

The comparative forms of framework analysis canvassed are - a) analysis using the idea of a 'categorical framework'; b) analysis in terms of the concept of an 'explanatory structure'; c) analysis in terms of the concept of a 'paradigm'; d) analysis which employs the meta-sociological concept of 'habitus'. These are reviewed in Appendix A, and referred to at appropriate points during the course of the analysis and in the concluding sections.

⁴⁵ Krippendorff 1990, p a7.

1.5 Statement of the Thesis

Product Semantics proposes a theoretical framework for product design on the basis of an appeal to the relevance and coherence of an account of user-interaction expressed in semantic and cognitive terms. This appeal comprises two stages. The first stage amounts to an argument that user-product interaction is best expressed in terms of semantic models. The second stage consists in an assertion that the key concepts and knowledge relevant to the product design process are embodied in the semantic model of the user-product relationship. The theoretical framework which is developed in terms of these arguments amounts to the assertion that a relevant and coherent account of design consists in the possession by the designer, or the embodiment in a design process, of a process model which systematically incorporates the semantic model of user interaction. The framework is expressed in terms of the constitution of this semantic model.

The theoretical framework proposed is articulated in terms of a number of key concepts whose collective role is to establish the sense of semantics in the case of products, relative to an experiential and cognitively based account of interaction. The key concepts defined explicitly or characterised implicitly are :- meaning, significance, understanding, affordance, and categorisation. The definitions of these concepts and of their interrelation constitute the core substantive content of the proposed framework.

It is the contention of this dissertation that although the product semantic account, and the concepts employed provide a basis for the theoretical characterisation of the user-product relationship, if these are analysed in accordance with the assumptions normally associated with such concepts, and adverted to in product semantic accounts, then the framework is conceptually flawed. This is the case both in respect of the analysis of the individual concepts used and in the consistency and coherence of their proposed interrelation.

Although this is the case, it is further argued that if the underlying product semantic stance is accepted, and certain background assumptions associated with the key concepts and their role in the explanatory structure clarified, then it is possible to derive an alternative interpretation which addresses the central issues of consistency and coherence. It also suggests a more general approach to cognitive characterisation, which draws on aspects of the product semantic conception, in clarifying a number of issues in semantic theory and cognition, and in shaping some aspects of design theory. The account is consonant with an important strand in recent empirical and theoretical work in cognitive science and philosophy, and provides support for an approach to addressing issues relating to the adequate characterisation of conceptual structure and experiential content, particularly in terms of the concept of affordance.

1.6 Strategy and Structure of the Dissertation

The strategy has been largely determined by the considerations noted in the section relating to methodological issues,⁴⁶ which is reflected in the structure of the dissertation. The strategy essentially consists in constructing as clear a picture of the framework in terms of the concepts deployed, and their relations, as the matter and form of product semantic accounts will allow. A reconstructive approach is adopted, setting the product semantic accounts against the theoretical contexts which are adverted to or implied.⁴⁷

Part A Stagesetting

Following an introduction to the historical and critical context of product semantics, the outline structure of the framework and the key theoretical approaches which characterise its development are introduced, together with an initial account of the nature of meaning in product semantic theory (Section 2).

Part B Analysis

In the sequence of sections which follow, the key individual concepts and relations are analysed. Section 3 addresses 'function' (which is central to the majority of design theoretic frameworks but which has a marginal role in product semantics). Section 4 is concerned with the concept of 'affordance' and its analysis. Section 5 addresses the concept of 'categorisation'. Section 6 examines theories and models of the nature, role and constitution of 'artefacts' and 'products' and locates the product semantic account in the context of theoretical frameworks. Section 7 addresses the concept of 'meaning' directly, and Section 8, indirectly in terms of 'expression'.

Part C Synthesis

The concluding sections comprise Section 9, where the explanatory argument structure of the framework is re-stated in the light of the analysis of concepts, and in terms of which inconsistencies in the framework are identified; Section 10 proposes a conceptual re-orientation to restore explanatory coherence to the framework, providing indications for the broader application of the approach, the implications of which for design theory and methodology and semantic theory and cognition are considered in Section 11. The conclusion, limits of the study and directions for further research comprise Section 12.

⁴⁶ See above, pp 9-22.

⁴⁷ For example, in the case of 'categorisation', the product semantic account adverts to the idea of 'prototype semantics' and related concepts drawn from cognitive psychology. The analysis treats the product semantic account both as an independent statement of a position, and in terms of the general context from which the ideas employed are drawn. Similarly in the case of 'affordance' the product semantic conception is set against the form in which the concept was proposed by Gibson, and in terms of an independent analysis of the logical form of affordance. In some cases the more general background is characterised prior to the introduction of the product semantic concept, generally for pragmatic reasons of exposition.

Section 2 Product Semantics

| | | |
|-----|---------------------------------------|----|
| 2.1 | Historical and Critical Context | 25 |
| 2.2 | Product Semantic Frameworks | 35 |
| 2.3 | Principal Theoretical Approaches | 40 |
| 2.4 | Product Semantics and Meaning | 47 |
| | <i>Cognitive/Contextual Approach</i> | 47 |
| | <i>Semiotic Approach</i> | 58 |
| 2.5 | Structure and Content of the Analysis | 64 |

2.1 Product Semantics - Historical and Critical Context

Product Semantics addresses questions raised in respect of the two key aspects of product design identified above - the product as interface with users and their practices, and the product as an element of material culture. These are regarded as separately identifiable but overlapping areas of theoretical concern, driven in the first instance by a particular complex of historical and critical perspectives.

In the first place, and from one historical perspective products are felt to have had the power to communicate, and to express the concerns and qualities of cultures. In addition at the level of the individual, the role of products as the props in a theatre of personal definition and expression, has been one of the key elements in the development of more systematic approaches to marketing and mediation. The critique of design provided by the proponents of product semantics focusses on these elements relating to the content of products, and concludes on the one hand that the idea of cultural significance has been lost in the rise of a dominant design ideology, whilst on the other, the deeper significance of individual expression has been trivialised in the crude conceptual content represented in the interface between product design, marketing and mediation.

The principal historical context in which such arguments are articulated is the perceived influence of modernist ideologies on the development of architecture and design in the twentieth century.¹ Recent product design is criticised for the doctrinaire homogeneity and cultural insensitivity of its output, which is perceived to be a consequence of the superficiality of received modernism, and which is contrasted with the richness, variety and cultural relevance perceived to characterise the products of earlier periods. The thrust of such arguments can be summarised in the perceived dominance of an ideologically driven formal language of design, to the detriment of the development of theories and methodologies pertinent to a deeper and more responsive form of design practice.

Product semantics has thus been represented as an alternative to modernism in design, a modernism that is frequently characterised as a 'quest for universal design'² which 'valorises the global nature of technology'³ and which 'systematically avoids conflicting

¹ As represented for example in the historical and theoretical writings of Pevsner and Read [Pevsner 1937, 1945, 1968; Read 1935]. The key features of design centred modernism have been characterised in terms of 'functionalism', 'rationalism' and 'essentialism' [See for example Boys 1996] and is related directly to functionalism for example by van deVelde [see Whitford 1992]. The functionalist element is traced by de Zurco in terms of moral or ethical positions to the Thomist idea of clarity of organisation and expression [De Zurco 1957]. The general objection in the product semantic account is to the idea of an ahistorical and acultural notion of a pure formal language in design and architecture.

² Krohn and McCoy 1989, p 113.

³ Krohn and McCoy 1989, p 114.

or irrelevant information'⁴ resulting in a perceived 'reduction to the unadorned and the essential'. Such an approach is perceived to have resulted in 'an aversion to narrative or expressive design'⁵ and promulgated the idea that 'there is only one way to articulate function with form'.⁶

In contrast product semantics seeks to make 'visual connections between the technological object and other aspects of life through metaphor, analogy, simile and allegory in their form'.⁷ This plurality and the endeavour to 'link meaning with form in functional objects'⁸ is perceived not to be new, but characteristic of the mainstream history of architecture and products. Modernism is presented in product semantic analysis as an ideological aberration, rather than the historical culmination of a rationalist programme.

The perception of product semantics as a reaction against modernism is supported and amplified by a range of observations which constitute a parallel rationale for the approach. The emergence of information technology and electronics as the dominant factors in technological development highlighted the increasing disjunction between mechanical function and form which had hitherto facilitated modernist conceptions of design - 'industrial products no longer have the alibi of the historic tradition of a gestalt or structure based on constructive technological or ergonomic criteria'.⁹ Nonetheless we have 'chosen uniformity over expression in the design of our products' and ironically 'just when microelectronics and new materials have finally liberated designers from the dictation of form by mechanical function'.¹⁰

Thus whilst at the outset, the emerging profession of product design largely operated with a paradigm in which the designer's role was perceived to be the packaging of technology, a technology which was predominantly mechanical, increasingly the well-defined working constraints provided by such paradigms and technologies have been lost. The new problems posed by the severing of the traditional form-function relationship, and which had been underpinned (in the context of the interface with users) by traditional ergonomics, stimulated the search for alternative rationales for formal expression and organisation in products generally.

⁴ Krohn and McCoy 1989, p 114.

⁵ McCoy 1990, p e3.

⁶ McCoy 1990, p e3.

⁷ Krohn and McCoy 1989, p115.

⁸ Krohn and McCoy 1989, p115.

⁹ Oehlke 1990, p e2.

¹⁰ Krohn and McCoy 1989, p 112

Such rationales proved hard to come by either within the technical framework of ergonomics or under the umbrella of modernist aesthetic and formal theories, particularly at a later stage during which the concepts of 'hardware' and 'software' emerged from specialised use and attained a more general and highly influential application. In the event the development of new rationales was primarily influenced by the use of such concepts in the context of the rapid development of approaches to computer interface design, which stimulated the more pervasive use of the 'interface' concept and its associated structure, as a paradigm for use with products generally.¹¹ This concept in particular has been of crucial importance in the development and orientation of product semantics which is characterised by Krippendorff as

'...concerned with human interfaces - with that layer of cognition in which we experience how we interact with our environment, that layer of cognition which renders things understandable, meaningful, transparent, alive and useable or that layer of cognition which centres us in our own experiential world. Product Semantics resides where human cognition and machine logic fuses'¹²

and in attempting to locate these ideas in a return to the underlying etymology of design as

'...making something, distinguishing it by a sign, giving it significance, designating its relation to other things, owners, users, gods..... one could say : design is making sense of things'.¹³

Responses to these ideas have occurred in both formal and informal contexts. In the less formal vein, designers and educators who sought a more firmly founded alternative to the modernist credo, and who eschewed the perceived superficiality, both of the eclectic stylistic references derived from emerging technologies and the caprices of post-modernism,¹⁴ turned to the exploration of rhetorical concepts in an attempt to achieve meaningful engagement with the user and some form of arguable rationale for aesthetic decisions in design. The results of this approach are to an extent typified by the widely publicised work of Cranbrook and its graduates in the USA, in which the attempt to define forms for new products is derived from the use of visual metaphor, rather than the restyling of historical precedents.¹⁵ Such work also points to an inherent difficulty in product semantics - the difficulty in determining the extent to which the enterprise is descriptive or reconstructive. At one level the programme is clearly concerned with explicating the nature of user-product interaction and is an analytic exercise which seeks to clarify and harness the complexity and richness of such interaction. At another level it argues for a change in practice which goes beyond this analysis, and which represents an

¹¹ Norman and Draper 1986.

¹² Krippendorff 1990, p a5.

¹³ Krippendorff 1989, p 9.

¹⁴ See for example Thackara 1988; Foster 1984; Branzi 1987, 1988.

¹⁵ Krohn and McCoy 1989 pp119-122; McCoy 1984; Cranbrook Academy 1990.

alternative ideological stance. At this level the distinction between reasoned argument and polemic, theory and manifesto is at times obscured in the literature.

On the more formal front the most significant changes have occurred in relation to the development and extension of ergonomics into areas relating to communication and cognition. In the first instance this was represented in the development of the concept of product legibility. This has been most evident in the design of complex interfaces (aircraft cockpits, power station control consoles), where correct interpretation may be crucial, but has subsequently informed approaches to user interaction in the case of a wide range of industrial and domestic products.¹⁶ Substantive work in this field has been pursued most vigorously in the context of human-computer interaction, resulting in a cluster of connected concepts which have been widely used.¹⁷ In the context of product semantics these concepts have been drawn into the core of the programme, the thrust of which is captured by Krippendorff in identifying that

‘...product semantics seeks to understand users’ understanding of their practices in interfacing with designed things and provide strategies for designing products that can either afford or supportively intervene in that understanding.’¹⁸

Dorsa has argued that such an approach is concerned essentially with

‘...the non-verbal communication of objects; it is based on a belief that objects can be designed to communicate information about themselves and that when these objects are properly designed users will be able to “decode” this information.’¹⁹

This aspect of product semantics has been strongly influenced by an analysis of a wide range of everyday products, in which the fundamental assumption is that failure in design rests in the lack of attention given to the cognitive abilities and strategies of consumers. The cases examined and analysed by Norman collectively demonstrate a number of key principles which include the importance of visibility, the provision of appropriate cues and clues, and feedback to users in respect of their actions. These principles taken together ‘...constitute a form of psychology - the psychology of how people interact with things’²⁰

Although Norman has worked essentially from examining product failure and in a sense has worked from a psychopathological standpoint without an explicit psychology to underpin it, the psychology that he alludes to is evident in the work of Gibson, who approaches user-world interaction through a theory of affordances.²¹ The concept of

¹⁶ Hasdogan 1993, for a review.

¹⁷ Norman and Draper 1986.

¹⁸ Krippendorff 1990, p a5.

¹⁹ Dorsa et al 1990, p 11.

²⁰ Norman 1988 (quote from p 9)

²¹ Gibson 1976, 1979.

affordance, which has played a pivotal role in the development of the philosophical and methodological content of product semantics, can in one sense be viewed as the loosening of a functionalist concept

'...the term affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used.'²²

The concept is in one sense roughly equivalent to the idea of potential function or potential use, but in the context of Gibson's notion of 'direct perception' for example, takes on a far deeper significance, linking it on the one hand to the idea of cognitive pre-programming and schemata developed in some areas of cognitive science,²³ and on the other to Heidegger's conceptual framework.²⁴

In addition to the application of these ideas to material and form, the idea of an affordance based cognitive psychology of everyday interaction has been extended, within product semantics, to concepts of space and spatial relations. The dominant model of an essentially geometric space articulated through the scheme of Cartesian co-ordinates is perceived to be inappropriate because

'...it provides no place for the representation of whole forms or gestalts....each projection works independently and without reference to a particular observer'

'...the geometric model of space is comprehensible only from outside.'²⁵

Semantic notions of space, on the other hand, are user-centred and conducted with the terminology of everyday relations (above, below, behind, on top of etc) and within the cognitive framework of affordances - space is perceived through its potentiality.²⁶

Although the formal and less formal approaches within product semantics are clearly some distance apart, they are linked by a common concern with the concepts of 'language' and understanding. In the less formal sphere, the rhetorical aspects of language and their role in communication are brought to the fore, lending weight to an argument for the reworking of the language analogy in design, both in respect of the significance of products for users and in respect of their articulation by designers. In more formal contexts the unravelling of the cognitive processes involved in computer interface and other product interactions have involved the creation and manipulation of a hierarchy

²² Norman 1988, p 9.

²³ Johnson 1987,1993.

²⁴ Heidegger 1967. King provides a useful overview of Heidegger's framework [King 1964] and Ihde draws out the implications of Heidegger's position for the development of a philosophy of technology [Ihde 1979].

²⁵ Lannoch and Lannoch 1989, p 41 and 40 respectively.

²⁶ Lannoch 1989; Lannoch and Lannoch 1989.

of formal languages in the characterisation of user understanding and the development of a number of methods of analysis including cognitive modelling, protocol analysis and semantic mapping. Such work represents a sustained attempt to create functionally legible and interactively responsive products, through the creation of descriptive and analytical languages of sufficient sophistication to capture the complexity of user behaviour and user understanding in cognitive terms.

Such perspectives have found more general parallels, for example, in an increasing concern with the relationship between 'natural' and 'formal' languages in philosophy, the interaction between concept formation and linguistic structure in cognitive psychology, and the re-emergence of semiotics as a potentially unifying cultural theory, all of which have been drawn on in the development of product semantics. They have also driven a more sustained attempt to flesh out the pervasive idea of 'languages' of design as the theoretical core in the development of a design process with the capacity to define and create culturally significant and functionally legible products. In doing so they raise important general questions in respect of the aesthetic and social values of products, their capacity for deeper individual and cultural significance, and whether such factors could conceivably be predicted and controlled in the design process.

Summary of Critical Content and Perceived Implications

In framing a critical approach and response to recent and current practice in product design, product semantics has focused on a number of areas or 'dimensions' of critique, principally - History, Technology, Ergonomics, Psychology, Methodology, Theory and Philosophy, and expressed its response to these dimensions of critique in terms of the implications for proposed changes in respect of two key 'domains' - the Philosophical/Theoretical domain and the Methodological/ Empirical domain.²⁷

Historical and Technological Dimensions.

The historical dimension of critique rejects modernist ideologies and formal languages of design, principally on the grounds that they a) neglect the element of individual, significance, b) neglect the element of cultural significance, c) promote an extreme rationalist view of design reflected in the idea of universal design solutions, which ignores context, d) diminish the 'narrative' and expressive aspects of design, e) provide no rationale for aesthetic decision-making in design.²⁸

²⁷ The structure of the presentation of critiques and their implications is broadly derived from the form in which they are introduced in Krippendorff 1990.

²⁸ The historical dimensions of the product semantic critique are primarily represented in the series of papers led by McCoy [McCoy 1984, Krohn and McCoy 1989, McCoy 1990]

The technological dimension of critique is taken to expose:- a) the inadequacy of design concepts based on mechanical paradigms b) the lack of an explicit alternative to the mechanical paradigm, c) neglect of the implications of hardware/software concepts, d) the inadequacy of the concept of materials as a set of 'givens' in the design process, e) the inadequacy of the form/function relation as an expression of the core of the technological problematic in design.²⁹

The implications of these dimensions of critique are represented in terms of a perceived commitment in the philosophical/theoretical domain which:- a) stresses culturally specific design as a general model, b) creates a locus for the articulation of cultural significance in products, c) creates a locus for the articulation of individual significance in products, d) proposes a core form/meaning rather than a form/function relation, e) proposes a relocation of technical concepts on the basis of a form/meaning relation, f) emphasises the centrality of the 'interface' concept, g) emphasises the utility of the hardware/software relation, h) proposes the concept of materials as subjects of design activity rather than fixed constraints, i) places the focus in products on their interactivity. These proposals are taken up in a substantive form in the methodological/empirical domain, in relation to the remaining dimensions of critique and their implications.

Ergonomic and Psychological Dimensions.

In the light of the broad parameters set in response to the implications of historical and technological critique, the substantive content of the ergonomic dimension of critique is taken to argue against :- a) overemphasis on the physical characteristics of people, b) overemphasis on task driven models of human behaviour, c) 'mechanisation' of interactive user models, d) stress on performance centred evaluation, e) strict verifiability as a criterion, leading to models which fail to capture the complexity of product interaction, f) a fundamentally 'behaviourist' stance, g) the primacy of 'normative' concepts and methods.³⁰

Similarly, the substantive content of the psychological dimension of critique argues against :- a) emphasis on the psycho-physical aspects of human-product interaction, b) neglect of the cognitive content of human-product interaction, c) the dominance of 'top-down' constructive theories of perception.³¹

²⁹ The technological dimension of product semantic critique is primarily addressed by Krippendorff in his two key papers [Krippendorff 1989,1990] together with the summary analysis of the formalisation of technology in modernist theory [Krohn and McCoy 1989] and the more general critique of the form/function relation [Lannoch and Lannoch 1989] and the objectification of the design process [Oehlke 1990; Lehtenen 1990].

³⁰ Krippendorff 1989,1990.

³¹ Krippendorff 1984, 1989,1990.

The implications of these dimensions of critique in the philosophical/theoretical domain are taken to be :- a) the centrality of cognitive models, b) the centrality of 'categorisation' as a cognitive process in providing a basis for the analysis of human-product interaction,³² c) the centrality of 'learning' as a concept, rather than normative concepts, d) the relevance of cognitive learning theories as models for human-product interaction,³³ e) the adoption of 'bottom-up' interactive theories of perception,³⁴ f) the primacy of the concept of 'affordance' rather than function.³⁵

These philosophical/theoretical shifts in perspective are reflected in the proposed adoption or development in the methodological/emprical domain of :-a) a 'cognitive' ergonomics, b) participant observation and protocol analysis, c) methods intended to characterise 'user models' d) normative methods for mapping subjective 'quality space' onto concrete properties and formal elements in the design process, e) interface analysis based on the compatibility of 'user models' with 'system image', f) categorial frameworks based on 'fuzzy set-theoretic' implementations of the key 'prototypical' and 'central member' models of categorisation.³⁶

Philosophical and Theoretical Dimensions.

The key elements of the philosophical dimension of critique are :- a) a systematic rejection of all forms of dualism, b) a rejection of behaviourism, c) a critique of the ontological emphasis in design philosophy, rather than epistemology and hermeneutics, d) the marginalisation of action theory and intentionality.³⁷

The key elements of the theoretical dimension of critique are :- a) a critique of the central role of 'function' as a theoretical concept,³⁸ b) a critique of the lack of an adequate theory for 'user modelling',³⁹ c) a critique of the rigidity of models of the design process, d) a critique of the emphasis in theory on 'problem solving' as a model, e) a critique of the

³² Athavankar 1987,1989,1990.

³³ Krippendorff 1990.

³⁴ Smets 1989; Smets and Overbeeke 1994,1995.

³⁵ Krampen 1989; Smets 1989; Lannoch 1990; Krippendorff 1989.

³⁶ Krippendorff 1989,1990.

³⁷ Causal/conventional, perceptual/symbolic,perceptual/cognitive, subjective/objective, and possibly mind/body (though this is not made explicit). Krippendorff 1989,1990.

³⁸ The concept of function in traditional theories is perceived to be a quasi-objective 'property' which ignores relativisation to individuals or relevant social groups, ignores the concept of agency and thus fails to capture essential intentional concepts such as 'understanding'.

³⁹ An adequate user model would need to be capable of providing a framework for interactivity which can encompass the cognitive components of interaction. This would involve a radical shift from classical models which essentially treat the human and the machine/product as theoretically independent elements in the context of analysis, rather than mutually modifying at both a pragmatic and a conceptual level.

theoretical emphasis on 'process management' as a model, f) a critique of the lack of a model for aesthetic aspects of the design process, and aesthetic decision making.

The implications of these dimensions of critique are represented in a commitment in the philosophical/theoretical domain to :- a) the concept of 'meaningful practice' as the foundation of an epistemology underpinning a philosophical psychology, b) the centralisation of 'cognition' c) the use of a theory of 'affordances', rather than function to underpin design theory, d) the centrality of the concepts of 'meaning' and 'understanding' in design theory, e) the idea that 'interface mediation' is the key role of the designer.⁴⁰

These are reflected in the methodological/empirical domain in terms of :- a) the use of interface theory as the theoretical underpinning for defining methods for user modelling, b) the role of a theory of 'meaning' and 'significance' to underpin and define ethnographic and psychological design methods.⁴¹

Methodological Dimension

The methodological dimension of critique reiterates a number of the criticisms apparent in the previously described dimensions, each of which has methodological implications, but places stress on the following key aspects of methodology :- a) critique of design methodology for its lack of methods for characterising users and their practices adequately, particularly in terms of understanding and cognitive competences, b) absence of methods for characterising the symbolic qualities of artifacts, c) static and closed models of the design process which do not reflect the recursive and self-referential nature of that process.

In addition to the responses in methodological terms represented in the previously discussed dimensions of product semantic critique, the methodological implications of this dimension are principally identified in :- a) the need for effective 'descriptive', 'creative' and 'anticipatory' methods, b) the need for a methodological approach which is closer in kind to ethnographic methods,⁴² c) the need for methods enabling the mapping of the factors from 'ethnographic' methods onto affordances, semantic attributes and

⁴⁰ Krippendorff 1990.

⁴¹ Krippendorff 1989.

⁴² See below, p 36-37. The principal methods identified are for example, Discourse Analysis, Perceptual Mapping, Cognitive and Semantic Mapping. Although the argument for the use of ethnographic methods is cogent, ethnographic methodology itself has been subject to its own internal critique, which is illuminating in this context. [See for example Miller 1987].

formal product properties,⁴³ d) the need for recursive and projective methods.⁴⁴

Table 1

The content of the product semantic dimensions of critique and their implications in the product semantic domains (Philosophical/theoretical and methodological/empirical) represented in the literature, are summarised in the table (overleaf).

Socio-Cultural Dimension.

Although there is no substantive basis for the identification of a discrete socio-cultural dimension of critique in the product semantics literature, these are clearly implicit in a number of the other dimensions. In addition it is important to recognise that the entire critique in all its dimensions is framed by an implicit socio-cultural model. The nature of that model will become evident in the presentation of the overall picture of the framework for product semantics in the next section. In summary, it is presented in terms of an interrelated set of domains for theory - a) domain of use, b) domain of language, c) domain of genesis, d) domain of (product) ecology. These are informed by higher order constructs which are not represented as a theoretical domain, but which are characterised metaphorically as 'mythologies'. The implications derived from the critical dimensions (above) are related to the domains for theory, in terms of issues, means and possible theoretical constructs, and carry their own implications.

Table 2

The relationship between the theoretical domains characterising the framework, and the content and implications of the dimensions of critique represented in the form of substantive proposals in the literature, are summarised in the table (overleaf).

⁴³ Expressed as a translation between different 'languages' [Lannoch and Lannoch 1989] but note the tendency to express this normatively and in terms of the hypostatisation of 'properties' (for example as a category of objectively held things).

⁴⁴ These are principally identified with 'learning theory', 'symbol theory' and 'metaphor theory'.

Dimensions of Critical Focus on Design

| | Historical | Technological | Ergonomic | Psychological | Methodological | Theoretical | Philosophical |
|--|--|---|---|---|---|--|--|
| Product semantics has developed from a multi-faceted critique of design theory and practice, resulting in a changed theoretical and methodological stance. | <p>Critique of modernist ideologies and formal languages of design.</p> <p>Loss of the cultural significance element of design, evident in the history of earlier periods.</p> <p>Rejection of the idea of universal design, and the diminution of culturally specific or individual design.</p> | <p>Exposure of the lack of rationale or theory for the relationship of form to function, as a result of the shift from a mechanical to an electronic technical paradigm.</p> <p>Questions raised by the emergence of the concept of interface, in computer hardware and software design.</p> <p>Questions raised by the 'software' concept</p> <p>Possibilities afforded by the extension of software and interface concepts and their general application to products.</p> <p>Possibilities afforded by the change in the concept of 'materials' from that of a given in the design process to a designed element.</p> | <p>Critique of the focus of ergonomics on the physical character of people, and narrow task driven models of human behaviour.</p> <p>Critique of 'classical' approach which tend to mechanise human interaction in terms of definable elements of performance, thus ignoring complexity for the sake of strict verifiability.</p> | <p>Critique of emphasis on psycho-physical aspects of human-product interaction, to the detriment of a substantial analysis of cognitive content.</p> <p>Critique of top - down constructive theories of perception, argues for bottom-up theories or interactive models which emphasise the meaning - ladenness of perception.</p> | <p>Critique of design methodology for its lack of methods for characterising users and their practices adequately in terms of their understanding and cognitive competences.</p> <p>Lack of methods for exploring the symbolic qualities of artifacts</p> | <p>Critique of the lack of rationale for aesthetic aspects of design as represented in design theory.</p> <p>Critique of emphasis in design theory on design as process management or as problem solving and parallel playing down of the development of theory related to the designers role as an interface mediator.</p> <p>Critique of the central role played by the idea of 'function' as a quasi objective property, which ignores the idea of 'agents' and the primacy of understanding.</p> | <p>Rejection of forms of dualism, including - causal/conventional, perception/symbol, and behaviourism.</p> <p>Critique of the ontological emphasis in design philosophy, arguing for the need for epistemological and hermeneutic perspectives.</p> <p>Argues for a concept - 'meaningful practice' which moves human cognition and action theory, intentionality, etc, to centre stage.</p> <p>Form follows Meaning.</p> |

Product Semantics Overview

Philosophical/Theoretical Domain

Stresses a perceived sense of culturally specific design as the historical norm and as a model.

Creates a place at a philosophical and theoretical level for the idea of products as a broad source of cultural significance.

Loss of a mechanical paradigm, exposes a 'form/meaning' rather than a 'form/function' relationship, leading to a relocation of technical concepts.

Extension of notions 'software', 'interface' etc, leads to technological concepts of 'intelligent' and 'inter-active' products.

Emphasises cognition as key factor defining relevant ergonomics.

Stresses the import of 'learning' and change in performance over normative concepts.

Introduces a concept of 'affordance' in re-defining 'mismatch', 'error', etc.

Centralises cognitive aspects of theory and with particular focus on classification and learning theories as a basis for analysis of human - product interaction.

Favours bottom - up interactive theories of perception, and theory based on 'affordance' concepts.

Identifies the basis of methodology as an 'intervention' in the 'practices of living'. Including an emphasis on ethno-methodological approaches, and a focus on the determination of the basis of the symbolic qualities of objects.

Shifts the emphasis of theory away from the idea of 'function' as the central concept.

Introduces the notion of 'meaning', 'under-standing' etc as the pivotal theoretical concepts.

Argues that interface mediation is the key theoretical role of the designer.

Centralises the notion - 'meaningful practice' as the foundation of epistemology underpinning philosophical psychology on the basis of a theory of 'affordances'.

Centralises cognition in line with a general thrust in the human sciences.

Methodological/Empirical Domain

Participant observation and protocol analysis, focus on affordance as a basis for 'cognitive ergonomics'.

Methods intended to establish the nature of 'user models' and their compatibility with the 'system image'.

Applies categorial frameworks based on 'fuzzy - set theoretic' implementations of the key 'prototypical' and 'central member' model for classifications.

Normative methods for mapping subjective 'quality space' onto concrete properties and formal elements in the design process, based on semantic differential etc.

Identifies the need for Descriptive, Creative, Anticipatory methods.

Ethnographic methods - Discourse Analysis, Perceptual mapping, Cognitive & Semantic mapping.

Ethnography mapped into semantic attribute, affordance, and formal product properties.

Recursive, projective methods based on learning theory, symbol and metaphor theory.

Interface theory as an expression of general aspects of agent/user protocol methods.

Unanalysed theory of 'significance' and 'meaning' lies behind ethnographic and psychological method.

Rejection of semiotics (unmodified) as an appropriate approach, dependent on interpretation of 'reference'.

Domains of Product Semantic Theory

| | Issues | Means | Theory 1 | Theory 2 | Implications/Issues |
|--|---|--|---|--|---|
| <p>Use psychological theory</p> | <p>Usability</p> <p>Making things recognisable - Self Evidence Semantic Accommodation Self-Instruction</p> <p>Making sense of artifacts Meaningfulness of things Understanding of practice</p> | <p>Physical Constraints, forcing functions Indicators</p> <p>Interface organisation and its symbolic content User - oriented protocols and 'affordance matching'</p> | <p>Categorisation through ideal types; constitution of differences.</p> <p>Theory of 'affordances' and related theories of meaning and understanding.</p> | <p>Deep Structures vs Surface Structures. (Generalised form vs actual manifestation)</p> <p>Intended use and properties vs accidental use/properties.</p> <p>User's cognitive models in terms of operational logic and identity of product, and structure of motivation.</p> | <p>Clarification of the sense given to 'deep structure'/surface structure'; 'underlying meaning' and 'manifestation'; 'type' and 'token', etc. Analysis of function/intended use; intentional/accidental properties; affordance; significance; sense; meaning; etc. Analysis of 'artificiality'.</p> <p>Analysis and evaluation of competing models/theories for categorial frameworks and their application to product identity and meaning.</p> <p>Analysis and evaluation of theories relating to cognitive user models</p> |
| <p>Language socio-linguistic theory</p> | <p>Meanings of objects arise in sociolinguistic context. Objects are constituted in language, actions on object structure are conceived linguistically.</p> <p>Objects have a crucial role - Individual Identity Interpersonal Communication Social Differentiation Social Integration</p> | <p>Noun-Adjective Constructions - natural models for perceiving products as possessing certain semantic qualities.</p> <p>Abstract -- Concrete Quality --- Property Meaning -- Manifestation (Semantic Differential, Butter's Method, etc.)</p> <p>Metaphor as prime 'linguistic cognitive mechanism'.</p> | <p>Theory related to the means by which products become incorporated in the larger system of artifacts and how they participate in human communication.</p> <p>Product theory relating to - Distinctions Definitions Social Identifications Differentiation of Meaning</p> | <p>Language as a conceptual model space</p> <p>Language as primary social carrier of meaning/medium.</p> | <p>Characterisation of socio - linguistic models and theories implied by product semantics expositions; evaluation of their intrinsic logical consistency and coherence, and epistemological status; evaluation of their compatibility with theories of affordance, meaning etc, advanced.</p> <p>Evaluation of overall product semantics cognitive and socio-linguistic models and theories in relation to other related frameworks, including - semiotics, structuralist linguistics; evaluation in relation to developing models in cognitive science and philosophy. Metaphor theory.</p> |
| <p>Genesis techno-economic theory</p> | <p>Production/Consumption path Artifact survival through the - Production, Dissemination, Consumption, Usage and Retirement, cycle.</p> <p>Network of interactions and exchanges, involving change of medium / representational language. 'Meaningfulness' sustained for all agents in the network.</p> | <p>Description of the network of production/consumption as a communication process.</p> <p>Provision of cyclical and feedback mechanisms in the process.</p> | <p>In a production/consumption network, Artifacts perceived as 'temporarily frozen' forms, gestalts, patterns, usages.</p> <p>Affordances as a universal model for characterising the perspective of agents in the network, relating them to motivation and incentive.</p> | | <p>Clarification of the design - production - consumption cycle. Development of 'artifact models' relative to different stages.</p> <p>Characterisation of the representational/communicative languages involved and dialogue across representational types and media (concept of translation, etc).</p> <p>Evaluation of the concept of affordance as a model for the characterisation of agent perspectives (and relation to 'motivation' and 'incentive')</p> |
| <p>Ecology interactive species theory</p> | <p>Dynamics of broader context of product interaction, social and cultural significance, and designer responsibility.</p> | <p>Organising principle underlying interaction between objects is 'meaning'.</p> | <p>Artifacts characterised as the species in an ecology of object interaction, which includes - Competition, co-operation and co-formality, parasitism and symbiosis.</p> <p>'Ecology' as an independent 'life of products', model. Ecology as a more inclusive socio-artifactual world model in which design theory is part of the ecology it describes.</p> | <p>Extension of ecological theory to include evolutionary and genetic conceptualisation of product or socio-artifactual worlds.</p> <p>Ecological theory at one level as theory relating to the 'mind' (cognitive models) of designers</p> | <p>Clarification and evaluation of ecological, evolutionary and genetic models for product interaction (In abstract and as embedded in socio-cultural models). Analysis of the role of 'meaning' as the principle underlying product interaction. Conceptual structure of 'artificiality'.</p> <p>Clarification and evaluation of implicit models of designer cognition and the structure of the design process; and the self-referential aspect evident at the 'ecological' level.</p> |
| <p>Mythology</p> | <p>Perception/communication of cultural identity and supra-cultural structures expressed through 'meaning' ecology - taking the form of governing 'myths', 'core fictions' and cosmologies.</p> | | <p>Artifacts - symbolic mediators between relatively stable and deep rooted cultural heritage, (often unconscious) and fast changing socio-economic contexts.</p> <p>Artifacts - symbolic mediators between the individual and the social/cultural.</p> | | <p>Clarification of the philosophical position implicit in the role envisaged in product semantics for higher level cultural and social constructs - expressed as 'mythology', and the relation of these to lower level models and theories.</p> <p>Clarification of the role of products as mediators between the individual and socio-cultural; role of objects in human cognitive and emotional development; individual 'myths' and 'folk psychology' in cognitive science.</p> |

2.2 Product Semantic Frameworks

The majority of writings in the product semantic literature are devoted to the analysis and development of individual aspects of the picture comprising the implications and commitments arising from the broad critique summarised in the previous section.⁴⁵ There are two notable exceptions, the overall framework model presented by Krippendorff,⁴⁶ and the extended treatment of semantic analysis by Vihma.⁴⁷ In order to gain some perspective, Krippendorff's account will first be outlined. The simplest way in which it is presented is in the form of a paradigm shift :-

| Old Paradigm | New Paradigm |
|--|---|
| Design is making forms to follow required functions | Design is enabling users to make sense of things |
| Emphasis is on efficiency and simplicity of operation - improves material conditions for users | Emphasis is on self-evidence in identification and understandability of use - enables users to centre themselves in a symbolically meaningful world |
| (End) products are designed to embody specific functions | (Unfolding) interfaces are designed to afford the cognitive models users have or are desirous to develop and practice |
| Training and instruction is separate from product use and typically precedes it | Interfaces are self-instructing and user competence is expected to emerge in practical use |
| Users are rewarded by conforming to objectively measurable performance criteria | Interaction is self-motivating, an engaging play in which users judge themselves by their own criteria |
| Errors are human and a problem users must learn to avoid | Errors reflect incomprehensibility and discouraging designs. Machines should be configurable or adapt to available cognitions |
| Machines are seen as constraining users to apply them as intended | Machines are seen as enabling users to create possibly unintended but meaningful practices |
| Designers are authorities on how things should look and be used | Designers co-operate with users in intervening into individual practices of living ⁴⁸ |

⁴⁵ They also tend to restrict themselves to a particular domain, (philosophical, theoretical or methodological).

⁴⁶ Krippendorff 1990.

⁴⁷ Vihma 1995

⁴⁸ Krippendorff 1990, p a7 (slightly adapted, omitting the cartoons).

Although this is clearly a rough caricature, not intended to capture the full philosophical and theoretical commitment of product semantics, it nonetheless identifies key features of the approach and also highlights the problem raised earlier in respect of the failure to clearly separate the theoretical content of an analysis from an ideological commitment.⁴⁹

The more formal and explicit development of the framework for design theory is represented in the subsequent exposition in two key papers by Krippendorff.⁵⁰ Having established a number of the key features of his philosophical and theoretical commitment and approach, which are essentially captured in the summary given in the previous section, Krippendorff outlines two aspects of the rationale for a framework of design theory which direct the formulation of a framework.⁵¹ The first of these is framed by the perceived needs of an adequate design methodology. Methodologically, in terms of its definition as an intervention in the practices of living :-

‘...design must (1) start with some appreciation of existing practises, (2) be able to anticipate the consequences of introducing improved or new artifacts, and (3) have a systematic (professionally acceptable) way of realising or embodying designers’ intentions. These tasks define three classes of methods that are quite common to all design activities but need to be developed if product semantics is to succeed...’⁵²

The classes of methods identified as necessary to achieving these aims are designated as ‘descriptive’, ‘anticipatory’ and ‘creative’ methods.

Descriptive methods are intended to establish:-

‘...what exists’ and ‘...calls for research into people’s understanding of things, the cognitive competencies in use and brought to bear on anything new, the symbolic qualities of familiar objects easily recognised in everyday life.’⁵³

and are exemplified primarily by ethnographic methods, discourse analysis and perceptual mapping.

Anticipatory methods are intended to:-

‘...assure that proposed affordances embrace not just the users’ cognitive models currently available but also those that will unfold in practice.’⁵⁴

⁴⁹ See section 1.4 ‘Methodological Issues’ pp 10-12 above.

⁵⁰ Krippendorff 1989, 1990.

⁵¹ The starting points differ in the two papers, but the thrust of the model is essentially the same.

⁵² Krippendorff 1990, p a7.

⁵³ Krippendorff 1990, p a7.

⁵⁴ Krippendorff 1990, pp a 8-9

and require

'...extrapolation from existing knowledge, and the theory here needed must be rooted in *cognition, learning and social interaction*, including the *symbolic involvement of institutions* (of production, communication and consumption).⁵⁵

The substantive methods identified include

'...cognitive theories of how metaphors, metonymies and cognitive prototypes work to anticipate the unfolding of user cognition. Learning theories are also available but rarely made to shed light on how users might explore ...complex affordances...'⁵⁶

which have the characteristic in the domain of product semantics of being

'...recursive methods that change their own premise (the conditions that give rise to the intervention in the first place) and are, I believe, unknown in engineering (the design of a bridge does not influence its underlying mechanics, physics or chemistry whereas the design of an interface inevitably changes the cognition it initially supports).⁵⁷

Creative methods are intended to support informed design decisions, for example

'...how semantic attributes come to be embodied in an artefact, how the ethnographies of particular practices are converted into the affordances of a product, how verbal descriptions of an ideal type become translated into easily recognised forms ... and must be accompanied by methods of testing the results...'⁵⁸

If the 'bottom-up' element of the rationale for the construction of a theoretical framework for design comprises the methodological aspect, then the second aspect of the rationale which embodies a broad philosophical commitment can be viewed as the top-down element. The contention is that whilst most disciplines have recognised and responded to the decisive shift from an ontological to an epistemological perspective in the development of theoretical frameworks, design has largely remained trapped within a redundant philosophical tradition with strong positivist leanings. Similarly, although the conceptual value of a cognitive stance has been generally recognised and embraced in a wide variety of disciplines, design continues to operate with an implicit mechanistic paradigm. To a large extent, the value of these philosophical and theoretical re-orientations remains unanalysed in product semantic accounts, and their intrinsic merit is assumed to be self-

⁵⁵ Krippendorff 1990, p a8. (Italics his).

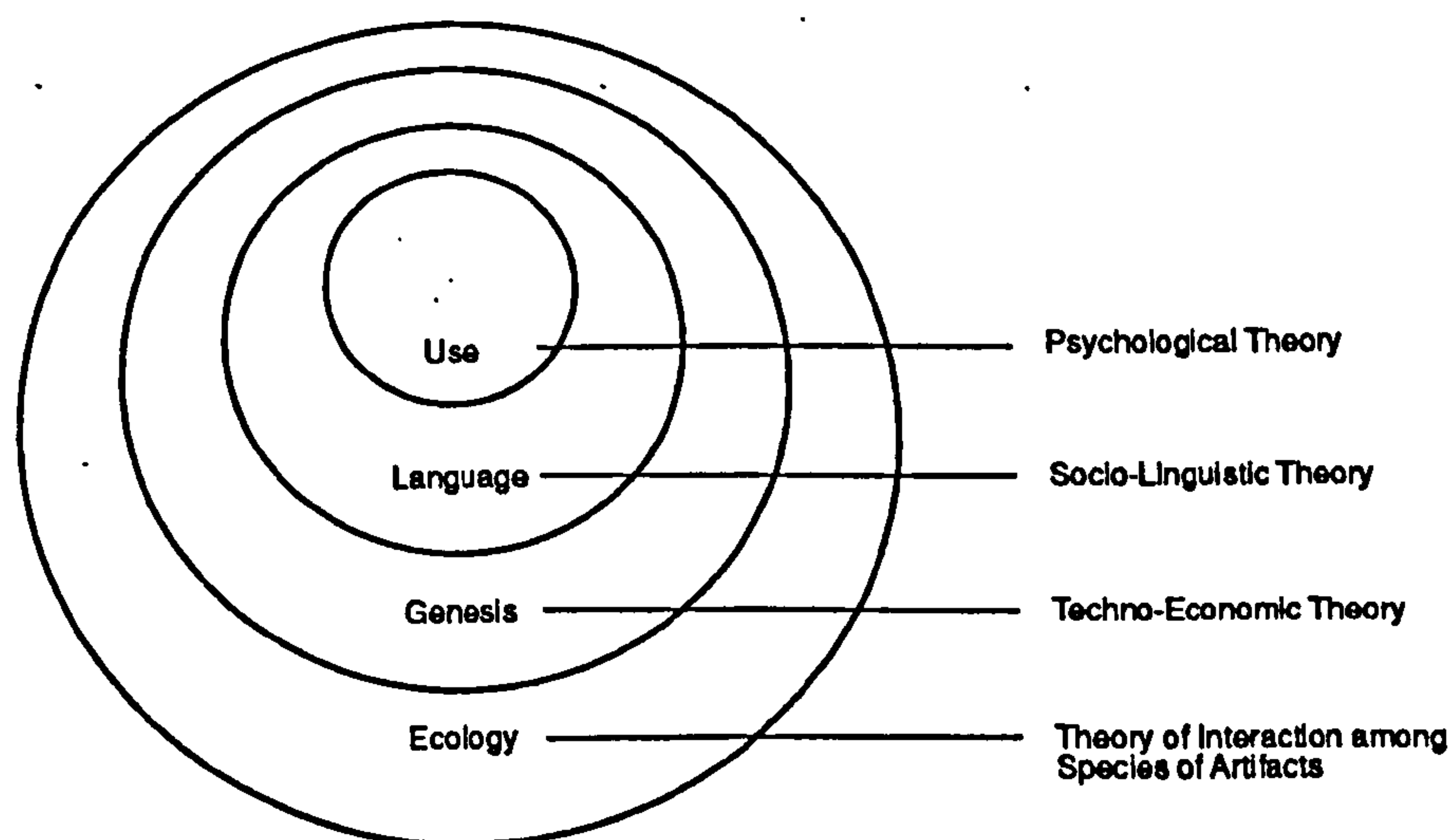
⁵⁶ Krippendorff 1990, p a8

⁵⁷ Krippendorff 1990, p a9. The status of 'recursive method' here is not clear since it seems to have dropped into a gap between the individual and the social, and between tokens and types. On one interpretation although the design of bridges (qua token) doesn't change the underlying physics etc, neither is this the case for interfaces. On the other hand the design of bridges (qua type) or the experience of bridges (qua token) surely does. One could argue that all artefacts introduce changed cognitions (viewed contextually).

⁵⁸ Krippendorff 1990, p a10

evident relative to the conceptual utility of the ideas of significance and meaning.⁵⁹ Nevertheless the upshot is the assumption that an adequate theoretical framework for design will need to encompass the contextualisation that is perceived to flow from an epistemological rather than an ontological foundation, and the concept of understanding and interactive engagement perceived to follow the adoption of a cognitive stance.⁶⁰

In the light of these 'bottom-up' and 'top-down' elements, Krippendorff proposes a theoretical framework which is based on an embedded set of four design theories, which represent the essential contexts in which artefacts '...should not break down and need to survive existing practices'.⁶¹ Each of these depends on the relationship between meaning, sense and affordance, and what is described as the '...circular enabling pattern of practice.'⁶² The four essential contexts for artefacts are identified as the context of 'use' where the emphasis is on psychological design theory, the context of 'language' which is supported by socio-linguistic design theory, the context of 'genesis' which is informed by techno-economic design theory, and the context of 'ecology' which requires design theories dealing with the interaction among species of artefacts.⁶³



⁵⁹ The notable exception is the opening section of Krippendorff 1990, where an informal and brief but explicit argument is presented for a conception of 'interfaces' and 'understanding' which rejects the objectivist connotations of 'function' and which embraces the idea of meaningfulness as the core of interactive engagement and links these to affordance, cognitive content and to contextualisation.

⁶⁰ The basis of the thinking which underpins these assumptions will not be directly addressed at this point, for two reasons. Firstly, the central aim is to clarify and examine the content and implications of the framework as it is presented and used, rather than the detailed philosophical rationale involved in undertaking the journey. Secondly, the philosophical issues are far from clear in the rationale for the journey, and are more readily discerned in the articulation of the key concepts that are selected as the key components of the framework. The philosophical issues that arise will therefore be addressed in retrospect. In addition, it may be the case that the broad thrust of the position embodies important conceptions which are not supported by the level of philosophical analysis deployed, but which invite a reconstructive approach.

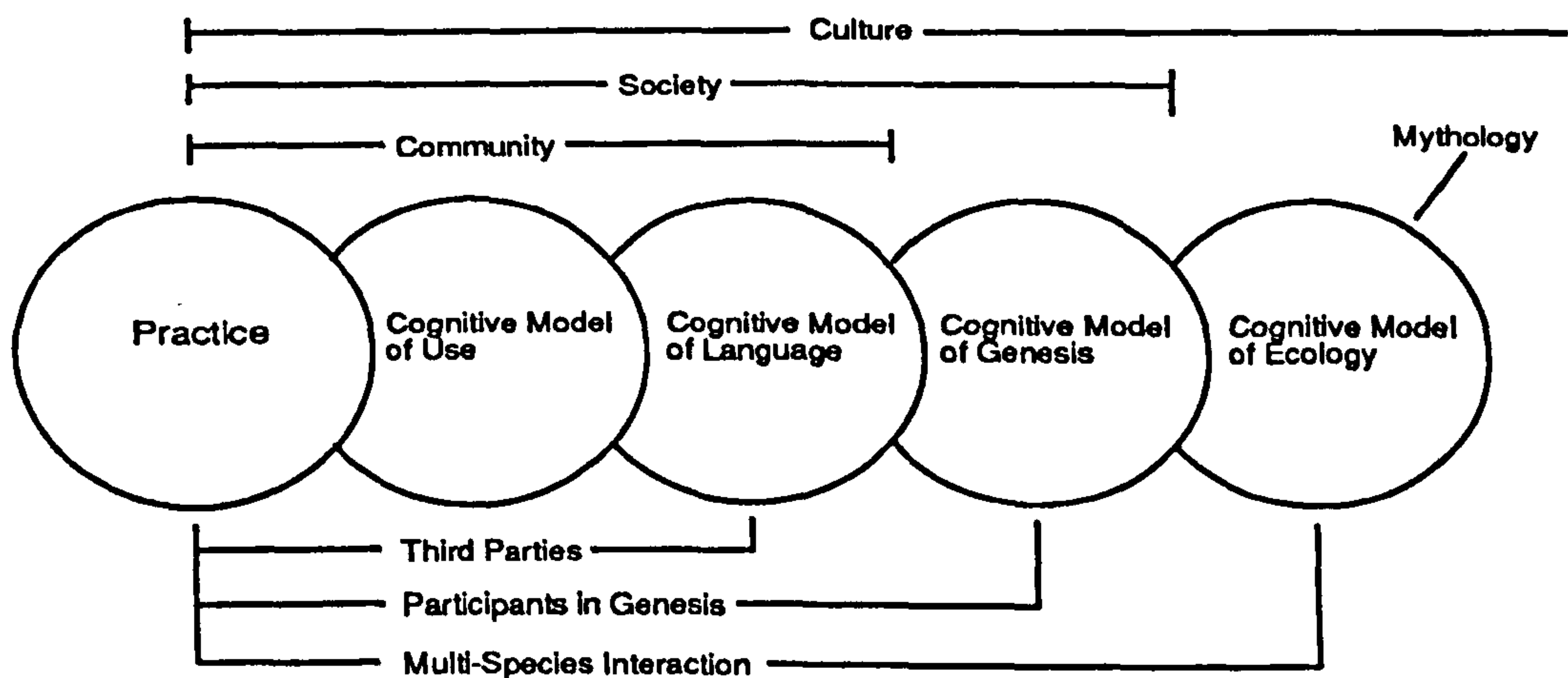
⁶¹ Krippendorff 1990, p a13.

⁶² Krippendorff 1990, p a13. This will be discussed in section 2.4 'Product Semantics and Meaning'.

⁶³ Krippendorff 1990, p a11.

Although in developing this simple nested contextual model, the primary drive has been the need to identify a structure for theory, derived from methodological desiderata, the background is visible in the idea that 'products need to survive existing practices', which are represented as occurring distinctly in the key domains that distinguish theoretical contexts.⁶⁴ In addition each of the domains is perceived to define a context for the relation between affordance, sense and meaning in the form of a 'circular enabling pattern of practice'. The neat match between the contexts of practice and the contexts for theory, which in principle need not coincide, is neat because they are both perceived to be driven by distinct cognitive models operating in each domain. The circular pattern of practice (user practice) associated with each domain is characterised by a cognitive model for that domain, and these are also the cognitive models that designers must grasp in ensuring that products can 'survive' in each domain.

The overall conception then is that characterising product interaction involves a nested or overlapping set of cognitive models, each associated with a contextually defined domain, which taken together constitute a framework for user understanding, and by derivation a theoretical framework for design. This is summarised graphically⁶⁵



⁶⁴ The hierarchical structure of domains is common to a number of independently derived product semantic accounts, although they vary in terms of the different ways in which domains are expressed. Vihma, for example derives an intersecting set of domains which include functional counterparts to Krippendorff's contextual set, in the context of a semiotic approach. [Vihma 1995, and see below pp 58-62]. Kutchinski-Schuster develops a model on the basis of Morris's conception of the divisions of semiotics [Morris 1971], which is structurally similar to Vihma's model. [Kutchinski-Schuster 1990]. Vakeva, defines an equivalent range of contexts in terms of a matrix which plots a 'culture/individual' dimension against 'arbitrary/contractual' relations. [Vakeva 1990]. Oehlke's nested hierarchy is categorially equivalent to Krippendorff's model, although a different terminology is applied to the domains. [Oehlke 1990].

⁶⁵ Krippendorff 1990, p a20 (adapted slightly).

2.3 Principal Theoretical Approaches in Product Semantics

Given this broad outline framework defined in terms of distinct but interacting domains which create contexts for meaning-making (circular enabling patterns of practice which encompass the relations between affordance, sense and meaning), how is the skeletal framework fleshed out ?

In an early and influential paper Product Semantics is defined as the study of the symbolic qualities of man-made forms in the cognitive and social contexts of their use and the application of the knowledge gained to objects of industrial design.⁶⁶ The exposition contains a number of formulations and distinctions which are preserved in the extended treatments which form the core of later characterisations of product semantics.⁶⁷ In the first place the object of study is identified as the symbolic qualities of man-made forms as manifest in two distinct contexts - the cognitive context of their use and the social context of their use. These contexts of use are separately identified in the definition and constitute separate but interconnected domains of theoretical speculation and empirical investigation in the later treatments.⁶⁸ In addition, the model presented envisages that the way in which the objects of industrial design will be informed in product semantics is through the application of the derived knowledge base.

The primary objects of study are the symbolic qualities of man-made forms. In the cognitive context of use, the nature of 'symbolic quality' is given shape by being broadly equated with 'the sense artefacts make to users'.⁶⁹ In this context product semantics is defined in contrast with ergonomics (which is presented as being committed to the technical rationality of product interactions in attaining system goals).⁷⁰

Product semantics is also defined as being concerned with the symbolic qualities of man-made forms in the context of their use, in the sense of studying how the products of design are symbolically embedded in the fabric of society and how they thus contribute to the generation, persistence and development of culture.⁷¹ The role of Product Semantics as a discipline or theoretical framework consists in providing a 'conceptual and linguistic

⁶⁶ Krippendorff and Butter 1984, pp 4-9.

⁶⁷ Particularly Krippendorff 1989, 1990; Athavankar 1990; Vihma 1995.

⁶⁸ Krippendorff's domains of psychological and socio-linguistic aspects of use.

⁶⁹ Krippendorff 1989 p10.

⁷⁰ Krippendorff 1989 p10

⁷¹ Krippendorff uses the term 'autopoiesis' (the process of self-production) to characterise the self-generating nature of culture. The term and its contrary 'allopoiesis' were coined in the context of biology to distinguish kinds of systems. [See Maturana and Varela, 1980]. Krippendorff notes the previous extension of the term to cultural and sociological contexts [Sagan and Margulis 1987; Touraine 1977]. [Krippendorff 1989 p10, note 3].

repertoire'⁷² for addressing these issues.

In a short introduction to his key expository paper, Krippendorff also derives a guiding epithet from the etymology of the word 'design' namely - 'Design is making sense (of things)'.⁷³ The ambiguity of the expression is accepted and taken as implying both that design is a sense creating activity, and that the products of design should be understandable or meaningful. The idea that the epithet might be taken to mean that design is concerned with the subjective meanings of objectively existing objects, is however explicitly rejected.⁷⁴ In addition it is asserted that the fact that something is recognised as a thing, is in itself a sense derived distinction, and on this basis that subjective/objective dualism is untenable.⁷⁵

Krippendorff argues that 'symbolic qualities' and 'sense-making', which are here equated with 'the meanings objects may have to different users', are not captured by the conceptions of traditional semiotics which rely on causal or referential theories. This assertion is based on a narrow reading of semiotics in which signification is equated with reference and summarily dismissed as only having application in the case of the use of overt signs in products, or the processing of information as part of the function of an artefact.⁷⁶ Vihma, by contrast, takes the view that although some interpretations of the semiotic programme are indeed restricted in this way, a more careful examination of the processes of signification suggest that they are capable of providing workable theoretical models that are applicable to products.⁷⁷

In either case the fundamental contention of product semantic theorists is that the key concept in a re-centred theoretical framework for design is 'meaning' - the meaning and significance of the product for all those involved with it. Such a choice of central concept, although clearly a natural one in this context, is also fraught with the philosophical difficulties that have accompanied attempts to explicate the concept of meaning itself. In particular one might point to the importance of concepts such as 'reference' and 'truth' in such attempts, and the difficulty in locating such concepts in the context of product

⁷² Krippendorff 1989, p10.

⁷³ Krippendorff 1989, p 9.

⁷⁴ The use of the parentheses is intended to preclude this interpretation. Compare 'Design is making sense of things', with 'Design is making sense (of things)'. Krippendorff 1989 p 9.

⁷⁵ The untenability of a subjective/objective dualism is not entailed by the fact that the recognition of something as a thing is sense-derived, although Krippendorff states this as though it were the case.

⁷⁶ Krippendorff 1989, pp 10-11. Krippendorff explicitly rejects three major forms of semiotic theory on these grounds - naive referential theory (denotative or objective referent theory); referential theory proper (relational denotative theory); physicalistic theory (behavioural theories). However the nature of reference in semiotics is not explored, and Krippendorff does on occasion conflate concepts, for example 'reference' and 'representation' in Krippendorff 1990, p a4.

⁷⁷ The application of semiotics to products is addressed below, pp 58-62, in relation to Vihma 1990,1995.

meaning. On the other hand the continuity of 'meaning' with 'significance', 'understanding' and 'language' is clearly attractive in a theoretical context in which the role of the designer is perceived to be primarily concerned with the problem of creating products which are communicative and responsive as interfaces, and significant in their participation in the socio-cultural arena.

Leaving aside for the moment the problems that arise if the concept of meaning is explicated in relation to 'truth' and 'reference' (the dominant thrust in recent philosophy), the program for product semantic theorists has largely consisted in making systematic sense of 'meaning' in terms of both the idea of a 'language' of products and design processes and the nature of users' understanding. In one sense the two principle theoretical thrusts in product semantics represents a choice made between these two major elements as prime movers in the development of theory - one approach leaning heavily on the framework of semiotics and linguistic analysis in the development of an analogy for meaning and significance in products - the other relying on recent developments in cognitive theory to advance models of meaning in relation to user understanding.⁷⁸

Neither approach has been fully developed to date, but both appear to offer prospects for their systematic development as more comprehensive theories for product design. On the one hand semiotic and linguistic approaches offer a framework in which an analysis of products as elements of material culture, and the associated transactions of the various parties involved (consumers, designers, manufacturers etc) might be assimilated into a programme for the systematic explication of language and communication, through the concept of the 'sign' both logically and sociologically. On the other hand, cognitive theory offers a framework based on the development of a general understanding of the way in which objects are perceived and understood as part of the overall structure of human cognition and action.

The emphasis in the semiotic/linguistic framework is necessarily on the continuity of products with cultural significance and exchange more generally. The upshot of this emphasis is that the theoretical stance inclines more to the development of contextual and critical models rather than the synthetic or formally descriptive. In the case of products, this means that indirect communication is more susceptible to analysis than direct communication.⁷⁹ In addition the overall theoretical framework, although systematic, appears to be difficult to apply at the level of resolution and with the degree of formality that might be demanded by an application in the context of product design practice. At levels of high generality, the theoretical framework does offer insights into the nature of

⁷⁸ Essentially Vihma's approach in contrast to the approach taken by Krippendorf and Athavankar.

⁷⁹ Barthes analysis of the 'Fashion System', provides a good example of this [Barthes 1985].

product significance which can form the basis for strategy, but at the next available level of analysis the problems that arise if the language analogy is pursued in the case of products, render the available methodologies impotent.⁸⁰

Some would argue that the difficulties that arise are symptoms of a fundamental flaw in the semiotic program itself - that in spite of the underlying attempt to draw all forms of signification into a single scheme, the result is in fact a theoretical stance and forms of analysis that are only applicable in the case of 'true' languages where the critical relation is one which ultimately involves the concept of 'reference'.⁸¹ Krippendorff notes that:-

'...the meanings objects may have to different users easily escape traditional semiotic conceptions insofar as they locate meanings either in the objective referents of signs (naive referential theory), in the imputed relation between signs and what they are intended to stand for or represent (referential theory proper), or in the somewhat more objectively describable form, nature, or features of sign vehicles (physicalist theory)'.⁸²

and Vakeva argues that the aims of product semantics are closer to pragmatics than semantics in the sub-divisions of semiotics proposed by Morris.⁸³

Although in terms of the major systematisations that have evolved, this is probably true, there are sufficient residual indications in the literature to suggest that aspects of the semiotic program could usefully be developed in the characterisation of products.⁸⁴ Other writers argue that product semantic approaches are compatible with semiotics, in so far as the discipline regards all objects from the point of view of significance. The principal difficulty in applying semiotics in the context of products lies in the strong ties in the theoretical literature between semiotics and linguistics.⁸⁵ The particular system of semiotic analysis chosen may have a profound bearing on the degree of its applicability in the case of products, and generally speaking systems which employ 'triadic' and 'quadratic' forms for representing meaning relations have been favoured in the product semantics literature.⁸⁶ Vihma, for example employs the triadic notation developed by Eco, whilst Vakeva favours the system developed by Greimas.⁸⁷

⁸⁰ The problem is parallel to the problem of underdetermination in respect of the perceived logical parity of explanation and prediction. The relationship between analysis and synthesis is similar, in that synthesis will always be underdetermining with respect to analysis (which is post hoc).

⁸¹ Vakeva 1990.

⁸² Krippendorff 1989.

⁸³ Vakeva 1990.

⁸⁴ Vihma 1990, 1995.

⁸⁵ Vihma 1990.

⁸⁶ The different forms of semiotic theory and their application have been analysed in a product semantic context by Vakeva [Vakeva1990].

⁸⁷ Vihma 1990; Vakeva 1990; Eco 1976; Greimas and Courtes 1982.

The approaches to product semantics based on cognitive learning theory, appear at first sight to be more promising in that they avoid the problem of reference, addressing the issues of signification via the more general communication models based on strategies used in human information processing.⁸⁸ They offer a model for the processes of recognition and categorisation in the case of products which have a continuity with the more general recent development of our understanding of cognitive processes, and which interface more readily with the intuitive models used by designers, and with the methods used in market research.⁸⁹ Although this is the case, the models developed so far are of limited scope (tending to deal primarily with categorisation on the basis of perceptual features) and applied within a limited domain (generally the immediate point of contact between the user/subject and the product).

The most developed general model is provided by Athavankar, which is derived from recent research in human cognition, particularly in relation to the processes of categorisation. In contrast to classical notions of categorisation employing 'hard edged' categories where inclusion is determined in relation to sets of necessary and sufficient conditions, Athavankar develops a Wittgensteinian model derived in detail primarily from the work of Rosch.⁹⁰ The model, which draws on the notion of 'family resemblance' and emphasises the key role of the central member of a category, provides an account of the mechanism of category shifts and boundary changes which parallels the intuitive and historical sense of product change perceived by designers, and which is difficult to explain in classical terms.⁹¹

The basic model is developed into a more comprehensive semantic account, by noting that a product will potentially be a member of many different categories. These will include a wide variety of levels of abstraction and category types. A 'trainer' for example, will fall into the categories of 'shoes', 'sports equipment', 'fashion accessories', and associative categories such as 'youthfulness'. The totality of categories and contexts in which the product operates, constitutes a compound statement which characterises the nature and significance of that product.⁹² Although the particular form in which the argument is developed lends itself to a conception of linked groups of nested fuzzy sets, which are also employed in semantic analysis, the connection with semiotics and linguistic analysis is more evident if the treatment is interpreted in terms of the more familiar dendritic structures and vector analysis of semantic space.⁹³ The approach and form of analysis

⁸⁸ Athavankar 1989, Oehlke 1990.

⁸⁹ Hasdogan 1993, Lawrie 1989.

⁹⁰ Athavankar 1989; Rosch 1978; Lakoff 1987.

⁹¹ See Section 5 'Categorisation and Cognition'.

⁹² Athavankar 1990.

⁹³ See for example McCormac 1985; Baldinger 1980; Kittay 1987.

provided is also notable for its structural and conceptual similarity to the methods used in product and consumer profiling in market research. The forms of analysis used in this field are reviewed by Lawrie, who also offers a representational model similarly based on the use of associative categories in defining consumer style and preference.⁹⁴

Models based on cognitive learning theory appear to offer the prospect of formalisation in a form that would make them susceptible to computer based manipulation and application. The nature of models developed to date underpin applications primarily geared to descriptive and taxonomic purposes, rather than to analytic and critical purposes, although these are not excluded in principle. Their potential ability to support the synthetic aspects of the design process are apparent, but at present only at a very general level.

Although the principal approaches taken in the theoretical development of product semantics are distinct, they are implicitly parts of an overall program the structure of which has been outlined by Krippendorff,⁹⁵ even though they remain formally unintegrated. To a large extent the two approaches operate at different levels vis a vis the program of characterising products. To oversimplify the point, cognitive theory operates primarily at the level which extends from perceptual encounter to the creation, naming and use of concepts and categories. Semiotic/linguistic theory operates primarily at a level where names and concepts are primitives, and where the aim is to explicate the processes of cultural communication in which they participate. The approaches overlap at the level of categories and names.

The two approaches also offer distinct formalisations which lend themselves to different functions within an overall theoretical framework. The application of cognitive theories to product design has so far tended to result in the development of effective descriptive and taxonomic models, but with limited analytical and critical capability. This is largely the case because the applications have been based on the categorisation of unanalysed wholes (relative identity of whole products within a class, rather than in terms of features).⁹⁶ The form of semiotic theories, on the other hand, lend themselves to the analysis and critical consideration of particular instances, rather than generalisation across types. The thrust of such theories has been in the elaboration of sub-structure, the roles of parts in wholes in the processes of signification.⁹⁷

⁹⁴ Lawrie 1989

⁹⁵ Krippendorff 1989, 1990 and see below, Section 2.4 'Product Semantics and Meaning'

⁹⁶ Although this is partly a pragmatic matter, it may also be indicative of an in principle limitation resulting from the orientation of the theoretical model itself. Nevertheless, it does seem clear that workable formalisations are available, which are susceptible to computer based applications (fuzzy set theoretical).

⁹⁷ Although this is the case, little work has been carried out on the 'parsing' of products or other elements of material culture, outside the realm of literary criticism, advertising and to a far lesser extent architecture.

The two approaches also operate largely across distinct contexts or domains. Cognitive theories assume that the underlying processes represented in the individuals under study are ultimately generalisable across the human population, even if their particular manifestations are culturally informed or determined. Such theory deals with processes operating in the domain of individual cognition. Semiotic theory on the other hand, makes assumptions about the structure of signification and communication and the nature of language across populations, even if their particular manifestations are informed or determined by individual personal histories, and thus operates in the social domain. Clearly the concern of each extends to the domain of the other, and one could argue that the critical locus for product design decision making is at the point of intersection, where cognition meets context, and this is indeed the stance taken in product semantics.

The point of intersection is identified with the concept of 'meaning', expressed in terms of signification, where this is interpreted as a form of contextual location which can be characterised in both semiotic and cognitive terms. The distinctive additional feature of product semantic accounts is the emphasis placed on the experiential nature of contextualisation, which is generally expressed in terms of the idea that meaning relations are operational and established in the context of action or engagement. This quality of direct interactive engagement is pursued in terms of the relational (or ecological) concept of 'affordance'.

In order to complete the process of stagesetting prior to the analysis of the individual conceptual components of the framework, some further consideration will first be given to two approaches to the characterisation of 'meaning', which stem respectively from a contextual cognitive account, and a semiotically driven account.

2.4 Product Semantics and Meaning

Cognitive/Contextual Approach

Given the stated concern with the symbolic qualities of man-made forms in a cultural context, and the explicit rejection of semiotic accounts which rely on the centrality of the concept of reference, Krippendorff instead presents a contextual account of meaning.

The basis of the account is that objects are always seen in the context of other things situations and people, and the kinds of response that we can make relative to objects, places them in kinds of context. Such contexts (purposive, social or linguistic for example) are not given, but cognitively constructed, whether they are remembered, recognised, anticipated or imagined. Meaning is a cognitively constructed relationship which selectively connects features of an object and features of its context into a coherent unity. The basis of such relationships is non-causal, but various and including - '...similarities, contrasts, family belongingness, associations, synchronicities, harmonies or social conventions..' and in some cases functional relations.⁹⁸

The idea of the meaning of an object is equated with identity, and relativised to the totality of contexts cognitively available to an individual :

'What something is (the totality of what it means) to someone corresponds to the sum total of its imaginable contexts.'⁹⁹

and

'...the meaning of something is the sum total of all the contexts within which someone is capable of imagining some sense for it.'¹⁰⁰

In this initial stage in the account of meaning, some important aspects of a definition of meaning are established :- a) Meaning is cognitively constructed. b) It consists in relationships that are established between an item and its contexts. c) The content of these relationships consists in the connection made between selected features of an object and selected features of a context. d) Meaning is achieved in the coherence and unity established in the connections made. e) The meaning of something comprises the totality of such contexts and constitutes its identity.

⁹⁸ Krippendorff 1989, pp 12-13. Although Krippendorff does not exclude the use of functional relations as the basis for some people's meaning relations, it is clear from the passage that these are primarily equated with the perspective of, for example, engineers and ergonomists and that his conception of the function relation is that it is essentially physical and objectivist in nature. The analysis to be presented in due course concludes that such an interpretation is unwarranted.[See Section 3 'Function'].

⁹⁹ Krippendorff 1989, p 13.

¹⁰⁰ Krippendorff 1990, p a12.

Although further aspects of the account are yet to be developed, a number of questions can usefully be raised at this stage. In the first place, there is an apparent drift in the account between an individually centred concept of meaning and an objective conception, in spite of the earlier explicit rejection of a subjective/objective distinction. It is ultimately unclear as to whether it is individual meanings or components of meaning that are made and cumulated to form a definitive meaning, and whether the cumulated definition is the property of an individual or a collective. Problems arise on either interpretation.

Let us accept for the moment that an important part of our coming to understand something consists in an individual constructive cognitive activity, whose nature is one of fitting objects to contexts. The fact that an individual is able to find some fit for an object in some unspecified context, does not in itself appear to accord with a general sense of 'meaning'. I might for example find a coherence between an object and a context in terms of its height and colour - the height and colour of the object is congruent with that of a real or imagined context - but does this in itself constitute a meaning. I would conclude that although such congruence might be significant, in the sense that it could turn out to be consequential relative to say, establishing the role of the object in the context, this is not necessarily the case and therefore fittingness does not in itself constitute a 'meaning' nor does it constitute significance. It might simply be the case that the object happens to fit the context in respect of these selected features, and nothing of particular consequence follows. In other words, fittingness to context is not a sufficient condition for meaning.

On the other hand, from the fact that this is the case one cannot infer that fittingness is not meaningful. I might well derive considerable satisfaction from fittingness in itself, and in such circumstances it might be natural to describe a given case of fittingness as being 'meaningful for me'. There is in fact considerable complexity in the distinct ways in which we use related terms such as 'meaning', 'meaningful' and 'meaningless' in language, and a limit in the extent to which they can be transposed from one form to another, without a change in sense.¹⁰¹

The second set of problems are connected with the definitive form of meaning - 'the meaning' - which is equated with the totality of imaginable contexts in which congruence or fittingness can be cognitively realised. In the first place it is not clear from the definitions given as to whether meaning constituted in this way is an individual matter, or the cumulative cognitive experience of some collective. The latter interpretation might be a way of acknowledging the public and shared sense of 'meaning', which might perhaps parallel the idea of agreed meaning as in the case of dictionary definition, for example.

¹⁰¹ This is discussed in Section 7 'Meaning and Semiotics'. Similar observations can be made in respect of the related group of terms which includes 'significance', 'significant', 'signifying' and 'sign'.

However it is difficult to square this interpretation with the rejection of the idea of 'objective' meanings, although clearly the success of communication and mutual understanding must somehow be underpinned in the case of objects, as with natural language. On an alternative interpretation, 'the meaning' is definitive for the individual rather than the collective, consisting in the full range of experiences of cognitive congruence that can be mustered by that individual in respect of a given object.

On either interpretation a problem arises relating to the scope of 'meaning'. Given that there are no upper or lower limits on the number of contexts constituting a meaning, it does not seem possible to establish conditions for the adequacy of meaning generally. Just how much of this totality of experience needs to be brought to bear in a given case of understanding, and is there some lower limit constituting the minimum conditions for establishing meaning? The more problematic aspect of scope however, is the lack of any qualitative criteria. The fact that no constraint is placed on the acceptability or rationality of congruence in contexts leads to the conclusion that meaning is not defeasible - it is in principle not subject to error. On one interpretation, this conclusion might be acceptable. If the imaginable contexts that I summon up are unsystematic and extremely bizarre, then we might wish to conclude that these contexts do indeed constitute the meaning that I construct, and a very odd meaning is exactly what you would expect from a madman. But the very sense of oddness of meaning in such a case is a relative one, and the underlying idea of meaning that it employs, normative.

An interpretation along these lines does then appear to run counter to the general sense of the nature and operation of meaning, in which it is possible to be mistaken about the meaning of something. This is clear in the case of linguistic meaning and also in the case of sign systems generally. Meaning operates within such contexts, partly in order to articulate distinctions, to bracket off some aspects of experience so that they can subsist as subjects, and the distinctions constitute differences that can be the subject of error. In the case of objects and non-linguistic contexts generally, the position is far less clear, but in so far as meaning and identity are equated, as they are in some of Krippendorff's definitions, similar problems arise. Confronted with an object and the problem of determining what the thing is, we are inevitably led to making distinctions, which are possible subjects of error, or facing the prospect of experience without structure, identities or even things. If identity is equated with totality of meaning, then it suffers the same fate, and although the composite meanings comprising that totality could in principle still articulate defeasible differences, this becomes a somewhat frail capacity if defeasible difference is lost when they are brought together.

The problem here is that in seeking to sustain a number of acceptable conceptions that we might wish to assert in respect of the nature of meaning, their joint expression in the form of definitions fails to sustain important distinctions in sense and usage and liberalises the concept to such an extent that it has no force. A general sense of the problem can be gained by an informal consideration of some of the ways in which we use meaning and identity statements - for example in the fact that one can contrast identity and meaning in expressions such as 'the radio is my constant companion and friend', 'the telephone is my lifeline'. This seems to me to capture a commonplace of language and experience, which accepts normative conceptions of objects and symbols, but does not thereby deny that our experience of them is more dense or replete than the normative conception. However, deriving identity from, or relativising it to, some unconstrained concatenation of cognitive experiences of congruence leaves it without foundation. This is the case because it contains no essential continuity in the constitution of identity from one occasion to another. Similar considerations apply in the case of the contrast between what something 'means' and what it 'means to me'. These are I think important locutions that mark off 'objective' and 'subjective' senses of meaning, which are conflated generally in product semantic accounts of meaning.¹⁰² Although there are apparent problems with the characterisation of meaning at the point of 'stagesetting', it may be that these will prove to be resolved as the account progresses.

Krippendorff's account is next developed through a consideration of the process by which meanings are constructed. The characteristics of such 'sense-making' processes are that they are cognitive and cyclical and continue until they result in understanding.

'Making sense is a circular cognitive process that may start with some initially incomprehensible sensation, which then proceeds to imagining hypothetical contexts for it and goes round a hermeneutic circle during which features are distinguished - in both contexts and what is to be made sense of - and meanings are constructed until this process has converged to a sufficiently coherent understanding'.¹⁰³

The idea here parallels the more cognitively centred versions of constructive theories of perception, extending the hypothesis/testing process involved in sensation leading to recognition, to encompass meaning and understanding. In addition it is clear from the account that understanding is conceived as relative - the process continues until 'sufficient understanding' is achieved (presumably relative to the context of the encounter).

¹⁰² The intention here is not to assert a subjective/objective dualism of the kind that Krippendorff rejects, and the term 'intersubjective' might therefore be substituted for objective. The disadvantage of the substitution would be that it appears to give credence to the notion and priority of 'private meanings' which are established and then shared. In general I would concur with Wittgenstein's arguments against the possibility of a 'private language' and their implications. [Wittgenstein 1972; Kripke 1982].

¹⁰³ Krippendorff 1989, p 13.

There are a number of problems with this account of the process. In the first place it does not appear to square with Krippendorff's own observations regarding the nature of perception, in the sense that :-

*'...people do not perceive pure forms, unrelated objects, or things as such but as meanings. The distinction between what an object is and what that object means to somebody may not be demonstrable as far as perceptual data are concerned.'*¹⁰⁴

which on the face of it suggests an approach which lies closer to 'direct' theories of perception.¹⁰⁵ Given the fact that we perceive things as meanings, and in the context that identity and meaning may be indistinguishable at the level of perceptual data, it could be argued that the interpretation given of the 'sense-making' process amounts to a speculative account of an unconscious or computational process at a sub-personal level.¹⁰⁶ Much of the problem of giving determinate sense to the account rests on the ambiguity or multivalence of the concept of 'context'.¹⁰⁷ The interpretation of 'context' is developed by Krippendorff in subsequent sections, and amounts to the identification of four broad contextual categories - the context of use or operational context, the socio-linguistic context, the context of genesis, and the ecological context - which are elaborated informally but in some detail.¹⁰⁸

A theoretical framework is proposed which is based on an embedded set of four design theories, matching the contexts for meaning, and which represent categorially the basic kinds of contexts in which artefacts '...should not break down and need to survive existing practices'.¹⁰⁹ Each of these depends on the relationship between meaning, sense and affordance in the form of the cognitive cycle of sense-making which is also described as the '...circular enabling pattern of practice.'¹¹⁰ The four essential contexts for artefacts are identified with the context of 'use' where the emphasis is on psychological design theory, the context of 'language' which is supported by socio-linguistic design theory, the context of 'genesis' which is informed by techno-economic design theory, and the context of 'ecology' which requires design theories dealing with the interaction among species of artefacts.¹¹¹ Each of these contexts may require distinct but related theories of meaning, or expressions of meaning relations, which are intimately connected to the forms of design theory that predominate in a given context.

¹⁰⁴ Krippendorff 1989, p 12.(Italics his). Krippendorff refers specifically to the work of Neisser in relation to the ways in which respondents react to and characterise their understanding of objects [Neisser 1976].

¹⁰⁵ Gibson's theory of affordances, for example [Gibson 1979,1982].

¹⁰⁶ Perhaps of the form of Marr's computational approach to visual perception [Marr 1982].

¹⁰⁷ To this point in the account this is not analysed.

¹⁰⁸ Krippendorff 1989, pp 16-37.

¹⁰⁹ Krippendorff 1990, p a13

¹¹⁰ Krippendorff 1990, p a13.

¹¹¹ Krippendorff 1990, p a11

The Context of Use

The theoretical burden in the context of use is primarily defined by the need to deal with the practical problem-solving aspects of our encounters with artefacts. Product semantics generalises its aims in this context in terms of the need for 'product legibility', 'semantic accommodation' and 'self-instruction'.¹¹² The essential theoretical questions that are perceived to arise are articulated in terms of the capacities and strategies of users, rather than the properties of products, and relate to :- a) the nature of users' cognitive models and operational logic, b) the strategies users employ in exploring the world and extending understanding, c) the nature of human motivation. It is argued that a theoretical understanding of these factors is required in framing adequate design theories in the context of use.

In relation to establishing the nature of users' cognitive models, it is suggested that this can be approached via a) the processes of categorisation and recognition,¹¹³ b) the distinction between deep structures and actual manifestations¹¹⁴ c) affordance analysis based on protocols, transcripts etc,¹¹⁵ d) analysis of the conditions and efficacy of 'feedback'. In relation to understanding user strategies for exploring the world, a) dynamic cognitive models, and b) theories of metaphor and metonymy, are suggested.¹¹⁶ In relation to the nature of motivation, a) motivational studies not limited to instrumentality, and b) based on the distinction between 'intrinsic' and 'extrinsic' motivation.¹¹⁷

The context of language

It is argued that artefacts are '...constituted in language, participate in interpersonal relationships through language, become built into social realities by language'.¹¹⁸ The

¹¹²Norman 1988; Dorsa et al 1989. The three principles are derived from models of action cycles for interactive systems of the type developed by Norman [Norman 1986] which are articulated in terms of goals, and execution and evaluation phases, and assume a rational planning model of human action. These are ultimately expressed in terms of the interaction between three models - the 'design model', the 'system image' and the 'user model' [Norman 1983]. The three principles can be interpreted as properties or attributes of the system image. Differences in approach in unpacking the model methodologically in a design context turn on the question of how the constitution of the system image is established, and how it informs or interacts with the design model. Krippendorff works primarily with the idea that one can generalise across cognitive strategies and infer a system image from a user model to underwrite the design model [Krippendorff 1990]. Athavankar approaches the question in terms of the categorial structure that users deploy in partitioning the system image space [Athavankar 1989], whilst Vihma addresses it from the perspective of the semantic constitution of particular system images from the resources available to the user from the system image space [Vihma 1995].

¹¹³Athavankar 1989, 1990.

¹¹⁴Krippendorff 1990, pp a13-14

¹¹⁵Krippendorff 1989,1990.

¹¹⁶McCoy 1990; Lannoch and Lannoch 1989; Krippendorff 1989

¹¹⁷Rheinfrank 1984; Krippendorff 1989 pp 21-22.

¹¹⁸Krippendorff 1990, p a15.

interactions between agents in the design process also involves a variety of 'languages' or forms of communication, which need to be effective. Linguistic structures are taken as evidence of the existence of deep structures relating to the understanding of artefacts generally. Language is involved in '... negotiating the emotional, social and political meanings of products, and the practices afforded by them.'¹¹⁹ The essential theoretical questions that are perceived to arise relate to a) the interactions through which products become part of the larger system of objects, b) the interactions through which objects participate in communication.

In relation to establishing the ways in which products become part of the larger system of objects and participate in communication, it is suggested that this can be approached by a) socio-linguistic theories relating to cybernetic epistemology,¹²⁰ b) socio-linguistic accounts of the ways languages are used in the design process,¹²¹ c) structural linguistic theories defining the conceptual relation between language structure, conceptualisation and action,¹²² d) socio-linguistic theories dealing with the role of products and practices in the expression of individual identity, social integration and social differentiation.¹²³

The context of genesis

This context is primarily concerned with the semantic component of the complex network of the production and consumption of artefacts, and the role of the designer and other agents in that network. The semantic element consists primarily of the forms of communication that support or afford the succession of transformations in the network.¹²⁴ The theoretical needs in this context relate to a) a communication theory that can adequately describe and account for the dynamics of the network, in semantic terms.¹²⁵

The design approach advanced implies a) attributing the possibility of understanding, creation and responsibility to all agents in the network b) conceiving of products as

¹¹⁹ Krippendorff 1990, p a16.

¹²⁰ Krippendorff 1990, p a15-16. Cybernetic epistemology is used here to capture the idea that language is constitutive of social reality as part of a dynamic interactive system at the social level.

¹²¹ Krippendorff 1990, p a16-17.

¹²² The account given is in terms of a particular theoretical position, in which language structure (for example, subject-verb-object constructions, noun-adjective constructions) serve as natural models for the ordering of semantic and intentional concepts, in the context of the perception of, and interaction with, artefacts. Examples of these in a product semantics context include Butter's method for translating semantic attributes into visual characteristics [Butter 1989], and Lannoch's proposal for a method of 'semantic transfer' which locates a product within a semantic space [Lannoch 1989].

¹²³ No indication is given of how this might be achieved, although it is clear from the general context that we are in the realm of social-psychology, material culture studies and ethnographic analysis.

¹²⁴ Krippendorff 1990, p a16

¹²⁵ Since the context takes in the whole cycle of planning, production, dissemination, consumption, use and retirement, the theoretical commitment will cross a number of discipline boundaries, taking the form possibly of a socio-psychological semantic theory rooted in material culture studies.

semantic 'carriers' in a recursive process.

The ecological context.

This context is essentially concerned with the way in which artefacts constitute an interactive world of their own, within the wider world. The account is based on the extension of the concepts of ecology to artefacts, considered as individuals and species. The theoretical need here is primarily for a) a theory that will account for the complex interactions occurring between large populations of species in interaction.¹²⁶ In addition, the distinction is made between ecologies with and without artefacts, which is articulated in terms of 'meaning'. This implies the need for b) a theoretical account of the semantic structure of artefacts in context.¹²⁷ The self-referential nature of this context implies that such theories are, or would need to be supported by c) theories of designers' cognition and practice.

In addition Krippendorff identifies higher level constructs which give coherence to and shape large cultural ecologies, which are collectively grouped under the heading of mythology. Artefacts symbolically mediate between these relatively stable higher level constructs and the rapidly changing socio-economic contexts of everyday life. The interaction and scope of the four embedded sets of theoretical contexts are summarised by Krippendorff in the form of a diagram,¹²⁸ which expresses these as processes in an 'ecology of the designers mind'. They are thus conceived as a linked and interactive set of cognitive models which bear on practice and which are informed by the higher level constructs that constitute mythology.¹²⁹

To what extent do the contexts and their characteristics identified by Krippendorff clarify and disambiguate the idea of meaning, and what role does 'meaning' play in the overall theoretical framework. In the first place it is clear that meaning in each context is equated with a parallel constructive cognitive process engaged in by individuals. The terms of this process are most clearly established in relation to the context of use, and the mechanisms that they consist in are common to the other contexts. The differences

¹²⁶ Krippendorff 1989, pp 34-37. Krippendorff adverts to previous work which takes the ecological approach to the characterisation of culture in developing his description [Boulding 1978; Bateson 1958,1972]. Thompson adopts a parallel approach which addresses the issue from the perspective of value [Thompson, 1979].

¹²⁷ Conceived here as the symbolic qualities that we attribute to objects relative to each other. It is noted that since meanings constitute the fundamental principle of an artefactual ecology, designers understanding is a part of the ecology that it creates and describes. Ecological design theories are parts of the ecology described. In this sense design theories in this context are theories of the designers mind and practice.

¹²⁸ See above p 39.

¹²⁹ No cognitive model is proposed for the sphere of practice, or for the realm of higher level constructs. Presumably the former is conceived to be constituted in terms of the remaining cognitive models, whilst the latter which are described as being to some extent unconscious (in a quasi Jungian sense) will escape cognitive characterisation.

between contexts are then largely to be found in differences in the kinds of background relevant to the particularisation of cognitive models for that context.

The context of use provides the key to the proposed nature of the cognitive processes involved. The essence of the process consists in the drawing of distinctions, and the testing of hypotheses implied by the distinctions drawn. The distinctions are made in terms of a limited set of variables or semantic dimensions namely :- identities; qualities; orientations; locations; affordances; states, dispositions and logic; motivations; redundancies.¹³⁰ The thrust of the characterisation of semantic dimensions is that they constitute the cognitive aspect of our individual engagement with products, typically expressed in terms of centred or displaced relations rather than as formal expressions in an abstract calculus.¹³¹ The construction of meaning in terms of semantic dimensions operates via two principle processes - categorisation and association. The fundamental process consists in establishing a type-identity through categorisation, and qualitative particularisation through associative mechanisms such as metaphor and metonymy.

If the pattern of meaning-making is set in the context of use, it will nonetheless be clear from the above that cognitive operations in that context are unlikely to be confined to strictly operational interactions. The role of naming and the nature of category articulation, for example, suggest strongly that the cognitive content involved in categorisation at an operational level will be affected or shaped by the constraints of the socio-linguistic context. Although Krippendorff in this account treats the four contexts separately, it should be borne in mind that they are regarded as a nested set, and are explicitly presented as such in other papers.¹³²

The presentation of contexts is programmatic, thematic, complex and informal and does not therefore lend itself readily to a systematic unpacking of meaning relations. However it is possible to approach these through an analysis of the key relata, and the terms of their relations.

¹³⁰ Krippendorff 1989, pp16-17. The term 'semantic dimensions' for the variables was coined by Lannoch. Lannoch 1984, 1990.

¹³¹ For example, spatial orientations and locations are expressed in terms of local relations such as 'front', 'back', 'on top of', 'above', 'below' etc, rather than in terms of metrics relative to some fixed frame of reference. The linguistic expression of these relations is taken to represent semantic space, experientially [Lannoch and Lannoch 1989].

¹³² See above p 38. Krippendorff goes as far as to assert that each of the contexts may require a distinct theory of meaning. Krippendorff 1989, p15. In his later presentation of the framework the nestedness of the contexts is made explicit both in the text and in an accompanying diagram. Krippendorff 1990.

In the context of use the relata are a person and a product (thing):-

Person / Relation /Thing

In the context of language:-

Person / 'Thing'¹³³ /Person

In the context of genesis:-

Person / Thing/ 'Thing' /Person

In the context of ecology:-

Thing / Relation /Thing

In the context of use the relation is essentially between a person and some thing in the world, and consists in a cognitive process primarily involving categorisation and association, structured in terms of a number of identified semantic dimensions. In the context of language (socio-linguistic context) the relation is between persons, with products (things) figuring as part of the cognitive cycle operating in establishing meanings in that context, in the form of expressions in language. In the context of genesis the relation is again between persons, but in this case it is the physical object and representations of it that figure primarily in the cyclical cognitive process constituting the relation. In the context of ecology both relata are things, but given that the context is again one of meaning-making the relation is constituted in persons construing the juxtaposition between things as being of certain kinds.

Given that the contexts are presented as nested sets, it should perhaps first be noted that unpacking the nested structure as a simple hierarchy will not square with the detailed account, unless certain assumptions are made about the independence of the cognitive cycle from any given context. This is the case because the terms of engagement in any given context cannot operate without drawing in the meaning models from other contexts. In the case of the context of use, for example, the account clearly (and rightly) points to the central role of names and naming relations in the cognitive operation involving the semantic dimension 'identities'. Similarly, although in the context of genesis the physical thing is the primary focus in the transactions involved between people, the transactions are conducted in terms of languages. But whilst in the first case one might draw the conclusion that the operational context always operates within a socio-linguistic context and inherits the characteristics of that higher order context, this cannot be inferred in respect of the latter, since the socio-linguistic context is embedded in the context of

¹³³ The use of quotation marks here is to indicate the idea of a substitute or sign for a thing rather than the thing itself (trading on the conventional use of quotation marks in the use/mention distinction).

genesis. The account implies that the interrelation between contexts is in practice multivalent and bi-directional.

Nevertheless there is an underlying sense in the account that perhaps mirrors the hierarchical structure in broad terms if not in detail. It could be argued that given that the most basic sense of meaning-making identified is contextual fit, then the most inclusive category of meaning-making consists in construing relations between things.¹³⁴ The next most inclusive category consists in active transactions involving things - action in relation to things. The next most inclusive category consists in active transactions involving symbols, and the innermost category involving individual interactions with things which depend on the inheritance of the characteristics of the series of sets within which it is hierarchically embedded.

There are two reasons for supposing that although the structure is broadly perceived in these terms, formally interpreting the hierarchy in this way will not work in detail. The first reason is the directness of the relation imputed to the central concept of 'affordance', which links the least inclusive and the most inclusive of the categories.¹³⁵ The second is the stated methodological commitment at a philosophical level to bottom-up theories of perception and cognition, which would imply an inverted hierarchy.¹³⁶

The remaining question is whether there is a general cognitive model of meaning-making that stands aside from any of the given categories, and is common to them all, but whose actual content would vary from category to category. The principle reason for doubting this interpretation is that in some cases the distinction between categories is made in terms of differences in the kinds of relation operating within them. For example, the basic relation held to be operating within the context of use is identified as a means-end relation and contrasted directly with the metonymic relation underpinning the socio-linguistic context.¹³⁷ However, the force of this observation in respect of the interpretation is unclear, since although intended in the account to demarcate contexts, it is not necessarily the case that there is a perspicuous equivalence between kinds of meaning-making and forms of reasoning. It is assumed for the present therefore that the interpretation most in keeping with the spirit of the account is adopted, which amounts to the assertion that there are parallel cognitive models having the same general form for each distinct context, whose content (defined by the context) gives rise to their particular forms.

¹³⁴ Including discriminating things as things.

¹³⁵ The concept and role of 'affordance' is discussed in section 4 'Affordance'.

¹³⁶ In this context Krippendorff adverts to the work of Neisser in support of bottom-up theories of perception and cognition [Neisser 1976], but it should be noted that Neisser's model is based on the interaction of both 'bottom-up' and 'top-down' theories in an integrated framework.

¹³⁷ Krippendorff 1989, p 24.

The meaning model presented in Krippendorff's accounts includes a number of general features which are characteristic of meaning models which have been developed more generally in the context of both philosophical and psychological semantics. In the first place, the scheme is generically 'ideational' rather than 'referential' - it seeks an account of meaning in terms of constructive cognitive operations, rather than in referential relations between signs and things.¹³⁸ In so far as it construes the nature of such operations, it does so in terms of the progressive refinement of mental representations, and therefore assumes the existence of mental contents or representations, and their individuation. It is therefore (in the general terminology applied) an 'intention-based' semantic scheme. However, the nature of the intentionality assumed is not necessarily equivalent to the intentionality ascribed by some theories to natural languages, although natural language analogies are used to articulate the scheme. This distinctness of sense is further brought out in the parallel drawn between meaning and use, which characterises the approaches of some logical positivists and the later Wittgenstein to meaning.¹³⁹ The account eschews those approaches to meaning which objectivise meaning as a relation between the terms of some language and the world, or a model, or a metalinguistic denotation.¹⁴⁰

Semiotic Approach

Vihma approaches the analysis of products from the point of view of semiotics, initially by assimilating Bense's interpretation of Peirce to the Aristotelian scheme of 'causes', and subsequently by developing the semantic element in the light of Eco's interpretation of the process of semiosis.¹⁴¹

The Aristotelian scheme embraces a number of the elements going into the constitution of some thing, within a basic means-end relation. What makes any particular thing is - the material that it is made from, the form that the material takes in something being a thing of a certain kind, and the agency that gives form to the material. Sense is given to the process and content in their inherence in an overall relation which teleologically captures the idea that things are intended for a purpose.¹⁴² Bense similarly expresses the content of a designed object in terms of three dimensions, the Hyletik (material dimension), the Morphetik (semantic dimension) and the Synthetik (formal or syntactic dimension) which

¹³⁸ These approaches to meaning are discussed in more detail below, See section 7 'Meaning and Semiotics'.

¹³⁹ See below, section 7 'Meaning and Semiotics'.

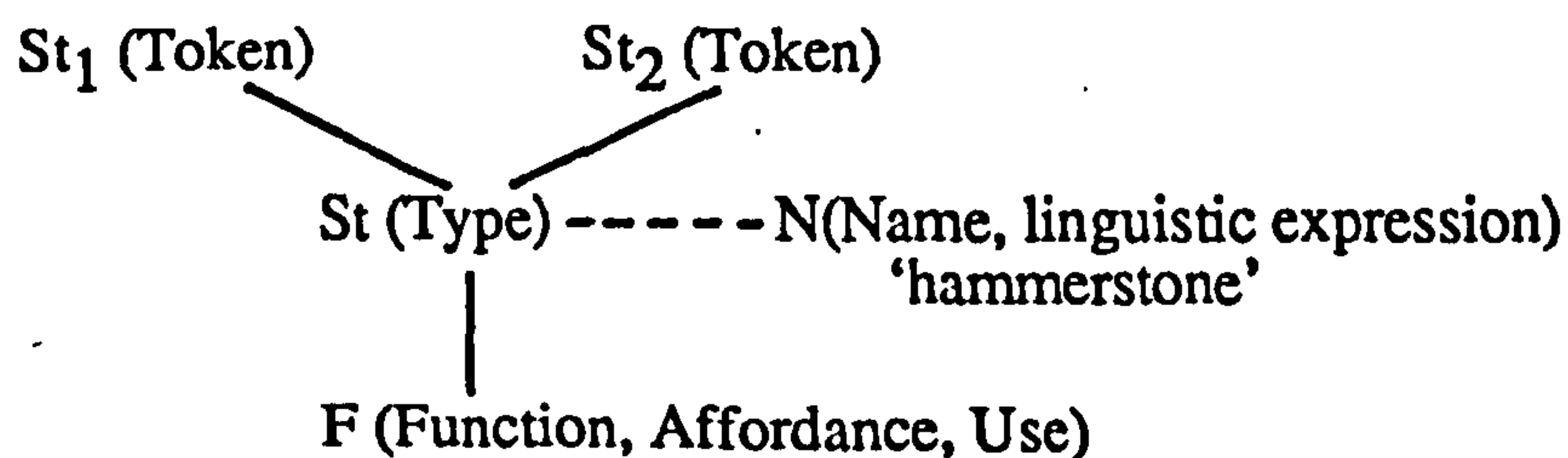
¹⁴⁰ See below, section 7 'Meaning and Semiotics'.

¹⁴¹ Bense's scheme could be subject to differences in interpretation. Given that the prime target here is Vihma's semiotic scheme for product semantics, I will only be directly concerned in the account which follows, with the interpretation given to it by Vihma in articulating her own position.

¹⁴² See below, section 6 'Artefacts'.

are contained within a fourth overarching dimension, the Pragmatik (dimension of use).¹⁴³ The essential difference between the two schemes is that the concept of agency and the means-end relation in the Aristotelian scheme is replaced by semantic and operational relations in Bense's scheme. The nature of signification and therefore the kind of meaning-making involved in a given dimension is articulated in terms of Peirce's classification of sign types - the Hyletik is primarily Iconic, the Synthetik primarily Symbolic, and the Morphetik primarily Indexical.¹⁴⁴ The Pragmatik is not associated with a characteristic sign type, but is the context which is both constituted by and gives sense to the relations between the other dimensions and their forms of signification.

Vihma's contribution to the development of a semiotic scheme, given this stage-setting, is to clarify the particular role of semantics in the characterisation of products. The basis for this lies in Eco's account of the nature of signification presented in the form of a hypothetical exercise in a priori anthropology. According to Eco the roots of signification consist in associations made between objects, mediated by an action. A man finds a stone and uses it for hammering. The process of semiosis begins when he finds another stone, which he recognises can be used in the same way as the first stone. The idea here is that the two stones are subsumed as a type, characterised in terms of a use.¹⁴⁵ In addition the type can be given a name or a symbol.



At this level of presentation, the structure of the process parallels the account given by Krippendorff. The essence of meaning-making consisting in the cognitive activity engaged in by an individual in assimilating individual object encounters to contexts through the operation of processes of association and categorisation. Eco's account clarifies the way in which such a process might be grounded in the relation between an action and the various things that might be used to perform it, and linked to a symbolic or

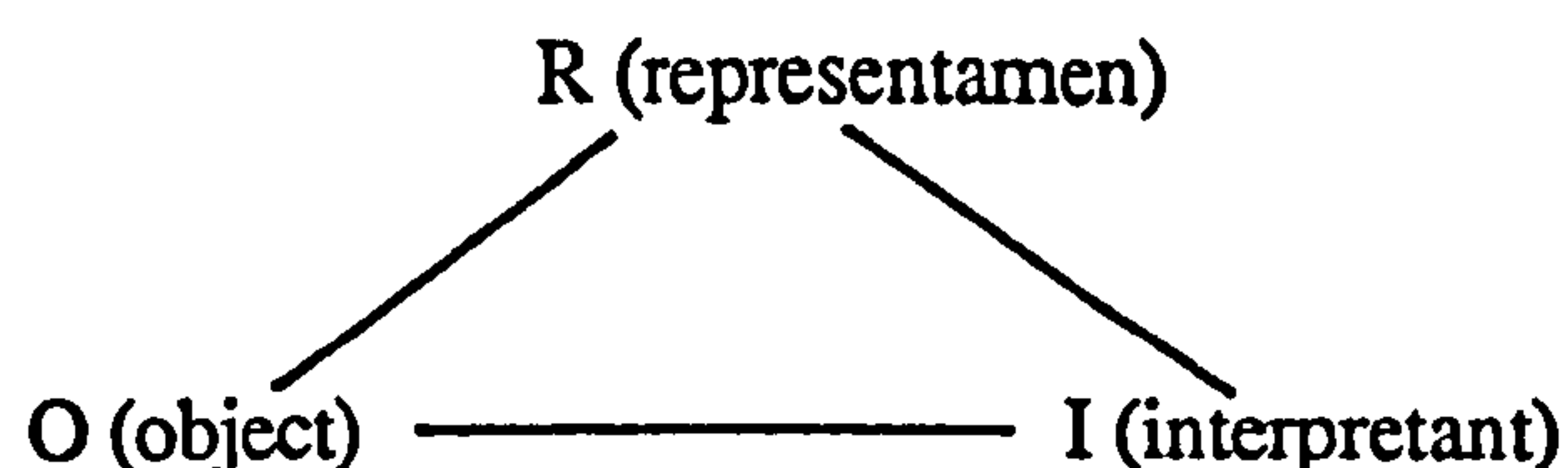
¹⁴³ The difference in the way in which the overarching element is defined in each scheme opens up the distinction between the centrality of function or of affordance in the characterisation of products.

¹⁴⁴ The primary articulation is therefore in terms of Peirce's 'relations of performance'. The dimensions are further characterised in terms of the sub-divisions in Peirce's scheme. The details of this classification are not essential to the consideration of Vihma's scheme, and are discussed below pp 231-234.

¹⁴⁵ The type is not a pre-existing category, but is constituted in the terms of the association between tokens. Vihma uses the term 'function' to designate the use-reference which binds tokens into a type, but given the context it is clear that 'affordance' or 'use' might be used to capture the designation. The idea and role of affordance are introduced by Vihma at a later stage in the account.

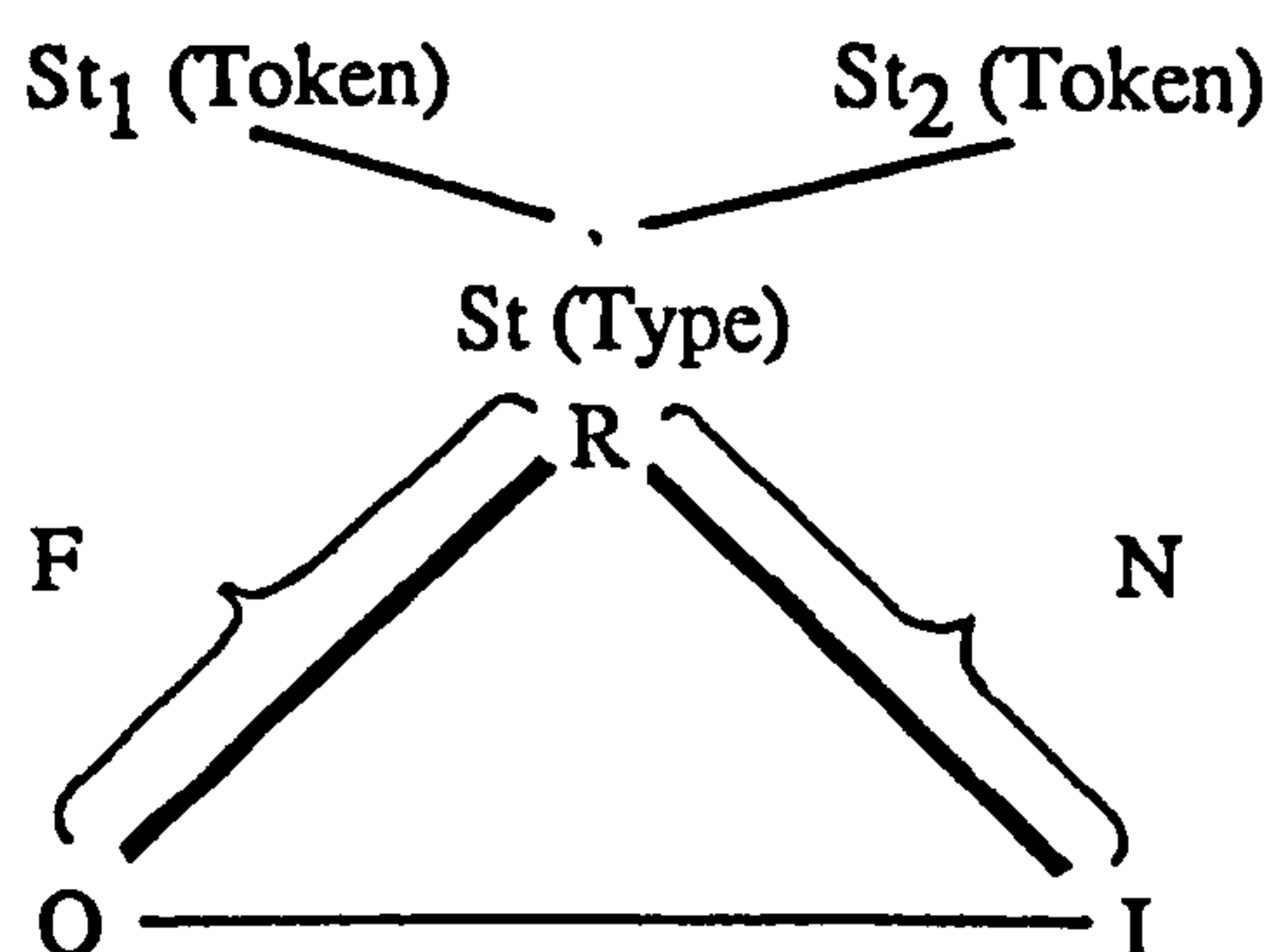
linguistic context.

Vihma's strategy is to interpret Eco's model in the semiotic scheme proposed by Peirce.¹⁴⁶ Peirce's conception of the structure of signification is that it is essentially a triadic relation, in which a Representamen (the basis of a reference), refers to an Object (the basis of a type), under an Interpretation (the basis of a meaning-making process).



The meaning of these terms in Peirce's scheme is by no means simple or transparent, and the interpretation given to them by Vihma does not square with those offered by other authors. However, for the present we will ignore this since the intention here is to gain a clear sense of Vihma's own semiotic scheme for semantics.¹⁴⁷

Interpreting Vihma's assimilation of Eco to Peirce in the form of a diagram results in the following juxtaposition :



The Representamen (R) in the triadic relation is equated with the significant form in terms of which tokens are assimilated as a type, and comprises whatever it is in the perception or cognition of a thing that provides the basis for its relation with the other terms. But its relevant content is in part defined by those relations. In the case of the two stones, for example, the relevant content is established by reference to common use - hammering, which constitutes the Object (O) term. The relation R-O is in this case a function or use-relation. Not all possible contents that might constitute the Representamen are relevant to the relation, but only those that are operative relative to the context of use (in this case for

¹⁴⁶ See below, section 7.4 'Signification, Semiotics and Meaning'.

¹⁴⁷ See below, section 7.4 'Signification, Semiotics and Meaning'.

example perhaps size, weight, hardness, shape and not colour or smoothness). The Representamen is therefore an abstraction from selected properties of the type relevant to a context of use - its significant form.

Given that the overall process of signification has an interpretative character, the Interpretant (I) is

‘...conceived as being like a process of interpretation, an on-going sign production.....the interpretant is not equivalent to an individual interpreter. However, a triadic sign necessarily involves an interpreter...’¹⁴⁸

The key relation in Vihma’s account of semantics is the object relation R-O which is taken to be the basis of the ‘...reference relations of the material product...’¹⁴⁹ and subject to distinctions of type in the form of iconic, indexical and symbolic relations. Iconic relations are essentially relations of similarity in which the form or perceived properties of a Representamen are interpreted as being like something else in some respects. Indexical relations are causal or existential relations between the Representamen and something with which it is contiguous. Symbolic relations are those in which the relation between the Representamen and Object are conventional rather than subsisting in any perceived inherent connection.

The meaning of a product is an individual interpretation of that product in terms of the various facets of signification, and in that sense is parallel to ‘hearer’s meaning’ in speech act theory. Vihma recognises the problem of the shareability of meaning, given its roots in individual cognition, and suggests that the public face of meaning is explicable in terms of the cognitive similarity of the individuals that share a form of life.¹⁵⁰

In contradistinction to Bense, Vihma does not regard the Pragmatik or context of use as encompassing or being constituted by the other product dimensions, but sees the four product dimensions as separate elements of product characterisation.¹⁵¹ The semantics of a

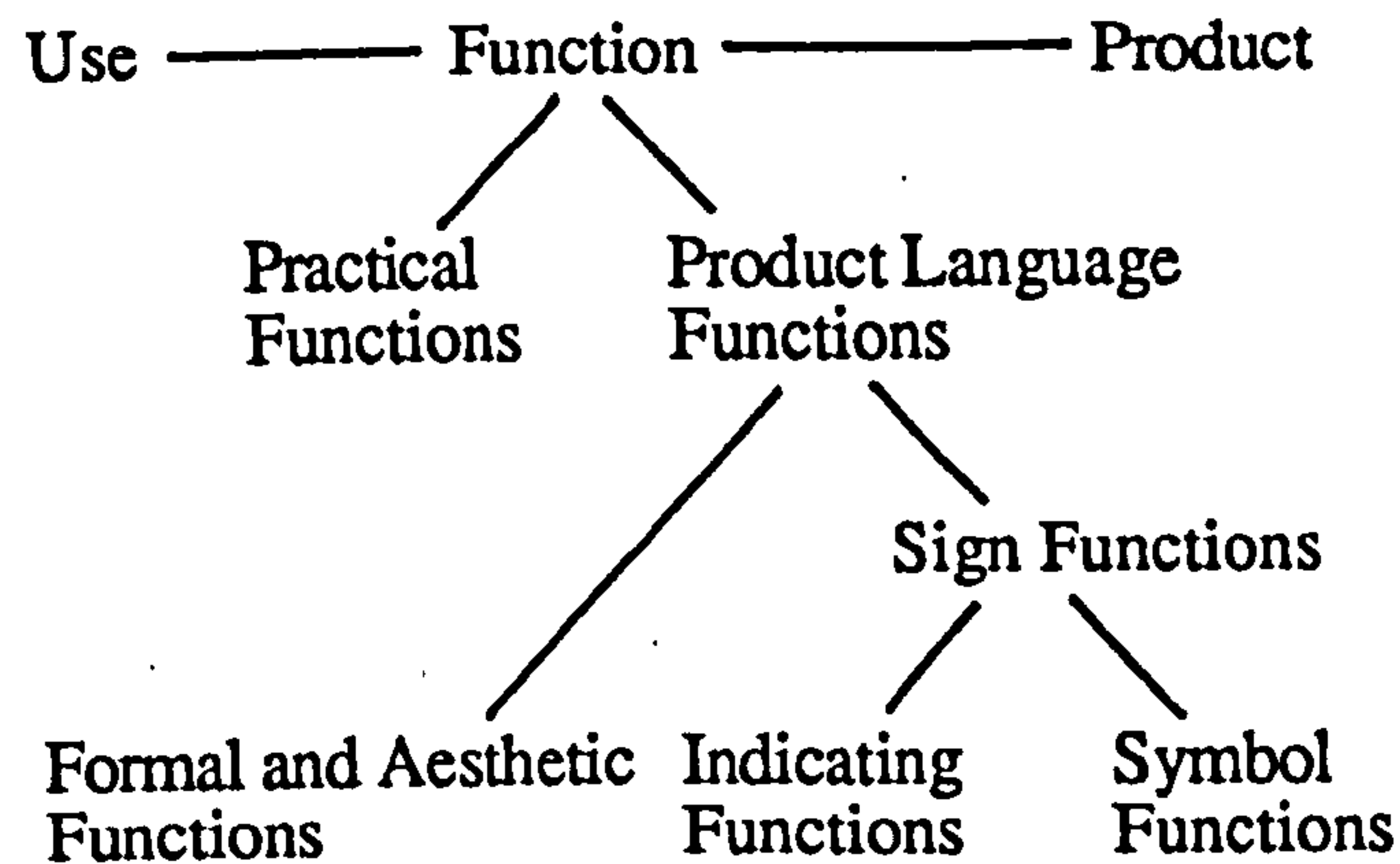
¹⁴⁸ Vihma 1995, p66. The Interpretant and the interpretant relation R-I are not given any further explanation in the account. A flavour of the relation between Interpretant and interpreter is given in a sentence quoted from Peirce - ‘A sign addresses somebody, that is it creates in the mind of that person an equivalent sign, or perhaps a more developed sign’ [Peirce *CP* vol 2, para 228].

¹⁴⁹ Vihma 1995, p67.

¹⁵⁰ Vihma 1995, pp74-88. Although the passage has Wittgensteinian undertones in its reference to the subsistence of language and symbolisation in shared ‘forms of life’, the impression given is that it is nonetheless possible to ground recognition and categorisation in individual cognitive activity, whose results just happen to be shared by a community and can thus attain a common sense. The account will therefore be subject to rebuttal from Wittgenstein’s own observations regarding the logical impossibility of a private language, and the inference that language and reference can only develop a logical sense by starting in a public context [Wittgenstein 1972; Kripke 1982]

¹⁵¹ Vihma 1995, p50.

product are seen as those aspects of the interpretation of a product which involve signification. Vihma therefore follows Gros (whom she cites) in the separation of practical functions from product language functions generally, and in the substructure of product language elements.



Indicating Functions include all the primary forms of categorial indices (features relating to type identity), whilst Symbol Functions refer primarily to historical and socio-cultural reference (features invoking stylistic identity and connotation, for example).¹⁵²

In broad terms Vihma's scheme consists of three product dimensions - the Syntactic Dimension, the Pragmatic Dimension and the Semantic Dimension.¹⁵³ The Semantic Dimension encompasses the variety of ways in which product elements can constitute sign functions (referential or expressive capacity). The Syntactic Dimension comprises the range of ways in which a product can be formally decomposed into elements and their specifications (compositional content). The Pragmatic Dimension comprises all the uses and contexts in which the product can participate, including the total life-cycle of products and their ecology (socio-cultural role). Clearly in the case of any given product these analytic categories will be interactive and not meaningfully separable as elements.¹⁵⁴ The range of contexts identified by Vihma in which meanings are constructed can be broadly equated with those identified by Krippendorff, although the partitioning of contexts for the purposes of analysis are not identical.

¹⁵² Vihma 1995, pp 39-40. [The diagram is adapted from Gros 1983, p70]. The signification element (sign function) of 'product language function' is asserted to comprise two separate components one of which links categorial features of the product to product types in terms of functions, whilst the other links features to external references. This is equivalent not only to the separation of syntactic from semantic elements, but also to the separation of some forms of semantic elements from others, since it is difficult to see how the connection between categorial features and product types can be made if socio-cultural links are hived off.

¹⁵³ The fourth dimension, the Hyletic or material dimension is variously treated as a separate dimension which is not subject to analysis [diagram Vihma 1995 p 50-51], or assimilated as a compositional factor in the remaining dimensions [Vihma 1995, p 51]. There is little treatment of the material element, but the account generally assimilates questions relating to material to the dimension of technique and construction (Syntax).

¹⁵⁴ Vihma 1995, p 51.

The differences however, stem largely from the different perspectives from which meaning-making processes are viewed rather than from a fundamental difference that is asserted in respect of the constitution of meaning. If the simple model of meaning derived from speech act theory, consisting of 'speaker's meaning', 'hearer's meaning' and 'the meaning' ('sentence meaning') is used as a base of comparison, then both Krippendorff and Vihma, using different formal constructions, equate the design of a product with 'speaker's meaning' and user interaction with 'hearer's meaning'. But whereas Krippendorff treats 'hearer's meaning' as basic and attempts to construct a framework for design in which the nature of 'hearer's meaning' is used to provide the basis for a definition of 'speakers meaning', Vihma starts from the content of the designed product, 'speaker's meaning' and attempts to understand the interpretative process involved in 'hearer's meaning'.¹⁵⁵ Both accounts explicitly refer to the overall context involving both 'speakers' and 'hearers', and both regard 'hearer's meaning' as a cognitive constructive process involving contextual fit, in which categorisation is the central operative cognitive mechanism. Semiotic analysis takes the object as given (as pre-structured, as presented) and unpacks the content in terms of the general interpretative processes available to the cogniser (cognitive abilities) as manifest in a particular socio-cultural context. Contextual analysis, defines cognitive abilities in terms of the structure of the socio-cultural context (as a generalised scheme) and uses these to characterise the general pattern of object encounters.¹⁵⁶

Nonetheless both accounts offer an intentional view of meaning, in which semantic content is unpacked in cognitive terms, is regarded as socio-culturally contextualised and essentially underpinned by physicalist assumptions. Both operate with the idea that meaning is embedded in the context of 'transactions' generally, both in the nature of our perceptual and behavioural transactions with the material world and in the context of communication, and that ultimately these are underpinned by the idea of 'affordance'.

¹⁵⁵ In both accounts the role of 'sentence meaning' is subsidiary and takes the form of an unanalysed reference to intersubjective commonality of meaning.

¹⁵⁶ The difference is in part a question of the degree to which each author subscribes to the view that the nature of design as a synthetic activity is capable of operating synthetically in terms of knowledge that one might gain of the nature of user understanding. Krippendorff is fully committed to the view that design ought to consist in working directly with knowledge of user's cognitive models, to the extent that he equates design activity with the designer's cognitive model which embraces user's cognitive models. Vihma is more sanguine in this respect, claiming only that knowledge of user's cognitive models can assist designers in making products more effective communicatively and interactively.

2.5 Structure and Content of the Analysis (Sections 3-8).

Although the differences between the cognitive/contextual and semiotic accounts are significant, there is sufficient similarity underlying the different forms of articulation of the central concept of meaning to warrant an approach which initially treats them jointly. An analysis of meaning theory in Product Semantics is undertaken in Section 7, via a comparison with developed theories of meaning and signification.

In preparation for this analysis some groundwork needs to be carried out. In the first place, the central concept traditionally employed in articulating the identity and meaning of products is 'function'. Krippendorff explicitly rejects the centrality of the concept of function, regarding it as a deterministic concept whose very centrality in design theory obscures any real understanding of the nature of user interaction. This sense pervades the product semantic literature and underlies the new slogan that 'form follows meaning'. Although most authors continue to use the term 'function', where this is the case its scope is generally restricted to a narrow technical or instrumental sense (or in the sense used in mathematics) which is used as a foil in developing alternative concepts. However no explicit analysis of function has been provided, and this is necessary in order to gain some purchase on the nature of the product semantic framework. An analysis of 'function' is developed in Section 3.

The rejection of 'function' as the central articulating concept for design theoretical frameworks, and the shift to a more cognitively-centred model draws in two key concepts, one operating primarily at the level of experiential interaction with the environment and the other explicitly articulated in terms of cognitive processes - namely 'affordance' and 'categorisation' respectively. The nature and role of 'affordance' is considered in Section 4, and 'categorisation' in section 5.

Section 6 analyses the different perspectives from which the idea of an 'artefact' has been viewed and identifies the particular orientation of product semantic accounts in relation to these, and this is followed by the direct consideration of 'meaning' in Section 7, and in terms of the idea of 'expression' and 'metaphor' in section 8.

The interrelation between these concepts, and the nature of the framework as a whole is discussed en passant in each section, as appropriate, but is addressed directly in Part C 'Synthesis'.

Part B Analysis

Section 3 Function

| | | |
|-----|--|----|
| 3.1 | Function, Purpose and Teleological Explanation | 65 |
| 3.2 | Function in Artefacts | 72 |
| 3.3 | Artefact Function - An Analysis | 80 |
| 3.4 | Role of Function in Design Discourses | 93 |
| 3.5 | Function, Intentionality and Meaning | 96 |

3.1 Function, Purpose and Teleological Explanation

A key element in the articulation of both formal and informal models in design and architecture, is the concept of function and the relationship between form and function. Although the centrality of such concepts in design theory, pragmatics and practice is clear, their use in these contexts is by and large unanalysed, save for certain exceptions in some of the more formal treatments relating to the logic and systematisation of design.¹ Product semantic accounts assert that the central role given to 'function' in traditional theoretical frameworks for design, is misplaced. The principal reasons which can be identified in the literature for this view rest on the contention that the functional relation institutionalises a deterministic and objectivist sense of the relationship between user and product, and consequently drives a flawed picture of the nature of the design process.² Although 'function' remains unanalysed within these accounts, a general sense of the product semantic approach to the issue can be gained from the following summary.

In traditional accounts users are characterised in narrow instrumental terms, typified by anthropometric and ergonomic models. They are conceived in an abstract and normative sense as having certain (predominantly physical) capacities, constraints and tendencies.³ Action centred user models are refined by the addition of psychophysical and psychological layers, which are treated methodologically as having a similar form and status as physical models.⁴ The resulting user model is essentially a model of an active physical mechanism endowed with a range of psychophysically defined sensory inputs, oriented towards external goals through a system of drives and preferences, whose behaviour and actions are controlled by an inference structure which is essentially deductive (and inductive) in character.

The parallel traditional characterisation of products is that they exist to serve particular purposes, which are also defined in instrumental terms. In so far as they have a substructure, the parts of products are also conceived as instrumental particulars. Although traditional accounts recognise that some aspects of products are not captured in this characterisation, the remaining elements or attributes are regarded as non-instrumental and belonging to a different order of analysis (such as the realm of 'style' or 'character').

¹ Recent key examples include Mitchell 1990 who analyses function in the context of a formal description of designs expressed in terms of the predicate calculus; Roozenberg and Eekels 1995 whose analysis reflects a broad range of structure-behaviour-function models, including for example Gero 1990; Hybs and Gero 1992; Umeda et al 1990; Purcell and Gero 1991; Gero, Tham and Lee 1992; Sturges 1992; Yan 1993. The more general location of 'function' in semi-formal schemes is outlined in Rosenman and Gero 1998. A less formal but seminal analysis which emphasises the context-dependence of 'function' is represented in Pye 1964.

² Section 2 above, particularly in relation to Krippendorff.

³ Krippendorff 1989, 1990.

⁴ Krippendorff 1989, 1990.

The relationship between user and product represented in the design process consists in mapping product instrumentalities onto user instrumentalities, and the essential relation is embodied in the concept of 'function'. The user exercises instrumental capacities through the parts of a product, which are given instrumental definitions relative to the purpose of the product as a whole. In traditional accounts 'function' is the term applied to relations of this kind. Given that parts are conceived as physical parts, and the theoretical perspective is developed via an analysis of existing products, the explanatory relation between the form of parts and their instrumental mapping is taken as determinate.⁵ The doctrine of functionalism (the idea that the form of parts is in some sense determined by their function), represents the formal theoretical statement of the extreme of this position.⁶

Having set up this generalised model of traditional theoretical frameworks for design, Product Semantic accounts then proceed to reject both the overall approach and the utility of the various concepts employed. The basis for this, as outlined in the previous section, depends on the case made for the inadequacy of instrumental conceptions generally, and the need for a cognitive account of user product interaction, where instrumental conceptions are replaced by species of 'ecological' relation which at the level of perception are articulated in terms of 'affordances' and at the level of cognition in terms of 'understanding' and 'meaning'. Nevertheless, in the detailed unpacking of user product relations, particularly in the context of categorisation, an instrumental conception of function is preserved.

Product Semantics thus accepts an unanalysed instrumental conception of function, which it asserts is the essential defining relation characterising traditional accounts, but relegates it to a minor role within its own theoretical framework, subsumed under the more general category of 'meaning'.

In addressing the Product Semantic framework, it is clearly necessary to gain some purchase on the nature of the concept of 'function'. Given the way in which the concept is presented relative to traditional accounts, one approach to this might be to make a direct comparison. However, since the concept is assumed, and remains explicitly unanalysed, in both traditional and Product Semantic frameworks, the strategy adopted will be to try and establish an independent analysis of 'function' which does not rest on the assumptions of any individual account based on a given theoretical framework for design.

⁵ Parallel to the assumed equivalence between explanation and prediction in deductive-nomological accounts. [Hempel 1965]. In fact the assumed equivalence is only determinate after the event. [Scriven 1962; Hughes 1976].

⁶ Product Semantic accounts tend to equate the determinate sense given to 'function' in traditional accounts with the doctrine of functionalism. However it does not follow from the fact that a specified relation between form and function actually holds in particular cases, that form is determined by function either generally or in any given case, since this would require that the relation be 'necessary'.

The most developed literature relating to the analysis of the concept of 'function' occurs not in design but in the philosophy of science, where the issues are problematised in relation to the use of these concepts in explanatory scientific contexts, particularly in biology. In such contexts, the meaning and analysis of the term 'function' is perceived to be firmly embedded in the more general teleological framework implied by the continuity of the term 'function' with, for example, 'purpose', 'role' and 'reason'. The early literature assumes a continuity in the sense of 'function' across contexts and has the general aim of either eliminating or explicating purposive terminology, in favour of causal accounts.⁷ The nature of such accounts varies in detail, but they are often explicitly or implicitly driven by a fundamental homeostatic or target-oriented system model, in which things or parts are taken to have functions in so far as they contribute to the maintenance of states or the achievement of goals of the systems of which they form a part.⁸

The most direct approach to an analysis of the concept of function, takes the form of attempts to define the relationships that must obtain between any thing and its purported function. Philosophically, the simplest forms of such criterial definitions are traditionally articulated in terms of necessary and sufficient conditions. Nagel, for example, proposes that a functional thing or part is a necessary condition for its effects - that statements such as 'The function of chlorophyll in plants is to enable them to perform photosynthesis' can be analysed as 'A necessary condition for the occurrence of photosynthesis in plants is the presence of chlorophyll'.⁹ On the face of it such an analysis is wrong in that whilst the first statement is presumably true, the second might well be false.¹⁰

Generally speaking one cannot sustain a view that any thing or part is necessary to a given outcome - alternatives are always potentially and often actually available. Indeed one important aspect of the concept of function is its role as an abstract marker, which preserves some essential conceptual distance between ends or outcomes and the particular means by which such ends might be achieved. This conceptual role is clearly of particular importance in the context of design.¹¹

⁷ The early accounts fall generally into a logical-positivist program, intended to show by reductive analysis that 'purposive' and 'functional' description and explanation does not involve a special kind of teleological causality. It is argued that such special forms of characterisation are not required and that the behaviour and organisation of both living and non-living things can and should be described in terms of straightforward causal and deductive-nomological forms.

⁸ Rosenbleuth et al 1943; Braithwaite 1953; Sommerhoff 1950; Nagel 1953.

⁹ Nagel 1961.

¹⁰ There is no in-principle reason for accepting a priori that chlorophyll is the only substance capable of photosynthesis. In addition it seems important to preserve the open-structured nature of functional attribution as well as formal attribution in our conceptual schemes.

¹¹ The openness and creative aspect of the design process depends in large measure on the abstract marker role that functional descriptions provide, allowing for clear specification without intrinsic formal constraint. The role of function concepts underpins the notion of alternatives in design, while providing criteria for assessing their applicability and adequacy.

In order to overcome the problems that arise with an analysis in terms of necessary conditions, a variety of strategies are adopted, generally taking the form of some relativisation to restricted contexts or conditions of use of the term 'function'. Nagel, for example, elaborates his schema in the light of this criticism by relativising the analysis to 'normal conditions' and 'normal circumstances', and to systems which are 'goal-directed'.¹² Strategies of this kind tend to have the effect of restricting the conceptual content of the term function in ways which do violence to the important abstract place marker role that it clearly has, and consequently severing the sense of the term in different contexts. Approaches of this kind prove difficult to apply in the analysis of function in the case of artefacts, although they can be sustained to some extent in the context of examples drawn from evolutionary biology.¹³ It is however, by no means clear that the sense of 'function' is distinct in the two contexts, and other writers have argued through the use of a wide range of counter-examples, that it is the basic analysis of the term that is flawed.

Hempel has provided an analysis which follows similar lines, but in which the dilemma that arises is made more explicit, and in relation to which it can be argued from the form of the exposition that the source of problems lies in certain general assumptions inherent in a logical-positivist approach.¹⁴

Hempel considers that the problem in characterising functions is essentially the problem of distinguishing between those effects that are functionally defining and those that are not. Functions are effects, but not all effects are functions. The contraction and dilation of the heart has the effect of circulating the blood, and also of producing heartsounds, but whereas the former is a function of the heart, the latter is not. What is the logical basis of the distinction? Hempel argues that a 'function' supports a necessary condition for the 'proper working of the organism'. Circulation of the blood fulfills this condition, whilst producing heartsounds does not.¹⁵

Hempel identifies a problem with this analysis, that in a logical-positivist context it has no

¹² Nagel 1961. Gruner for example restricts the explanatory use of function ascriptions to 'systems' [Gruner 1966]. This strategy as a general case, and in particular, is conclusively refuted by Nissen [Nissen 1971].

¹³ Ayala has effectively argued the case for the indispensability of 'teleological' descriptions and explanations and concludes - '...teleological explanations imply that the end result is the explanatory reason for the existence of the object which serves or leads to it. A teleological account of the gills of fish implies that gills came to existence precisely because they serve for respiration'. '...the use of teleological explanations in biology is not only acceptable but indispensable'. [Ayala 1970, p 12].

¹⁴ Hempel 1965, 1959. The formal restrictions placed on the concept of scientific explanation, the insistence on deductive-nomological modes of reasoning and the conflation of prediction and explanation as concepts in a logical-positivist framework can be viewed as the source of the major conceptual problems that occur in formal accounts of explanation generally. [Hughes 1976].

¹⁵ Such an argument ultimately depends on some form of relativisation to goals or ends. In the context of evolutionary biology it is possible to articulate a distinction in terms of those effects that are selected for in natural selection and those that are not. [for example see Ruse 1973].

explanatory force. Such a conclusion is however only warranted on the assumption that the point of functional characterisation is to explain the presence of the item (organism, mechanism, process etc) that is functionally characterised. It is clear that Hempel believes that explanatory force can only be secured if the analysed form of a function statement can be construed as the explanans in a deductive-nomological argument.¹⁶ However this can only be satisfied if the analysed form of the function statement will support a necessary condition for the functional effect - which is essentially the recurrent problem faced by all analyses of this type.

An alternative general approach taken by a number of authors attempts to distinguish between those effects that are functions and those that are not by reference to the fact that functional effects necessarily contribute to some 'good' that is conferred on the system of which the functional element is a part.¹⁷ The essential idea here is an attempt to generate general criteria for a distinction between functions and effects on the basis of a relativisation to the contribution of functional effects to the system as a whole - a distinction between essential and adventitious consequences.

The 'good consequence' approach can be criticised on a number of counts. In the first place it can be argued that it cannot deal adequately with 'function' in the case of artefacts, since the intention of the user or designer can logically circumvent any reasonable sense of 'good consequence', and completion of the analysis would therefore need to include some additional reference to the beliefs and intentions of the relevant human agent.¹⁸ Secondly it is clear that analyses of this kind will fail to identify sufficient conditions for functions, since they provide no distinction between good consequences that are intended and those that are merely adventitious.¹⁹ In addition such analyses fail to provide generally applicable conditions for the ascription of function. The production of heartsounds, for example, although not considered to be a function of the heart, can have good consequences for the owner of the heart in the context of medical diagnosis.²⁰

¹⁶ Hempel 1965.

¹⁷ Canfield 1964; Sorabji 1964; Lehmann 1965; Ruse 1973; Woodfield 1976. The nature of the good consequence to which the functional account is relativised varies in particular accounts, some allowing for their nature to be unspecified within the analysis [Sorabji 1964; Woodfield 1976] and others identifying particular forms of good consequence - for example, proper working under normal conditions [Hempel 1965] or survival and reproduction in the case of organisms [Ruse 1973].

¹⁸ The problem is that there is no clear sense of who the good consequence is good for. A terrorist bomb may have good consequences for a political group but for no one else. There is no in-principle reason why a designer should not devise an artefact which has no identifiable good consequences for anyone, but such an artefact might have a perfectly understandable function, and its parts could clearly have identifiable functions. [Achinstein 1977].

¹⁹ Wright 1972, 1976. The issues involved in the distinction between intended and incidental effects are explored in the more formal analysis (below).

²⁰ Frankfurt and Poole 1966. All artefacts and organic systems will have some adventitious consequences, some of which may prove to be useful in some way at some time. The point of the distinction is that some consequences are the subject of selection or retention precisely because of certain characteristics that they have.

A related alternative approach to the definition of function is centred on the idea that the characteristic feature of functional effects is that they contribute to a goal of the system of which they are a part, both in the case of artefacts and non-artefacts. A function of hands is to grasp objects, both because they exhibit this capacity and because their doing so contributes to the goals of the owner of the hands. Similarly the function of a thermostat is to turn the heat on and off in response to external changes, since this contributes to the maintenance of a constant temperature - a 'goal' that is embedded in the system. Such goals, particularly in the case of inanimate objects may be attributable to the user, owner or designer of the object or system, rather than directly to the object or system.²¹

The general problem with goal-referenced analyses is that it is the actual performance of a function that contributes to a goal, and numerous counter-examples can be devised in which potential functional effects or intended functional effects never occur. The 'goal doctrine', cannot supply necessary or sufficient conditions for the ascription of function.²²

Although both direct and indirect approaches to an analysis in terms of necessary and sufficient conditions is ultimately flawed, the explanatory context in which Hempel, for example, placed the analysis of function statements has proved suggestive in terms of general strategies for a group of related analyses provided by other authors. Achinstein has characterised this overall approach as the 'Explanation Doctrine'.²³ The essence of the idea, evident in the work of a number of authors, is that function statements constitute etiological explanations of the existence or presence of the functional items.²⁴ The most general analysis of this kind is provided by Wright, who argues that function statements are explanatory in the sense that they provide the reasons that the functional part 'is there' - how the functional part came to exist, came to be present, continues to exist, exists where it does, why it is used etc.²⁵ To say that the function of some artefact or part is such and such, is to signal that the definiendum is intended to have etiological explanatory force.²⁶

²¹ Boorse 1976; Nagel 1961. Living systems are replete with embedded 'goals' and these may have no significant relation to the capacity for intentionality of the living system, but are merely homeostatic targets that have been selected for in the process of natural selection. The distinction between paradigms for the animate and the inanimate may not be as sharp as one might believe, except in terms of the particular process of selection that is in operation in the different systems.

²² Achinstein 1977. Safety devices, for instance, may never be brought into play.

²³ Achinstein 1977.

²⁴ Ayala 1970; Wright 1972; Bennett 1976; Levin 1976; Wright 1976.

²⁵ Wright 1976.

²⁶ It is possible to treat this conclusion as having a broader perspective. In one sense one could argue that functionality is not a property, but rather that it represents a framework through which one approaches the world, in parallel possibly to frameworks such as 'causality'.

Although analyses of this kind come closer to an intuitively correct sense of the role of function statements, in formal terms difficulties remain which are associated with the essential locution 'is there'. The vagueness of the specification, which is essential to capturing a generality over cases, and the resulting diversity allowed in its interpretation in given cases, opens up the possibility of counter-examples in which the distinction between functions, goals and aims is lost. In addition Wright himself identifies a wide range of function statements (which he describes as variant or non-standard uses) which refer to artefacts designed or used to serve certain functions that they are actually incapable of performing.²⁷ It is by no means clear that such cases can be marginalised as 'variants' from some acceptable norm since they potentially open up the question of whether a correct analysis of function statements requires relativisation to the beliefs and intentions of agents.

Although there is no ultimate consensus in the literature relating to the analysis of 'function' a number of general features of the concept can be usefully extracted. In the first place the function of some thing or part relates to the part that it plays in the context in which it occurs. Functional things or parts are perceived to have defined roles in the sense that their functional effects make a clear contribution to the systems of which they are a part. Any effective analysis of the concept requires a clear distinction to be made between those consequences or effects that provide reasons for the existence or persistence of a thing or part, and those that are in this sense adventitious.

Such a distinction can be articulated in the case of artefacts in terms of the intentions of the various agents involved - designer, maker, user. In the case of non-artefacts, and in particular biological systems and their parts, it appears that a parallel distinction can only be articulated in terms of assumptions made relative to particular theoretical positions - in short the fundamental tenets of evolutionary biology.

Although the thrust of the literature is embedded in the context of an attempt to provide a unitary analysis of 'function' across the artefact/non-artefact divide, and in most cases is driven by the desire to secure a form of analysis which would eliminate teleological and intentional reference, some implicit reference to intentions or frameworks of belief appear ultimately to be ineliminable.²⁸ In the section which follows, independent and informal consideration will be given to the use of the term in relation to artefacts, as a preamble to developing an analysis of the concept.

²⁷ This issue is addressed in the context of the attempt to generate a semi-formal analysis of function (below).

²⁸ In the case of living systems this would amount to an assumption regarding the truth or necessary acceptance of a particular theory or theories, for example, theories of evolutionary biology.

3.2 Function in Artefacts

The least contentious and consequently the least discussed use of the term 'function' occurs in the context of the description and analysis of artefacts. We refer to the functions of parts of artefacts and to the functions of artefacts themselves - the function of a clock spring and the function of the clock. In cases such as these, at least part of what is conveyed in ascribing a function to an artefact or part, is a reference to what the artefact or part does. The spring provides the motive power for the clock mechanism; the clock indicates the time of day.

In the clearest cases an artefact or part has been designed to do a particular job in a given situation; its existence and form are the result of a conscious desire to provide the means to some end, in some context. There are also cases, however, in which the notion of specific design is perhaps too sophisticated a description of the situation, but which we would nonetheless recognise and even characterise in similar functional terms - 'the function of the newspaper stuffed under the door is to prevent draughts'.²⁹ An important common element in these cases of function ascription is that we are concerned with the consequences of something as having a certain form, behaving in a certain way, or simply being where it is - the effects of its particular presence.³⁰

Although in ascribing or talking about the function of a thing or part, we are in some sense referring to what that thing does, not all descriptions of what it does seem to qualify as acceptable ascriptions of its function. In the context of the clock, the action of a spring might be described as 'slowly unwinding' or the action of a weight as 'slowly descending'. However we would not generally subscribe to these as functions of the weight or spring. We would not think it correct to say that the function of the spring is to slowly unwind, or that the function of the weight is to gradually descend, even though these may be correct descriptions of the actions of these respective parts, and may indeed be the ways in which they are intended to work.

Only some descriptions of what a thing 'does' appear to qualify as correct ascriptions of function. The notion of specific design - that a thing is designed to provide the means to some end - provides a sense of the essential explicit or implicit reference in a function ascription, a reference to the end for which the various action descriptions are means. In a function ascription the particular means can often be ignored, but what appears essential is some sense of the end served. The function of a clock, for example, is to indicate the

²⁹ We might well use simpler locutions having the same implicit force, such as '...its there to keep out the draught', and so on.

³⁰ This element seems to be the importantly correct feature of all etiological accounts. [For example Wright 1976]

time, however this is in fact accomplished.³¹

In the case of artefacts it is clear that when we talk of the ends served, the word 'end' is used in the sense of 'purpose' or 'goal'. The purpose served is that of some human agent, usually the designer or user of the artefact in question. If we accept that this is the case, then questions arise in respect of the ends that are served by the parts of artefacts or systems. The system itself, in this case the clock, has the purpose of indicating the time of day and the spring contributes to this outcome. However I do not think we would normally articulate the function of the spring in terms of the end served by the clock. We would not say that the function of the spring was to contribute to indicating the time of day, although in one sense it does.

On the other hand neither would we normally describe the function of the spring as 'turning the spindle'³², even though this could be regarded as a proximate end served by a consequence of the spring's action - namely, its slow unwinding. In this case I think that we might be tempted conclude that this is not an adequate characterisation of the function of the spring because turning the spindle is not an end in itself. It is merely a single link in the chain of functional parts that together result in the indication of the time of day. Clearly though, if we follow this line of argument, we will be driven back at least to the conclusion that the relevant end served by the spring can only be referenced in terms of the purpose of the system - the indication of time. Presumably, the argument need not terminate at the boundary of the artefact or system, since the mere indication of time may not be an end in itself in the world of human affairs, but assists further ends such as enabling us to keep appointments and the like, which serve more remote ends.³³

However we do not normally regard the functions of artefacts and their parts in this way, we do not normally refer the function to some ultimate end in a chain of means-end relations. Instead we regard artefacts and their parts as having restricted scope within such a cascade of means-end relations - a limited scope that is reflected in the ends that we consider appropriate and relevant in a given case. In the case of the clock spring, we regard the spring as providing the power for the whole mechanism and we might say that 'the function of the spring is to power the mechanism'. The action of the spring stops short of actually governing the relative positions of the hands and the face, and we do not regard this aspect of the working of the clock as a function of the spring, even though the

³¹ This form of functional definition in terms of ends which provide a specification for an open-ended range of means to those ends are the crucial factor in the employment of functional concepts in design.

³² In some contexts it would be appropriate to describe the function in these terms. This is explored further in the context of the semi-formal analysis of function (below).

³³ In biological contexts the argument is often pursued to ultimate ends which are perceived to legitimate the ascription of functions. Such ends are often the fundamental tenets of evolutionary biology, such as genetic survival.

action of the spring is required for that function to be performed. The function of the spring is to provide power, and that is the extent of its scope within the system. We could put this another way and say that the essential contribution of the spring to the system is the provision of power.

Such observations are clearly some distance from the ability to provide a formal definition of 'function', and indeed there is no guarantee that a general definition can be found, but perhaps they do provide some insight into the characterisation of the concept and suggest an approach for which there may be an 'experimental method'.

Given that the function of an artefact or part is concerned with the essential contribution that it makes in a given context, some sense of the scope of the concept might be brought out by considering the conditions under which something might be considered acceptable as a substitute for that artefact or part. There seems to be a clear and important relation between the question 'what is the function of this part', and the question 'what would be acceptable as a substitute for this part'.

As a first step in our 'experimental method' we might try substituting a part which has the same or similar form and dimensions of the spring, but which is made of some other material. In order to answer the question of whether the new spring was an adequate substitute, we could check the performance of the clock to see that it was still working properly. The question of what constitutes 'proper working' would depend on the context of use and the history of the clock's previous performance, but we would expect the clock to continue to meet certain defined performance criteria (for example in terms of standards of precision and reliability, or levels of required intervention). In our rudimentary experiment all variables except one, the new spring under test, are held constant. If the new part meets the required standards in respect of relevant performance characteristics, we would regard the new spring as functionally equivalent to the original spring, within this particular context of use.

This will not in itself tell us what the function of the parts is, nor does it imply that the parts have a function within the system. They may be functionally equivalent in the sense that neither has a function. Nevertheless we can imagine extending this crude experimental method by selectively varying the kind of substitute parts that are introduced into the system. The selection of substitutes will be guided by our view of what it is that the part is essentially doing in the given context, each constituting an interpreted model used to test our theories about the functioning of the part within the system. We might compare alternative substitutes, such as a descending weight or an electric motor and look for the common consequences that they have for the system. In this way we would come

closer to establishing the nature of the particular contribution made by the part to the system.

Although this may not be a particularly effective way of discovering what the function of a part is, it does point to important elements in the notion of 'function' itself. All artefacts which are to be used for a purpose must, in their organisation or behaviour, satisfy certain conditions. Certain states or activities must be maintained for it to be used for that purpose. These characteristic maintained states or activities constitute the proper working conditions of the artefact. It is in relation to these that we analyse the function of its parts. To regard the parts of an artefact as having functions is to regard them as contributing to certain maintained states of that artefact - meeting a range of performance criteria at an acceptable level.

In addition it is important to note that the expression of such performance criteria, which collectively might be referred to as a functional specification, will essentially consist of parameters and tolerances relating to outcomes and not a formal description. Any substitute parts that meet the relevant parameters at the right level will count as having the same function, regardless of their formal properties. This aspect of the notion of function is clearly of crucial importance in design contexts, since it provides a conceptual place marker for formally diverse kinds of instantiations that are linked at an abstract but tangible level through their relation to commonly defined ends and outcomes.

Although the discussion has been carried out with reference to a specifically designed artefact, there is no particular problem involved in extending the idea to cases of more casual use, such as stuffing a newspaper under the door to prevent draughts. In this case as well, certain performance criteria will have to be met in order for the newspaper to be used for excluding draughts. Anything that is used for a purpose will have to satisfy certain criteria in order to be so used, and these criteria being satisfied at a certain acceptable level will constitute the maintained states of the system.

Similarly, although the discussion has been carried out in terms of the function of a part of an artefact, there seems to be no particular problem in extending the discussion to talk of the artefacts themselves. In the case of the clock we might say that its function is to indicate the time of day, and it does this in a context in which people tell the time by looking at a clock and have expectations in respect of its performance. In this sense the proper working conditions of the clock go beyond the mere fact that the clock is in mechanical working order, to include, for example, the fact that there is access to and understanding of the indications of time that it makes, for those people for whom it has

that use.³⁴

That such a reference to a context of use may be required is highlighted if we consider the case of a bomb, where the function of the clock may be to trigger the detonator rather than to indicate the time. In the case of artefacts the context is often taken for granted, with the result that in talking of the function we appear to be concerned only with proper working conditions in the sense of the maintenance of internal states and activities. Although reference to these alone may be sufficient in the case of the ascription of function to parts of artefacts where the context of the artefact is clear, in the case of whole artefacts, some external contextual reference is required.

Thus in the case of parts of artefacts what is meant by the function of that part is, the consequence of some properties, states or modes of activity of the part which contribute to relevant maintained states of the artefact of which it is a part. In talking of the function of the part, we refer to the contribution that it makes to the normal working of the artefact as defined by its design criteria or criteria of use. Similarly in the case of whole artefacts, it is the contribution made by the artefact to the context in which it is used or for which it was designed, that is its function. This way of looking at what is meant by function does not provide us with an answer to the general question raised regarding the particular ends which may be appropriately referred to in function ascription, but rather eliminates a direct reference to ends altogether.

Although it does this, we have already seen that what constitutes the maintained states of a system is that certain criteria are satisfied at some acceptable level, and these are ultimately defined by the purpose for which the system is intended to be used. The uncertainty as to which particular ends may be appropriately referred to in function ascription is translated into an uncertainty regarding what will constitute the maintained states of the system. The advantage gained is that whereas the determination of appropriate ends has no perspicuous general methodology, there is an empirical basis for the determination of maintained states in terms of what we might describe more familiarly as performance criteria.

The two different though connected referends identified, nevertheless point to a dichotomy that has remained present throughout the discussion in the reference to the human agent involved who determines the ends that are served and the states that are maintained. When we talk of the function of a thing, then often what we are referring to is

³⁴ The opening out of the context in the case of artefacts, raises the question of whether it is correct to refer to functions in an expanded context or whether the word 'purpose' is more appropriately used. There does not seem to be a coherent argument for the systematic and non-overlapping use of either term in the realm of artefacts and human affairs generally (*pace* Roseman and Gero 1998).

it's intended use, the purpose for which it was designed or made - the human agent in this case being the designer or maker. Alternatively we may be referring to the use to which the thing has in fact been put - the human agent being the user. The two forms of referend that have been considered in the case of function ascription, namely, 'ends served' and 'states maintained' may be seen to correspond broadly with the distinction in agents.³⁵

The distinction is not a sharp one and does not provide a means of assessing the correct kind of reference in particular cases. Things are not always used for the purpose for which they were intended. In cases where the actual use does not correspond with the intended use, we seem reluctant to transfer the reference to the intentionality involved from the designer to the user and thereby change the referend of the associated function ascription. In function ascription intended uses are hard to shake off.

A raising hammer, for example, is designed for a particular purpose, namely compressing metal in the process called raising. If it is nonetheless used for cracking nuts, we would not generally infer that it had become a nutcracker or changed it's function, even though it might be perfectly suited to cracking nuts and is never used for anything else. The reference to the context of use is not sufficient to change our view regarding it's function. In talking about it we would distinguish between the use to which the artefact has been put, and its function.

If I use a desk lamp to dry photographic prints, then I do not think we would be tempted to describe the lamp as a print dryer, or refer to it's function as 'drying prints', simply because it was so used. However if this practice of using the lamp to dry prints were to be adopted by me standardly in my work, we might be more inclined to describe the function of the lamp in terms of its use as a print dryer.³⁶ However, generally the standardisation of a context of use does not seem sufficient to warrant a change in the function ascribed. In this case I think that we would be more inclined to use a grammatical construction such as 'functions as' to indicate that although the artefact is actually performing one function, it was originally intended to perform another. We might say that in my studio set up the lamp functions as a print dryer. Although this type of construction seems acceptable in this case, it does not fit so comfortably in the case where a raising hammer is used to crack nuts. Here I think we would be more inclined to say that it is 'used as' a nutcracker, or is 'used for' cracking nuts. Although these variations in construction and usage do not

³⁵ The more natural articulation in terms of the user would appear to be 'ends served' since the user is not generally responsible for the product specification but simply makes use of the features that the product has, in achieving desired ends. The designer or maker, on the other hand, is directly involved in the creation of a specification and in that sense is crucially concerned with the identification or determination of relevant maintained states.

³⁶ We might for instance say that the lamp 'functions as' a print dryer, or more simply that it is 'used as' a print dryer. The issues involved in the different levels of intentionality is taken up later in the context of discussions of artefacts and artifactuality.[See Section 6, below].

necessarily point to any clear and systematic description that could be used to help elucidate criteria for function ascription, they do point up certain factors that affect the way in which we decide the appropriate referend in applying the term 'function' in the case of artefacts.

In the first place our reluctance to transfer the reference in ascriptions of function, to established contexts of use, is in many cases a result of the fact that artefacts are commonly type-identified by reference to their intended functions. An object counts as a nutcracker if it's 'proper' activity is to crack nuts, if it was intended that it be so used. Function statements in respect of these type-identified objects appear to be analytic - 'the function of a nut cracker is to crack nuts'. This is however not the case since a function ascription implies more than the fact that a nut cracker cracks nuts, or generally that a doer of X does X. It further states that the doing of X is a function, an activity that it was intended should be done by X. The identity of artefacts is commonly tied to their intended function at the point of their design, manufacture or mediation. They have relatively settled roles within the cultural context in which they were designed and made to be sold, bought and used. The degree to which we are reluctant to re-assign a function to an artefact by reference to a context of use, is directly related to the extent to which it has a secure functional type-identity.

Although this is the case, there is a second factor which plays a part in determining the reference in function ascription, which in certain circumstances may over-ride the function ascribed in functional type identification. The extent to which we may be inclined to ascribe a function to an artefact relative to a context of use, depends in part on the extent to which that artefact can be regarded as part of a larger whole within that context; the extent to which the artefact has become a clearly identified part of a larger system.³⁷ If a clock is used to trigger a bomb then I think it would be correct to say, for example, that the 'function of the clock is to trigger the detonator'. We would not be inclined to make an implicit or explicit reference to the fact that there is an intended function of the clock in terms of which it was type-identified, by using a construction such as 'functions as a trigger' to mark off it's particular use in this case. The clock here is not a substitute for a part that would normally be used in these circumstances, it is a part of the bomb in it's own right. It is the trigger. The function of the clock qua token of the functionally defined type 'clock' is over-ridden here because it has acquired the role of a clearly defined part of another system. The ascription of function to the clock in this case takes the form of the ascription of function to part of an artefact, not only because it is no longer being used for

³⁷ Many artefacts encountered commonly in design have this feature of dual identity which is dependent on whether the artefact is self-standing or part of a system when it is under consideration. A typical example would be a component such as a set screw. This has a clear functional identity of its own, but in many cases will sublimate that identity in the particular role that it has in a given system, for example, as an adjustable stop.

it's intended function, but also because it can be regarded as a part of a system that is sufficiently integrated to be considered as a functional whole in its own right.³⁸ Where identity is in part tied to intended function, as is the case with the majority of common artefacts, a change in ascribed function is generally only made where the artefact can sublimate its identity as part of a system with a clear functional identity of its own.

It could be argued that one reason why we do not regard cracking nuts as a function of the raising hammer in our previous example, is that this particular hammer is a single token of a type, and the remaining tokens of the type are busily being used to compress metal in raising. Although this is part of the explanation, the example of the clock/trigger shows that it is possible to circumvent the relationship between a token and its functionally defined type, even in a case where other tokens of the type are fulfilling their intended functions. There is also an important sense in which the intended function supervenes even where the remaining tokens of the type do not fulfill their intended functions. This is the sense in which the function of an artefact is assigned by the designer or maker, and even if none of the artefacts produced were ever used for their intended purpose, it might still be appropriate to say that the function was that stipulated by the designer or maker.

Although it is too restrictive to say that performing some activity is the function of an artefact only if a designer or maker intended that it be so used, a designer or maker's intention that something created is intended to perform a certain activity does seem to be sufficient in many circumstances for the activity to be correctly said to be the function of the artefact so created.

³⁸ The distinction between types of contexts can be important. A bomb may be a manufactured product in which the timer is a specifically designed and manufactured component, in which case the question of identity will not arise. In the case of the average terrorist bomb, the design and manufacture depends on the use of standard components which will have other roles in other contexts.

3.3 Artefact Function - An Analysis

Although there are a number of other important considerations yet to be introduced regarding the criteria for function ascription in the case of artefacts and their parts, the issues so far addressed may be clarified by bringing together the arguments advanced, in a more formal way. I will herefore construct a partial analysis of what is meant by saying that the function of some artefact or part is such and such, on the basis of what has been outlined so far.

I introduce a standard form for function ascription and a standard notation :-

‘The function of A is F’,

where A is a place marker for the name of an artefact or part, or an identifying description of an artefact or part, or a referring expression that refers to an artefact or part; and where F is a place marker for a description of some ‘activity’.³⁹

In the first part of our earlier discussion the general conclusion was that the function of an artefact or part is something that is done by that artefact or part, an activity that it performs in the sense given to ‘activity’ in the above notation.

On this basis an initial partial analysis of

‘The function of A is F’

might take the form

‘A does F’⁴⁰

However as we have seen, not everything done by A counts as a function of A, not every description of what A does is relevant to the ascription of a function to A. Let us then consider the criteria that can motivate a distinction between those activities of A that we

³⁹ The term ‘activity’ is interpreted broadly so as to include things done that are not strictly speaking actively performed. Thus descriptions such as ‘supporting the roof’ and ‘excluding the draught’ would be acceptable substitutions, in addition to things that are actively done such as ‘cracking nuts’. The description of the activity may take a variety of grammatical forms, for example, taking the verb in the infinitive as in ‘to support the roof’.

⁴⁰ There are a number of general difficulties associated with analyses of this form, including the fact that they are indeterminate in respect of temporal factors; when A does F. They do not distinguish between cases where F is done continuously, where F is done intermittently, or where A is known to have done F in the past, for example. In the latter cases the question would arise as to whether F is a function of A only when A is doing F, or whether it has that function in virtue of a single or occasional performance. Although temporal factors could be built into the scheme at this stage, little purpose would be served and the complexity of the formulation would be markedly increased. The effect of temporal factors will be introduced in due course; at present we will assume that A is actually doing F when we consider a function ascription in respect of it.

regard as functions of A and those that we do not regard as functions.⁴¹

The distinction that is made in the dictionary definition of function is that it is 'the special kind of activity proper to anything; the mode of action by which it fulfills its purpose'. As we have seen, in order to decide what the purpose of an artefact or part is, we need to refer to the purpose of the relevant human agent involved. The beliefs and intentions of the designer or maker in creating it or of the user in using it determine the activities that are proper to a particular artefact. Some reference is therefore required in the analysis both to the fact that what is done by A serves some end, and that the end served is that of some relevant human agent.

The least restrictive form that provides a reference to an end served would result in the partial analysis :-

'A does F and F serves some end'.⁴²

One difficulty with the analysis as it stands is that although A does F and F serves some end, there is no essential connection between A doing F and F serving that end. It does not therefore exclude the possibility of F serving an end accidentally. If in the case of my lamp/print dryer, I place prints under the lamp in order to examine them, and incidentally they are dried by the lamp, and I intended that the prints should be dried (although not by the lamp) then on the above analysis, the function of the lamp is to dry prints. This is clearly not the case. That the prints be dried was not something intended in using the lamp, although I intended that the prints be dried, and the lamp did in fact dry the prints.

The use of any artefact will have some adventitious consequences, and some of these may serve my purposes, but this does not entail that they are functions. I wear glasses to compensate for defects in my sight, and incidentally they are effective in keeping dust out of my eyes when I am cycling, but that is not their function.

⁴¹ It will be seen that the direct substitution of a description of an activity in the form of either a gerundial expression or of a verb construction in the infinitive for the place marker F in the analysis, will not always work. Some alteration of the tense or a bracketed notation might be required. This will also be the case as further additions are made to the analysis. Since we are assuming for the present that A is actually doing F when we consider a function ascription in respect of it, this will usually mean changing the verb to the present tense. Any problems that arise in respect of the philosophical or logical import of such grammatical changes will be considered at a later stage in the analysis.

⁴² An analysis of this form is suggested by Woodfield [Woodfield 1976], who notes the kinds of complexity that can be involved in the reference to whose particular ends are served. Rather than specify in the analysis whose ends are served, one could regard the schematic function statement itself as elliptical for a fuller statement that relativises the function to some agent or set of agents. Rather than specify the particular agent involved, one can stipulate that the agent whose ends are served by F is the same agent for whom F is functional. For the present we will assume that the agency is consistent.

In addition to the fortuitous consequences of F being done by A, problems also result for the analysis from the fact that some of the things done by A may in themselves be accidental. This may be so even in a case where what is done by A accidentally, was an intended outcome serving a purpose. If a spanner falls into the works of my printing press and lodges in the mechanism in such a way as to slightly restrict the movement of the registration adjustment lever, and this results in the prints being perfectly registered; then on the above analysis we would have to conclude that the function of the spanner was to affect the adjustment in registration (assuming that I intended that the lever be restricted to effect perfect registration). I think that it is clear in this case that to suggest that the spanner has such a function is incorrect, since the action and the outcome are accidental.⁴³

Certain modifications must therefore be made to the analysis to indicate that F is not just done by A accidentally, but rather that A was intended to do F. Reference must also be made to the fact that F does not just serve some end fortuitously, but was intended to serve an end. The analysis could initially be augmented as follows :-

‘A does F, and
A is intended to do F, and
F is intended to serve end E’

The question arises as to whether any end intended to be served by the activity F is relevant to the ascription of F as a function of A, or whether a particular end must be specified in respect of which A is intended to do F.

We can imagine circumstances, for example, in which a component A, an upright in a structure, is intended to stiffen the walls for the purpose of bracing the windows, but where in general the activity F in the system is intended to serve the purpose of supporting the roof. Would we be justified in ascribing F as the function of A in respect of the fact that F (stiffening the walls) serves the general end E (supporting the roof), as we seem to be in calling F the function of A in respect of the particular end E₁ (bracing the windows), the purpose that A serves in doing F. Although the latter ascription seems

⁴³ An alternative view is advanced by Purton [Purton 1979] in his discussion of an analysis by Wright [Wright 1973] in which the distinction between accidental and intended effects is raised. His contention would be that we withhold calling such an effect a function not because it is accidental, but rather because the spanner would not be regarded as part of the machine. I think this is implausible. If I place the spanner in the mechanism in order to restrict the lever, then I think it would be correct to say that the ‘function of the spanner is to restrict the registration lever’. There is no strict and one-sided relationship between describing something as a part and ascribing functions. We cannot assume at the outset that all parts of artefacts necessarily have functions, some may be entirely superfluous. Conversely, in some circumstances the fact that I make an impromptu addition to a mechanism in order to contribute to its proper working will constitute good grounds for calling that addition a part of the mechanism. Even though in this case there are probably good reasons for not regarding the spanner as part of the mechanism, the fact that I use it to effect an intended contribution to proper working is sufficient to regard it as functional.

justified, I think that the ascription of function is in fact misplaced. Even though it is true to say that the ascription of function is only justified in relation to a relevant end, an end which is directly related to the artefact or part in respect of which the function is ascribed, the way in which such reference can be made is restricted by a complication in the nature of function ascription itself. In the present case in order to ascertain the function of A, we need to discover what are the limits within which it makes its essential contribution to the system of which it is a part. Which aspects of its relation to the system controls the form that can be taken by A in making its contribution to the system. The intended contribution that A makes in this case is clearly 'bracing the windows', and in the absence of any further specification, A could take any form that contributes to the system under this description.

The particular way in which A makes its contribution to the system is not relevant. The fact that the bracing of the windows is accomplished by stiffening the walls is incidental to the function of A even though it was intended that A should brace the windows by stiffening the walls. The purpose that A serves could have been served if A had taken the form of a window frame buttress rather than a wall stiffener. If we are to choose a functionally equivalent substitute for A within the system then we would have to look for something that would brace the windows, regardless of whether it did this by stiffening the walls.

The second of the examples given above, in which the activity F is called a function of A because it is the means by which A achieves the end E_1 , is initially more plausible than the first example, because it does not sever the relationship between A and the end served. In the first example the only connection between A and the end served is through the medium of F. However as we have seen this initial impression is not well founded, but in fact stems from a complication in the grammatical forms that can be taken by function ascription itself, which has implications for the proposed augmented analysis as a whole.

A function may be ascribed directly to an artefact, for example, 'the function of the spring is to drive the mechanism'. We will term this form 'Simple Function Ascription'. In many cases however we ascribe functions to artefacts less directly, and without the use of the word 'function'. We might say, for example, that 'the spring turns the spindle in order to drive the mechanism', or more simply 'the spring is there in order to drive the mechanism'. In these cases function is ascribed in virtue of the meaning of the teleological connective 'in order to' which precedes the activity described. We will term this form of ascription 'Teleological Function Ascription'.⁴⁴

⁴⁴ These distinct ways of ascribing functions correspond to the distinction that is made between Functional Analysis and Functional Explanation by Nagel [Nagel 1961]. A similar distinction is made by Woodfield [Woodfield 1976] who distinguishes between Function Statements and Functional Teleological Descriptions.

In Simple Function Ascription an artefact (or part) is specified as having a certain function. Such a statement might be the answer to a question such as 'what is the function of that part?' In Teleological Function Ascription the existence of the artefact (or part) or the activity that it performs is explained by indirect reference to a function that it is said to have. Such an ascription might be an answer to questions such as 'what is that artefact for?' or 'why does it perform that activity?'. The grammatical form taken by the two types of ascription are distinct in that Simple Function Ascription is two-termed and superficially of subject-predicate form, whereas Teleological Function Ascription is three-termed and includes a main verb in the infinitive or an associated verb construction.⁴⁵

The grammatical form of the three termed teleological form of ascription can be assimilated to that of simple ascription, if the activity or property of A is treated as though it were part of the description of A (for example, 'The function of A's doing F is to E').

The augmented analysis presented earlier can therefore be seen as equivalent to a conflation of the two forms of ascription. In the light of the previous example relating to window bracing, it became clear that in order to determine the function of A, it was necessary to look for the essential contribution made by A to the system of which it is a part. In identifying end E as that contribution, the activity of F was relegated to the role of the means by which E was actually achieved by A. This is equivalent to the form of Teleological Function Ascription exemplified in the previous paragraph.

In considering possible additions or modifications to the augmented analysis, it was concluded that an extra intentional element was required, relativising the activity to an end. Leaving aside for the moment other issues, this might be expressed as :-

'The function of A is F'

is equivalent to

'A does F, and
A is intended to do F'

I think that it is clear from the examples that the equivalence is not well made. Although the pillar does stiffen the walls, and is intended to stiffen the walls, its function in the structural system is in fact to brace the window and it does this by stiffening the walls. Similarly in the case of the clock, the spring does turn the spindle, and is intended to turn

⁴⁵ Arguments have been advanced for regarding both of these forms as primitive. Wright argues that function ascriptions of all kinds are intrinsically explanatory, and that the simple ascription of function, on analysis, yields a teleological form of statement. [Wright 1973;1976]. The majority of authors that give consideration to the question regard the simple ascription of function as basic, and that although they may be explanatory under certain circumstances, they are not intrinsically explanatory and their power to explain is contextually dependent. [for example Cohen 1951; Woodfield 1976].

the spindle, but its function is to drive the mechanism by turning the spindle. It can be seen that the inclusion of a bare reference to the system of which A is a part, would not assist the analysis. What is still required is a distinction between those activities that are performed by A that are in some sense essential to A, and those that are incidental, whether intended or not.

In the context of the examples, this amounts to a distinction between activities that are functions of A and those that are merely the means by which those functions are fulfilled. Since the distinction sought is intended to differentiate between the activities of A that are merely the means to further activities, and those that are not, perhaps such a restriction could be placed on F in the analysis. This could be expressed positively by requiring that F be an end :-

‘A does F, and
A is intended to do F, and
F is an end’

The difficulty remains of giving a suitable meaning to the term ‘end’ so that proximate ends are excluded, and ‘means’ to ends are not regarded as proximate ends. The problem is that these terms are relative and what is regarded as an end at one level of system analysis may be regarded as a means at another level. In the earlier example of the clock, for example, we could regard the turning of the spindle as an end under a restricted analysis of what the spring does, but we could equally regard the turning of the spindle as a means to the end of powering the mechanism. Although it was seen that intuitively there are reasons for adopting the latter alternative, the difficulty lay in formulating a general specification for the level of analysis of a system that would isolate those ends relevant to function ascription.

The general problem posed by the relativity of the terms ‘means’ and ‘end’ are brought out by Peters, who indicates that if something can be regarded as an end,

‘...this is not because it is a definite terminating point of activity but because activity previous to it varies concomittantly with changes in the conditions necessary to define it as an end. The concept of means is just as necessary to bring out what is meant by an end as the concept of end is to bring out what is meant by a means’.⁴⁶

Which provides the clue that rather than define ‘end’ in terms of its relation to a system at a particular level of analysis, one might define it in terms of that for which it is an end.

⁴⁶ Peters 1958, p6.

As we have seen, in order to fulfill functions, artefacts and their parts must conform to certain performance criteria that are defined by those functions. The form that they can take is governed by certain criteria that are constituted by the minimally acceptable limits of their intended performance or use. The relationship is one of the fitting of an artefact or part for a particular intended performance or context of use. In which case the requirements of that performance or context of use define the working limits acceptable for that artefact or part.

In terms of possible modifications to the analysis then, the function ascribed will vary in accordance with the ends used as specifications. If the design and manufacture of the spring was passed to a sub-contractor, whose knowledge of its context of use was limited to the fact that it was required to supply some level of power in turning a spindle, he would use this as a specification for the spring and regard this as its function. In the light of further information the function ascribed might change, as would the specification. The analysis could reflect in this way the different possible levels and perspectives in the analysis of a system and the consequent alternatives in whether an activity is regarded as a means or an end, and thus warrant a range of functions ascribed.

The difficulty of finding a general specification for the intuitively relevant end in different function ascriptions so as to exclude ends too proximate and ends too remote, is also overcome. The ends that are relevant in function ascription are those ends that are used as specifications for an artefact or part, in relation to a particular intended performance or context of use, by an agent responsible for their design or manufacture. In so far as reference to the agents involved remains external to the analysis at this stage, in accordance with the earlier stated proviso, we could incorporate the above modification in the formal analysis as follows :-

‘A does F, and
A is intended to do F, and
F is an end which defines the performance criteria for A’

Before considering this formulation further, we shall return to certain aspects of the analysis, hitherto left in abeyance. We have so far left the question of the temporal scope of a function ascription open, by assuming that the artefact or part under consideration is actually performing its function at the time the ascription is being considered. We will now drop that restriction.

It is clear that not all artefacts with accepted functions will actually be performing them all the time. Desklamps spend a fair proportion of their time switched off, and raising hammers remain in cupboards. When they are not in use we do not regard them as having temporarily lost their functions, but rather we regard them as having functions although

they are not being fulfilled. We might therefore think that an artefact has a function in so far as it performs the activity on some occasion, and thus can be seen to have the capacity to perform the function.

However it also seems correct to ascribe a function in respect of an artefact that never fulfills that function. Safety devices may never be brought into play, and clocks remain unwound and unsold. These cases suggest that what is required in the analysis is a dispositional sense of 'does' rather than a staunch 'A does F'. In the appropriate circumstances 'A would do F'; 'A is capable of doing F'; 'A would be capable of doing F if it was in working order', and so on.

It is however possible to construct examples which suggest that even the substitution of a dispositional form would not be adequate. There are circumstances in which it appears to be correct to describe something as having a function F even if it never actually does F and would not generally be thought to do F in the appropriate circumstances. I might hold the belief that I can kill werewolves with a silver bullet, and manufacture one for that purpose. I would say that the function of the silver bullet is to kill werewolves. The fact that there are no werewolves, or if there were they might well be immune to the effects of silver bullets, does not seem sufficient in itself to deny my ascription of that function to the bullet. The fact that I create the bullet in accordance with my belief and my understanding of the performance criteria required of the bullet relative to my belief, seems in some sense to be sufficient for me to correctly ascribe that function to the bullet.

In general although I may be mistaken about the capacity of A to do F, the fact that I believe that A is capable of doing F, and I use F as the specification for A in the light of that belief, is sufficient for me to say correctly that the function of A is F. Function ascription is thus relativised to the beliefs of the human agent involved.

Although this appears to add a further complication to the general formal analysis of function, it may not be necessary to modify the analysis by the addition of dispositional or conditional clauses and some form of relativisation to beliefs. An alternative approach would be to drop the A does F clause altogether, leaving :-

'A is intended to do F, and
F is an end used to define the performance criteria for A'

This would leave open the question of whether A does F always, sometimes or never, but would leave the required intentional element intact. It also preserves the essential point that in the case of artefacts the function ascribed is that end served which is used as the specification for an acceptable A. It would also appear to be unnecessary to include a

clause relating to A's capacity to do F, which as we have seen need in the extreme case only amount to a belief by the agent responsible for A, that A has the capacity to do F. This is the case because if A is intended to do F by an agent, this in itself implies that the agent believes A to be capable of doing F.

The proposal for an analysis of

‘The function of A is F’

is therefore

‘A is intended to do F, and
F is an end used to define the performance criteria for A’

The proposed analysis has been developed primarily through the consideration of examples drawn from the core sense of function as an instrumental concept relating physical parts to wholes, which is the sense common to the broad use of the term in different design contexts and theories. Nevertheless the final form of the analysis does not restrict itself to contexts and conceptions of this kind. This is important because ‘artefacts’ as a general term for non-natural things can include uses which are not squarely physical or instrumental in the core sense, and more significantly because the ‘function’ concept, as opposed to the term, has a high degree of generality across contexts. One test on the viability of the analysis rests on its capacity to survive the transposition to such contexts.

It seems clear that the analysis will serve in non-physical contexts. The function of ‘a right to veto’ in a decision making context might be to enable an individual party to prevent the forwarding of a decision to which they do not agree, in spite of the concensus of all the other parties. It is clear that the right to veto is intended to meet that described end, and what constitutes a veto (its performance criteria) consists in whatever forms relevant to the context meet the criteria prescribed for the achievement of that end. There may be a variety of ways in which a veto can be expressed, but what is common to them is the fact that in the given context the specification for the properties that they need to hold to constitute a veto, are defined relative to achieving the end. In bidding at an auction the function of my raising my hand is to enter a bid, but I might also do this by tweaking an ear or rubbing my nose. The end ‘entering a bid’ does not of itself define the form of the action, but rather constitutes that in terms of which some of my actions can count as functional relative to the context. The range of acceptable forms are those which in the context meet the criteria set by the end. In this case there will be a set of conventionally accepted actions that are taken as constituting ‘entering a bid’, and which if performed will be assumed to have that function, but it will nevertheless be a matter of interpretation

and judgement in a given case, and where an action is judged to be accidental, it will not be taken as functional relative to the end.

In many cases where it would not be natural to use the term 'function', the concept is nonetheless in play. A question such as 'why is the button red?' is likely to prompt an answer such as 'it is red in order to indicate that it is an emergency stop button'. The general form of questions of this kind are cues to two distinct kinds of response. On the one hand they potentially cue a request for an analytical causal account - 'the button is red because the plastic from which it is made contains a red pigment' - on the other they may cue a request for a teleological explanation of the type given in the above example.⁴⁷ The teleological version of the question signals a request for a distinction within types - why is it red rather than green, or some other colour - on the assumption that a choice has been made for a reason and with some aim in mind. The underlying question is of the form - 'what is the reason for its having been made to be red', and the response follows the pattern of implicit functionality. The red colour of the button has been selected in order to indicate that it is an emergency stop button, and the choice of red as an appropriate colour has been made in the light of that intention. The criteria for colour choice are framed by the intention, and the appropriateness of a given colour choice is judged in the light of our beliefs relative to that intention. Red is a good choice in terms of the attribute 'colour' since it stands high in the order of colours ranked relative to the intention of 'indicating emergency stop-ness'.

The core of functionality is selection in terms of properties or attributes, in the context of a reciprocal means-end relation. Selection in this sense implies the existence of a value system - the selected item or attribute is judged to meet the criteria for selection inferred from the intended outcome, to some degree, and some things will be perceived to meet the criteria better than others. Things or properties may de facto be selected, for example, in that they may be selected by separation due to the action of some physical process, and things or properties may be selected in their separation by the application of a physical process, but 'selection for' (selection in the context of a means-end relation) implies that the criteria for selection embodied in the means of separation are defined relative to the intended outcome. Whilst particles may naturally separate into layers in solution, and may be separated by placing them in solution, each depending on the selective effect of some of their properties, the intention to separate them by placing them in solution depends on understanding the reciprocal relation between that intention and the inferred criteria

⁴⁷ The interpretation of the question marks out a distinction in assumptions made relative to natural and artefactual orders. The question 'why are leaves green?' is more likely to lead to the answer 'because they contain chlorophyll' or 'because they are full of green stuff'. In artefactual contexts it is assumed that attributes have a banal causal agency (it is red because someone made it to be red, in the kind of way that things come to be made red) whilst in natural contexts it is the presence of an attribute that is first in need of explanation. This is of course not the end of the story. Having established the primary vehicle for an attribute, the question of agency, genesis or teleology can equally be raised.

identifying properties relevant to that means of separation.

It will be clear from the above examples that the application of the concept is essentially normative. The possibility of ascribing function in particular cases rests on the existence of a background which embodies a relevant value system, and the possibility of the individual ascription of 'weird' functions depends on the institution of function ascription itself, which in turn depends on shared conventions and normative conceptions of reasonable belief and intentionality.

It would be possible to build some sense of the normative nature of 'function' into the preceding analysis, but this would involve unpacking the notions of intentionality prior to their consideration in the context of affordance and meaning, which would take us too far from what is conceptually embodied in product semantics.⁴⁸ For the present we will accept the analysis, noting the normative sense in terms of which it is underpinned.

In the case of artefacts it is clear that the function relation is not intrinsic, and the doctrine of functionalism is false, since form is not determined by function, but rather the criteria for their co-relation are defined in terms of an intended outcome, leaving open the possibility of there being different ways of achieving a given outcome. In the case of 'natural' functions, on the other hand, it may seem as though we are dealing with the discovery of intrinsic relations - we discover that it is the function of the heart to pump blood, or the function of chlorophyll to support photosynthesis. But in these cases the move from a causal description (the heart pumps blood, chlorophyll supports photosynthesis) to a functional description, also involves the operation of a value system. The function attribution confers a normative status on the relation between a thing and its activity. It is not just asserting the fact that hearts do pump blood, as rivers flow to the sea, but that they are there to pump blood. The fact that some natural things are given normative status is reflected in the degree to which we are able or willing to apply judgements of performance - a 'malfunctioning heart' is appropriate but a 'malfunctioning river' is not. But the relation is not intrinsic and the normative status deceptive. The attribution of function is made relative to some purpose or end that can be asserted of the system in question, which provides the basis for a value system supporting judgements of relative performance. In the case of artefacts we either know or presume what they are for - what they are there to do - and can thus assess the degree to which they succeed, and the relative contribution made by the parts of which they are

⁴⁸ This could be expressed within the analysis, for example by separating the intentional element from the core expression. The analysis of 'The function of A is F' might then take the following general form - 'X intends that A is there to do F, and F is an end used to define the performance criteria for A'. (Where X is the relevant agent, and intends is the general term for intentionality which captures the sense, both of belief and determination). The normative aspect could then be expressed in terms of the conventional constraints on 'intending'. This would preserve the structural analysis, and allow room for the application of normative criteria, without assigning priority to either individual or collective notions of intentionality.

composed. In the case of some natural kinds - notably living things - we make a similar presumption in the ultimate criterion of survival value.⁴⁹

The proposed analysis of function has been developed for the case of artefacts, but it clearly could be argued that the sense of function is common in both natural and non-natural contexts, and relativisation to intentionality precludes a common application. Although this is strictly true, given the specific form of the analysis of function for artefacts, the perspective or theory dependence of function attribution in non-artefactual cases suggests the basis of a common sense. In both cases there is a core underlying account which is essentially causal - 'the spring turns the spindle', 'the heart pumps blood'. In the case of artefacts the teleological form of expression reflects the presumption of agency, which is broadly captured by intentionality - 'the spring is intended to turn the spindle' or 'is there to turn the spindle' - which underlies the normative character of function attribution. In the case of natural kinds the normative character stems from the presumption of generality - the move from 'this heart pumps blood' to 'hearts pump blood' - coupled with the theoretical perspective providing the context in which these events are given sense. In both cases there is a core causal description, a normative character to the attribution of function, and an implicit intentionality which in the one case takes the form of the presumption of agency implicit in the 'folk psychology' of persons and action, and in the other a relativisation to particular beliefs or systems of belief.

The different senses of 'function' are essentially a reflection of different locations on a continuum of contextualisation. At one extreme of the continuum, process-oriented (synthetic) uses of the concept emphasise the senses of function which lie closest to the idea of assigning a role to some thing or attribute. At the core of the continuum which takes in both process and product and their relation, the paradigm uses of the concept revolve around the instrumentality and conditions of instantiation of means-end relations. At the other extreme, product-based (analytic) uses emphasise the idea of discovery - finding out the actual role of some thing or attribute, relative to an assumed context.

⁴⁹ It is the fact of a value system, rather than its particular form, which licenses function attribution. Christian fundamentalists would presumably wish to assert that God made all things and made them to have a place and a purpose within the order of things. Their value would reflect that place and purpose, and functions ascribed accordingly. Evolutionists, on the other hand, would deny that there is anything other than a de facto natural order, but assert that there is a value in survival or reproduction for the persistence of a genotype. Which is not to say that the purpose of the natural order is genotype survival - it has no intrinsic purpose - but rather that success or failure in survival (which is simply a de facto matter) is the criterion that we adopt as the basis for making judgements of relative performance. Assertions of both kinds are theory or perspective dependent. The degree to which we are willing to assign functions depends on our view of the natural order. In the context of some theories, the Gaia hypothesis for example, rivers and forests have functions and can therefore malfunction, because they are considered to be parts of a global system with the ultimate value of homeostasis.

Although the analysis of function reveals its relativisation to intentionality and ultimately to individual intention, this does not imply that the concept is inherently individualistic. This is so because it is the structural role of 'function' conceptually and linguistically which warrants both individual and normative conceptions, and one could reasonably hold either to be primitive in developmental or logical terms, in the absence of any further theoretical contextualisation or philosophical commitment.

3.4 The Role of Function in Design Discourses

The above analysis of 'function' draws together the strands of the use of the term in a range of contexts, and highlights its conceptual role in linking intentionality in relation to the natural and artefactual world with the contents of those worlds. The concept on this analysis is ultimately relativised to belief in so far as intentions are always the intentions of some agent whose sense of what might reasonably be expected to be able to fulfill some intention, and by what mechanism, fills out the account in a particular case. In this respect the justifiable instantiation of the concept in a given instance is belief-dependent and a matter for an individual.

Nevertheless, the use and articulation of the term takes place in a public rather than a private context, and as such is essentially normative. The countervailing force resisting the idea of the priority of individual accounts, draws its strength for example from the abstraction of the concept in the context of a discipline and its discourse. In this sense it runs parallel to the formalisation of terms generally in more restrictive contexts of use. In the case of 'explanation' for example, whose underlying sense might be given in terms of a process of communication in which someone is enabled to understand something on some occasion, the abstraction of the concept in the context of 'scientific' explanation removes the *ad hominem* elements of communication and understanding, replacing them with atemporal logically and epistemologically constraining rules on relevance, adequacy and completeness. These provide a strict and normative sense of what can count as an explanation, which is separable from factors which would be termed 'psychological'.⁵⁰

In the case of 'function' the normative sense is strongest in respect of the kinds of beliefs that are acceptable in linking an end with the means that are held to be responsible for it. On the whole a general consensus is achieved in respect of what kinds of links appear reasonable and acceptable, and these are defined by the commonalities occurring in our more general frameworks of knowledge and belief. Nevertheless, weird functions are intelligible. They are intelligible because 'function' is a marker for a particular nexus of relations involving belief, which apply equally to weird and to banal beliefs.

A second normative force is apparent in design discourses, and this relates to implicit restrictions that are placed on the kinds of intended roles that can appropriately be circumscribed by 'function', which typically underpin the interpretation of functionalist theories. In these cases some kinds of intended roles are excluded from the list of functions, and 'function' as a concept is restricted in scope to 'physical' or 'instrumental' functions. In the context of an extreme realist or behaviourist position, one can

⁵⁰Hempel 1965; Hughes 1976.

understand why the use of the term might be restricted to relations of physical causality or co-variation. One can equally understand why, in less restrictive applications, relations of this kind are treated as though they were primitive and fundamental, and other relations regarded as parasitic on this basic sense. In the process of the formalisation of informal concepts generally, parallel strategies are apparent, for example in the adoption of the idea of 'strict and literal meaning' as a grounding idea in the theory of meaning in the philosophy of language.⁵¹

However, such moves misconceive the scope of the concept. This is the case because the ascription of function makes no special appeal to, or denial of, the operation of causal relations. The operation of causality and the subsistence of causal relations are assumed to be operative in relation to function, just to the extent that it is assumed they are generally under whatever given metaphysical scheme is being employed. The point of the functional relation is to pick out relations of a particular kind - those that reciprocally link means and ends - whether these are conceived as operating under some strictly defined regime of physical causality, in terms of our folk-psychological conceptions or some acausal notion of mystical influence or divine agency. The assertion that 'the function of the yellow blob is to create a feeling of warmth (by symbolising the sun)' is no less central to the concept than 'the function of the spring is to power the clock (by turning the spindle)'. In general the concept links a means to an end, whilst leaving a place marker open in respect of the particular way in which the means is instantiated - 'The function of A is F (by X)', where the criteria for what counts as an appropriate reading of X is ascertained in terms of F.

In Product Semantic accounts, the function concept is assumed to be both determinate and deterministic. It is assumed that the sense of its general use within design is derived from the particular interpretation given to it in the context of functionalism. The form of A is determined by F. This is not inherent in the concept, which only goes as far as expressing that in the relation between A and F, F provides the basis for determining the criteria applicable to judging the relevance and acceptability of A. It is further assumed that in so far as design restricts itself to instrumental conceptions of user and product, which are taken to be inherent in the use of the function concept, it fails adequately to capture the totality and reality of product content from the point of view of the user. But in general, it will always be the case that aspects of a given product will fail to be circumscribed by what is determined as part of the design process. At the purely pragmatic level, many aspects of product content will remain undetermined in the design process even though they necessarily become determinate in the substance of a given product.⁵² The conclusion that the failure to take into account aspects of product content that it would be

⁵¹ For example in the analysis of theories of meaning. [Platts 1979].

⁵² Pye 1971.

desirable to take into account is due to an adherence to a design process centred on function, does not follow. If these further aspects of product content were to be drawn into the process then the inference could equally be that they should now be counted among the things comprising the functions of the product (to the extent that criteria for their content could be determined relative to some end).

Design as a process seeks to arrive at a specification for a product. Such a specification must needs be sufficiently determinate to enable the product to be brought into existence. There is no inherent constraint on how the specification is arrived at, nor any absolute sense of how determinate the specification need be in general, but only relative to a particular case. But what is necessary (but not sufficient) for any effective design process is an adequately determinate specification. Without this there could be no product.⁵³ Whether 'meaning' or some other notion better captures the core conceptual relation in a theoretical framework for design, than 'function', is yet to be discussed. But at this point two things should be clear. The assumption that function per se is determinate, deterministic and restricted to physical instrumentality is neither argued for cogently within the Product Semantic account, nor suggested or supported by separate analysis. Leaving other considerations aside, the contention that theoretical frameworks for design are overconstrained by the nature and central place of the concept of function, rests on a misreading of the nature and working of the concept.

The role of 'function' in design discourses can be generally summarised as follows. It is a relational concept linking means and ends, which provides a place-marker which can be filled out in the form of a particular means, and for which the relation indicates the bare logical conditions for a particular instantiation, in terms of the constraints which serving a given end implies for the case of the means. This (A) is there for that (F), and it is in terms of the relation to (F) that we ascertain the relevant criteria for choosing or evaluating a given (A).

⁵³ A specification can clearly take many different forms, encompassing different strategies to secure sufficient determinacy (including precise specification in terms of a formally defined structural or procedural representation, through to gestural indications relying for their force on tacit conventions or traditional precedent).

3.5 Function, Intentionality and Meaning

The above account of artefact function depends on the notion of derived intentionality. Artefacts have no intrinsic intentionality, and their functions are established via the intentionality of agents. In the case of natural organisms functions are similarly established relative to the intentionality of agents in the sense that licensing functions is relativised to beliefs held by agents (via their evolutionary or other theories). However there are features of the account common to both artefacts and natural organisms which appear to have a parallel status and which do not depend intrinsically on the idea of intentionality, derived or otherwise. These are captured by the idea of 'selection'.

Something has a function to the extent that its properties are selected relative to some end. To take the example of a vending machine equipped with a coin detector, we might say that the function of the coin detector is to recognise and accept genuine English coins (C's), which it does by going into state S.⁵⁴ This is what it is there for, and it is in terms of this that we are able to make judgements about the appropriateness of the various candidates for prospective coin detector. When the machine is working properly, we would expect it under normal conditions to recognise and accept C's, and not to accept anything other than C's. Nevertheless it would be unrealistic to suppose that any mechanism will perform perfectly, and indeed this machine will sometimes fail to accept perfectly good C's and will accept metal blanks of a certain size (B's) and German coins (K's), which just happen to be perfectly similar to C's. What enables us to judge that the detector has performed properly - has not made a mistake - is the intentional context licensing the function. The detector is intended to recognise and accept C's - to go into state S in the presence of C's and only C's. If it were not for this, then we would on examining the performance of the detector, only be in a position to conclude that it was a C, B, K detector.

If the same detector were installed in an equivalent machine in Germany it would continue to perform in the same way. However in this context it is intended to detect K's rather than C's and what would have counted as correct performances previously, now count as mistakes. The detector would go into a given physical state indicating this, but we might no longer be certain whether to call this state S, or to designate it with a new name to reflect the change in its function. Physically, nothing new is happening, and what makes this detector a K detector and not a C detector, and the state an S_K state rather than an S_C state, is the task in terms of which it has been selected.

⁵⁴ The vending machine example has become a standard example in discussions concerning meaning and intentionality since its introduction by Dennett [Dennett 1987] to counter the views of those opposed to evolutionary accounts of meaning, notably Fodor and Searle [Fodor 1980; Searle 1980,1985]. It is presented here in an anglicised and simplified form to meet the more restricted concerns of the current discussion.

The corollary of this parable is that a parallel story can be told which treats detection in the case of some organism on the same basis.⁵⁵ The frog's visual system, for example, is sensitive to small dark moving spots on the retina, which in the wild is generally instantiated in the form of passing flies. The 'fly detector' is connected to the mechanism which unleashes the frog's tongue, and thus provides the frog with nutrition. Although we will be unable to distinguish between the detector qua 'fly detector' and 'small dark moving spot detector' on the basis of what is evident about the mechanism and its states, we will be able to do so on the basis of the actual environment of selection. It is a 'fly detector' (that is its function) because the relevant environment of selection is one involving flies and not small dark spots. If frogs were to be transposed to artificial environments in which flies did not exist but where food pellets regularly moved across the visual field, sensed as small dark moving spots, then presumably selection would take place in terms of food pellets.

In what sense is it possible to say of such a case that the function of the mechanism or the meaning of its state-content has changed? As in the case of the artefact, the mechanism remains the same, with the same limits to its discriminatory capacity. It is the environment of selection that has changed, and it is this that licences talk about changed functions and meanings - the function of the mechanism and the meaning of its states - or talk about functions and meanings at all.⁵⁶

Where does this leave human intentionality. The analysis of artefact function and natural function relativised the concept to intentional content - the intentions and beliefs of agents, but these remain unanalysed. The above examples relativise function to environments of selection, in both artefactual and natural cases, which could conceivably be articulated without reference to intentionality and in terms only of de facto conditions of selection. Given that the relation between the psychological states (of human beings) and their contents must presumably have developed through some parallel process of selection, can we dispense with intentionality generally in the case of accounts of both function and meaning, in favour of some account based on de facto selection. This is clearly a large question, and any response will depend on issues yet to be addressed, but for the present it is sufficient to note that the examples outlined above can motivate arguments in either direction. On the one hand they can be used to support the notion that there is nothing

⁵⁵Traditionally a frog detecting flies. The example is derived from the classic paper by Lettvin, Maturana, McCulloch and Pitts 1959.

⁵⁶Dennett, in his discussion of such examples notes that the principal criticism of evolutionary accounts of meaning is that they are insufficiently determinate - they fail to motivate an intrinsic distinction between kinds of content (for example between 'fly here now' and 'dark spot here now'). [Dennett 1995, pp407-410]. However it is clear that the idea of an intrinsic determinate distinction of this kind would be generally incompatible with the idea of selection and evolutionary theory, since for selection to take place there must be some inherent indeterminacy with respect to content. The evolution of mechanisms generally is dependent on the possibility of relational change, which in turn depends on some flexibility in the terms of the relation.

special or prior about intentionality - it is simply a way of describing an emergent property of systems at a certain level of complexity in their adaptational relation with their relevant environments. On the other hand they can be used to support the idea that no sense can be given to the notions of function and meaning outside a context which is driven by human intentionality.

For the present it is sufficient to note the following features of 'function'. It is a relational concept which reciprocally links means and ends, in terms of the way in which the criteria for what can be counted as means are constrained by the connection with identified ends. It is a normative concept, in that acceptable links between means and ends are conventionally established, either by agreement, consensus of belief, or de facto conditions of selection, for example. It is also a normative concept in the sense that the attribution of function goes beyond the description of causal or covariant relations, and requires contextual evaluation. In the case of artefacts, and by derivation natural organisms, function is most naturally articulated in terms of the intentionality of agents (for example the desires and beliefs of individuals), but the license for individual function ascription derives from the generality of ascription which in turn depends on the institution of ascription. The question of whether the institution of function ascription depends ultimately on the priority of intentionality, or whether this can be analysed in terms of selection, remains open.

The connection between function and meaning that can be articulated in terms of the discussion so far, is broadly illustrated in the above examples of detectors in artefactual and natural contexts. The function of a mechanism consists in those aspects of what it 'does' which are the subject of selection. But whereas a function is ascribed to the mechanism in terms of the subject of selection, meaning is ascribed to states of the mechanism relative to the process of selection. A given state has 'meaning' in so far as it can be identifiably related to that process. If the priority of intentionality is asserted, then this is equivalent to saying that the function of a mechanism relates to those aspects of what it 'does' which are intended, and meaning is attributable to those states encompassed by the intention. If the priority of intentionality is not presumed, then the function of a mechanism relates to those aspects of what it 'does' which are the basis for some process of selection, and meaning is attributable to states of the mechanism in terms of which selection takes place. In the one case it is more natural to think of the meaning relation as more inclusive, with function as a special case of meaning, whilst in the other the function relation is more naturally inclusive, with meaning as a special case. But these need not be presumed to be mutually exclusive positions if generalised, nor exhaustive in terms of the possible relations between meaning and function.

Section 4 Affordance

| | | |
|-----|--|-----|
| 4.1 | The Concept of Affordance | 99 |
| 4.2 | Affordance in Product Semantics | 111 |
| 4.3 | An Analysis of Affordance | 119 |
| 4.4 | Affordance and Semantics | 125 |
| | <i>Affordance, Function and Teleological Semantics</i> | 125 |
| 4.5 | Affordance and Cognitive Models | 130 |
| 4.6 | Role of Affordance in Design Discourses | 136 |

4.1 The Concept of Affordance

In product semantic accounts the concept of function plays a subsidiary role to meaning, and is generally reserved to refer to the objective description of instrumental relations in the context of physical causality, and as such to the deterministic embodiment of designer's meaning in product specifications. Given their central contention that the key to design theory and practice rests on understanding the product interface from the point of view of the user, it is perhaps not surprising that in seeking to ground the idea of product meaning in the perceptual and cognitive content of user-experience, proponents have turned to the concept of 'affordance' as one of a group of linked concepts used to articulate the nature of meaning relations, rather than 'function'.

The concept of affordances plays a central role in Product Semantics theory, for example, in linking meaning and sense with understanding, perception and cognition. Affordance itself is not defined explicitly within Product Semantics, but is more often alluded to in references to the work of Gibson from which it is drawn,¹ and further characterised in the way that it inheres in an overall conceptual scheme underpinning user-product interaction. Vihma² and Krampen³, for example, make direct use of Gibson's scheme in developing the idea of affordance in the context of product semantics. Krippendorff refers to Gibson but introduces the idea in a more fundamental way, and in terms of the central aim that he perceives to lie at the heart of Product Semantics both as a philosophy, and as a collocation of design methods, in

'....understanding the different practices of interfacing with designed objects.'⁴

Understanding generally, is conceived as involving the interaction (or the creation of connectedness), between different modalities of experience.⁵ Understanding in a given situation is thus akin to creating a systematic complex pattern of percepts rooted in experience. In respect of 'things', understanding involves relating them in this way to

¹ Gibson 1966, 1979.

² Vihma 1995.

³ Krampen 1989.

⁴ Krippendorff 1990, p a10.

⁵ Krippendorff 1990, p a11. Understanding is here conceived as the systematic relation between cross-modal sensory experiences in given contexts, and as such appears to be unsupported by a particular theoretical framework. However given the general philosophical commitment that Krippendorff espouses, this would be an oversimplification of his position. His concept of sensory perception is in fact rooted in the idea that the dichotomy represented by perception vs cognition is misconceived, and perception/cognition is in itself 'meaning-laden' in a sense that is perhaps similar to position taken by Heidegger [Heidegger 1962] and some phenomenologists [Merleau-Ponty 1962] and the psychological stance taken by Neisser [Neisser 1976] and the later versions of ecological theories [Gibson 1979]. This contrasts with the distinction that is made between perceptual and cognitive meaning, where perceptual meaning encompasses interaction between modalities, and cognitive meaning is reserved for constructions relating to propositional knowledge.[See for example, within the product semantic tradition Smets 1989; Smets and Overbeeke 1994, 1995].

their contexts of use and practice. 'Meaning' and 'sense' are linked to understanding and explanation as distinct manifestations of our experience of things which are related in the following way.

'Something makes sense when we understand the role it plays in a particular context, when we have a satisfactory explanation of it.'

Meaning, is constituted in a gathering together of contexts of making sense, extrapolated to include imagined contexts, so that

'...the meaning of something is the sum total of all the contexts within which someone is capable of imagining some sense for it'.⁶

The abstract sense of 'meaning' then captures the generalisation to a range of contexts the variety of senses that could be made of something in different settings. Affordances are the relational properties characterising the range of practices (and associated cognitive models) that are actually supported by a thing, and constitute the means by which sense making, understanding and meaning are grounded in perception and physical experience.

If the meaning of a thing consists in the range of practices or cognitive constructions apparently supported or afforded by that thing, then it is possible to conceive of a mismatch in the sense that our expectations may not be met. On this conception, the role of the designer is to design products whose affordances (models and practices actually supported) are at least sufficient to match their meanings (models and practices apparently supported).⁷ A chair which looks comfortable, but which turns out to be hard to sit on, fails to afford the kind of sitting that it meant.⁸

Vihma, locates the concept of affordance squarely in the process of perception, and following Gibson, characterises perception as information-based rather than sensation based. Although the perception process is directed by knowledge about the world, which affects our expectations, particularly in the form of positive feedback, and perception is active in the sense that 'preconceptions' are significant in shaping a perceptual process which consists in active interpretation, the key to understanding the process lies in the idea that our experience of the world is inseparable from our 'readiness to act'. This view

⁶Krippendorff,1990 p a12

⁷Krippendorff,1990 p a12 'Product semantics aims at the design of things whose affordances cover at least the range of meanings users have in mind...'

⁸Note that this formulation is not the same as that proposed by Gibson [see below pp 101-105]. Gibson squarely locates the source of 'meaning' in the object, in the sense that what is afforded rests on the physical properties of the object, even though the affordances of particular species consist in the organisations of those properties that are attended to by species members. Krippendorff is anxious to keep hold of a stronger cognitive element in the interaction, and does so by shifting the emphasis from the object to the model that the user has of the object.

of perception is equated with the essential intentionality of perception in Husserl's philosophy, Wittgenstein's use of the concept of 'seeing as' and Gibson's psychological concept of 'perceive affordance'.⁹ It is also traced back to the term 'demand character' in Koffka's scheme for gestalt psychology, and linked to Krampen's use of the notion of 'invitation character' and Lannoch's 'action opportunity'.¹⁰ Nonetheless it is Gibson's theory of affordances and direct perception that has been most influential in shaping product semantics.

The concept of 'affordance' was developed by Gibson as part of an attempt to provide a 'direct' explanation of the perception of the properties of the environment. The difficulty encountered generally in psychology in providing satisfactory explanations for the perception of shape, size, quality, position and change in objects, had led him to question the fundamental assumptions upon which the mainstream of perception psychology was based. The key assumptions implicit in the mainstream position are traced back to the philosophy of Locke and the distinction between primary and secondary qualities, and to the Cartesian programme to integrate physics and psychology through the conceptual framework of a primary/secondary quality distinction. The primary qualities identified by Gibson (position, shape, size, duration, motion, solidity) are those which are objectively measurable, and roughly equate to the core spatial and temporal dimensions that constitute the commonplace abstractions of classical physics and mathematics. The secondary qualities (colour, taste, smell, sound, warmth, coldness) are essentially taken to be the subjective sensations. The programmatic assumption of the mainstream position is taken to consist in the principle that objects are reconstructed in perception or cognition from lower order percepts of their constituent properties or qualities.

Gibson contends that the concepts of physics provide an inadequate and inappropriate basis for the explanation of perception, as does a phenomenology without biophysical underpinning, and that a sounder basis can be found in an 'ecological' approach. Rather than accepting the primacy of properties framed in terms of spatio-temporal abstractions, or in terms of the phenomenal qualities of subjective experience, the key organising principle in perceptual explanation, could be conceived to lie in the constructive relationship between an organism and its environment. The concept of 'affordance' is intended to capture this in the sense that affordances are properties of the environment relative to a given organism.

In terms of prevailing theories of perception, Gibson's theory stands at one extreme of a continuum of positions ranging from the idea of 'direct perception' to which he

⁹ Vihma 1995, pp 47-50.

¹⁰ Krampen 1986,1989; Lannoch 1984.

subscribes, to the various versions of the idea of 'inferential perception' which represent the dominant view in recent psychology. Generally speaking all recent theorists acknowledge that information participating in the perceptual process is derived both from current sensory input and from previous knowledge and experience, differing in the importance accorded to each of these sources, and their more precise characterisation.¹¹

The essential features of inferential theories of perception are that perception is not directly given by the stimulus input, but rather that sensory information is used as the basis for making inferences about that stimulus, and thence about the world, through its interaction with internal hypotheses, expectations and knowledge. It is an active and constructive process and in so far as it is in part based on hypotheses, and results in perceptual projections which are only testable in action, will be subject to errors of various predictable kinds. In such theories the information available from sensory data is typically conceived as being partial, fragmentary and unsystematic, requiring considerable input from structuring processes derived from previous experience, for example.¹²

Inferential or constructive theories inevitably focus on the fallibility of perception, and their principal successes in terms of prediction and explanation have been in accounting for a range of perceptual errors. On the other hand the principal criticism of such theories stems from the same characteristic - they present a picture of the potential fragility of perceptual success which does not accord well with the fact that perception is to a very high degree successful.

In contrast, direct theories of perception deny the paucity, fragmentariness and unsystematic character of the sensory input, arguing that it is not only rich and well structured, but requires relatively little processing or hypothesis building. Gibson, the principal exponent of this theoretical perspective, drew on a range of experimental work principally related to visual perception and in the context of complex spatio-temporal tasks, to support his contention.¹³ He subsequently argued in more general terms that some higher order characteristics of the visual field change relative to others as subjects move within their environment. The relative values of these variants and invariants provide a rich systematic source of evidence that is directly perceived and used in action.

¹¹Theories of direct perception are also referred to as ecological, bottom-up or data-driven theories; Theories of inferential perception, sometimes known as constructive perception or constructive theories are also referred to as top-down or conceptually driven theories.

¹²Gregory 1973, 1980.

¹³Gibson 1966;1979. His work in this area developed from considering the optical information available to pilots in manouvring and landing. His observation was that the core of their perceptual information lay in what he termed 'optical flow patterns', the perceived motion of the visual environment relative to a fixed point towards which the pilot was moving, which was inherently structured in terms of the systematic relationship between the perceived speeds of parts of the visual field and distance, for example. He extended this idea to include a variety of other perceptual field concepts, including 'texture gradients'.

In extending this idea to perception generally he rejected the notion that the principal source of meaningfulness in the perceptual process lay in the interaction of percepts with stored knowledge and experience, arguing that objects are directly perceived in their potentiality, their 'affordances'.¹⁴ The content of a percept will then depend on the potential inherent in a given object, constrained by the capacity of perceivers to detect particular affordances, which will in turn depend upon their current psychological states.¹⁵ In short Gibson argues that all the information needed to make sense of the visual environment is directly present in the visual input and unmediated by inferential processes. I do not infer from some internal analysis the hypothesis that if I used the ladder then I could climb, but perceive the possibility directly.

Gibson's theory provides an antidote to the sense of fragility of the perceptual process emphasised in inferential theories and provides an explanation of the very high degree of accommodation that is in fact achieved. On the other hand the corollary for direct theories is that perceptual errors are difficult to account for, other than in a long term evolutionary context, although they undoubtedly occur, not only in the case of the highly artificial experimental situations that Gibson criticised, but also in real world contexts.¹⁶

Gibson's picture of perception gives a particularly important place to the role of the affordance relation in perceptual learning and development, the core of which is taken to be the assimilation of bodily location and stance relative to a systematically related range of higher order perceptual 'constructs'. The key elements of these for visual perception include spatial properties such as the spatial orientation and layout of surfaces and their occlusions, spatio-temporal properties represented principally in terms of change in spatial properties, and proprioception, the detection of self-location and self-movement (as distinct from kinesthetic feedback). The objective properties or physics of the environment provide the basis for all affordances, but the affordances themselves are constituted in the relations made by an organism with the properties of its environment, the essence of the relation lying in the potentiality that subsists in the interaction. Thus

¹⁴ Inter alia - a ladder affords ascent and descent, and a chair affords sitting. There are problems here of course, connected with the specificity of the context (eg. are the affordance of ladders perceived per se or only in the light of an appropriate context - a need to climb the tree in order to rescue the cat). On the one hand there does seem to be an element of learning and a normative social context, which form an essential part of an overall picture, whilst on the other one can conceive of perceptual primitives that are not conceptually informed in this way. This raises questions relating to the level at which affordance operates, particularly in relation to design products which might be conceived as fully socialised objects.

¹⁵ Gibson 1979. Gibson employs the examples of hungry or tired subjects and their perception of oranges and seats, but generally the discussion leaves it open as to whether affordance capacities are marshalled in response to psychological states, or whether they are focused by them in terms of selective attention.

¹⁶ Gibson criticised the theoretical inferences drawn from experimental results, particularly those relating to two-dimensional visual illusions which had played an important role in the development of inferential or constructive theories. Nevertheless in many cases these results are also apparent in three-dimensional real world contexts (eg the vertical horizontal illusion)[See for example Gregory 1973].

rather than inferring higher order structures and relationships from fragmentary percepts, the perceptual system is attuned to higher order structures per se, which are referenced in terms of action and the potential for action.

The classification and refinement of the concept of affordances is carried out in terms of a systematic consideration of the support for, or constraints on action which a variety of basic types of surfaces/surface layouts, or substances, potentially provide. Surfaces, for example, may be horizontal (affording standing or walking), vertical (affording leaning or preventing further progress), horizontal and raised (affording getting underneath and sheltering) and so on. Substances may afford pouring, smearing or shaping by manipulation, or resist change of shape, for example. The range of affordances which the same objective physical environment affords will be different for different species, defining their distinctive ecological niches. Affordances thus provide an organising principle for perception in terms of a level of description at which perception can be squarely located in the general run of the adaptive biological development of organisms.

Gibson contrasts his own approach with that of the Gestalt psychologists, in the location of his core interactive concept in the physical rather than the phenomenal object.¹⁷ The affordance does not change with the needs of the observer, but constitutes a permanent relation which is the ever present result of permanence in the properties of the physical object.¹⁸ It is this that provides the basis for a biological and evolutionary underpinning, in that the relation of potential and the nature of perception in a given species consists in the adaptive development of behavioural mechanisms relative to environmental factors. There are clearly factors lying outside this relation which will affect whether a given behaviour is marshalled on a given occasion, but the potential is built into the perceptually mediated behavioural relation. A given species has a particular set of adaptive relations with its environment, defined in terms of its action in relation to the objective physical properties of that environment, which are perceived directly in terms of action potential.

The corollary for Gibson is that on the basis of these constructs, one can approach the ideas of 'value' and 'meaning' in a new way. The meaning or value of a thing consists simply in what it affords. Taking this stance offers the possibility of challenging both the Cartesian dualism of the mental and physical, and the idea that meaning is located in a separate mental realm. On the other hand the degree to which the concept can be generalised and thus serve as a model for all human meaning contexts is questionable.

¹⁷ Gibson 1982, p 409. Koffka's 'demand-character' for example, is located in the behavioural rather than the geographical environment, stimulated by the need of an observer and cashed out in terms of a tension in the behavioural field including the observer and the object. Demand character would thus come and go in line with the changing needs of the observer [Koffka 1935].

¹⁸ Or characteristics of change etc (permanent does not imply unchanging).

The concept of affordances is essentially an ecological concept. It describes a developed relation of significance between a given species and its environment, accounted for in terms of evolutionary adaptation, which proposes a central role for higher order perceptual field constructs in the perception and understanding of the contents of our environment. This natural and ultimately causal relation is used to underpin the ideas of significance, meaning and value generally. The complexities of our interaction with the objects and events of the social world are to be accounted for in the same way as our interaction with the natural evolutionary environment. The underlying sense of 'affording', is taken to be the same in the case of a flat topped low rock and a chair affording sitting, an abacus affording arithmetical calculation, and an insurance policy affording peace of mind. The immediate difficulty lies in reconciling the more or less general and persistent physically characterised higher order constructs that could conceivably be the material for adaptive development, with the abstractions and changing conventions of the social order.¹⁹

Although this extension of the basic affordance concept to encompass social relations is evident in Gibson's writings, it is only fully developed within Product Semantic accounts. Krampen, for example, in a number of papers introducing the concept and reporting related empirical studies, moves smoothly from an account of Gibsonian basic affordances to 'ritualised' affordances, 'social' affordances and 'affective' affordances and thence to a distinction between 'denotative' and 'connotative' meaning. The essence of this transition lies in moving from the application of basic affordances, as general capacities relative to persistent features of the natural environment, to an equivalent account of tools, weapons and similar artefacts whose susceptibility to a similar analysis clearly depends on the simple relationship between their functionality and perceptible physical features. The recognition that the relationship between humans and their environments is considerably more complex than the basic relation acknowledges, is accounted for in terms of the development of 'ritualised' affordances, which are conceived as layered accretions to basic affordances, driven by processes of socialisation. Ritualised affordances are exemplified by social affordances such as the differentiation of types through specialisation of function, as in the social designation of buildings as houses, factories, schools and so on.

The recognition that an account which restricts itself to differentiation of type cannot do justice to the patent richness of object significance is addressed by Krampen through the distinction between denotation and connotation.²⁰ Whilst differentiation of type through

¹⁹ The use of the concept in this way is suggested and developed by Gibson [Gibson 1982] but is particularly marked in the way that it is taken up in product semantic accounts [for example, Krampen 1989].

²⁰ The terms denotation and connotation derive from their use in making a similar distinction in semiotics. [See for example Barthes 1967,1985].

the layering of basic and social affordances is essentially denotative - indicative of the distinction between kinds of thing, further significance takes the form of individuation of the members of a kind in terms of the nature and distribution of their properties. This aspect of signification is termed connotation, which is in part equated with style and assumed to operate through the operation of 'affective' affordance.

Throughout this complex transition the implicit assumption is made that the affordance concept has remained unchanged, but given the nature of the basic concept this is unconvincing. Whereas the basic level represents a biological adaptation to higher level feature detection relative to body movement and action, the additions are on the face of it dependent on communally held social constructs. Awareness of potentiality in the abstract sense of 'seeing-in-terms-of-the-possibility-of-action' does not in itself constitute identification or recognition of type, whilst recognising things as being of a certain type seems at least to imply the need for a conceptual structure if not conceptual representation. This appears to be the case even at the lowest level of social affordance, where type structure is already conventional rather than natural. But is particularly so at the more refined levels where further distinctions appear to depend on an analytic rather than a holistic relation to relevant properties.

The underlying problem is revealed in the idea of 'perceive-affordance' - embodying the fact that there can be a mismatch between what is taken to be afforded and what is actually afforded - a disjunction that is essential to the idea that something can be misperceived or misconceived, and equally therefore to the idea that it can be perceived or conceived. Affordance without 'perceive-affordance' in effect reduces the relation to a direct and inevitable connection between environment and organism with the force of a causal relation - an unmediated stimulus/response model.

The principle lying behind accounts of perception based on affordance is the co-evolution of perceptual and physical systems relative to environments. If we take the external world as an objective given, and treat the perceiving system in isolation, and as providing instructions to a separate system of effectors, then the resulting specification required for the system to derive an effective model of the world becomes inordinately complex. The specification becomes simpler if the perceptual and effector systems are taken together as integrated components of an active organism. The ecological approach to perception takes this one step further, arguing that if we drop the idea of an objectively given world, and treat the environment of the organism as an additional component, we are able to derive a far simpler and more realistic specification.²¹ The evolutionary process operates in terms

²¹ The approach is parallel to that taken by Simon in characterising artificial systems in terms of their environmental contexts and 'inner' and 'outer' worlds [Simon 1969] and recent approaches in cognitive science and artificial intelligence [reviewed and developed theoretically in Clark 1997].

of de facto selection operating, for example, on rudimentary sensory and motor capabilities. These are collectively selected for in terms of their capacity to survive given environments. All three elements (perceptual system, motor system, environment) are subject to change, and it is the relative mutual compatibility of all three elements in a given complex at a given time which determines survival.

This nexus underpins the affordance relation. Given that species over evolutionary timescales achieve relatively stable forms and environmental relations, the sensory-motor system will have adapted relative to a level of holistic environmental interaction relevant to that organism in terms of survival and selection. It is in this sense that affordances can be equated with meanings. Meaningfulness for a given species is constituted at the system state level which matches the level of holistic environmental interaction. The evidence for this lies in the capacity to operate with high level environmental variants and invariants. We perceive the world, not as fragmentary stimulus events which continue to be pieced together until a meaningful whole is built, but rather as operationally referenced wholes or complex relations which can then be subject to reconstrual. Surfaces are perceived as surfaces, solid objects as solid objects, with properties and attributes - we encounter solid ground (walkable), soft surfaces (pliable, bounceable), unyielding masses (climbable, go-roundable) - each matching a holistic sensory-motor complex.

In the majority of Product Semantic accounts, the complexity of product interaction is negotiated in terms of an unanalysed use of the affordance concept, and on the assumption that there is an inherent continuity in its import, from perception through to cognition. This does not seem to be justified. There is a crucial difference and an important equivalence between saying that 'a conjunction of surfaces at a certain height affords sitting', and saying that 'a chair affords sitting', which consists in how what we see is described. At the level of perception, we are only justified in saying that the content of 'perceive-affordance' is the possibility of sitting, and this can be sensed equally in either case. But the affordance relation does not of itself offer a conceptual structure, type structure or identity conditions, and its conceptual role in direct perception is limited to mapping the environment in terms of action potential. When it is asserted that we perceive meanings rather than percepts, this should not be taken to imply that when we perceive a product we directly perceive product meanings, but rather that at some level the perceptual encounter is structured by a perceptual system which is organised in terms of a holistic response to action potential.

How does this cash out in practice. Let us suppose that I am trying urgently to open a pair of locked cupboard doors. I cast about for a suitable means and find a steel ruler with which I attempt to prise the door open. When I perceive the ruler I perceive it directly in

its potentiality relative to the action - 'ah, here's a priser' - and apply it accordingly. As it turns out the ruler flexes and I am unable to prise effectively. The perceive-affordance is not matched by what the ruler can actually deliver. I look for an alternative priser, but now I have a sense that I am looking for something that won't flex too much. I find a rigid triangular scale rule, but this won't insert into the gap. What I need is something thin enough to insert like the steel rule but rigid like the scale rule. I hit on the idea of combining them, slipping a pair of rings from a ring binder over them both, and succeed in prising open the doors.

The underlying story here is a complex one which can be told in a number of ways, but at its root is the idea that at some fundamental level my perception of the world is organised in terms of the potential offered in my total overall engagement with the world as a bodied and minded action-oriented organism. I perceive the ruler in its insert-ability and prise-ability, the scale rule in its rigidity and the rings in their encompass-ability and hold-together-ability. But whereas in the first use of the steel rule the holistic sense of affordance may well be operative, when it succeeds and fails it does so in certain respects and an analytic sense of content is introduced, which then seems to run in parallel with the idea of affordance as I move to try out alternatives.²² If I had been more reflective in my approach to the cupboard, then I might have tried out various keys from a box of loose keys in the next office, in the knowledge that keys afford the opening of locks that they match. But the idea of affordance in this case seems to be of a different order - the fact that keys afford the opening of locks is an item of cultural knowledge, not something that I perceive directly in the general potentiality of the key.

The tendency in Product Semantics is to run together all the ways in which products support, enable, allow for effective interaction with them, under the rubric of affordance. The effect of this is to move the ground in one of two directions, both of which ultimately defeat the viability and utility of the concept, other than as a loose metaphor for user-product relations. If all interaction is assimilated to affordance defined in relation to direct perception, then all product relations and product meanings are directly perceived and culture is assimilated to nature. If on the other hand, the scope of affordance is not restricted to a definition in terms of direct perception, but is taken to range across higher cognitive functions, then the adaptational basis of the relational definition is lost, and

²² This model has strong parallels in other accounts, for example the cyclical process of 'seeing-moving-seeing' characterising reflective action [Schon 1983; Schon and Wiggins 1992; Liu 1996]; the characteristic features of 'situated action' [Suchman 1987] and the embodied model of cognition [Varela, Thompson and Rosch 1991]

nature is assimilated to culture.²³ Both tendencies are apparent in product semantic accounts, and generally both positions are together operative in individual accounts, suggesting that the concept employed under the same name is distinct from 'affordance' as defined by Gibson in the context of direct perception. The clearest expression of the relation as defined within product semantics is due to Krippendorff and will be discussed in the next section.

Although Gibson's theory per se, has offered a number of important insights which have helped to shape the course of studies of perception,²⁴ there are two principal respects in which it might be regarded as weak or incomplete. In the first place it is not underpinned by a substantial account of the theoretical basis of the relation of higher order construct detection which underpins the perception of affordance, to lower order percepts and associated mechanisms that empirical evidence suggests have evolved in its implementation.²⁵ Secondly, and in the current context more significantly, Gibson's concept of affordances fails to accommodate the richness and complexity of significance in the material world and falls far short of a general account of meaning that is perceptually based.²⁶

²³ Each of these positions are of course tenable [for the general background position see for example Dennett 1995 and Searle 1995] but both involve placing constraints on the applicability of affordance. Dennett would presumably find a role for affordance in a straightforward evolutionary scheme, limiting it to those relations that are the subject of selection. Searle on the other hand would contest the power of an evolutionary account to underpin cognition and meaning, and might on that basis elect to use it generally in describing a relation of accommodation between individuals and objects, on the assumption of the priority of intentionality.

²⁴ It is argued for example that Gibson's approach in some ways prefigures the work of Marr in developing computational approaches to visual perception [Eysenck and Keene 1990; Marr 1982]. In addition in so far as it emphasises the bodily basis of perception and cognition it also stands as a forerunner to a wide range of work in human conceptual development in cognitive science and artificial intelligence [including Johnson 1987, 1993; Sheets-Johnstone 1990; Varela, Thompson and Rosch 1991; Clark 1997].

²⁵ This is not necessarily to be regarded as a direct criticism of the theory, since such mechanisms might in principle be supplied, and in any event the inability to specify such mechanisms would not in itself invalidate the theory.

²⁶ Gibson's theory of affordances operates at an indeterminate level in the categorisation and characterisation of objects, successfully relating only to some forms of attribution. In practice of course objects are very largely significant in respect of their histories, and such histories largely constitute their meaningfulness. This is often an individual matter (the significance of the chair that my father used to sit in, and so on), inviting the question of whether the concept of affordance operates primarily in the public domain - does it capture a normative sense of meaning? A similar argument could be advanced in the public domain for a given interest group (the significance of a statue of the virgin mary). So what is left, if so much of the meaning content is not apparently caught by affordances? One possibility is that the kernel of Gibson's notion relates to a less specific level of cognitive operation, for example the generic notion of episodic memory in the development of culture [Donald 1991] the physical/perceptual basis of schemata [Johnson 1987; Lakoff and Johnson 1980; Sheets Johnstone 1990] or the 'somatic marker' hypothesis linking cognition and emotion, Damasio 1994].

Taken as a whole, the available empirical evidence in the field of psychology points to a complex picture involving both direct and inferential perception. The situation in this case is similar to that found in respect of theories of categorisation and concepts - different and apparently competing theories tend to be supported by evidence drawn from distinct experimental contexts.²⁷ Inferential theories, which emphasise top-down processes, have tended to be supported by empirical studies in sub-optimal conditions either in respect of temporal conditions or in terms of stimulus clarity. Direct theories, on the other hand, have concentrated for empirical support on visual perception in optimal conditions.

The interaction of direct and inferential processes has been demonstrated, for example, in the case of word perception.²⁸ Neisser has generalised the idea in providing an outline for an integrative theory, typifying a range of more recent approaches which involves the interaction of processes of perceptual exploration with both the stimulus environment and mental schemata.²⁹ Effectively, schemata which embody knowledge gained from previous experience, guide the process of perceptual exploration of the stimulus environment by constraining the search parameters. If the perceiver fails to find information from the stimulus environment to match schema information, then this is assimilated in the modification of the schema.

The application of the concept of affordance in product semantics both captures the sense of our direct engagement with the world in its potentiality, and raises questions in respect of the level at which it can be applied. In psychological terms there are two principal reasons for doubting the direct applicability of the concept of affordance as developed by Gibson. Firstly the concept itself does not fully capture the complexity of perceptual and cognitive engagement with products, which actually involves both top-down and bottom-up elements. Thus although there is a sense in which our perception of things can be described as direct rather than inferred, there is a stronger sense in which this can be seen as articulated within a framework of experientially and conceptually grounded schemata whose basis is at least in part socio-culturally constrained or determined. Secondly, in so far as the concept is used to underpin user-product interaction, it is indeterminate with respect to content unless itself underpinned by meaning or function. The distinction between products and other things in the world is precisely that they are conceived and brought into being intentionally in a socio-cultural context, and as such their content is socio-culturally defined and expressed through the operation of conventions, rather than the indexicality of causality or covariance in the natural order.

²⁷ See below, Section 5 'Categorisation and Cognition'.

²⁸ Tulving, Mandler and Bauml 1964. The probability of correctly identifying a word varies as a function of duration and contextual richness, both individually and in combination.

²⁹ Neisser 1976.

4.2 The Concept of Affordance in Product Semantics

It was suggested in the previous section that the general use of the concept of affordance across the perception/cognition boundary, and across the nature/culture divide, in product semantics, indicates that it differs significantly in content from the concept as applied in articulating the idea of direct perception. The most explicit context provided for an appraisal of the concept occurs in the account developed by Krippendorff.³⁰

Krippendorff is clearly attracted by a general philosophical rejection of dualism, and the specific possibility offered by a broad interpretation of affordance in providing a basis for the concept of meaning as applied to objects. His conception of affordance and meaning differs in some important respects from that of Gibson. Krippendorff interprets Gibson's concept as essentially an objective expression of object-content, and suggests an alternative interpretation in cognitive terms.³¹ Object meaning is constituted in the expectation of a user in relation to an object, whilst affordance denotes all the possible behaviours that confirm (or disconfirm) such expectations when they are tested out.³²

At a common sense level, the idea that a product engenders a certain expectation in a user, which may or may not be met, does identify a source of mismatch which can be used to characterise certain aspects of our cognitive engagement with the world (and the design process), but it falls short per se of a justification for the application of terms such as meaning and sense, that are carried by the account. In seeking to avoid the objective and deterministic sense that Krippendorff reads in Gibson, the ecological sense of the concept is lost, taking with it the basis for the location of meaning in a specifiable relation underpinned by a phylogenetic evolutionary explanation. Meaning for Krippendorff roughly equates with perceive-affordance, although given his explicit rejection of dualism this might be better expressed as 'cognise-affordance'.

The basis of Krippendorff's characterisation lies in the simple notion that a user when confronted with a product, derives expectations from the interaction with that product. Although such expectations, on the account given, are not clearly differentiated with respect to their source, it may be assumed that they are constituted in the interaction by a combination of the objectively definable features of the object and the perception and construal of the object by the user, in some unspecified holistic sense. These are

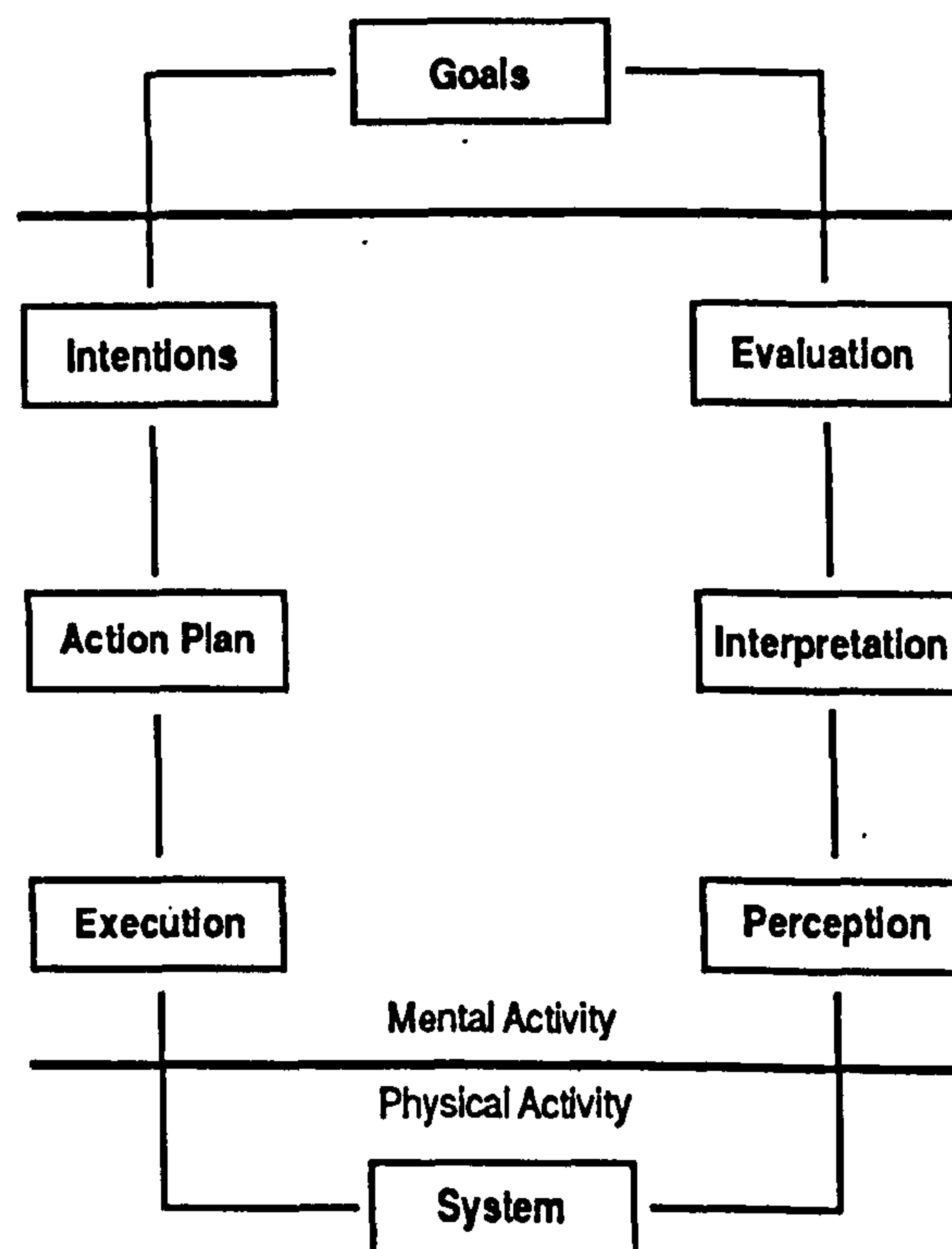
³⁰ Krippendorff 1989.

³¹ Krippendorff 1989, pp 19-20, where it is suggested that Gibson uses the term in an objectivist or naive realist sense, implying that objects possess affordances which are then picked up by users. This ignores the relational and 'ecological' thrust of Gibson's development of the concept, and essentially misconstrues its import.

³² Krippendorff 1989, p 19. To some extent, this can be interpreted as a difference in terminology, given that Gibson introduces the idea of perceive-affordance to encompass the need to accommodate mismatch.

presented as distinct cognitive models in terms of which the subsequent analysis is carried out, and in terms of which the design process is characterised.

If this caricature of the scheme seems familiar then this is probably because it bears a close resemblance to the model types developed in the context of interactive and user-centred system design. Such models are essentially of two kinds, each intending to capture theoretically and schematically a key aspect of the active relationship between users and products. The first type of model consists of an analysis of the cycle of cognitive processes involved in a task oriented interaction between a user and a product, and is best illustrated for our present purposes in the following diagram :-³³



In terms of an interaction with a novel product the cognitive cycle could start at virtually any one of its nodes. One might for example encounter the product without any prior experience and form a picture of its possibilities as a product, and then try to use it for some purpose or another. One might, on the other hand be familiar with the product type and make immediate use of it. In any event the product encounter will engender some expectation in the user which will help to shape intentions and actions with respect to the product, in the hope of some outcome. The nature of the expectation is likely to be a

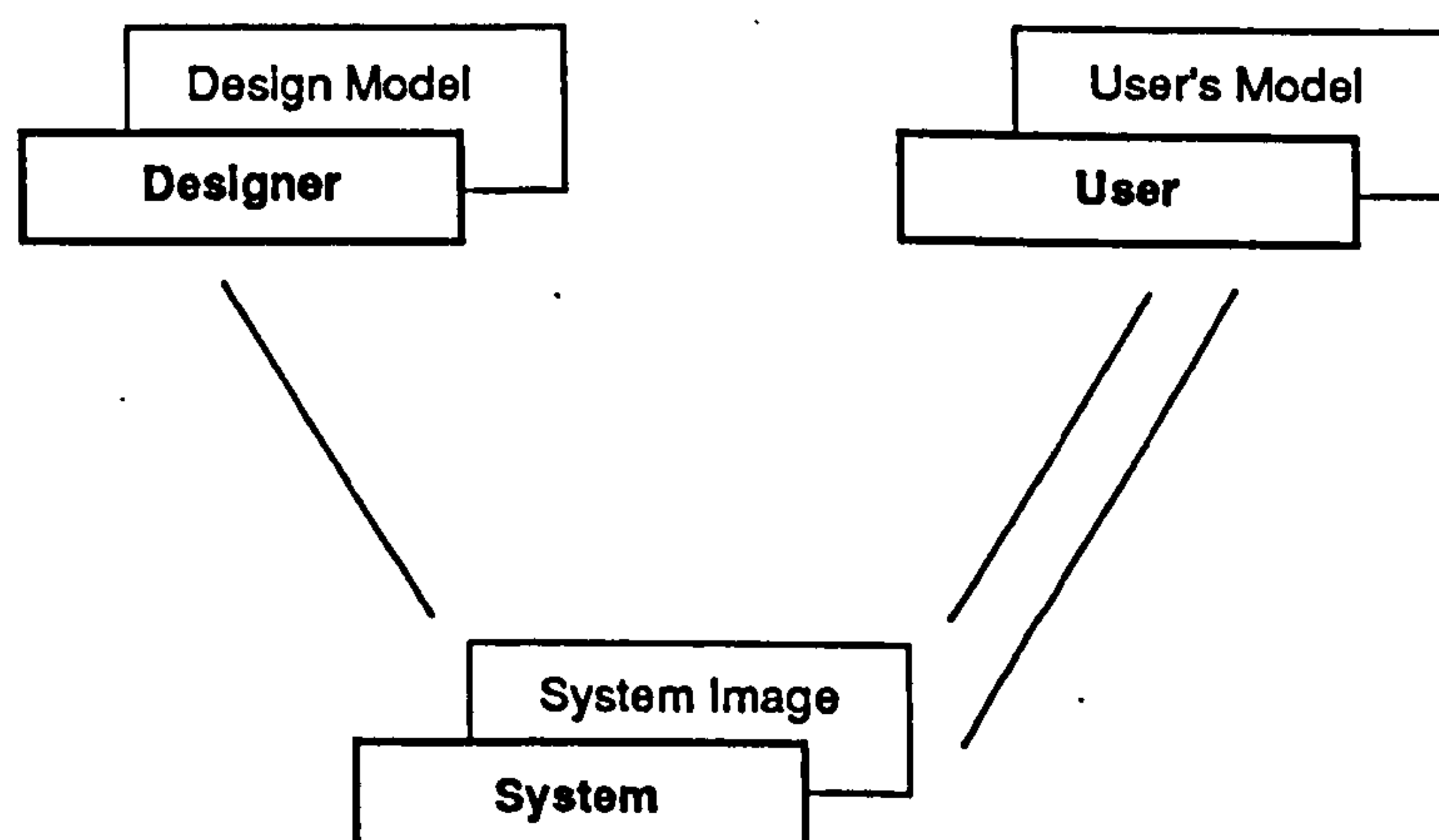
³³ Adapted from Norman, 'Cognitive Engineering' [Norman and Draper 1986, p42, fig 3.3]. It is not essential at this stage for the diagram or the scheme that generates it to be correct or exhaustive.

complex matter, dependent in part on elements derived from previous encounters with products and any associated knowledge and theories that are brought to bear, and in part on perceptual and interpretative engagement with features of the product itself.

Products themselves can also be viewed as embodiments of cognitive models, involving expectations - those of the designer. As Suchman has expressed it :-

'Every human tool relies upon, and reifies, some underlying conception of the activity that it is designed to support. As a consequence, one way to view the artifact is as a test on the limits of the underlying conception.'³⁴

The relation between the terms of this interaction expressed as models or images, constitutes the second schematic level commonly identified in interactive and user-centred system design, and is again best captured succinctly in a diagram :-³⁵



The product interaction involves three main classes of model or image. The Design Model is the conceptual model held by the designer (or design team) in the generation of the system or product. The system or product in its physical implementation constitutes an 'image' (the physical characteristics of the product itself, together with any mediating material such as documentation, instructions, packaging etc). The User Model is the mental model of the system or product that is developed by the user and is constituted in the way that the system image is interpreted against the background that the user brings to the interaction. The essential aim of the design process expressed in terms of this system of models is that the User Model should be compatible with the Design Model, in terms of its implementation in the System Image.³⁶

³⁴ Suchman 1987, p3

³⁵ The diagram and rubric is adapted from Norman [in Norman and Draper 1986, p47]. Norman is concerned with interactive computer systems, rather than products in general.

³⁶ Krippendorff does not make direct use of this scheme in his exposition, but it is consonant with his account both in his task oriented approach, and in the division of user interaction into three parallel parts.

The Design Model results in a specification for a product, which if implemented yields a real world product.³⁷ The specification, within certain limits, determines the physical content and organisation of the product. The Design Model on the other hand relates that physical content to the intended uses and roles of the product - its intended affordances. The product itself and its parts can be said to have functions to the extent that their physical content and organisation are constrained by criteria relevant to meeting intended affordances. But there are no built-in guarantees, and the process can fail both in respect of the presumed content of the intended affordance relation and the actual capacity of the physical parts and their organisation to support intended affordances, even on the assumption that the intended affordances are relevant and appropriate.

In so far as a product is faithful to its specification, it embodies the intentionality of the design context in which it was created.³⁸ There is however an inherent limitation in the degree of intentionality that can be ascribed, which is constituted in a number of relatively independent factors. In the first place, any design process will be limited in the scope of its specification in the sense that there will necessarily be limits of precision associated either with respect to the capacity of the design language used to communicate the specification, with the capacity of the designer to identify and discriminate axes and magnitudes that might conceivably form part of the specification, or the capacity of subordinate processes to interpret the design language or implement the specification.³⁹ Secondly, and in principle, not all aspects of a product can be endowed with the same degree of intentionality. This is in consequence of the fact that a design process is essentially a process of selection and optimisation, against certain factors that have been prioritised for direct or indirect consideration. In this context the inherent limits of intentionality are set in two ways. Some factors relevant to the content of a product will be identified, but intentionally given relatively less weight in the optimisation process. Others may be neglected in intentional terms, but may nonetheless feature in the product.

The Design Model in addition to nominating and optimising intended affordances, will also be concerned with the specification of perceive-affordances or meanings. In terms of the scheme of models, we could say that the specification derived from affordances is instantiated in the Product/System, whilst the specification derived from perceive-

³⁷ There is an ambiguity in the idea of a design model, in the sense that it can be used to refer to the model which is used to drive the design process in the generation of a specification, or to the model represented in the completed specification. For the moment we will assume that the design world is perfect and that there is no discrepancy between these.

³⁸ 'Design context' is here used as shorthand for the whole process of design, production, marketing and retailing, appropriate to a given product, and will therefore vary in particular content from product to product.

³⁹ Subordinate processes here refer to any of the processes involved in a design context relevant to a given product, that follow on from the specification of the product in a design language. Pye discusses some of these limits in the context of an assessment of the importance of workmanship in the final character of manufactured and crafted products [Pye 1964,1968].

affordances is instantiated in the Product/System Image. This of course assumes that they can be treated relatively independently, and Krippendorff's articulation of the relation between affordance and meaning suggests that this is indeed the case. However it is difficult to see how they can be treated separately. To what extent can we say of a product that it affords some activity or another, if it is very difficult or even impossible for the user to perceive the possibility. In practice the Product Image and Product together constitute a complex which are the integrated subject of user interaction. It could also be argued, on the assumption that a Gibsonian version of affordance is operative at some level, that they cannot be separated in principle. This is the case because perception and action co-evolve and capacities to act relative to a given environment embody relative correlation between affordance and perceive-affordance. Nevertheless, it may be the case that the level at which this correlation is operative falls below the level which is relevant to product encounters.⁴⁰

The principal reason for treating them as separate is a methodological one. The physical product constitutes the common ground mediating between the various models and images. It is specified via the Design Model, which effectively nominates intended affordances and the product content intended to support them, based on assumptions about how that content will be perceived and interpreted by the user. The User Model operates in relation to the physical product in identifying and interpreting its content in terms of perceive-affordances, which in principle cannot match intended affordances, although it may well include some or all of them.⁴¹ In order to gain some purchase on the type and extent of the match between the Design Model and the User Model, the physical product is subtracted from both sides of the equation (as the common reference) and comparisons made between intended perceive-affordances and actual perceive affordances.

However, the result of taking this tack is to highlight an equivocation about meanings, which are equated with perceive affordances and intended perceive-affordances (user's meanings and designer's meanings respectively). Designer's meaning is constituted not only in intended perceive-affordances but also in intended affordances. User's meaning however is constituted only in perceive-affordances, whilst affordances are the means of verifying meanings. A designer designs a switch which has the intended affordance of turning something on and off and the perceive-affordance that it should be recognised as having the potential to turn that thing on or off. The meaning of the switch is constituted

⁴⁰ The relevant level of correlation might be in the general perception of substance and objecthood rather than in terms of types or identities.

⁴¹ Both for the reason noted above that no product can be completely specified, and because the open-textured nature of the definition of affordance allows for an infinite number of possible affordances for a product or any of its perceivable content.

both in its physical capacity and in its image. When the user approaches the switch it has a perceive-affordance (equated with meaning), which may or may not be matched by the affordance.⁴² But this seems unconvincing. If something looks as though it is there to turn things on and off, but in practice it turns out that this is not what it affords, then we would surely be more likely to conclude that we were wrong about its meaning - it didn't mean that, it actually meant something else - rather than saying that it does not afford what it meant. User's meaning is in fact symmetric with designer's meaning, although the terms of the relation are seen from different perspectives in the two cases.

The problem here appears to stem from the different senses of affordance that are implied in locating the concept at perceptual or cognitive levels. If it is located at the perceptual level then all that can be said about the switch is that the meaningfulness of its content consists in the sensing of its switch-ability and its actual switch-ability. If it is located at the cognitive level then the context can open out into questions relating to its potential in relation to things that cannot directly be perceived, such as its capacity to turn something on and off, which is underpinned by what is afforded perceptually but relies on a conceptual structure that goes beyond direct perceptual knowledge. Given that product semantic accounts either reject a sharp distinction between perception and cognition (or deny this form of dualism altogether) and operate in terms of cognitive models, they are committed to the latter sense.

In the light of the above considerations, the direct equation of meanings with perceive-affordances cannot be sustained, and the source of meaning cannot be contained within the concept of affordance per se. Nevertheless the less formal idea of a mismatch between expectation and outcome, and the use of a version of the affordance concept to express relations of accommodation between users and products, are clearly potentially important elements of the expression of user-product interaction in terms of cognitive models.

A further problem that arises from the account of affordance, is that it obscures the important distinction between meaning as a subjective and an intersubjective construction. It is not clear whether an object has a meaning common to the community in which it occurs, or whether it can only have a 'meaning for me', aspects of which we presumably ought to be able to share if social communication is to succeed. Given that meaning is defined by Krippendorff in terms of the idea of 'making sense of things' and this in turn consists in an individual ability to find contexts that the thing fits, it would appear that meaning is essentially a complex act of understanding by an individual. The content of

⁴² Krippendorff 1990 p a12 '... a chair means sitting (among other meanings). If a comfortable looking chair is hard to sit on, it does not afford the kind of sitting it meant'. 'If an icon on a computer screen suggests that clicking the mouse on it would 'flip the screen' to the next 'page' but does not in fact do so when tried, we say meanings and affordances mismatch'.

such an act of understanding includes not only the gathering together of all the particular contexts in which the object figures, but also the total of the imaginative projections of context that can be construed. The delimitation of meaning therefore appears to be individual, radically indeterminate and incomplete in principle.

That 'meaning' has this unsecured transitional role between public and private, physical world and mental world contexts, in Krippendorff's scheme, is grounded in its relation to affordance. In its most liberal form, the affordance of a thing or product is taken to consist in the totality of cognitive models, uses and practices that it allows for in the context of its interaction with a user. Again there is an indeterminacy with respect to the generality of the term, in the equivocation that exists between normative and idiosyncratic ascriptions of its use - are affordances individual or are they socialised and intersubjective.⁴³ Such a notion is also indeterminate in the sense that there is no in-principle limit to the range of purposes that a user might, however abstrusely, contrive for a given object, or to the range of cognitive models that might similarly be supported or engendered. The problem with the account is that although it is contextualised relative to a world of agents and interactions, the characterisation of terms is essentially non-intentional. The absence of explicit intentionality in the structure precludes the possibility of giving any non-trivial sense to the language analogy or to user's cognitive models, on which a product semantic account ultimately seeks to be grounded.⁴⁴

Although there may be good reason to accept this kind of indeterminacy (which has parallels in the indeterminacy and essential incompleteness of 'description' for example), the problem of meaning for Krippendorff is exacerbated by equivocation regarding the location of meaning. Although it is explicitly stated that meaning is a cognitive construct, in the elaboration of the concepts that constitute and are constituted by 'meaning' it is clear that meaning is also construed as an objective property of objects, at least in part. An element of the Gibsonian concept has thus survived the redefinition, although now severed from its ecological context, and sorely in need of an alternative underpinning for the interactive relation. The clue to the form that this might take is that the contribution of the object in 'suggesting' or 'meaning' is akin to the sense of meaning that is often accorded to natural signs, for example in an expression such as 'clouds mean rain'.

⁴³ Bearing in mind that in shifting the ground of the concept from an ecological to a cognitive context, no basis has yet been provided for making the distinction.

⁴⁴ The absence of intentionality at this level is not a problem for Gibson, since the 'reading' of the features of the environment is direct and not mediated by cognitive models or representations. It is thus a prime candidate for inclusion in the category generally defined as being composed of elements having 'non-conceptual content' [Evans 1982; Peacocke 1992; Bermudez 1995. See Section 11, 'Semantic Theory and Cognition']. Krippendorff's cycle of expectation and testing, on the other hand, which is pitched in the realm of the consciously accessible and conceptually structured, clearly must involve explicit representation and conceptual content.

The parallel is not only made in the fact that such an articulation is based on the notion of evidence supporting an expectation, ultimately underpinned by an inductive causal link, but also because such 'meanings' although inherent in the constitution of the thing are also subject to constructive interpretation by a subject.⁴⁵ Thus the 'natural' ecological relation supporting Gibson's concept is replaced by a relation that in semiotic terms might be characterised as a natural sign.

The essential distinction here is between a linguistic context of 'meaning', and an essentially extralinguistic context which is subsequently drawn into a linguistic framework. Clouds are suggestive of the possibility of rain, in the sense that there is a natural, causal, external relation between clouds and rain, which provides the basis for an expectation of rain if we are presented with clouds. But this is clearly different from other forms of signification underpinning meaning, such as the relation of words to their meaning. In the case of words, meaning is commonly taken to be intentional rather than natural and the intention expressed via conventions and rules embodied in a linguistic structure, which can then be applied to the world. How then are we to interpret meaning in the context of objects? In product semantic accounts the tension between these two positions remains unresolved, and this is most evident in the deployment of the concept of affordance which is used both to support the idea of an underlying extralinguistic context for meaning, and in the context of cognitive conceptual frameworks articulated in terms of the priority of meaning as a property of 'language-like' systems.

There are a number of possible approaches to grounding these issues. One would be to pursue the analysis of 'meaning' and its relation in the context of products, independently of the definitions provided by Krippendorff and other proponents of product semantics.⁴⁶ A second would consist in attempting a clarification of the nature of 'cognitive models' as they are conceived in product semantics.⁴⁷ A third might consist in pursuing the insights offered in relation to the characterisation of affordance and interaction with objects, but independently of the use of analogies with language or extensions to meaning. The latter approach will be taken up first in the context of an analysis of affordance as a parallel to the previous analysis of function.

⁴⁵ The basis for the link lies in an extralinguistic empirical fact which constitutes the basis for the link which may then be expressed in language.

⁴⁶ This will be addressed in Section 7 'Meaning and Semiotics'.

⁴⁷ See Section 4.5, p 130 below.

4.3 An Analysis of Affordance

The concept of affordance attempts to capture the content of a product in terms of its potential for use, against which can be set the collection of expectations of use that a product can be said to engender through our interaction with it. Thus a poker is hard, metallic, pointed, directional, has a handle and so on. It invites us to grasp it and use it in a certain way. However, it does not in itself carry a specification of its intended use. In fact, the affordance of a product, what it actually allows us to do or conceptualise, will inevitably go beyond its intended use, constrained only by our capacity for imagining or engendering contexts, and the limits of its physical content. Pokers are used as weapons, levers, skewers and so on, both because their physical properties support such uses and because of our capacity to generalise such properties conceptually in conceiving contexts of use for them.

In order to progress the analysis, I introduce a standard form for the ascription of affordances and a standard notation :-

‘X affords A’⁴⁸

where X is a place marker for some thing (object or product) or an identifying description of an object or product, or a referring expression that refers to an object or product;⁴⁹ and where A is a place marker for a name, identifying description or referring expression for an ‘activity’.⁵⁰

What sort of substitutions are acceptable for place markers X and A. Although conceivably X could be substituted by all manner of instances, including products, natural objects and conceptual schemes, we will for the moment assume that X is a place marker whose substitution instances are products, in the general sense of things artefactual. What substitutions are acceptable for A. The underlying sense of the object or content of an affordance given in product semantic analyses is that it is something that is done either actively or passively. Thus a knife affords cutting, an abacus affords calculating and an insurance policy affords peace of mind, although clearly there are distinctions of sense to be made in respect of such a range of examples, and ones which

⁴⁸ Clearly there are a number of alternative forms for the ascription including - ‘A is an affordance of X’, ‘An affordance of X is A’ and so on, each of which might be regarded as attributing a slightly different sense to ‘affordance’ particularly in respect of the status of the attribution (whether A is a property of X, for example). The expressions are however logically equivalent and we will adopt the simplest form of the expression at this stage of the analysis.

⁴⁹ The limitations to be placed on, and removed, regarding the scope of this place marker are defined in the course of the analysis.

⁵⁰ The term ‘activity’ is interpreted broadly so as to include things done or states maintained, that are not strictly speaking actively performed. It is also assumed that the expressions used to describe ‘activity’ may take a variety of grammatical forms.

throw light on the underlying nature of 'affordance'. Initially the substitution instances of A are defined to be things done actively or passively. On this basis our initial analysis of

'X affords A'

might take the form

'X does A'

Clearly this cannot be a complete analysis. Although the fact that A is something that is done by X, does constitute a sufficient condition that A is afforded by X, it is not a necessary condition. A knife affords cutting whether it is actually being used to cut or not, in the sense that if were to be used for cutting it would cut, reflecting the fact that affordance is intended to capture the sense of the potentiality of objects. If the affordance of X is not simply the doing of A, but rather the capacity to do A, then perhaps the affordance might be regarded as an attribute or property of X, which might be expressed in the notation as :-

'X has the property A'

However it can be seen that this formulation is also inappropriate since an action cannot of itself be a property or attribute, but is rather something whose possibility is underpinned by the possession of relevant properties. In the case of the knife, for example, which might possess certain properties like a sharp blade and a good sized handle, constituting some of the conditions for the possibility of cutting, the cutting itself is not an intrinsic property of the knife. These observations suggest that what is required in the analysis could be a dispositional sense - the idea that if something were to be used then it would be capable of performing the activity, which in its simplest form could be expressed in the notation as :-

'X can be used for A'

A knife affords cutting in the sense that it can or could be used to cut, but clearly there are limitations - a particular knife does not have an unconstrained capability for cutting, but would need to be sharp enough for the job. A leather paring knife 'affords' the activity of thinning the edges of a cut hide, but only for example, by bookbinders and leatherworkers who have been trained to use one. It could be argued by extension that the fact that the knife affords leather paring is dependent on a whole range of contextual factors, for example the availability of a suitable surface for paring. To what extent then is it true to say that a product affords an activity generally, simply because in certain rather special circumstances it can be used for that activity. In other words the actuality of 'can be used for' is heavily context dependent in a variety of ways. This is a problem for the concept of affordance that is used in product semantics since it constitutes the objective

basis for the design activity - the attempt to match product meanings to affordances. The problem is parallel to that discussed by Pye in respect of 'functions', who argued conclusively that function could not be something intrinsic to an object, but is necessarily dependent on contextual relativisation for its sense.⁵¹ The 'can be used for' of affordance, is in fact surrounded by provisos - 'can be used for cutting, a certain range of materials, by somebody skilled enough, in an appropriate context etc etc'. This could be expressed in the analysis by requiring that contextual relativisation is included :-

'X can be used for A by person N in context C'

where N relativises the analysis to persons, and C to contexts.⁵²

If reference to context is necessary then it is not clear in what sense affordances can be directly perceivable and general. What is the concept of affordance intended to capture? Although the characterisation of affordance is generally conducted in relation to individual interactions, the examples given are uniformly at a level of functional generality, suggesting that perhaps the concept may operate in relation to classes rather than particulars. One possibility is that affordance is type-related rather than token-related - although there are particular knives and particular occasions of use, these are instances of the general concepts of 'knife' and 'cutting' and their relationship. This approach would reflect a level of compatibility with the scope of the psychological concept of affordance that has been argued is the appropriate interpretation in the context of direct perception.⁵³ This would not require relativisation of the analysis which might thus be expressed in the notation as :-

'X's can be used for A'ing'

This does not appear to ground the analysis, since it is still not clear what the force of 'can' consists in. Presumably in principle any thing can be used for any purpose, so long as there is no condition that it be successful. I can use a blunt knife for cutting, but this would not afford cutting to the same extent as a sharp knife. So where are the limits of potentiality set by the concept? In the case of 'function' the concept was found to be grounded in intention or selection and the reciprocal relationship between the intention of an agent in respect of some thing, and its role in defining the nature of the thing. In the

⁵¹ Pye 1964 pp 7-17.

⁵² Presumably the fine detail of the analysis could be unpacked in terms of some general specification relating to the capacities of persons relative to given activities ('understands the activity', 'is suitably trained', 'is strong enough') and to contexts ('other necessary equipment is available and in good order'). It might be argued that similar conditions are implicit in all analyses of this kind, and to require them as part of the analysis is to elevate *ceteris paribus* clauses beyond their status. However, in this case, where the product semantics argument is for a concept derived from a direct perception of potentiality, rather than an inferential one, the cognitive content intrinsic to the situation, but apparently lying beyond the percept, needs to be brought out.

⁵³ Eysenck and Keene 1990, pp 88-92.

case of affordance, no such underpinning is available, since in one sense it constitutes the objective content of a thing relative to its potential use. An affordance is the capacity for use embodied in a thing, which is unconstrained by the intention embodied in its design and production, and open to endless creative interpretation. In the case of 'function' the properties of a thing relevant to a function are those picked out in the intentionality of the agent, or process of selection, as being relevant to the end for which the function is ascribed.⁵⁴ Presumably in the case of affordance, although the intentionality is absent in the constitution of the thing relative to its capacity to afford, the basis of such a capacity similarly resides in its properties. It is possible that the equivocation of application between token and type might be resolved if one pursued the concept in terms of the properties of X rather than X itself.⁵⁵ For a particular knife to afford cutting in a given context, it would need to possess certain relevant properties. This would be true of all knives in all cutting contexts, although the properties and their particulars might be different in each case. Nonetheless there is a family resemblance among the range of particular instances and the sorts of relative properties that prove to be relevant to the 'family'. Affordance as perceived would then consist in our capacity to recognise and assign relevant properties possessed on a particular occasion, to the appropriate 'family' constituting the general concept. Tokens are tokens in respect of certain of their properties, which enable them to be recognised as being relevant to a situation type.⁵⁶

'The properties P of X, where X is a token of the type Xt, enable X to be used for A, where A is a token of the type At' (relative to N,C)

What are the status of such properties ? In the case of affordance they cannot be necessary properties since in principle no particular property is necessary to a given outcome.⁵⁷ On the other hand, if X is truly to afford A, then the totality of the expression should provide a sufficient condition for A, since the bottom line in affordance is that A is actually supported or sustained. This might be expressed in the notation as :-

'The properties P of X, where X is a token of type Xt and where A is a token of the situation type At (relative to N,C), are sufficient for A'

In general terms it should not be surprising that the concept of affordance is expressed in terms of sufficiency, since the concept as deployed is devoid of intentionality and

⁵⁴ See section 3 'Function', above.

⁵⁵ It is notable that the examples given of affordance by writers on product semantics are predominantly if not exclusively also functions.

⁵⁶ Although this construal might be seen to be inimical to the concept of direct perception, since it apparently involves analysis in terms of concepts and inferences, this is not necessarily the case. The foundational exemplars driving Gibson's theory are situated examples of holistic perceptual fields. Such fields, although composed of perceptual particulars might nonetheless be perceived holistically in terms of the relations between elements. This conception could be applied in the case of action families such as 'cutting'.

⁵⁷ It will always be possible to imagine a logically acceptable if empirically unlikely alternative to a given property. The point here is a logical one rather than an empirical one.

intended to capture the open-endedness of potentiality - anything with the right properties can be used to underpin an action or secure an outcome.⁵⁸

There are two problems with this formulation. In the first place it is relativised to product types, which at the very least involves a prior conceptual apparatus sufficient to support type-identity, which cannot be available in the context of a concept which underpins the possibility of type-identity. Secondly, it analyses affordance in terms of the identifiable properties of an object and as such falls short of the idea that the concept subsists in the relation between an individual and some aspect of its environment (the object), rather than simply in the possession of objective properties themselves (which are unanalysed in a basic affordance). One way of approaching this would be to contain the individual relativisation within the encounter, both in stating the affordance and in its analysis, which might be expressed in the notation as :-

'X affords A (for N)'

can be analysed as

'X is sufficient for A (for N)'

Although this brings us closer to the relational sense of the concept, it is both too inclusive and too restrictive. It is too inclusive in that it places no constraints on the capacity to afford, whereas it will clearly be the case that a given object may afford in one context and not another.⁵⁹ It is also too restrictive in the sense that whilst X must be a particular and not a type, this is not the case for A, since A is an instance of a repeatable activity type which is the basis for the selection for an affordance. This could be expressed by modifying the analysis to :-

**'X is sufficient for A, where A is a token of the activity type At
(for N in context C)'**

or, to localise the activity with the subject :-

**'X is sufficient for N to A (where A is a token of the activity type At)
in context C'**

This appears to come close to the use of the concept in product semantics since it expresses the idea that affordance is essentially concerned with the capacity of an object to enable an individual in a given context to engage successfully in some activity. On the other hand it does not capture the concept developed in the context of direct perception,

⁵⁸ In contrast to the concept of function which is not susceptible to analysis in terms of either necessity or sufficiency of conditions, but is intentionally relativised.

⁵⁹ A surface may afford a good grip and safe climbing when it is dry but not when it is wet.

since in that case the relation is associated with species rather than individuals, and with type-identified contexts and objects - N is a token of a species type, X is a token of an object or environment type, limited by C a token of a context type. In the context of selection in which affordances develop, the process of selection which links species capacities with environmental properties operates with respect to classes of sufficiently similar individuals in environment property clusters defining sufficiently similar classes. Which might look like this if expressed in the notation :-

‘X (a token of type Xt) is sufficient for N (a token of type Nt)
to A (a token of type At) in context C (a token of type Ct)’

The common ground lies in the sufficiency of X to enable N to A. The principal difference is that in the case of the ecological concept, the sufficiency applies in respect of the generality of the terms relative to the raw material of selection, whereas in the product semantic concept the sufficiency applies in respect of individual objects supporting the defined activities of individual agents.

4.4 Affordance and Semantics

Basic affordance is a generalised expression of the relations between persons and worlds. As an empirical hypothesis it is implemented in the context of evolutionary theory to express the accommodation that takes place between species and their niches in respect of their connected capacities to sense and to act. The pattern that develops is a pattern in a species-world complex, and not a pattern that can intrinsically be partitioned into subject and object regions. Nevertheless in pragmatic and theoretical terms we use higher order capacities to assign parts of the pattern to subjective and objective orders. The commonest interpretation of affordance assumes subject-object dualism and matches the capacities of individuals to properties of the world.

In cognitive terms, affordances find their natural home in the more general context of teleological semantics.⁶⁰ Semantic theories of this kind offer an account of mental content and representation in terms of the adaptational role of symbols and of the mechanisms that produce and respond to them.⁶¹ The basis of the idea is that accounts of mental content cannot depend on relations of similarity between mental contents and the external world, but must have a causal basis. However if mental content is expressed simply in causal terms, for example, in terms of the empirically established covariance of a characteristic activity in a neural structure with some environmental feature or motion, then it gives rise to problems of indeterminacy with respect to the identity of the feature with which it is supposed to covary. Teleological semantic theories attempt to overcome this problem by expressing covariance in terms of teleological concepts such as 'function' rather than direct causation.

Affordance, Function and Teleological Semantics

Teleological theories employ a normative sense of function, rather than an operant or dispositional sense, which is underpinned either by the intentions of designers or by the operation of the processes of natural selection.⁶² In the case of evolved organisms functions are relational in character and ultimately pinned to gene persistence.⁶³ The consequences of this differ in detail in the case of different organisms but typically involve the development of characteristic patterns of relationships with the environment which enable the gene bearer to persist appropriately within that environment. Parts or

⁶⁰ Also termed 'adaptational role semantics' [Cummins 1989].

⁶¹ Millikan 1984, 1986, 1989, 1994; Papineau 1987; Dennett 1987; McGinn 1989.

⁶² Millikan refers to this as 'relational proper function' in the sense that it reflects what some mechanism, trait or process is supposed to do, designed to do, selected in terms of, rather than simply what it does or what it might under certain circumstances be disposed to do [See for example Millikan 1989].

⁶³ Dawkins 1982; Dennett 1987.

characteristics of organisms are therefore generally defined relative to environmental parameters. The function of a mammalian lung is to enable interchange of gases with the environment; the function of an octopus sucker is to enable its tentacles to better grasp objects in the marine environment; the function of tomcat scent is to establish a territorial boundary as a signal to other tomcats; and so on. Function is defined in terms of a relation with the environment because the characteristic bearing the function has evolved in response to environmental relations.

Teleological semantics extends this idea to the cognitive realm on the basis that whatever mechanisms are present and responsible for mental representation have also evolved through natural selection via relations with the environment. Thus if a mechanism has evolved to be sensitive to some environmental factor, then this will characterise its relational proper function. A cognitive state is representational in respect of the environmental factor to the extent that it is a state of a mechanism whose relational proper function has evolved in response to that environmental factor.⁶⁴ Frogs, for example, have evolved a mechanism for catching flies which involves a rapid strike of the tongue which is evoked when flies are perceived moving across the visual field.⁶⁵ The assumption is that there is some mechanism which mediates between the fly's presence and the projection of the tongue. In that case the presence of the fly is supposed to trigger the mechanism to go into a given state S, and its being in this state is at least a partial cause of the projection of the tongue. The state S, on a teleological account, is asserted to have the content (to represent) something akin to 'fly' or 'fly, there'. Representational states (or mental states having content) are states of a mechanism whose relational proper function is defined in terms of its mediation.

The principal criticism of such teleological accounts is that they fail to individuate mental contents unambiguously, since they are both indeterminate in respect of attributions of function and transparent with regard to the substitution of ascribed predicates. The supposition in the above example is that the function of the mechanism is to detect the presence of flies, and it is on this basis that one can assert that the state of the mechanism in the presence of flies has 'fly' as its content, and means that there are flies about. But one could also argue that the mechanism has evolved to respond to small-black-things-moving-in-a-certain-way, in which case by a parallel argument the state of the mechanism will correspond to having 'small-black-things etc..' as its content and therefore a related

⁶⁴ Cognitive states themselves do not have relational proper functions on this account. Theories which approach the problem of mental representation directly via functionalism are generally termed 'functional role semantic theories'. The essence of these theories is that they assert that mental contents are individuated functionally, either through causal or computational relations. [Field 1977, 1978; McGinn 1982; Loar 1982; Block 1986, 1987]. For a general discussion of functional role semantics see Cummins 1989.

⁶⁵ This is a much used example in the discussions of teleological and causal semantic theories, which I believe was first used in this context by Fodor (anecdotal).

meaning. The function of the mechanism must be specified differently in each case, each supporting different conclusions about its content, and on the face of it there is no way of choosing between interpretations. Since the basis for making the argument is the consequence of introducing a simple disjunction, and in principle a similar disjunction could be applied to any similar function statement, functions and therefore the contents of the mental states which they support will be indeterminate. The related problem is that ascriptions of biological function must be transparent, since there is no logical bar to the substitution of alternatives for what it is in the environment that is supposed is being represented. Logically the function of the mechanism can be asserted equally to be 'to represent Fs' or 'to represent Gs' provided that the statement 'F if and only if G' will support relevant counterfactuals. This is problematic for a semantic theory which regards intensionality as a distinguishing feature of mental functioning.⁶⁶

The importance of the concept of affordance in semantic theory rests in part on the role it can play in disambiguating functions and function ascriptions. It will be clear from previous discussion that affordance is a relational concept linking an organism to features of its environment, and that it is not a primitive concept in any sense that would preclude the existence of mechanisms that might underwrite the operation of the relation. In an evolutionary context it will also be clear that in terms of survival, the crucial relation is not drawn in terms of the objects and substances that constitute the environment, but rather in terms of what the environment affords.⁶⁷ The environment might on occasion afford nutrition or escape, for example, in one of the various forms that these might take. On the other hand, as Gibson makes clear, it is the invariant physical properties of the environment that constitutes its objective contribution to the relation. Similarly it is the constitution of the organism relative to such invariants that constitutes the other term of the relation. The upshot is that the significance of the environment for a given organism will consist in the affordances that it supports, where these are constituted in the mutual relation between organism and environment resulting from the evolutionary development of that organism. Grass affords nutrition to rabbits, whilst foxes afford death, and rabbits have developed physically, perceptually and cognitively to respond as organisms to these affordances. In doing so they have developed a variety of physical structures and mechanisms, within the competence of their genetic inheritance and the process of natural selection, to sustain relations of affordance.

⁶⁶ Although the problems of indeterminacy and transparency are closely related they are not identical in their consequences. It is possible to accept the fact of the indeterminacy of mental content whilst wanting to hold onto intensionality. Dennett, for example, regards intensionality as a distinguishing feature of cognition but appears to be willing to live with indeterminacy of content. [Dennett 1987].

⁶⁷ This does not imply that identity is unimportant, but rather that identity is important to the extent that it is correlated with affordance. Affordance is the more primitive concept.

This picture implies the existence of at least two levels of relation. At the level of the organism there is the relation of affordance, whilst at the level of physical mechanisms (parts or characteristics of organisms) that concretely realise elements of the affordance relation there is a some form of normative functional relation. This is not surprising. Rabbits have evolved relative to grassy environments in respect of the fact that grass prospectively affords nutrition. This has involved both the development of a physiology which has the normative function of coping with the digestion of cellulose and a perceptual system which (inter alia) has the normative function of enabling the detection of grass. These are both mechanisms which constitute the means by which aspects of the affordance of the grassy environment in respect of nutrition is realised for the organism.

There are then two distinct levels at which functional specification can be made. At the level of the organism we might well assert that rabbits are pretty good at detecting grass and are well able to perceive grass. Their ability to perceive grass let us say depends on their possessing a pair of perceptual mechanisms attuned respectively to 'greenishness' and 'grassodour'. Although it might be true to say that the rabbit perceives the grass, the perceptual mechanisms do not perceive grass but are the means by which the rabbit perceives grass. The perceptual content in the two cases are distinct even though the possibility of the rabbit's having grass as its perceptual content is dependent on the content of the perceptual mechanisms that constitute the rabbit's perception. This is so because the proper function of the mechanism relative to the organism is not the same as the proper function relative to the mechanism possessed by the organism. The proper function of the perceptual mechanism relative to the organism is specified in terms of the affordances of the environment - in this case detecting 'nutritiveness', whilst the proper function of the perceptual mechanism per se is specified in terms of the way in which nutritiveness is detected - by detecting greenishness and grassodour.

Affordances disambiguate functional attribution by providing a distinction in the levels at which particular attributions can be assigned. At the level of the organism the attribution of function is relativised to the affordances of the organism. At the level of supporting mechanisms function is relativised to the discriminatory parameters of the mechanism. In the case of the frog, the function of the perceptual system for the organism is the detection of flies. This is the case because flies afford nutrition for the frog. This is achieved by the perceptual system through the use of a mechanism which is sensitive to small-black-things-moving-in-a-certain-way, to which the function is relativised. In the cognitive domain this distinction is important, since it underwrites different specifications of content. The indeterminacy of function attribution results from the logical possibility of introducing disjunctions, coupled with the fact that these are attributed to the same object.

The concept of affordance clarifies the sense that in the case of typical classes of disjuncts, the terms of the disjunction are in fact attributions relative to different objects - in the one case the organism and in the other the supporting mechanism. The ambiguity associated with the transparency of predicate ascription is similarly resolved through the distinction between objects articulated in terms of affordance.

It is not particularly important at this stage in respect of our consideration of the role of affordance as a concept in Product Semantics that we be convinced that some form of teleological semantics is an appropriate model. The point is rather the role that affordance plays in relation to the concept of function and models of cognition.⁶⁸ Mental states are the states of an organism, and even though the possibility of such states rests on the mechanisms that mediate the affordance relation, and are states of the mechanism functionally specified relative to the organism, the mechanisms themselves cannot be attributed the same states since they have distinct proper functions.

⁶⁸ The principal arguments made against teleological or adaptational role semantics, apart from questions relating to the indeterminacy and transparency discussed above, is that it is incompatible with computational theories of mind, on the grounds that it essentially involves 'historical' concepts. [Cummins 1989]. The argument is roughly that cognitive systems in computational terms are formal systems. The identity of cognitive systems is a formal matter which is distinct from a particular realisation. In the case of teleological semantics, the states of cognitive systems and therefore the representational content of such systems depend on evolutionary history. However given the concept of affordance and the distinction in levels, one could argue that in terms of the mechanisms that implement cognition, formal equivalence is not historically dependent, even though evolutionary history is individuating at the level of the organism.

4.5 Affordance and Cognitive Models

At the level of philosophical psychology Product Semantics is articulated in terms of cognitive models, and although the theory of mind or the semantic theory operative within it is not explicitly stated, the role of the affordance concept is clearly important. The acceptance of this concept in either one of its interpretations carries with it a number of related theoretical commitments and possible conceptions of cognition and cognitive models.

Although the concept of affordance is most often expressed as capturing the content of objects vis a vis their potentiality in terms of supporting physical action and practice, it is also employed in a more abstract way in relation to user's cognitive models. In the same way that products are conceived as affording some instrumental activity of the user, they are also said to support or to afford user's cognitive models.⁶⁹ It is not immediately clear whether the reference to cognitive models is intended to be restricted to those models actually operating in a given user-product interaction, those that are merely relevant in some way to user-product interaction, or more generally in respect of all cognitive models that the user might conceivably generate or employ. In addition although there is a simple sense in which it can be argued that product interactions only occur via cognitive models, this is a rather strange articulation in the context of a concept derived from a notion of direct perception. Leaving aside the question of just how this juxtaposition is justified within the product semantic framework, we will first address the relationship between affordance and cognitive models in user-product interaction generally.

The most immediate possibility is that affordance is restricted to cognitive models directly involved in user-product interaction, in other words models that in interactive systems theory would be termed 'user models'.⁷⁰ User models are cognitive models generated by the user through interaction with the system image, and in terms of which the user understands the system and their interaction with it. They are constituted in the interaction as a product of the cognitive background that the user brings to the interaction, and the perceived content of the product (system) image.

I have a fan heater which has a certain formal organisation, recognisable parts and indicative symbols. It is grey and visually undemonstrative and loses itself in the general neutrality of the surrounding decor. It has a cable and an electric plug for example, which no doubt afford my sense that this product is electrically powered and I should plug it in

⁶⁹ Krippendorff 1989, pp 16-17.

⁷⁰ See above pp 112-114.

when I want to use. It's formal organisation indicates that it has a front and a back, a top and a bottom, which suggests how it might be placed, and from where heat will emanate. It has numerical and iconic symbols which suggest ways of controlling different degrees of heat that might be generated. In more abstract terms my cognitive model involves an 'image' of a system which takes in air from the room, which collects heat on its passage through the heater and carries it out into the room. I know from using the heater that it sometimes switches itself off, after a while, and I surmise that it is able to measure temperature in some way and responds, presumably when the level I have set has been reached. The handbook that came with the heater tells me that one of the printed icons indicates how I might select one kilowatt operation rather than two kilowatts. No doubt my model of the system is packed with other information and assumptions about the system, but let us assume that the above description captures enough for the moment.

Clearly the picture I have generated on a few moments reflection, depends both on the elements of the product that constitute the system image and my particular perception of the system, but it is not clear as to what constitutes my user model. In one sense one might argue that my user model consists of everything that is brought to the interaction, in another that it comprises just those elements that directly bear on an understanding of the interactive relationship with the product. There are a number of problems here, whose general character can be indicated by considering the question of the temporal structure of such models. My first interaction with the product was in going to buy a fan heater. Ignoring the surrounding complexity of the situation and focusing on just one factor, a key element in my choice was the relative visual anonymity of the product. Roughly speaking I had judged that there was not much apparent functional difference between the three choices of heater available, and one could argue that my 'cognitive model' of the three heaters was primarily constituted by a general and relative sense of potential visual cohesion with a neutral environment. Once the heater was in place this factor dropped into the background as I tried out the controls. Now that I have been using it for some time and have gained an experiential sense of the meaning of the numerical and iconic indices, my interaction is minimal consisting in turning it on and off, and at times noting it's insensitivity and the irritating noise that it makes.

I would surmise from this that either I generate a cognitive model relevant to the situation in hand, built of just those factors that are occurrent, or I have a replete and complete cognitive model, selected parts of which are marshalled in a given context (or some intermediate cognitive alternative). What is not at issue is the fact that the model is constituted or possibly reconstituted in the interaction. Presumably though, the balance in that interaction can differ radically from person to person and from case to case. I could conceivably bring a set of beliefs to the situation, for example, that are so extreme and

preconceived that the content of the product (system image) is virtually ignored in the interaction. Alternatively I could be so lacking in relevant cognitive background that I cannot even begin to engage with the system image.

Presumably one would not want to argue that a particular formal organisation necessitates a particular cognitive model.⁷¹ I can for example imagine that although I have a general functional image that is a fundamental part of such a model (draws in cool air, picks up heat, gives out warmer air), there are alternatives. One could for example imagine a cognitive model which regards the heater as collecting air which is then heated and released (on an analogy with a water heater), or as the magic box which mysteriously generates hot air. Any of these could in principle be compatible with the same formal organisation. In what sense then can it be asserted that products afford cognitive models.

There is a trivial sense which turns on the idea that cognitive models need material of some kind (content) for their operation, and such material might be provided via our engagement with products. But it is difficult to see that any particular content could either be sufficient or necessary to afford a given cognitive model. In the case of physical affordance, the physical properties of the object place limiting conditions on its capacity to afford, so long as what is described in the affordance relation is confined to physical particulars. A chair affords sitting because it has certain properties (right height, sufficient strength) that allow for acts of sitting; an abacus affords arithmetical calculation because it has certain properties (appropriate arrangement of beads that can be moved and spaced) that allow for acts of calculation, but only in a context in which the physical actions (bead moving) are given meaning by their systematic relation to a conceptual model of the system of natural numbers. It is not clear what properties could be marshalled generally in respect of affording cognitive models. This is so for two reasons. Firstly, the concept of affordance relates to success in action. A chair affords sitting if sitting can be accomplished with it. A cognitive model per se accomplishes nothing, but is a construct that is itself employed in cognitive acts. So the appropriate comparison would need to be in terms of something affording the successful construction of a cognitive model. But what criteria are there for judging that a cognitive model has been successfully constructed, other than in its deployment in a successful cognitive task such as making an inference. Secondly, there is no perspicuous sense of the content of an object (for the purposes of 'affording' a cognitive model) that can be independently specified, since content is determined by the cognitive model.

⁷¹ This is certainly not the aim of product semantics since it would reduce interaction to a direct causal relation, which is explicitly rejected [Krippendorff 1990, p a3; Vihma 1995, p 41].

The problem in deploying the affordance concept in this way is that it disengages the elements of user-product interaction, and in so doing places far too great a requirement on the individual elements. If we ignore the specific assertion that products afford cognitive models, and return to the broader terms of engagement indicated in product semantic accounts, then I think that the relations become clearer. Engagement with a product involves both product content and whatever mental and physical baggage is brought to the encounter by the user. The product has content for the user only in so far as the user establishes that content in the interaction. It may well be the case that one would wish to assert that the product has an objectively specifiable content, which is independent from the content identified by any given individual user, but in terms of the interaction the relevant content is that which is determined by the user. It is in this sense that one can concur with product semantic accounts, that the meaning of the object is constituted in the cognitive activity of the individual in interaction with the object. It is in this sense that 'function', expressing the connectedness between intended affordance and product content might be construed as deterministic, if perceived to be detached from the user's process of meaning-making. And it is in this context that affordance plays its particular part in the product semantic framework, expressing the relations of accommodation that take place between an individual and an object in an interaction. In a cognitive context meaning and affordance develop together. In a novel product encounter, I might on the basis of previous experience and the conceptual framework that I bring, expect that a product will have certain properties and attributes - it will be heavy, will behave in certain ways, and will impress my friends. When I come to try it out, it may turn out to behave rather differently, and as I use it, I gradually achieve an accommodation between expectation and outcome.⁷² Ultimately I might become so familiar with its potential that I come to find unexpected new uses for it. At each stage what it affords is different, and what it perceive-affords (means) is different. Both affordance and meaning can change and develop.

Nevertheless, in order for there to be any kind of meaning-making process, there must be some systematic basis for such relations of accommodation, whether one conceives of these as resting on rules or principles underlying the relation, or alternatively as the normative result of some de facto process of selection. The basis for this in product semantic accounts is contextual fit - my ability to find a cognitively based context in which this new thing can find some sort of place in my existing conceptual schemes or in the practices in which I engage. An Inuit encountering an abandoned flashlight in the snowy wastes of Greenland, might discover that if this odd object which is good for gripping is prodded in a certain place, then light appears (and disappears when it is prodded a second

⁷² It might turn out to be lighter than I thought, enabling me to carry it to work and finding new contexts for it, and far from impressing my friends, I find that they can't believe that I would spend so much money on something so frivolous; and so on.

time). In some ways it is comprehensible as a source of light (relative to experience of seal oil lamps for example), although it is a rather peculiar light source since it points and doesn't seem to have a flame. In other ways it may not match any operative experiential or conceptual model. Finally the batteries run out and the light dies and cannot be reanimated no matter how much it is prodded, and even though it is filled up with seal oil.

For a while the flashlight affords illumination, and it also affords the cognitive model operative in the interaction to the extent that I am able to create some accommodation for the content of my interaction with it, in pre-existing conceptual and instrumental categories. I do not need to understand how it really works or what it is intended to do - it can find a place and therefore a meaning in terms of what I perceive to be its content and what it affords for me, given the conceptual and instrumental categories that I have.

Nevertheless there must come a point, unless the regress is to be infinite, where I must either possess some innate conceptual and instrumental categories, or the capacity to generate such categories from a non-categorical structure.⁷³ The ecological concept of affordance derived in the context of direct perception provides the basis for the development of categorial structure in the co-evolution of perception and action, which at some level remains operative in interaction, even when that interaction is informed by a developed categorial structure and conceptual scheme. But this clearly does not imply that 'affordance' is operative in the same sense in respect of both.

There seems little doubt that the bulk of any discussion of a user-product interaction must be carried on in terms of higher order conceptually driven cognitive models, and that these are socio-culturally relative, and trade on categorial structures revolving around type identity. At such levels of interaction user models are not detachable from design models, since they are jointly co-ordinated as elements of a socio-cultural whole which structures the artificial environment. Unless this were the case, it would be difficult to conceive of there being any intersubjectivity of affordance or object meaning that did not directly depend on commonly held categorial structures resulting from adaptation at a species level. The very possibility of a design process depends either on such commonly held adaptive structures, or the co-ordinating effect of socio-cultural structuring principles.

Product semantics offers a scheme involving a sequence, or a nested hierarchy, of key cognitive models (models of use, language, genesis, ecology), each of which determines an order of contextual fit which is dependent on their content.⁷⁴ On one interpretation of

⁷³ Or the ability to acquire such categories from others, although this raises the question of how the categories are acquired by those others.

⁷⁴ See above pp 51-57. Strictly speaking the order of contextual fit is determined by content types, not tokens.

the scheme the sequence is such that the higher order models depend on those of a lower order - implying that the cognitive model relating to the context of use is the most fundamental. On this interpretation the ecological concept of affordance finds a natural home in providing the underpinning for an account of object meaning which is essentially the account developed by Gibson. The elaboration of meaning relations involving objects going beyond direct perception then depends on the interaction of this basic affordance-structured relation with the variety of cognitive processes drawn in by successive contextual orders. The context of language draws in categorisation, type-identity and naming (semeiosis) primarily in relation to the natural order; the context of genesis draws in a similar range of processes primarily in relation to the socio-cultural order; the context of ecology draws in the idea of autopoiesis - the autonomous generation and transformation of culture.

However the temptation of this interpretation is resisted, since in the characterisation of the context of use, it is clear that affordance is counted as one among many 'semantic dimensions', including identities, suggesting that features of the context of language are also operative. This in turn can be interpreted in more than one way, the least divisive of which is the idea that although instrumental relations such as affordances might have developmental and logical priority, in a fully articulate product interaction all contextual orders are in fact operative.⁷⁵ The more radical interpretation turns on the Wittgensteinian argument for the priority of language and the derivation of its sense from participation in a shared 'form of life', potentially robbing affordance of both logical and developmental priority. Product semantic accounts tend to remain ambivalent with respect to these conceptual alternatives.

Given the divergence of the product semantic account of affordance from the ecological concept derived from direct perception, and the ambivalence in application and logical status resulting from the possibility of different interpretations of the relations between meaning-making contexts, further clarification of its nature and role will depend on the examination of other key elements in the framework in subsequent sections.⁷⁶

⁷⁵ Placing it hypothetically in anthropology for the sake of an example, one might imagine a primitive state which is pre-linguistic and pre-symbolic and involving only instrumental relations such as affordances, to which additional complexity is added as cognitive abilities develop. The 'modern' state involves the full range of cognitive abilities, which cannot be disengaged in considering an interaction. Donald proposes a scheme which is of this type [Donald 1991].

⁷⁶ The issues are primarily addressed in section 7 'Meaning and Semiotics'.

4.6 Role of Affordance in Design Discourses

The affordance concept has not generally had a role within design discourses prior to its appearance in product semantic accounts although Gibson himself has deployed the concept of affordances in articulating an outline for a theory of design and architecture.⁷⁷ The essence of this theory is that the concept of affordances can equally be applied to modified or artificial layouts and substances as to the natural parallels in terms of which adaptation to perceptual 'invariants' has developed. Design consists in organising affordances in the modified or artificial environment, and success in design will then depend upon realising the possibility of our perceiving and accessing affordances in the artificial environments that we create. The possibility of establishing general principles on this basis as criteria for formal organisation, in terms of the concepts of affordance or meaning is at the root of the framework for design theory elaborated in product semantics.

The difficulty in sustaining the programme on the basis of affordance is clearly evident in the approach taken by Krippendorff. Whilst for the most part Gibson is content to leave the bulk of sense-making within the realm of direct perception and environmental layouts Krippendorff, at the outset of his key papers, is at pains to establish that our understanding is not pinned at the level of surfaces or layouts, but extends deeply into the conceptual structure of objects as represented in our cognitive models.⁷⁸ If the ground is shifted substantially from the perceptual to the cognitive realm, then the import of the concept changes with it. The perceptually located concept of affordance, provides a grounding for perception within the general run of evolutionary accounts applying to species, and the substratum for an engagement with the world based on the idea that this is oriented in terms of potential for action relative to the environment, for a given species. In these terms affordance is pre-conceptual and generic. The cognitively located concept on the other hand, is conceptually based and centred on the individual, although ultimately dependent on the underlying capacities and abilities shared by individuals of a given species. In the one case affordance is the foundational relation with the world from which all higher level relations extend, in the other it is a particular relation among many which subtend from the possession and deployment of the conceptual structure possessed individuals.

The common ground consists in the idea of mutual accommodation between individuals and their environments (worlds), logically underpinned by the idea of sufficiency as the limiting case for the terms of the interaction. Its perceived role in design contexts is to underwrite the perceived need to reject a static and intrinsic subject/object dualism in

⁷⁷ Gibson 1982, pp 413-416.

⁷⁸ Krippendorff 1990 pp a3-5.

considering user-product interactions, in favour of a dynamic model of mutual accommodation. The effect of this is to shift the emphasis in design theory from the idea of products as having an objectively specifiable content which is subject to interpretation by users, to the idea that product content is a construct of the individual created during the course of an interaction and in parallel with the construction of significance. Using the concept of affordance to articulate the idea also emphasises the fact that although such processes are cognitive, they are not confined to a separate mental realm, but arrive intrinsically wrapped up in the physicality of our engagement with the world. So although Gibson's ecological concept is not carried through into product semantics with the full force of perceptually based meaning, the core idea of mutual accommodation and the embodiedness of perception and cognition nonetheless constitute grounds for meaning.

The problem with 'function' for product semantics is that it is the core concept relating product content to intended affordances, in the context of arriving at a specification which must of necessity be sufficiently objectively specifiable to enable a particular product to come into existence, and as such it vies with the essential subjectivity and relativity of content. But this is only a problem if the content that is specified (and the assumed relation between that content and the affordances intended) are taken to be identical with the content available to the user in interaction with the product, and this is by no means a necessary interpretation.

Extending this to the idea of centralising the concept of meaning rather than function in design theory, suggests that we should reject the notion that product content can be objectively specified in terms of sets of physical features as givens in the individual construction of meaning. That is to say they are not analogous to specifiable syntactic elements and structures which can then be semantically interpreted - in product interaction syntax and semantics are constructed in parallel. But although this follows from the general thrust of the product semantic argument, it is not a conclusion that is generally drawn, and the majority of accounts ultimately adhere to the separation of syntactics and semantics in the analysis of product content and the construction of meaning.

Section 5 Categorisation

| | | |
|-----|--------------------------------------|-----|
| 5.1 | Categorisation in Product Semantics | 138 |
| 5.2 | Categorisation, Concepts and Kinds | 148 |
| 5.3 | Prototype Theory vs Theory Theory | 159 |
| 5.4 | Abstract Concepts and Schemas | 164 |
| 5.5 | Categorisation and Product Semantics | 168 |

5.1 Categorisation in Product Semantics

Product semantics as an approach is built on the contention that an effective design process requires the designer to gain an understanding of the content of user-product interaction, in terms of the cognitive models deployed by the user. It is argued that the basis of such an understanding is to be found in the idea of contextual fit which is typified primarily at the level of product interaction in the types of cognitive models and strategies which are involved in processes of categorisation. The centrality of categorisation in product semantic theory and practice is evident in the work of a number of authors,¹ but is addressed most directly and fully in the work of Athavankar, whose model of categorisation based on prototype semantics has become generally accepted within product semantics.²

Athavankar develops his argument in the context of a distinction between the physical world of objects and the internal mental representations that constitute and are constituted by our interaction with that world of objects. Such internal mental representations are not simply mirrors of that world, but the results of an active intellectual process which is in large measure shaped by cultural forces, ensuring conformity with culturally accepted norms. The structure of the 'mental world' in relation to our interaction with objects is revealed in the process of categorisation. Recognition of a new product, for example, depends on the possession of a relevant mental concept with which we are able to associate the new product through specific perceptual clues. Perceptually accessible features of the new product initiate a mental search that activates a class of similar examples that have previously been coded, structured and labelled with lexical terms, to which the product can be assimilated.

Athavankar argues that classical notions of categorisation based on defining features and necessary and sufficient conditions for membership of a class are insufficiently flexible to account for the human ability to deal with deviant or marginal cases with the evident confidence that is in fact the case. The subtlety of such categorisation is well brought out in the difficulty that is experienced in developing discrimination rules that could be applied by non-human systems. He proposes an approach to the characterisation of the categorisation process that is based in part on the work of Rosch,³ who pointed out (inter alia) that there is a correlation between perceptual and functional feature bundles in most objects, giving them a relatively high degree of predictability, and that in the interests of cognitive economy non-identical objects are treated as equivalent where differences are

¹ Krippendorff 1989, pp 17-19, 1990, p a13; Vihma 1995, pp83-85; Lannoch and Lannoch 1989, p4.

² Athavankar 1989; 1990.

³ Rosch 1975,1978; Rosch and Lloyd 1978; Rosch and Mervis 1975; Rosch, Mervis, Gray, Johnson and Boyes-Braem 1976.

not behaviourally relevant. These observations are taken together with the concept of 'family resemblance' developed by Wittgenstein⁴ which emphasises the idea of a conceptual structure based on families of exemplars with an overlapping structure of shared attributes, the role of central or typical members of 'families' and the fuzziness of class boundaries.⁵

The scheme that Athavankar proposes, consists in characterising a cognitive strategy in which concepts are defined not by the boundaries or bounding conditions for classes but rather by the core - a stereotype or prototype, often consisting of a typical or preferred example of the class - which serves as a central point of reference for the category as a whole. Categories or classes have a graded membership, whose gradations are arrived at by comparison of candidate members with the prototypical core exemplars.

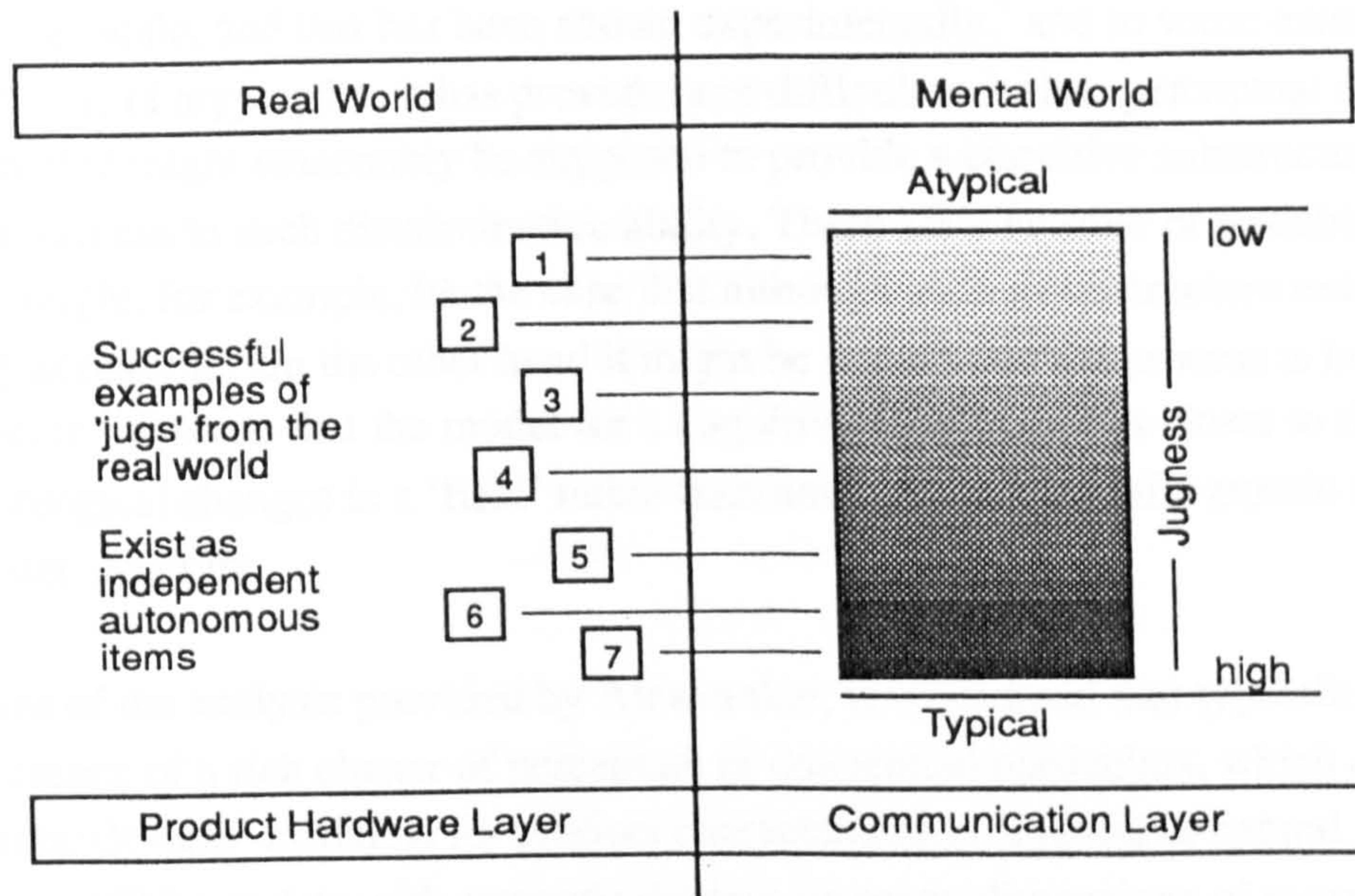
Although the distinction and discontinuity between classes is preserved through the grounding provided by the central members, which anchor a given category, the boundaries themselves are fluid, allowing for change in both concept and category. Innovation in design (and development and change in conceptual structure generally) exploits the fluidity of boundaries, and the flexibility in the links between category members captured by the idea of 'family resemblance'.

User understanding and product communication is rooted in the process of abstraction in which selective assimilation of members to classes is made on the basis of treating non-identical objects as equivalent in relation to behavioural criteria.⁶ Emphasis is placed on the distinction between objects in the material world, which have an autonomous status, and the asymmetric linear structure of graded class membership which characterises the world of mental concepts. In the course of the analysis, the structure of these relations are expressed graphically as follows :-

⁴ Wittgenstein 1972, para 65-77.

⁵ The essential point of Wittgenstein's treatment is to demonstrate that a property-based rule structure approach to defining conceptual categories will not work for key classes of category. So for example, although we are able to decide in practice what counts as a game, the range of examples we can muster (chess, football, hide-and-seek, charades, and so on) are not united either by necessary property possession or by partitioning definitions. Instead there are a range of loose characteristics which are game-like in some sense (they are forms of play, tests of skill, contests etc) which act as conceptual nuclei which gather examples. The idea of a game is constituted in the network of different associations between clustered examples. The result is that it may be the case that particular paired examples, or paired clusters, have no feature or definitional element that they share, but are only linked via the intermediates with which some features or definitional elements that are shared. The argument for a family resemblance structure for concepts (and their linguistic designations) is continuous with the overall sceptical argument against the possibility of the justification of rules in terms of matters of fact.

⁶ The general description of the process of abstraction which Athavankar derives from cognitive psychology is consonant with models used in information processing and causal theoretical accounts of cognitive processes. [See for example, Dretske 1981] in which the use of the terms digital and analogue (defined in terms of the relative encapsulation of information) are used to underpin a cognitive account of knowledge and abstraction.



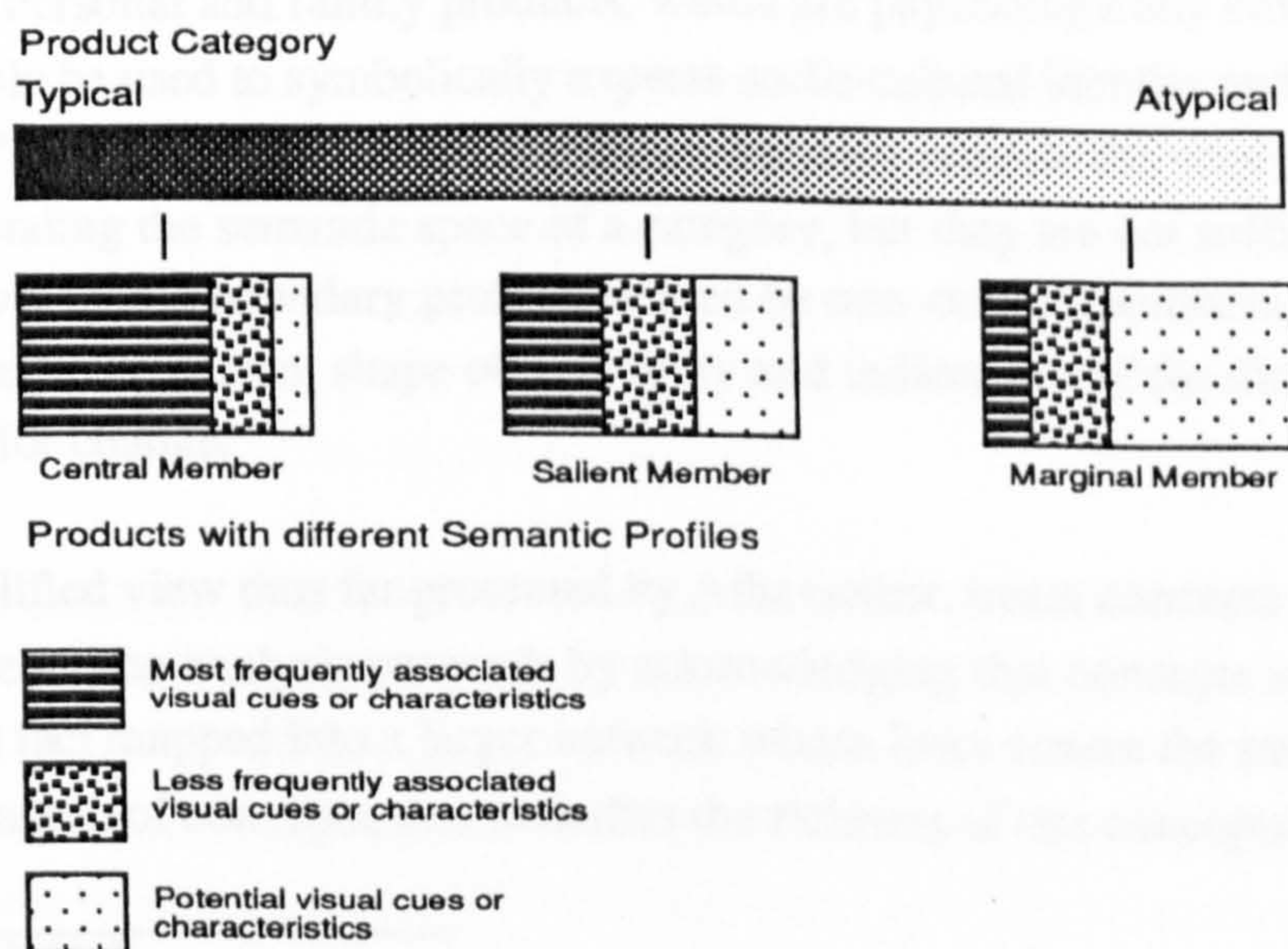
In product semantic terms, the designer's role can be expressed as an attempt to create a physical object in the 'product hardware layer' which occupies a defined place in the 'communication' layer. At this level of analysis, the designer's task as presented, is one-dimensional and clearly a trivial reflection of what is in practice a complex and subtle multi-faceted problem. Accepting for the moment that what we are presented with at this stage is a much oversimplified model, and setting this aside, one question that arises is the extent to which the process is both conservative and normative. At first sight this may well seem to be the case, but if a clear distinction is held between the prototype as an expression of a dimension of identity, rather than an aspiration for all objects of a type, then the question dissolves.

The problem for the designer in product semantic terms is a communication problem, which can be expressed in terms of the position in 'semantic space' that a proposed product should occupy, and the characteristics that the object would need to be endowed with if it were to successfully occupy that space. The characteristics which can be used and which constitute perceived positions in semantic space, are just those respects in which the typicality of central class members are typical and the respects in which these are linked to the non-central members that round out the category. Generally speaking these respects will consist in particular perceptual or conceptual features.

The model so far provided represents one dimension of a multi-dimensional semantic space, where the character of the object is expressed by a hypostasised abstract universal property such as 'jugness'. Although it is certainly true that there would be a very high degree of concordance between subjects in the grading of objects from typical to atypical

on a linear scale, and this has been shown experimentally,⁷ and to some extent distinctions in the forms of atypicality, it has proved more difficult to isolate perceptual defining features that might reasonably be supposed to provide a cognitive substructure to account for our success in such discriminative ability. There are a number of possible reasons for this. It might, for example, be the case that although such a substructure exists, it is not readily accessible. On the other hand it might be argued that the process is intrinsically holistic, in the sense that the model for a cognitive substructure is closer to the idea of morphological changes in a 'field' rather than having a conceptually atomic architecture, or cluster structure.

In terms of the analysis provided by Athavankar, it is assumed that typicality consists in the presence of a rich cluster of perceptual or conceptual particulars, which constitute the 'semantic devices' available for product characterisation. Typical or central members of a category will be replete with semantic devices on many dimensions of semantic space. Less typical members may have fewer such devices, or they may be associated with only some dimensions of the relevant semantic space as a whole. Each product will therefore have a particular profile within the semantic space of the category, whose dimensions are defined by the dimensions expressed in the central or typical members. The relevance of particular dimensions or devices can be expressed as a function of the frequency of their association with central membership, creating a formal matrix against which semantic profiles can be matched.



⁷ Labov 1973.

Products characterised by high frequency semantic devices would be located close to the centre of the category, whilst less typical members would display fewer or less frequently used semantic devices, including those not generally associated with the category which would need to be assimilated independently. The atypical members would therefore occupy a place at the boundary of the category and in a position to introduce new dimensions into the semantic space of the category. This aspect of the model is particularly important since it provides a mechanism for evolution and change in the constitution of categories themselves. Athavankar's central hypothesis is that the categorisation scheme provides a cognitive model to underpin the way in which designers can locate products in terms of their qualitative content, and an account of the mechanisms involved in the definition and introduction of new products. The essential element in this latter process involves the comprehension of the relevant semantic space characterised by the central member, and manipulation of the fuzzy boundary of the category and the gradation of its semantic dimensions.

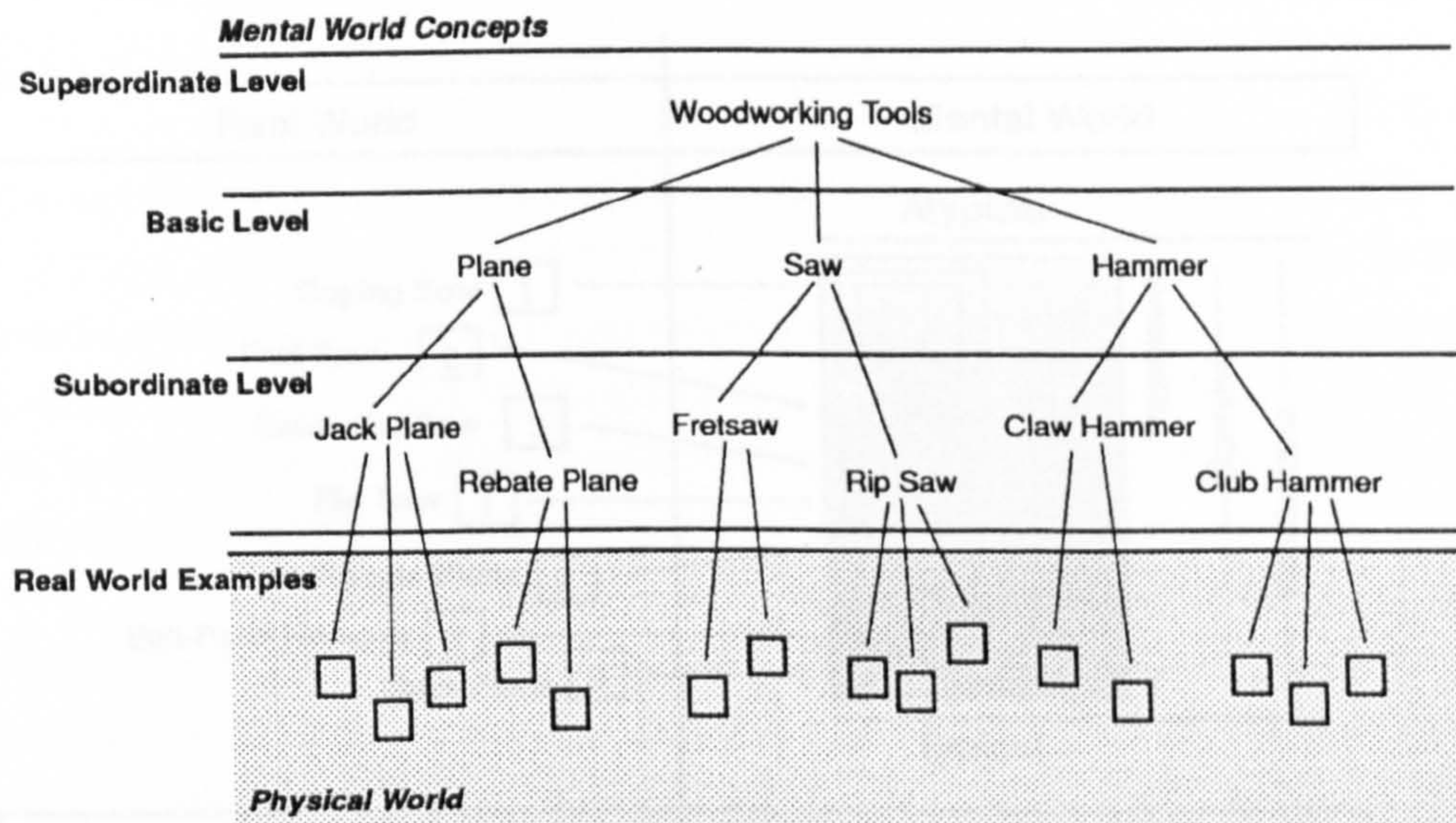
The central member functions as a metonymic representation of the category as a whole, and it does so in two distinct respects, which Athavankar bases on relevant alternative models of metonymic representation derived from the work of Lakoff.⁸ On the one hand, and predominantly, object categories are metonymically represented by 'typical' examples. On the other, object categories may be represented by 'salient' or 'ideal' cases. In either event, the exemplars are culturally influenced, if not culturally determined, and also dependent upon the nature of the product relationship relevant to the product category. Personal and family products, which are psychologically close to users, may for example be used to symbolically express socio-cultural identity and reveal sub-cultural variation.⁹ The character of the central member may provide the necessary conditions for comprehending the semantic space of a category, but they are not sufficient, and are rounded out by the boundary profiles created by non-central members, which give final expression to the current shape of a category and indications of the dimensions of potential for change.

The simplified view thus far presented by Athavankar, treats concepts as isolated and independent. The analysis proceeds by acknowledging that concepts are not autonomous but are in fact mapped into a larger network whose links ensure the multi-dimensional interanimation of concepts, that underlies the richness of our conceptual structure.

⁸ Lakoff 1987.

⁹ Athavankar bases his argument partly on the work of Rao in respect of the 'psychological distance' of products from users [Rao 1984]. In these cases the socio-cultural influences and pressures may be subtle, and reflected in the relevance of ideal, salient and typical examples to the semantic profile of particular products. The extent of the variation subculturally is also typified in the case of personal and domestic products, where fashion, interior decor, choice of cars and choice of personal products and accessories, for example, can produce radically different notions of category shape. [See Lawrie 1989 for profiling in a market research context].

Athavankar argues, on the basis of recent work in cognitive studies relating to concepts and categories,¹⁰ that a key aspect of the structure of conceptual networks is their layered and nested hierarchies. A specialised product such as a fretsaw, is a special case of a more general category 'saw', which is in turn subsumed by the more general category of woodworking tools. Such a structure might be graphically represented as follows :-



The variety of real world examples is partitioned into types at three fundamental levels, in the mental world. These are hierarchically arranged and inclusive, and in principle any level could function as the subordinate in a set of higher level categories, although in practice the level described as the basic level has a distinctive set of characteristics, with particular import in the overall cognitive scheme.¹¹ The spatialisation of this hierarchical structure is perceived to be essential to understanding the network of concepts pertaining to man-made products, whose genesis is the result of a deliberate and synthetic process, in contrast to the evolution of natural species.¹²

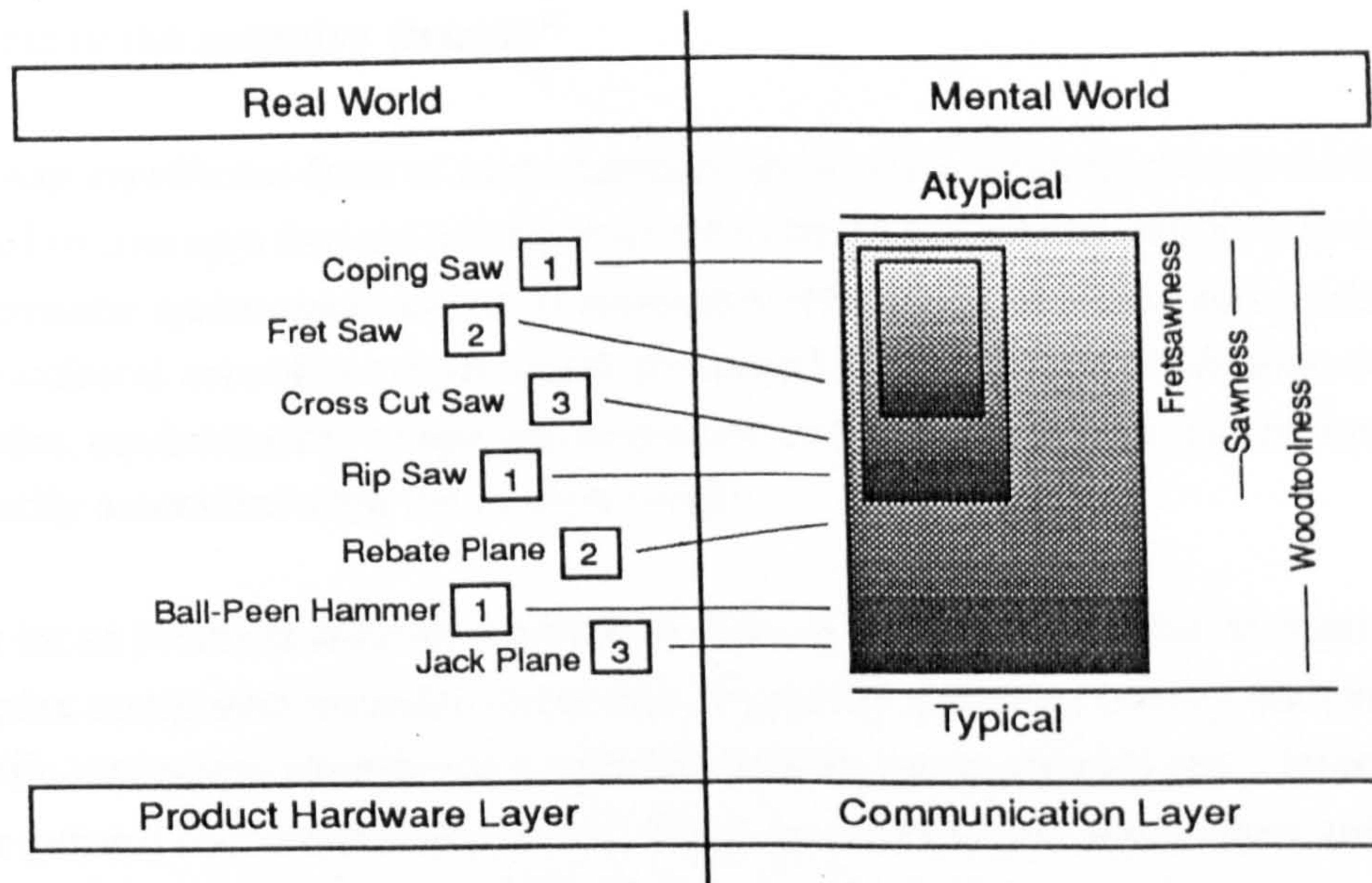
The significance of the two-dimensional spatialisation is constituted in its capacity to make explicit the nature of the extended network of semantic devices which underpin the complexity and subtlety of product characterisation. Semantic devices at basic and superordinate levels are intrinsically linked to the subordinate categories that constitute the lowest level of mental representation of real world exemplars, and create pathways via the

¹⁰ Athavankar 1989, pp 105-107; Collins and Quillian 1969; Rosch 1978; Newport and Bellugi 1978.

¹¹ These are discussed below pp 152-154. The implications of taxonomic structures of this kind are discussed by Athavankar 1989, pp 106-107.

¹² This distinction is problematic because of the unclarity of the differences in conceptual structure in the case of natural, nominal and artefact kinds [see below pp 148-162].

hierarchical structure to more distantly related particulars. Superordinate levels thus capture sets of characteristics that reflect a generality of category 'belongingness' that can guide the definition of semantic devices that will sustain category identity.¹³ The hierarchical levels of the system can be represented graphically in terms of Athavankar's fundamental model, to express the nestedness of category levels.



The tracking of semantic devices falling under the umbrella of the parent class, provides a strategy for the designer to explore innovative profiles in semantic product space, without jeopardising primary category identity. Treating products as members of more inclusive classes, in the product domain, is parallel to the process of abstraction which typifies relevant aspects of human cognition generally.¹⁴ The relevance and success of the strategy is thus perceived to lie in the direct analogy between the exploratory pattern of the designer and the more general constructive conceptual development of human understanding.¹⁵

¹³ They do not however appear to have the same properties of inheritance of higher level characteristics that are associated with the levels structure of natural kind classifications. The degree to which the levels structure in respect of artefacts parallels that of natural kind concepts, may be the basis for the articulation of fundamental semantic distinctions that operate in the cognitive realm [See Atran 1987; Schwartz 1978, 1980 and Putnam 1970 1975 on the differences in natural, nominal and artefact kinds, and below pp 148-150, 154-162].

¹⁴ Dretske 1981. [See p 139 note 6].

¹⁵ It could also be argued (and seems to be implied at one point by Athavankar) that the intuitive strategies of designers is formally constituted by such search patterns, even if they are not so recognised [Athavankar p110-111]. The importance of Athavankar's contribution to the development of product semantics as design theory results in part from providing a clue as to the relationship between informal and holistic methods and the more formal expression of an underpinning theoretical account.

Further complexity, and richness in semantic devices is introduced into the conceptual scheme via the fact that products may belong to more than one superordinate category. Although this is the case and there are product examples which retain their duality, it is largely true that ultimately product form will develop so that allegiance tends to reside with one category rather than another. This abhorrence of a product serving two masters is noted by Athavankar,¹⁶ who nonetheless points out the importance of both conceptual and real hybrids in creating richness and variation in semantic profiles, and the general dynamic of the cognitive process.¹⁷

The most significant facet of extra-category association however, lies in the links that are created to concepts that are wholly external to the superordinate category and lie beyond the semantic space associated with taxonomic identity. Such links bind products into socio-cultural nets of concepts which are rooted in expressions of identity, social class, attitudes, environments or specific occasions and whose forms of expression may not be primarily associated with the product world.

In so far as products animate conceptual links of this kind, they can be regarded as complex compound semantic statements. Typically, products convey not only their specific taxonomic identity via a semantic profile, but in addition carry associations with more general conceptual categories.¹⁸ These associations are nonetheless articulated through the same kinds of semantic devices involved in taxonomic identity, whether by accident or by design. Athavankar's core conception of the mechanisms that create articulation within the semantic system involve the operation of two fundamental kinds of processes.

The first process, which lies closest to taxonomic identity, consists in the creation of semantic devices through association with functional properties and functional change. The physical qualities of products are strongly influenced by their functional requirements, and this is often though not necessarily reflected in their form and appearance. The relationship between properties supporting functionality and the semantic devices through which they are coded constitutes the primary means by which design can harness or create more complex conceptual structures in the communication layer. This is most evident in situations where a product is subject to functional change. The concrete physical expression of functional change may be immediately apparent in the product, and provides a relatively accessible and stable semantic device with associative links to a

¹⁶ Athavankar 1989 pp107-108, 1990 p d18.

¹⁷ Athavankar 1989 pp 108-110.

¹⁸ For example, the semantic identity of age-related products, gender-related products and activity or event related products (and their forms of expression) is not pinned to simple taxonomic identity, but also to categories organised in terms of the homogeneity of a user group, or the social coherence and significance of 'occasions'. [Athavankar 1990 p d23, 1989 pp109-110].

broader category through the hierarchical structuring of a category and particularisation of a product type. This may seem anomalous. How can the creation of a narrower subdivision within a category serve to open that category to a broader conceptual framework? It is able to do this, because the basis for the subdivision of a category is made in terms of more abstract concepts. The particularisation of members or groups of members of a category, and their association with semantic devices, both draws from and contributes to the broader semantic network.

Where there is either no functional change, or where functionality is not reflected in distinctive semantic devices, at the taxonomic category level, semantic codings may nonetheless be created to serve functions at higher levels, related to cognitive needs or marketing, for example. In cases where there is no 'automatic' expression of functionality,¹⁹ codings can be created in the form of semantic devices which are deliberately associated with non-apparent functionality.²⁰ This idea can be extended to cases where functionality at the taxonomic category level is not directly involved, for example in the articulation of product difference for marketing purposes.²¹ This involves the second of Athavankar's fundamental processes of semantic articulation.

Semantic articulation of this latter kind depends on understanding the nature of graded category membership in the case of compound concepts, consisting essentially of two independent but interacting mental concepts deriving their definitions from discrete groups of semantic devices associated with their relevant superordinate categories.

Greater specificity within the primary category can be achieved by overlapping association with the semantic devices associated with the relevant superordinate categories. The influence on the semantic space of the product category, from the superordinate categories, accounts for the possibility of change and shifts in concepts. Nonetheless the identity of the product is ultimately articulated in terms of its membership of the primary category, and the perception that it does so will be crucial in determining its success in communication. In cases where the influence of semantic devices derived from superordinate categories is too strong, the product may either fail to retain a clear identity, or be perceived to be inappropriate.²²

¹⁹ Where there is a direct connection of formal properties with an associated function. However this does not presume a form/function relation of a functionalist kind, but rather that there is a de facto established association which has developed culturally and historically.

²⁰ For example the colour coding of invisibly functional parts of sports shoes.

²¹ For example 'go-faster' stripes on cars (derived from sports cars, which have stripes and which do go faster).

²² This is essentially the case with gimmick products such as Mickey Mouse telephones, but includes less extreme examples where the core character of products (taxonomic identity) is overwhelmed by other aspects of its compound identity. Athavankar uses this scheme as a criterion for product success and failure in communication terms.

In many cases the relevant superordinate categories will not have the same structure or parameters for a relevance class as the primary category. They often consist of collections of examples of products that are clustered and categorised in terms of various dimensions of their socio-cultural use. Such dimensions include categories of users, occasions of use, socio-environmental contexts of use, socio-economic class and status and level of technology, for example.

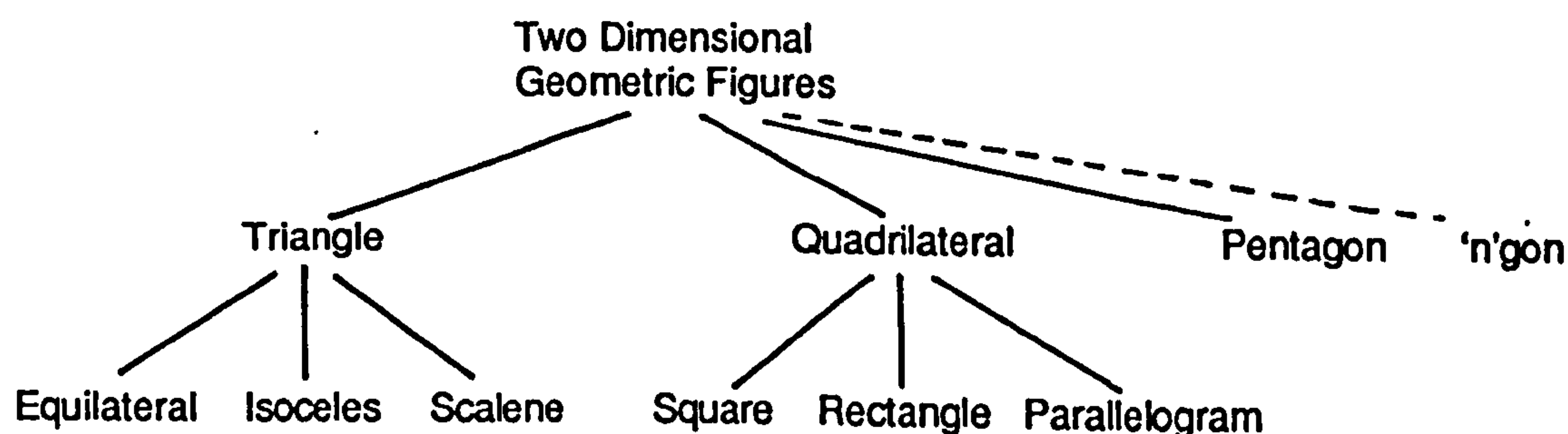
Ultimately then, products can be viewed as compound semantic statements, expressing their identity through a complex set of semantic devices associated both with a primary membership category and by association with a relevant range of semantically broader superordinate categories. Membership of the primary category is underpinned by functional identity and associated semantic coding, and is fundamentally metonymic in character. Particularisation and differentiation of products within the primary category, and the development and change of that category is achieved primarily through discrimination at the basic level, and through associative links (which are typically metaphoric in character) with selected superordinate categories.²³ A model for product differentiation and identity in the context of communication which is empirically and theoretically grounded in the operation of prototype semantics, underpins a categorial model for the cognitive domain of the user. This in turn can be used to account for the dynamics of product development and assimilation, and to provide a rationale for the intuitive and informal processes employed by the designer, which can be formalised in terms of semantic profiling through category analysis.

²³ Athvankar stresses the importance of the non-taxonomic elements of compound semantic statements and equates these with metaphor, which he regards as having the key role to play in the articulation of product identities [Athvankar 1990 pp d 25-28].

5.2 Categorisation, Concepts and Kinds

One approach to elucidating the nature of concepts and conceptual categories might be to imagine what would be involved in explaining a concept to someone for whom it is unfamiliar. Exercises of this kind tend to generate lists of features or properties which are associated with the given concept, and whose nature is dependent upon the level of specialisation or technical knowledge of the subject, and their degree of familiarity with the concept. In addition it is evident, even in the case of relatively concrete concepts, that the characterisation of conceptual categories may be divided into a small number of fundamental approaches, distinguished by the distinct forms taken by the lists of defining attributes generated.

Mathematical concepts such as 'triangle' are typically characterised by the generation of attribute lists which include a) the various elements of a description or formal definition of 'triangle', b) examples or representations of triangles, c) references to the fact that triangles are particular examples of more general classes of objects. Analysis of such lists shows that one cluster of attributes locates the concept of a triangle within a hierarchically organised categorial framework which will include reference to superordinate and subordinate categories



A second set of attributes might be described as referring to the perceptual features of triangles, such as - 'having three straight sides', 'joined at the ends'. A third set of attributes is concerned with the analytical properties of triangles, such as - 'having internal angles adding up to 180° .

A selection of those properties from the three sets of attributes which apply to all triangles and only to triangles, enables us to construct a formal definition of 'triangle' in the form of a set of necessary and sufficient conditions. We can thus specify a conceptual rule which will invariably identify triangles and distinguish them from non-triangles. Although this is the case, it clearly does not follow that such a rule is involved in the recognition of

triangles, nor that the form in which the concept is represented is captured by the rule. It is arguably the case that our in-vivo processes of categorisation lean heavily on the less formal and more perceptually oriented sets of attributes, and that the function of the reference to superordinate and subordinate categories is to locate the contextual boundaries within which categorisation takes place. Analytical properties on the other hand, provide the means by which verification of the correctness of a categorisation can be grounded and tested.

Similar observations can be made in the case of everyday artefact concepts such as table and chair. These will be included in contextually locating superordinate categories such as 'furniture', and elaborated through subordinate categories such as 'dining table', 'easy chair'. Other sets of attributes will identify perceptual features of chairs such as -'having a horizontal or near horizontal surface'. The non-perceptual or analytical properties of such objects being typically expressed in terms of functions or affordances - 'used for sitting'.

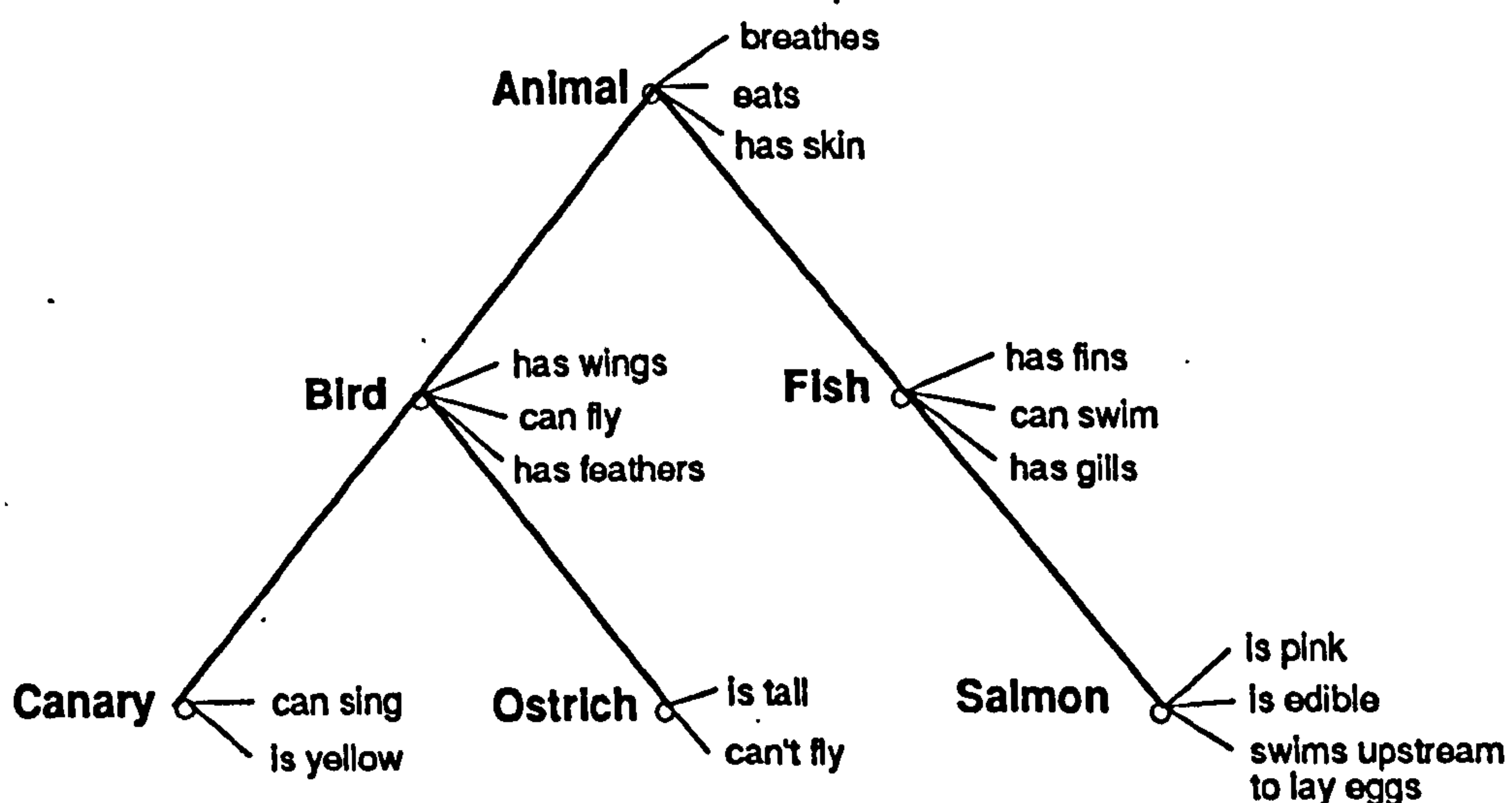
The difference between such everyday concepts and mathematical ones appears to rest on the fact that although there are non-perceptual properties which are defining, there are no necessary perceptual properties common to all examples. In addition there do not appear to be any combinations of properties which are both necessary and sufficient for such concepts. The properties that we can muster as representations for such categories are relatively ill-defined and fuzzy. In cognitive terms the implication may be that such concepts are not represented in terms of lists of properties which are defining and distinguishing, but rather that they are based on selected perceptual properties associated with typical examples.

A further fundamental type of conceptual category relates to living organisms. The attribute lists generated in respect of things falling within this category such as 'cats' and 'apples' typically take two forms, which may be combined. The two forms correspond to the typical patterns associated with mathematical concepts on the one hand, and artefact concepts on the other. One type of list resembles that drawn up for 'chair', which lacks a combination of features which apply to all cats and only cats, and which implies a fuzzy representation. The second type of list resembles the list for 'triangle' in providing a set of defining and distinguishing criteria, which would constitute a biological definition.

Although the possibility of dual representation for the same concept is most readily apparent in the organic conceptual category, it may be that dual or multiple representation is a feature of all types of conceptual category, and dependent on context or cognitive development. Early classical studies of acquisition strategies and processes present the view that individual concepts are represented by lists of properties, and that these lists

constitute definitions for the concepts. In addition concepts are considered to be hierarchically stored, and the cognitive effort required to verify a particular statement concerning a concept reflects the number of levels in the hierarchy that must be considered in arriving at a verification.²⁴

Collins and Quillian's influential model of how information is organised and stored in semantic memory was derived from studies of the representation of natural rather than the artificial or constructed concepts typical of earlier studies. In relation to biological classes for example, they proposed that information was organised into hierarchies. The higher levels consist of broad general categories, dividing into more specific categories at lower levels. An example of such a hierarchical classification is exemplified by part of their schema for the superordinate category 'animals'²⁵



The schema nonetheless retains the classical notion of how individual concepts are represented - as lists of properties or features, a combination of which applies to all and only category members, as a definition of the category. Exceptions are allowed in the case of lower level categories, where the defining features operate as a default.

One of the key challenges to classical views was in the first instance a response to the fact that anomalies in the experimental results, associated with such hierarchical organisation suggested that not all examples of a concept category had cognitive parity. In experiments

²⁴ Bruner et al 1956; Collins and Quillian 1969.

²⁵ Diagram adapted from Roth and Frisby 1986, p40.

dependent on the relative time taken to scan a defined set of levels in a hierarchy, it was found that some embodied examples could be more rapidly verified than others.²⁶ If conceptual categories are clearly defined (as in the classical view) and hierarchically structured, then one would expect all the instances in a given category to have parity, and hierarchically parallel statements to have closely similar verification times. The fact that this was not the case suggested that some instances of a conceptual category might be judged more typical than others.

Considerations such as these prompted a number of psychologists to question the homogeneity of conceptual categories. They were able to show experimentally that many everyday categories appear to have an internal structure in the sense that their members are accorded differential status. Some members are more typical than others. Rosch, for example, concluded that the idea of 'typicality' is central to the way conceptual categories are mentally represented and that members are in fact ordered in terms of perceived typicality, and this is reflected in performance in a variety of cognitive tasks.²⁷

An alternative line of enquiry involved investigation of the boundaries of categories. In contrast to the expectation implied by the classical view, it was found that the boundaries of some conceptual categories are both fuzzy and context dependent.²⁸

Further experimental work by Rosch and her colleagues attempted to elucidate the relationship between attributes and category members. They concluded that attributes did play a role in the mental representation of conceptual categories, but not through providing sharp edged membership criteria, but rather by association with typicality. The items which subjects rated as most typical held a greater number of attributes associated with the category than less typical items, and held fewer attributes that might be associated with contrasting categories.²⁹

The most fundamental aspect of this empirical work lies in the challenge it poses to the traditional view of concepts, as consisting of conceptual primitives which are logically combined to form more complex concepts. This view was compatible with both the main strands of theoretical thinking relating to the idea of categories. For those with an objectivist stance, the idea of primitives was linked to the notion of categorial frameworks as reflecting external reality via natural kinds. Mentalists, on the other hand, were able to

²⁶ For example 'a sparrow is a bird' is more rapidly verified than 'a parrot is a bird' (relative to a given culture).

²⁷ Rosch 1973, 1975.

²⁸ Labov 1973. It has been argued by Atran that Labov's result, which was restricted to everyday household objects, does not imply the fuzziness of all conceptual categories, and further that it may be definitely rejected in the case of living kinds [Atran 1987].

²⁹ Rosch and Mervis 1975.

conceive of conceptual primitives as finitary symbols which could be combined to form complex conceptual categories.

In fact, most cognitively basic concepts turn out to be poor candidates as primitives, since they have an internal structure, they sit in the middle of conceptual hierarchies and are neither straightforward reflections of the external world nor purely mentalistic. Cognitively basic concepts such as dog, table, house form the core of hierarchies :

| | | | |
|----------------------|-----------|-----------|-----------|
| <i>Superordinate</i> | Animal | Furniture | Buildings |
| <i>Basic Level</i> | Dog | Table | House |
| <i>Subordinate</i> | Dalmatian | Trestle | Cottage |

and are basic in four principal respects. In terms of *perception*, it is the highest level in the hierarchy at which a single mental image is associated with the concept as a whole, and where there is consistency in the overall shapes associated with the things to which the concept applies, and where subjects are quickest in identifying correct applications of the concept. In the context of *language*, it is the level with the shortest, most commonly used and contextually neutral words, among the first to be learned by children and the first, historically to enter the lexicon. In terms of the *organisation of knowledge*, it is the level at which the majority of attributes associated with category members are held. In terms of *functioning*, it is the highest level at which there is commonality in the use of motor programs for dealing with the things that the concept applies to, and the level at which most culturally determined functions for things are defined.³⁰

Reference has been made a number of times to the idea of a 'kind'. An unanalysed sense of the import of the term is nicely captured in the idea that two things or people may be 'two of a kind' - which in part perhaps carries with it the sense that they share some fundamental nature or property. In the context of categorisation the most common and familiar use of the term kind is in the context of a 'natural kind'. In folk theoretical terms natural kinds are object types that occur naturally (eg tigers, lemons, diamonds, water).³¹ In cognitive terms such object types are described categorially as having very rich correlated structures. In addition they are associated with the belief that their cohering as a kind depends on their sharing an underlying fundamental property or essence. Diamonds

³⁰The relationship of this list of basic level properties to some of the principal features of the product semantics account, will be apparent even from a superficial reading. For example, the link from the generality of motor programmes to the idea of affordance; the relativity and cultural determination of function; a holistic view of perception which is meaning related, rather than feature or property related.

³¹I will allow myself for the moment to be exposed to the danger of working with the same examples as a train of philosophers who have addressed the notion of 'kinds' as a central issue. [The key papers in the developing discussion are Quine 1969; Kripke 1971,1972; Donnellan 1966,1972; Putnam 1970,1972,1973; Schwartz 1978, 1980; Putman 1982. A collection of key papers on this theme (including a number of those cited here) are gathered in Schwartz 1977].

are diamonds by dint of their all having the same fundamental atomic structure, even though their identification will usually be based on perceptual features.³²

The underlying idea finds its antecedents in Locke's differentiation between 'real' and 'nominal' essences,³³ yielding a parallel distinction between 'natural kinds' and 'nominal kinds'. Natural kinds are kinds in respect of their shared real essences, whilst nominal kinds have no real essences but only nominal essences - criterial definitions established by convention. Thus in contrast to a natural kind like 'diamond', a geometric kind such as 'triangle' has no underlying essence that causes it have the properties that it has, but only the nominal form of a criterial definition.³⁴ Artefacts and products, will generally not be captured by conceptual frameworks of this kind, since in these cases there does not appear to be an underlying definitional rule waiting to be discovered. Nevertheless attempts have been made to extend the idea of 'natural kind' to non-natural objects, and through the extension of the concept of 'nominal kinds' to include functional definition.³⁵

In addition to the theoretical arguments and supporting experimental work which have cast doubt on the classical conception of concepts and categorisation, an independent line of argument stemming from the consideration of theories of meaning in philosophy has also added critical weight and suggested a more complex picture. Philosophically, within traditional theories of meaning, the classical standpoint regards category terms as having both an 'intension' and an 'extension'. The intension is essentially the set of necessary and sufficient conditions that define the category (or concept), whilst the extension identifies the set of things to which the term applies. The extension is thus demarcated by the criteria provided by the intension.

³² The identification features of natural kinds may well have a strong prototypical basis. The common prototype for diamond, for example, is likely to be a cut diamond of a certain size, and most of us without experience of finding raw diamonds, would not recognise a diamond in its natural state.

³³ Locke 1690. The distinction that Locke makes is that there is no set of perceptual features that are essential to a thing, but rather that the nature of a thing results from its having a real essence which is unknowable since it is not perceivable. The nearest we can get to comprehending a thing is through its nominal essence, a conventionally fixed definition reflecting the perceptual experience of language users.

³⁴ Schwartz 1978. It is possible to take a different view if one believes that triangles are pre-existing forms which are discovered rather than created, in which case one could argue that the real and nominal essences are the same. Locke appears to have taken this view. However, although the basic distinction appears clear, in practice it is difficult to identify purely definitional nominal kinds. Even in the case of 'triangle' considered earlier, for example, characterisations typically included descriptions falling short of a definition, examples or representations, and particularisation from more general features of geometric classes.

³⁵ Putnam 1970,1972,1973. Putnam argues for the co-extensivity of 'kind' across natural and artefactual categories on the basis of their indexicality. Schwartz opposes this view on the grounds that artefact kinds are a special case of 'nominal kinds' (like 'bachelor') which are not indexical but take the form of an analytic specification [Schwartz 1978]. Putman takes the hypothetical perspective of an alien anthropologist and points out that he would need to adopt the same assumptions as an observer in respect of the workings of both 'natural' and 'artefactual' kinds, and that the distinction that we make is based on the difficulty we have in seeing our own behaviour and its products as parts of a 'natural' process [Putman 1982].

Although the alternative philosophical account, initially driven by Wittgenstein under the rubric 'family resemblances'³⁶ appears to offer a distinct view, it is nonetheless a criterial account of category terms. So although there may be no set of necessary and sufficient features, the intension is in practice constituted by some subset of the overall resemblance feature set, and the extension derived from the applicability of the various possible subsets. This account thus also regards the meaning of category terms as being characterised (albeit in a more complex way) by a set of criteria associated with the category.

The radical challenge to a criterial account of any flavour is posed by the Causal Theory of Reference, which asserts that category terms are in fact akin to proper names.³⁷ In the case of proper names, it is argued, reference is not secured by the operation of criteria in the relation between intension and extension, but rather by processes of 'baptism' or 'assignment' and causal continuity. An intensional account would generate lists of facts associated with a name - Richard Hughes carried out research on Metal Colouring, Richard Hughes visited St Catherine's monastery etc - but these would not constitute criteria used in determining the extension, since if we discovered that these facts were not true we would conclude that Richard Hughes did not do those things. In other words the extension or applicability of the name is not criterially determined, even though the assertions might be a useful means of identification. Reference in the case of proper names is established through assignment and causal continuity, and the fact that this is the case is supported by the way in which we treat associated counterfactuals.

Accepting for the moment that this constitutes an acceptable account of proper names, proponents of the Causal Theory of Reference assert that certain species of category terms - namely natural kind terms - function in a similar way to proper names. In the case of certain types of categories and concepts, associated counterfactuals do not challenge the extension of a term in the way that they would be expected to on a criterial account. In the case of such categories we allow the reference to resist a direct counterfactual challenge, as we do in the case of proper names. In one sense this can appear to be no more than the family resemblance account in a different guise, since the fact that I encounter a green lemon and do not counterfactually challenge the notion that lemons are yellow, or alternatively conclude that this is not a lemon, can be explained in terms of the fact that there are no features that are essential to the intension of a term, and therefore no associated conclusions to be drawn in relation to the extension. However, the point being made in the Causal Theory goes deeper than this, constituting an essentialist position which has affinities with the approach taken by Quine.

³⁶ See above, p 139, footnote 5.

³⁷ Kripke 1971,1972; Donnellan 1966,1972; Putnam 1970,1972,1973.

Kripke and Putnam regard natural kind terms as 'rigid designators' in that they necessarily refer to a set of things which do in fact share a set of essential properties, even though these essential properties are not known. This may seem to be a peculiarly unnatural construction, as some authors have pointed out,³⁸ but is held to reflect the stance that we take in respect of natural kind terms. In other words, although what constitutes the essence of a natural kind term may not be correct in our accounts, or may not be ascertainable at all, we operate with these terms on the assumption that the members of a category that they designate do nonetheless share essential underlying properties. The Causal Theory thus addresses the same problems as family resemblance, but accounts for them in a different way.

In cognitive terms the intuition of causal reference theorists should cash out in terms of certain expectations associated with them being met. The principle area in which this has been addressed is in considering the role of natural kinds in supporting inductive inferences. In the context of cognitive developmental studies, one testable expectation of the essentialist position would be the way in which the assumed unobservable properties underlying natural kind terms might be expected to license inferences between category members. Gelman and Markman,³⁹ for example have hypothesised that certain kinds of inductive move might be expected to take place in the absence of support from perceptual features. Knowledge of what kind a thing belongs to, for example, might be expected to lead to assumptions about shared properties, even in cases where the things under consideration are markedly different.

Predictions of this kind run counter to the received wisdom from the literature relating to child development, which place great emphasis on the role of superficial perceptual properties in the way in which young children accomplish cognitive tasks such as classification and word definition.⁴⁰ A wide range of empirical developmental studies of the understanding and inference structure associated with natural kinds has however shown that the picture is a complex one. It has been demonstrated, for example, that children do not depend on perceptual similarities in inferences relating to the distinction between living and non-living kinds.⁴¹

Support for the family resemblance view of concept definition is drawn from three principal kinds of observation. Firstly, the fact that in the typical case subjects are unable

³⁸ Canfield 1983; Keil 1989 for a discussion of the empirical background in the light of Boyd's unpublished 1984 lecture approaching the question from the point of view of 'causal homeostasis'.

³⁹ Gelman and Markman 1986, 1987; Markman 1989.

⁴⁰ See for example Flavell 1963, 1977; Mansfield 1977.

⁴¹ Carey 1985. However Keil has argued that it is only at the level of the most basic distinctions that categories are treated as natural kinds, and the conclusions cannot be generalised across natural kinds [Keil 1989]

to provide a definition in classical terms, even when the terms are familiar and confidently and accurately applied. Second, the degree to which subjects' responses imply a graded conceptual structure and the consistency in their ability to make relative judgements of the typicality or otherwise of exemplars. Thirdly, the degree to which the sets of properties generated by subjects in response to category terms and members consistently map to a family resemblance structure rather than to a definitional structure of classical form.⁴²

It has been suggested that there are three principal reasons for the existence of a family resemblance structure for conceptual categories.⁴³ The first is based on the operation of flexibility in relation to classically defined concepts, where categories are stretched to include members which do not possess all the necessary and sufficient features. The second suggestion relates the appearance of family resemblance structure to functional role in an explanatory structure, typically as a consequence of the functional requirements of folk theories.⁴⁴ The third possibility is that categorisation may be processed holistically rather than analytically, resulting in a family resemblance structure.⁴⁵ It has been argued that defining category membership on the basis of overall similarity may be adaptive in militating against the consequences of definitional errors, or misplaced assumptions,⁴⁶ and a similar stance has been suggested in the context of taxonomic structure generally.⁴⁷ Such accounts of the cognitive origins of family resemblance structure need not be regarded as competing since they are not inherently incompatible, but may rather form parts of a more complex ontogenetic account.⁴⁸ One important feature that underlies such explanations is the adaptive advantage of the 'whole object assumption', which is well supported by a range of empirical studies.⁴⁹

The acquisition of a culturally conventional classification system involves two distinct kinds of inductive task - the acquisition of culturally significant categories and the

⁴² Although this is the case, it should be noted that in some cases the degree to which the evidence supports a family resemblance view may be argued to be compromised by features of the task situation in which it is embedded [Markman 1989]. In addition the significance of evidence adduced in support of graded structure generally can be called into question in the light of findings which demonstrate that clear definitional categories may nonetheless exhibit a graded profile [Armstrong, Gleitman and Gleitman 1983].

⁴³ Markman 1989.

⁴⁴ Carey 1985; Murphy and Medin 1985. If a schema based approach is taken in relation to unpacking folk theories, the relationship between schemas models a family resemblance structure.

⁴⁵ Kemler-Nelson 1984.

⁴⁶ Wattenmaker, Nakamura and Medin 1988.

⁴⁷ Sokal and Sneath 1963. In the context of botanical classification, particularly in the case of genera with closely similar species, more accurate and consistent results are obtained using lateral rather than hierarchical keys. The property cluster strategy associated with the former avoids error propagation through a hierarchy based on dichotomous decision making.

⁴⁸ Markman 1989

⁴⁹ Markman and Hutchinson 1984; Waxman and Gelman 1986; Markman 1989, pp 26-38.

acquisition of the category terms contained in the language.⁵⁰ Empirical studies of the interaction between these two kinds of task have suggested that there are at least two distinct types of strategy involved in category formation. Taking the fundamental case of ostensive definition as an example, it is not obvious how reference is established, since an ostensive act might refer to an object type, a part, one or more of its properties, or a contextually established relation. Generally speaking adult categories are based on strategies associated with both taxonomic and thematic relations.⁵¹ Classical theories of categorisation support the view that childrens categorisation schemes are based on thematic rather than taxonomic relations, the latter developing at a later stage. But although a number of studies have shown that thematic relations are of particular interest to children, it is also clear that they do not interpret category labels as referring to the thematic groupings that are of occurrent interest, but when presented with a label assume that it refers to whole objects of a type.⁵² In the absence of an explicit linguistic prompt categorisation is predominantly thematic, whilst in the context of a linguistic label categorisation is predominantly taxonomic.⁵³

The hierarchical structure of categories and the characteristics of basic level categories noted earlier can be argued to stem from the focus of the whole object assumption, and the adaptivity of developmental holistic strategies generally. If the question of the character of categories at different levels of the hierarchy is addressed in these terms then the relationship between holistic and feature based accounts can be assimilated in terms of the richly correlated structure of basic categories, which is a reflection of their correlated occurrence in the world. The world is not characterised by arbitrarily distributed attributes but rather by distinctive correlated clusters⁵⁴, generally described as 'kinds'. In principle there is no epistemologically clear distinction to be made between one category or class and another, in terms of their 'naturalness' or faithfulness to the world. However there is an important intuitive distinction that is in fact made between the category 'white things' and the category 'dog', for example, which is reflected both in our expectations and the different ways in which inductive reasoning is deployed relative to such categorial distinctions.⁵⁵

⁵⁰The importance of this distinction is made clear by Markman in relation to empirical studies of category acquisition in children [Markman 1989]

⁵¹ The two relational forms are paralleled in distinctions in two principal classes of inference structure - deontic and indicative reasoning [See Section 10.2 below].

⁵² Markman and Hutchinson 1984; Waxman and Gelman 1986; Markman 1989.

⁵³ Markman cites the example that in the absence of labels children often selected cars and tyres as being the same kind of thing, but if a dummy name was attached to the car and they were asked to find another thing of the same kind then they more often selected a bicycle (in the same superordinate category as car). [Markman 1989]

⁵⁴ Rosch and Mervis 1975.

⁵⁵ Gelman and Markman 1986,1987

At the level of superordinate categories however the distinction is even less clear, reflecting perhaps the vagaries of culturally significant thematic groupings rather than the 'natural order', and approximating generally to the form of ad hoc categories, having few common perceptual features and defined for example in terms of use or context.⁵⁶ In theoretical and epistemological terms there is no in-principle distinction that can be marshalled. In cognitive terms the difference is thought to lie in the fact that common superordinate categories are explicitly represented or prototypically tagged, whilst ad hoc categories are implicitly represented and contextually tagged.^{57 58}

Such observations are supported both by empirical studies of adult cognition, where the relationship between recall and implicit representation supports the view of ad hoc categories, and in a developmental context where the difficulty experienced by children in dealing with superordinate categories has been accounted for in terms of their implicit rather than explicit representation.⁵⁹ In addition, the 'whole object' assumption which rests on the principle of the mutual exclusivity of classes, is deployed first in the context of basic level categories. In superordinate and subordinate contexts, terms may appear to contravene the mutual exclusivity condition.⁶⁰

The nature and characterisation of categories and the distinction between hierarchical types bears directly on the product semantics cognitive model, which rests on feature based prototypical categorisation. This is particularly clear in the case of the distinction between 'natural' superordinates and ad hoc categories, which it can be argued is paralleled in the difference between function and affordance, but also applies to the characterisation of basic categories. The implications of these empirical and theoretical observations for categorisation in product semantics will be addressed following a consideration of the principal alternative to prototype theory, and the impact of findings relating to abstract concepts and categories on general conceptions of categorisation and conceptual frameworks.

⁵⁶ Barsalou 1983.

⁵⁷ Barsalou 1983.

⁵⁸ The superordinate category 'furniture' or 'mammal' for example, which are probably explicitly represented via a loose rule system and preferred exemplars, in contrast with ad hoc categories such as 'things which I could use to prop up the books'. In the latter case although salient features or categories can be inferred from the features of the object under consideration, these are only marshalled in the context of a problem or task.

⁵⁹ Horton and Markman 1982.

⁶⁰ Where a given object is correctly identified as a table (basic), the assertion that it is a 'trestle'(subordinate) or 'furniture'(superordinate) are treated as paradoxical.

5.3 Prototype Theory vs Theory Theory

Athavankar's product semantic scheme rests squarely on the view that the conceptual structure of artefact kinds are governed by 'prototype semantics'.⁶¹

Prototype theories are essentially supported by the results derived from three principal kinds of experimental work, in so far as they provide evidence for 'typicality effects', the intuitively appealing claim that some examples of a category are considered to be better examples than others. They are typified by the experimental work of Rosch and Mervis. The first group of such experiments involved asking subjects to rate examples of a category on a scale. In other experiments, subjects were asked to list as many properties of a category example as they could within a limited time. The examples already judged by the first set of subjects to be more typical were found to share more properties with other members of the category than those judged less typical. The third group of experiments involved setting a simple taxonomic problem to subjects, who were asked to judge whether a statement asserting that an example belonged to a category was either true or false, and their reaction times and error rates were recorded. Faster reaction times and fewer errors were found to be associated with the examples previously judged to be more typical of a category.⁶²

The results of such experiments show a strong correlation between typicality, degrees of family resemblance, and reaction times for associated cognitive tasks such as categorisation. The inference drawn from such experiments when they are taken together with postulations regarding the hierarchical nature of human conceptual organisation, is that many of our conceptual categories consist in prototypes expressed as weighted clusters of features characteristic of each category. Such clusters are essentially probabilistic, rather than lists of necessary and sufficient features, and weighted in terms of the frequency of features shared. The degree to which prototypes can be regarded as holistic exemplars, whose content can be conceptually unpacked in terms of properties, or should be regarded as probabilistic instantiations of properties per se, is open to debate, but ultimately the sense that can be given to prototype semantics generally, emphasises this feature based probabilistic interpretation.

Prototype semantics can be challenged on a number of grounds, both in terms of the experimental work itself and the conclusions drawn. In the first place it has been shown that the features that subjects associate with concepts are context dependent and subject to wide variation. In principle there appears to be no bound to the range of association that a

⁶¹ The term coined for the general extension of the Rosch categorisation model [Coleman and Kay 1981].

⁶² Rosch and Mervis 1975 ; Rosch 1978.

a subject can make, relative to changes in context.⁶³

It can also be argued that a strong correlation between typicality of category example and reaction times is insufficient to justify an inference that the meaning of the term employed is probabilistic and prototypical. It has been shown for example that conceptual categories thought not to be structured in probabilistic terms, but rather in terms of necessary and sufficient conditions, will nonetheless exhibit typicality features and related differences in reaction times in an experimental context.⁶⁴ The results suggest that prototype representations cannot be inferred from prototype effects, and moreover that classically organised concepts not suspected of having a prototypical structure can nonetheless give rise to prototypical effects. Although the results of this work can in principle also be used to support an argument that all concepts, including essentially definitional ones, are in part prototypical and probabilistic in structure, given that these do not necessarily affect category membership, the conclusion would still have to be drawn that at least part of the meaning of such concepts is divorced from the individuation of instances.⁶⁵

Typicality effects might be characteristic of all or most conceptual categories, and their appearance or non-appearance in one experimental context rather than another, a reflection of distinct cognitive strategies at work relative to the context. It can be argued that a variety of models are used in the comprehension of categories, and that each model will tend to privilege certain exemplars.⁶⁶

Some aspects of human conceptual ability, such as the ability to make cross-conceptual links are also difficult to account for on a probabilistic and prototypical account, where concepts are relatively self-contained and bounded and where categorisation is conceived as a simple matching of features between concepts and instances. It has been shown that exemplars of a category that are characterised by correlated rather than unrelated features are easier to categorise, and that the grounds for categorisation of instances is context dependent.⁶⁷ The import of this may be that categorisation might be more appropriately characterised in relation to a theoretical background, and in terms of processes of inference. Athavankar's strategy, which emphasises the role of superordinate categories in particularising instances, could be interpreted in this way, in so far as it provides an account which embeds concepts in a network, although the role of inference and theoretical background in his scheme is in fact negligible.

⁶³ Barsalou 1982; Barclay et al 1974.

⁶⁴ Armstrong, Gleitman and Gleitman 1983; Smith and Medin 1981.

⁶⁵ Keil 1989.

⁶⁶ Lakoff 1987.

⁶⁷ Barsalou 1982, 1993.

The larger framework includes concepts which are not captured by simple object in the world models, and which may also be culturally specific. Studies in cognitive anthropology have focussed for example on concepts such as weeks and days of the week, which do not exist in nature but are human constructs, and whose structure varies in different cultures. 'Tuesday' is only meaningful relative to the idea of weeks and their structure, and the structures required for the characterisation of such concepts are commonly taken to be represented by 'frames' and 'schemas'. The central claim of theorists working in these fields is that cultural reality is located in the culturally specific schemas used by people, rather than in the artefacts of society.⁶⁸ Artefacts and the conditions for their categorisation are socio-culturally defined via their inherence in schemas. Schemas are collected together in complex relationships which reflect or create accepted structures for particular domains of experience, and are referred to as *folk theories*.⁶⁹ The patent relativity of the meaning of such terms, their pervasiveness and the implications of this for conceptual structure generally, has meant that 'schemas' have become generally accepted within cognitive science, and the idea has been extended to characterise all lexical items.⁷⁰ These are regarded primarily as designating an element in a schema (or frame, script or cognitive model). Schemas themselves have been likened to idealised cognitive models whose meaning is not generated in terms of external correspondences, but whose idealisation may be abstract.⁷¹

The principal alternative approach to the prototype theory which has been dubbed the Theory Theory⁷² attempts to account for the perceived deficiencies in prototype semantics by regarding concepts as enmeshed in a more comprehensive theoretical network. In carrying out particular cognitive tasks such as categorisation, a framework of explanatory beliefs in which concepts are embedded is brought into play, reducing the emphasis on individual attributes in conceptual representations, and emphasising interaction and interanimation among concepts within a complex theoretical network.⁷³

The distinction between the two theories is well brought out in the work of Keil in his studies of conceptual development in children, where evidence can be found to support both theories. However in this context the theories are not in conflict, but rather represent different developmental stages. In the case of natural kind and artefact concepts, there

⁶⁸ Holland and Quinn 1987

⁶⁹ See below, Section 7.6 'Folk Psychologies and Meaning' pp 247-256.

⁷⁰ Lakoff 1989. Lakoff draws on Brugman's analysis [Brugman 1988] which identifies two levels of prototype structure - low level structure which concerns the relationship of concepts to the things they are applied to (where the fit may be a matter of degree), and high level structure which relates to the internal structure of concepts and how they fit together in the form of networks.

⁷¹ Lakoff 1989 p 109.

⁷² Khalidi 1995 (The 'Theory' Theory is sometimes also referred to as the 'Network Theory').

⁷³ Murphy and Medin 1985; Neisser 1987.

appears to be a change from an initial reliance on categorisation through superficial features to one which draws on deeper explanatory concepts.⁷⁴ Children at later stages in development will resist the recategorisation of kinds on the basis of change in superficial features and turn to theories relating to internal structure and genesis, for example. The thrust of Keil's developmental characterisation is consonant in broad outline with a range of diverse developmental theories in psychology, including those of Vygotsky, Werner, Piaget and Bruner.⁷⁵

A parallel view advanced in a philosophical context which has been particularly influential, regards clusters of perceptual attributes as the most basic form of conceptual categorisation, based on an innate capacity for similarity spacing, which develops under the auspices of the notion of 'natural kinds' into fundamental differentiating scientific principles providing defining criteria.⁷⁶ Individual conceptual development and the evolution and maturation of fields of study are thus conceived to progress from a feature based prototype semantics to theoretically characterised underlying principles, providing categorial grounding, and a basis for the 'natural kinds'.

The Prototype theory and the Theory theory have nevertheless generally been presented as competing categorial models of concepts and conceptual structure. However it is possible to take a different stance, based on the fact that the supporting experimental evidence for each model is based on characteristically different experimental types. Prototype theory is supported primarily by experimental evidence relating typicality and family resemblance under time constraint. Theory theory is supported primarily by experimental evidence based on protocol analysis of inferential task situations not subject to time constraint. Each could therefore be capturing different features of an overall conceptual structure, or gaining a different viewpoint on that structure. There are probably two principal ways in which the theories could be assimilated as though this were the case.

One possibility would be to regard the Prototype theory as a special case of the Theory theory, which operates either with respect to a particular level of the overall conceptual framework, or in specific circumstances. There is some evidence to suggest that there may be a difference in the cognitive strategies deployed, dependent on whether the contextual situation requires or allows for reflection, or requires an automatic response. Murphy and Medin, for example, point to the difference in theoretical knowledge that is invoked in a routine categorisation of a relatively typical and uncontentious case, and the categorisation of a novel or a marginally typical object.⁷⁷ The difference may be perceived

⁷⁴ Keil 1989. The so called 'characteristic to defining' shift. The timing varies for different concepts.

⁷⁵ Keil 1989 [review pp 5-23; re Vygotsky, Piaget, Werner, Bruner].

⁷⁶ Quine 1977.

⁷⁷ Murphy and Medin 1985.

to rest in the distinction between a concept's core and its identification procedures, as in the view that the graded structure of judgement is an expression of an identification procedure for rapid sorting, whilst it is the theoretical core structure that is used in inferential judgement relating to category membership.⁷⁸ Such a view could be interpreted as though the Prototype theory operates as a 'default' mode relative to the Theory theory.⁷⁹ Rosch, a principal proponent of the Prototype theory notes that categorisation is responsive to context, and that '...in the absence of a specified context, subjects assume what they consider the normal context or situation for occurrence of that object'.⁸⁰

The problem with the strategy of treating the Prototype theory as a default, as Khalidi has pointed out,⁸¹ is that it changes the conception of what prototypes are, or more radically, involves denying the existence of prototypes, and acknowledging only prototypical effects.

An alternative possibility is that the two theories pick out different aspects or phases of cognitive development, with an initial dependence on categorisation based on characteristic features giving way to categorisation in terms of defining criteria. A view of this kind is consonant with the results of empirical studies relating to cognitive development in children, and also acknowledges the philosophical argument that some form of perceptually based 'similarity spacing' is a necessary foundation for any categorisation process.⁸²

The evidence drawn from empirical studies is inconclusive in so far as it seeks to substantiate the case for a particular view. Nevertheless it is possible to conclude that prototype semantics are insufficient to account for all the effects noted, and that contextual factors and conceptual relativity are important elements in the nature and deployment of categorisation strategies. The principal context in which the implications of a broader view of conceptual frameworks and categorisation have been considered is in relation to abstract concepts.

⁷⁸ Gleitman, Armstrong and Gleitman 1983

⁷⁹ There are clearly a number of distinct ways of interpreting the 'default' mode. One possibility is that prototype effects emerge from cognitive short cuts that enable us to access a section of the theoretical framework related to diagnostically more useful information. Alternatively there may be background theories that are brought into play, on an 'in normal circumstances' assumption, that operate in contexts where time is constrained. Views such as these are considered by Khalidi [Khalidi 1995]. An alternative approach which to some extent matches developmental theories such as that of Vygotsky, might regard prototype effects as reflecting a developmentally and cognitively more primitive mechanism, which is retained even when more complex procedures have developed, and is brought into play under particular circumstances [Vygotsky 1962,1978]. This has parallels in the two pathways relating to emotional response which reflect different developmental stages and which then operate in distinct circumstances (although in this case the mechanisms are hard wired)[Le Doux 1996; Damasio 1995].

⁸⁰ Rosch 1978, p43

⁸¹ Khalidi 1995, p409

⁸² Keil 1989; Quine 1969.

5.4 Abstract Concepts and Schemas

The inherent relativity of words and concepts such as 'tuesday' to frameworks of conventions or beliefs for their sense, has led to the consideration of a more inclusive theory of concepts which emphasises their location within generalised and culturally specific cognitive structures referred to as 'frames' or 'schemas'.⁸³ Fillmore, in particular has sustained an argument for frame semantics which holds that words and lexical items are in fact generally defined relative to such schemas, and forms of frame or schema accounts have become generally accepted in cognitive science.⁸⁴ This has carried with it a radical change in the underlying characterisation of 'definition' itself. Rather than conceiving of definition as a collection of necessary and sufficient conditions on less complex (and ultimately primitive) concepts, it consists in designating an element in a frame or schema - definition is identifying a role for a word or lexical item within a relevant frame. In Fillmore's terms, frames are abstractions and idealisations relative to models of social structure for example, rather than simple correspondances with external reality, and lexical terms can be spelled out in the form of necessary and sufficient conditions relative to such idealised models. In relation to a culturally specific model of social structure, for example, a bachelor is an unmarried man of marriageable age.⁸⁵

The principal extension of conceptual categorisation beyond frame semantics occurs in the recognition that most abstract concepts are metaphorically structured in terms of more concrete concepts. An influential study by Reddy, for example, has provided detailed analysis of the role of the 'conduit' metaphor in the comprehension of the concept 'communication' by English speakers.⁸⁶ Metaphorical concept structure has since been the subject of intense activity in this field, establishing both the pervasiveness of a relatively small number of underlying general schemas, and associated inference structure,⁸⁷ and the important finding that a given conceptual domain can be structured in conflicting ways by the adoption of different metaphorical concepts.⁸⁸ Although the majority of abstract concepts are metaphorical, target domains can be a mixture of non-metaphorical and metaphorical structures. The function of the metaphorical structure is to provide sufficient structure to support inference in the target domain.

⁸³ Holland and Quinn 1987; Lakoff 1989.

⁸⁴ Fillmore 1982.

⁸⁵ Fillmore 1982. Lakoff points out the difficulty even in a relatively simple case such as 'bachelor' (are the Pope, Tarzan or a man in a coma since childhood, bachelors?). If the necessary and sufficient conditions are retained then the definition must be stretched by abandoning or modifying the idealisation. [Lakoff 1989, p 109].

⁸⁶ Reddy 1979. For example - Ideas are objects; linguistic expressions are containers; communication is sending idea-objects in linguistic containers (for example 'I couldn't get my idea across').

⁸⁷ Lakoff and Johnson 1980; Johnson 1987; Lakoff 1987; Turner 1987; Lakoff and Turner 1989; Sweetser 1989; Kovecses 1990.

⁸⁸ Gentner and Gentner 1983. Conceptualising electricity metaphorically in terms either of a 'fluid' or a 'crowd' yield different inference structures.

A relatively small number of fundamental metaphors at a deep level can capture or drive the potentially infinite range of particulars that might in principle be associated with a given concept. This is possible because the cognitive landscape at this level is structured in terms of the generalisation of geometric relations in the form of a cognitive topology, which preserves neighbourhood relations and which employs a range of topological concepts in the form of image schemas. In the case of a relation concept such as 'over' for example, which is a composite of topological and orientation concepts, the relevant image schemas would include those relating to concepts such as 'paths', 'bounded regions' (or 'containers'), and 'contact'.⁸⁹ A relatively small number of particular image schemas such as these are in fact used to conceptualise a very large and wide ranging class of activities and properties.

The character of image schemas can be best drawn out in terms of examples such as the 'container' schema.⁹⁰ The basis of the schema is in terms of bodily experience which includes both the fact that we experience our bodies as containers and our experiences of being contained. The schema has three essential structural elements - an interior, a boundary, and an exterior, which as a structured whole or configuration gives rise to an associated cognitive logic. The nature of such a logic is derived from the configuration of the schema which is inherently meaningful in virtue of bodily experience, and comprises forms of inference that flow from the application of cognitive operations to the configuration. In the case of the container schema for example, where B is a 'container' with contents A, and C is a 'container' with contents B, the cognitive operation of 'superimposition' preserves the relation that A and B are contained by C, whilst the cognitive operation of 'focusing' will preserve the relation that A is contained by C.⁹¹ The use of this metaphorical source schema in other conceptual domains is illustrated for example by the fact that the visual field is understood as a container (things go in and out of sight), or by the fact that personal relationships are also understood via container schemas (one can be trapped in a marriage and get out of it). The inference structure of the target concept domain (visual fields or personal relationships) will mirror the logic of the source domain (container schema).

A further example which draws out a different inference structure is the 'part-whole' schema. This schema is grounded in the fact that we are whole beings with parts, and we experience both our wholeness and our parts, and the part-whole structure of other objects, in our interaction with the world. The structural elements of the schema are a

⁸⁹ The essence of 'over' for example, is that for something to go over it must have a trajectory and make a transition from one bounded region to another, marked by an impediment or feature, without contact.

⁹⁰ Johnson 1987; Lindner 1981; Lakoff 1987 case study 2 (set theoretical models as container schema driven)

⁹¹ In this case it will be clear that the cognitive operations on the configuration are the basis of a rule of deductive logic - modus ponens. By extension since categories are metaphorical containers, Boolean logic is a product of the logic of a container schema and a mapping of container schemas to categories.

'whole', 'parts' and a 'configuration'. The schema yields an asymmetric logical structure - If A is a part of B, then B is not a part of A; and irreflexive - A is not a part of A; a whole cannot exist without the existence of its parts; if all the parts exist then the whole only exists if the parts exist in the configuration; if the whole is located at place P then the parts are located at P; and so on. The schema can provide the model and inference structure for a very wide range of target domains, including, families and social organisations.

Abstract concepts are generally understood in terms of metaphorical mappings from the structures of more concrete concepts. They are thus conceived to be grounded in experience and not arbitrary in the sense that might be accorded to a symbolic framework. Mappings are independent of the particular domains in which they are realised, essentially cognitive, and asymmetric. Evidence of their existence are drawn from two principal areas of empirical research - systematic polysemy and cross-domain inference correspondence. Systematic polysemy refers to cases where there is a systematic correspondence between the senses of words in the source domain and the target domain.⁹² Cross-domain inferences, refer to the preservation of inference patterns in mappings from the source to the target.⁹³ One important property of a conceptual system conceived in this way is that concepts may be structured by different metaphors in different and conflicting ways, and this is borne out in related empirical studies.⁹⁴

Sustained work in a number of fields including cognitive science, anthropology, neurophysiology, and linguistics have tended to converge on a schema based characterisation of conceptual structure whose features might be summarised in the following way. Some concepts are directly grounded in bodily or social experience in the form of basic level concepts. Other concepts are projected from these through metonymic mapping, metaphoric mapping and category formation. The conceptual system as a whole is grounded in basic level concepts and cognitive topology, which consists of analogue structures for the perceptual recognition of spatial relations and the representation of the internal structure of concepts, and which carry an inherent inferential structure. The picture of concepts and categorisation that emerges is at considerable variance with the scheme that underpins the cognitive model employed in product semantics, which is squarely based on a conceptual framework grounded in prototype semantics at all levels.

The conception of a schema-based account of categorisation nonetheless trades on the idea of basic level concepts, and assumes that these are essentially constituted as concrete

⁹² For example, words referring to vertical spatial dimensions (up, down, high, low, rise, fall, etc) are used systematically to characterise quantity on the basis of Up is More, Down is Less (prices fell, sales rose, for example) [Lakoff 1987, 1989]

⁹³ For example, Lakoff's metaphor that 'anger is a hot fluid in a container'. Inferences about enclosed hot fluids map onto inferences about anger. 'He boiled over, blew his lid., got more and more steamed up' etc [Lakoff 1987].

⁹⁴ Gentner and Gentner 1983.

concepts capable of metaphorical extension. The nature of concrete concepts and their genesis remains elusive in such accounts, but generally it is either assumed that they pre-exist the larger framework as embodied experiential relations of some kind, or that they subserve basic functions within a conceptual network. On either account it is assumed that they approximate to a prototypical rather than a definitional structure, although clearly this has distinct implications in the two different contexts.

5.5 Categorisation and Product Semantics

When we encounter a new object, product or phenomenon, a range of cognitive processes are brought into play, which are designed to bring the object within our range of familiarity or understanding. The new object is assimilated into the existing framework of concepts, and both enlarges and modifies that framework. One of the primary cognitive processes involved in this 'rendering understandable', is commonly called categorisation, and involves the assimilation of the new particular in a more general form, to the existing structure of models and concepts available to us.

The process (which is undoubtedly complex, involving the application of a range of more fundamental cognitive processes, including memory) has been variously described, but has generally been viewed as assigning the new object to some region of a partitioning of the world-as-perceived into relatively discrete classes. To a large extent classical notions of categorisation (the basis of a division into classes) are based on partitioning definitions - sets of necessary and sufficient conditions providing criteria for inclusion in a given class. Although it has always been recognised that some objects would remain marginal in respect of membership of a given class, the ultimate need for a sharp edged decision was driven by the limitations of deductive logic and its requirement for unequivocal identity in performing logical operations over objects and classes in reasoned argument. The epistemological complexity of objects was expressed primarily through the multiplicity of different classes for which membership could be claimed for an object, rather than through the application of some concept of degrees of membership of a class. In contrast to sharp edged classes of this kind, whose boundaries are defined by criteria expressed as necessary and sufficient conditions, the process of categorisation in vivo appears to be more complex and fluid in at least two distinct respects.

In the first place, apparently well-formed cognitive classes do not always appear to be susceptible of definition in terms of the possession of well-defined sets of attributes. It appears to be the case rather that classes more often consist of overlapping groups of objects each possessing a range of membership attributes, but where no individual object meets all possible criteria. Such a view is expressed by Wittgenstein in terms of his concept of 'family resemblance'. Secondly, it appears to be the case that we are inclined routinely to apply the concept of degrees of membership of classes. Some objects are considered to be more centrally representative of a class, whilst others are at best, marginal members. In addition the boundaries of in-vivo classes seem less sharp than is allowed for in logic, to the extent that there often appears to be a continuum between related classes, with some objects occupying the space where the continuum moves from one identifiable class to another.

Such everyday and philosophical speculations on the nature of classes and categorisation have been supported by a range of recent empirical studies in cognitive psychology, dealing with the relationship between concept meaning and perceptual attributes. In characterising classes of objects, for example, subjects show a high degree of agreement in identifying the central members of a class, but diverge markedly in their attempts to define the boundary. Such studies have tended to support the notion of 'natural' or 'intuitive' categories of object as being structured around key examples or models which function as the central members of the category, with less central members linked to these in a variety of respects, and extending to marginal members which might have little in common with each other, though linked via intermediaries to the central members.

The form taken by the core cognitive model in product semantics, which is identified with categorisation, is squarely based on a prototype semantics driven by a family resemblance account. Classes of object are structured around prototypes, the classes themselves changing their centre of gravity in response to boundary changes. Objects within classes gain the particularities of their significance through association beyond their class via superordinate categories. The former is conceived as an essentially metonymic relation and the latter as metaphoric. Object meaning is arrived at through multiple categorisation and constituted in the location of the object-as-perceived in the resulting network of category relations - its position in semantic space.

The evidence for the dominance of prototype semantics in categorisation is far from clear. Although empirical studies support the contention that the classical view of discrete, hard edged categories defined in terms of necessary and sufficient conditions fails to account for the apparent fluidity of categorisation in vivo, or the apparent internal structure of categories implied by graded membership, they do not conclusively establish a prototypical basis for categorisation as a whole. There is little doubt that prototypical effects are clearly observable, but the fact that these may be apparent in the context of unpredicted categories, and that prototype effects are highly context dependent, suggests a more complex structure. This is reflected both in the need to hypothesise a 'frame' or 'schema' based model to accommodate more abstract concepts, and in the strategy which regards categories and concepts as elements in a theoretical network and semantically defined by their place in that network.

In addition the thrust of recent work in cognitive development points to the shift from 'characteristic' to 'defining' features as typifying early development, reflected in an epistemological commitment to the idea of 'kinds' with underlying essences which is represented in inference patterns and the deployment of counterfactual arguments.

The prototypical categorisation model presented in product semantics is insufficient to provide the cognitive basis for a semantic account of user product interaction. At a superficial level, it does not meet the requirements simply because it operates entirely at a feature based perceptual level but offers no account of the relationship between perceptual encounter and understanding, beyond relative perceptual identity. At a deeper level, the assumptions built into the account regarding the form taken by representations are never unpacked, and no commitment is made even in the broadest sense to any particular cognitive stance. The model is therefore difficult to evaluate conceptually, since its roots remain buried. Nevertheless, it does appear to capture the intuitive approach taken by designers particularly in relation to the nature and manipulation of visual identity,⁹⁵ which relates closely to explicit models used effectively in marketing research, and as such remains an important and informative heuristic with potentially significant methodological implications for design practice.⁹⁶

However it is possible to develop the model further than is the case in product semantic accounts, if the concept of affordance is drawn into the account of categorisation. Since the centre of gravity of cognitive accounts generally has shifted markedly in the direction of 'schema' models and the systematic building of categorial frameworks from a finite repertoire of primitives through metaphorical extension to new target domains, and since the primitives are grounded in physical or social experience, the prototype semantic account of categories could be grounded in the idea of affordance. Provisionally it might be accepted that cognitive grounding for prototype categorisation could conceivably be made through an action-oriented and bodily based schematic concept of the type represented by basic affordance. This is particularly the case because in Athavankar's scheme categorisation at the basic level is essentially metonymic in structure, whilst one key role of superordinate categories within the overall framework is to individuate significance through metaphoric association.

It is generally accepted that the conceptual categories that we actually form are in part determined by the structured nature of the world, (natural and social) and in part determined by our available perceptual mechanisms and behavioural repertoire. Thus although it is generally agreed that the world does contain intrinsically separate classes of things - '...information rich bundles of perceptual and functional attributes...that form natural discontinuities'⁹⁷ it is also clear that their existence as separately perceived and conceived things is dependent on the sensory and motor capacities of a given species in interaction with that world. It is generally also assumed that categorial schemes reflect the need to maximise available information with the least effort (referred to as the principle of

⁹⁵ And by analogical extension, to other perceptual components of product identity.

⁹⁶ Lawrie 1989.

⁹⁷ Rosch et al 1976, p

'cognitive economy').⁹⁸ At a fundamental level these ideas can be collectively grouped in terms of the concept of affordance, which acknowledges that the relation between experience and categorial structure (in terms of perceptual and behavioural organisation) are the results of adaptation at the species level.

At higher levels, cultural factors play a key part in determining the particular categories that are developed by different social groups and individuals. In this case cognitive economy must clearly be contextually relativised in a sharper sense that goes beyond fundamental structuring at a species level - distinctions which are critical for one individual, social group or culture, may not be relevant for, or satisfy the requirements of others.⁹⁹ The ways in which cultural factors interact with the inherently structured nature of objects and events in the world via our perceptual mechanisms (at the level of affordance) in the generation of a categorial framework, is clearly a complex matter. Nevertheless one important consideration will be that the categories formed by a particular social group must be capable of being shared by the members of that group - the principle of 'shareability constraints'.¹⁰⁰

In terms of studies of cognitive development this idea is consonant with the observation that the structure of superordinate categories is closer to that of ad hoc categories than basic categories, the distinction resting in the degree to which each is either explicitly or implicitly represented. Given that ad hoc categories are generally not explicitly represented, and that they are primarily referenced in behavioural and contextual terms, they might be argued to be contiguous with affordance concepts. Similarly, since superordinate concepts remain relatively fluid, although their representations are socially grounded linguistically, their partially inexplicit ad hoc character allows them to play a metaphoric role in the significance of both tokens and types of basic level categories for which they are not superordinate.

The role of language in this respect is of particular interest, since studies in cognitive development suggest that whilst unlabelled categorisation is metonymic in a thematic sense, the introduction of linguistic labels prompts metonymic categorisation which is essentially taxonomic. Names and kinds are intimately related. Thematic relations may then play the role of establishing significant groupings in contextual and behavioural

⁹⁸ Rosch 1978. Rosch contends that natural and cultural categorisation is structured in terms of two key principles - 'perceived structure' and 'cognitive economy'. The first adverts to the fact that if objects were simply de facto bundles of arbitrary combinations of attributes we would not achieve categorisation. In fact the basis of our perception of the world is underpinned by the non-arbitrariness of perceptual and functional groupings. The second highlights the fact that there needs to be a compromise between the specificity and the generality of categories. Basic categories correspond to the level of categorisation which best meets the joint requirements of the two principles.

⁹⁹ Reflected in the local attenuation of categorial schemes (gourmets, tea tasters, Inuit perceptions of snow).

¹⁰⁰ Freyd 1983

terms whilst taxonomic relations establish normative individual kinds, assigning things to their proper places. The two forms of relational ordering can be conceived as orthogonal axes defining a basic semantic framework. The mechanism that underpins the possibility of basic categories (ad hoc behavioural and contextual thematic association) however, continues to operate as the flexible element relative to basic categories that have become more or less fixed (explicitly represented taxonomic structures) in a given socio-linguistic (or socio-symbolic) context.

Drawing these various strands together results in the following picture. The raw material for basic categories are formed on an ad hoc associative basis through the operation of adaptive selection in terms of affordance, and are essentially thematic in character. In the context of human social groups, and in particular through the mechanisms of naming and symbolisation represented in languages and language like systems, persistent shareable categories are socially filtered and increasingly take on a taxonomic rather than a thematic character which is reflective of their role as stable terms in communication associated with allowable inferences, and institutionalised in the form of 'kinds'. These kinds constitute basic categories and are associated with the inference structure in terms of which they are filtered. More complex concepts and relations develop, and are structured, through the extension of basic categories (and their associated inference structures) to new domains.

Superordinate categories develop in a similar way, but in relation to basic categories rather than affordances, originating as ad hoc categories which become stable as a result of their utility in socio-cultural contexts, and may similarly acquire a taxonomic character and become instantiated in the form of explicit representation. Subordinate categories develop either as differentiations of type in basic categories, through association with basic or superordinate categories, or as initially basic categories which are left behind as differentia when a category becomes more generalised.

This picture is consonant with the model of signification and symbolisation operative in product semantic accounts developed in terms of semiotics, and with network models expressed in terms of orders of contextual fit. It is also compatible with the range of empirical results obtained in relation to categorisation, and provides the basis for an explanation of the relation between classical, prototypical and network theory accounts, and the relation between the ecological and product semantic concepts of affordance.