Throughout this century Australian archaeologists have debated the nature of types and the efficacy of typological classification. In each decade this debate has been manifested in a slightly different form, reflecting contemporary concerns and the current problems in explaining assemblage variation. Hayden's (1977) paper from the 1974 Australian Institute of Aboriginal Studies conference is one of a number that accompanied a new phase of debate about the interpretation of implement form and assemblage variation. He used ethnographic observations of stone use by contemporary people as his means of addressing this debate, as did a number of other researchers whose influence rivals Hayden's (e.g. White 1967; O'Connell 1977; Gould 1966, 1980). Nevertheless, while Hayden may have seen his work demonstrating the value of ethnoarchaeology, the continuing importance of the paper lay in the re-evaluation of conventional views of prehistoric implements. The issue upon which he was focused was the interpretation of the morphology and relative abundance of traditionally recognised implement types. Because descriptions of archaeological materials had often been confined to identifying implements, and the culture historical conclusions based on the presence or abundance of those implement types, the interpretation of Australian prehistory was tied to the interpretation of implements. In the 1970s the most common interpretation of implements presumed that specimens of each implement type were created according to strict guidelines of style, designed and used as functionally specific tools. Hayden (1977: 178) characterised this view as

... the still pervasive and subjective feelings among archaeologists that stone tools could not simply have been used in a totally profane or simple minded fashion. Although this is a subjective evaluation I think that most archaeologists, somewhere in the seat of their limbic systems, feel that most stone tools were carefully crafted, and that the stone tool maker was doing his best to make a tool worthy of his ancestors, or himself, or his group, or something else. Perhaps more importantly, archaeologists expected that prehistoric men were striving after the particular form that they crafted, and that all else was waste, or 'debitage'.

Hayden's observation of artefact manufacture and use led him to doubt such notions, and accept instead a number of propositions that were to him surprising. Four 'surprises' have been influential and illuminate the debates about artefact interpretation:

1. Stone artefacts may have been treated in an entirely profane manner by their makers.
2. Formal implements, typically retouched flakes, may be poor indicators of the range and frequency of artefact use in an assemblage. Implements may constitute only a small proportion of the artefacts in an assemblage that were actually used, and a number of different morphologies could all be employed for the same function.

3. Retouching is often a means of rejuvenating a dysfunctional edge, rather than an attempt to produce an ideal form from the outset.

4. Factors that condition the form and abundance of retouch need to be better defined, but are most likely to involve raw material properties, raw material availability, and the form of hafting.

Each of these related points contributed to a coherent view of prehistoric stone artefacts as a largely mechanical response to the economics and human ecology of hunter-gatherer life. In a number of guises this view developed in the 1980s and 1990s as an alternative to the stylistic explanations of archaeological assemblages (e.g. Hiscock 1994a). The history of these debates in Australia, and their most recent expression, is worth examination.

**Artefact manufacture is profane**

Implement types in Australia have often been distinguished from other stone artefacts on the basis of the extent of retouch and their standardisation of form. In the absence of a technical understanding of artefact manufacture early typologists saw these features as a direct reflection of the intention of the knapper (e.g. Etheridge and Whitelegge 1907: 237). The regular retouch and repeated shape of objects recognised as implements was seen to occur because these were end products, completed in accordance with some design. Early classification systems all reveal this notion (see Etheridge 1891; Howchin 1893, 1934; Kenyon and Stirling 1900; Kenyon and Mahony 1914; Noetling 1907), and the expectation that distinct classes of implements would have been made is clearly observable in correspondence from the period (see Wright 1977). In the early decades of this century typological descriptions and analyses were primarily aimed at identifying the functions of each type (see below). However, while the inferred uses of these artefacts were often profane, the image of these implements as specially and laboriously shaped for some purpose imbued each typology with the implication that those specimens retained particular meaning for their makers.

The assertion that regular and complex forms implied a standard design led some researchers to question how regular and complex forms had to be before intentionality was apparent. Consequently, as a primary division some classifications differentiated between standardised and irregular forms. For example, Noetling (1907) divided implements from Tasmania into two groups: those with bifacial retouch, which he called 'Morpholithes', and those with unifacial retouch, which he dubbed 'Amorpholithes'. The former group were considered by Noetling to be intentionally standardised hafted tools, while the latter group were seen as being unsystematically created and used as
unhafted, hand-held tools. Similar divisions are found embedded in other typological systems of the day.

Debates about whether intentionality/meaning was a necessary correlate of a regularity of form, and if so how regular the form must be, are found in a number of publications prior to the mid-1930s. Two opposing viewpoints are revealed in the literature. One view was that intentional designs were poorly reflected in implement form. Kenyon (1927), for example, argued that implement form was largely determined by raw material properties; while Towle (1930) viewed retouching solely as a means of resharpenering edges, rather than shaping desired forms (see below). The contrary view was displayed by Tindale (1932) in his criticism of Howchin's (1921) claim that 'crude implements' of great antiquity had been found in gibber areas of central Australia. Tindale's evaluation of these objects involved equating artificialness with the shaping that created implements that evidenced design, and the expectation of a high degree of standardisation in implement types (see Howchin 1933: 7–8). It was Tindale's more rigid notion of implement classes that was most influential during the 1940s, 1950s and 1960s.

With the pursuit of intellectual frameworks that would explain chronological change in implement types, initiated by Hale and Tindale (1930), these repeated artefact forms were taken to reveal designs which had a social significance to the maker. Increasingly during and after the 1940s, McCarthy (1947, 1948, 1949, 1953, 1958, 1963, 1964, 1967) and Tindale (1957, 1961, 1968) employed a concept of implement as not only designed end products but as items embedded with social meaning that could reveal contact between, and developments within, ethnic groups. Consequently, diffusion of traits or migration of groups into Australia from the north was often emphasised over internally generated changes, with McCarthy (1953: 257) stating that 'invention, as such, is not a feature of Aboriginal culture', and Tindale (1957: 39) concluding that '...probably we are dealing with culture shifts in terms of tribal displacement as well as in part changing implement fashions...

In this context standardised typologies were seen to be the only way to correctly identify 'archaeological cultures' through inter-site comparisons (Tindale 1968: 628; McCarthy, Brammell and Noone 1946: 1–2; McCarthy 1958: 181). Changes to classificatory systems were discouraged, with Tindale (1968: 628–30) advocating a system of Linnean-like nomenclature in which new classes of implements would be accepted only when a detailed illustration and description of the 'type specimen' was published. The rigidity of the classificatory systems reinforced the notion of rigidly defined and readily distinguished implement types.

Beginning in the late 1960s a number of archaeologists observed that the manufacture of flaked stone artefacts by Aboriginals and New Guineans was neither careful and standardised nor did it hold great social significance for the artisans (e.g. Gould et al. 1971: 163; White 1967, 1968, 1969; White and Thomas 1972). Hayden's paper on artefacts from the Western Desert was therefore one of several that began to again query the meaning of implement types, and by dedicating the paper to a consideration
of these 'surprises' it promoted active consideration of the issue throughout the late 1970s and 1980s.

The reappearance of this debate over the nature and interpretation of typological forms has seen opinions polarised. On the one hand researchers emphasising the social/symbolic role of implements have seen implement forms as symbols or identifications (e.g. Johnson 1979: 144), symbols of social reorganisation (e.g. Bowdler 1981: 110), or stylistic phenomena (e.g. White and O'Connell 1982: 125). On the other hand, researchers heeding Hayden's message that stone artefact manufacturing may be profane have emphasised the economic/functional aspects of implements (e.g. Bird 1985; Byrne 1980; Hiscock 1988, 1993, 1994a; Kamminga 1982; McNiven 1994). One significant consequence of the view that artefact manufacture is a profane economic activity is that artefacts that have been used (i.e. tools) will not necessarily be specially shaped to a preconceived form, and hence will be difficult to identify on the basis of morphology alone. Implications of this realisation are manifested in the other surprises described in Hayden's paper.

**Implements as a measure of function**

That special kinds of implements were shaped for particular purposes must be taken for granted... (Howchin 1934: 22)

Acceptance of this notion led to early classifications, particularly those by Kenyon and Stirling (1900), Kenyon (1927), and Howchin (1934), being aimed at functional descriptions based on the proposition that each implement form was indicative of the function for which it was designed. This inclination to functional descriptions is most obvious in the labels that were used, with classes being described as 'knives', 'chisels', 'scrapers' and so on. Later classifications, particularly McCarthy, Brammell and Noone (1946), McCarthy (1967) and Mitchell (1949), clearly constructed their types on the basis of perceived morphological distinctions in artefact assemblages, although the expectation that implement classes reflect functional classes remained.

Indications that implements were not an effective measure of site activities and artefact use were noted by a number of authors. Among the criticisms were observations that some specimens of the type were not capable of functioning in the suggested way (e.g. Kenyon 1927: 283), that the retouching which shaped the implement was not necessary for that function (e.g. Towle 1930: 11), that specimens within the same implement type may have had different uses (e.g. Howchin 1934: 22), that Aboriginals often produced tools casually and without creating them in specific shapes (e.g. Horne and Aiston 1924), and that variations in form could be explained by reference to other factors, particularly raw material properties.

Nevertheless, interpretations of function based on implement form were often very persistent. For example, although Noetling (1911) correctly explained fracture features
such as bulbs of force and erailleure scars as mechanical products of the manufacturing process, these interpretations were rejected in favour of functional ones. Hence Horne (1921: 185) viewed erailleure scars on scrapers as 'thumb grips' designed to enhance use, and Legge (1927: 28) reinterpreted Noetling's hammerstones as 'pounders' for breaking shells and bones.

The hope that simple macroscopic examination of the characteristics of implement types would provide a direct insight into prehistoric tool use has continued into recent decades. For example, regional prehistories have often discussed inter-assemblage differences in implement percentages as a direct reflection of different toolkits, perhaps associated with seasonality of site occupation (e.g. White and Peterson 1969; White 1971; Allen 1974). Occasionally the underlying proposition, that most tools were implements, each type with a standard function, was tested or refined by innovative approaches, such as numerical comparisons of variations in implement types and vertebrate fauna (e.g. Clegg 1977; Bowdler 1981). Following the lead of Mulvaney and Joyce (1965) and J.P. White (1969), one attempt to link implement form and function involved detailed study of the characteristics of edges assumed to have been used (e.g. Ferguson 1980; but see Hiscock 1982). More dramatically, some researchers attempted to maintain the direct equivalence of implements and tools by denying Hayden's observations of the frequent use of unretouched flakes. For example, Cane (1984, 1992) used statements by Aboriginal informants to argue that there was a significant correspondence between archaeologists' implement classifications and Aboriginal ethno-taxonomy of tools. He concluded that since some contemporary people did not consider flakes to be useful they were in prehistoric times merely manufacturing by-products, and that formal implements constituted the bulk of stone artefacts that were used. However, the problem with that conclusion was determining a) whether the stated ethno-taxonomy is matched by the behaviour of artefact making or use, b) whether the contemporary system described by Cane is the same as precontact behaviour, and c) whether the minimal use of flakes was a widespread pattern or a regional aberration. The only obvious means of choosing between the models proposed by Hayden and Cane was to directly examine prehistoric artefacts, implements and non-implements alike, for physical evidence of usewear.

A direct test of Hayden's propositions, through usewear analyses, did not occur immediately. Initial application of usewear approaches to prehistoric Australian assemblages reveal the strength of the presumed connection between implements and artefact use. Throughout the 1970s a number of researchers, and particularly Kamminga (1977; 1978; 1980; 1981; 1982), attempted to use the new microscopy-based usewear approach to determine the functions of the implement types defined by earlier typologists. Although Kamminga (1978: 353) was aware that the analytical technique could be applied to complete assemblages, he assigned priority to understanding the functions of implement types, a strategy which fulfilled the imperatives of earlier decades, but did not test or develop the notions advanced by Hayden. It was not until the following decade that an entire assemblage was analysed by Fullagar (1982), who demonstrated
that typologically recognisable implements constituted a small proportion of the artefacts which had been used prehistorically, making it reckless to rely on them alone for functional interpretations of the assemblage. For example, at the Aire Shelter II site in Victoria Mulvaney (1962) had only been able to identify 11 artefacts with macroscopic retouch or edge damage, representing 0.7% of the assemblage; but in a usewear study of the entire assemblage Fullager (1982: 75) discovered that 13.3% of the collection contained evidence for use, and that most of these artefacts were unretouched flakes. This kind of usewear research not only verified Hayden's position on the limitations of implement typology for inferences concerning function, but also stimulated investigations into the interpretation of retouching.

**Retouching as rejuvenation**

It should be emphasised that this secondary retouch was done with the aim of 'resharpening' or rejuvenating a dulled working edge into a more suitable one. (Hayden 1977: 179)

The notion that retouching of flakes was not necessarily aimed at creating a standardised predetermined form had been raised by Australian researchers on a number of occasions. For example, in following Kenyon's critique, Towle (1930: 11) argued that retouch was primarily employed to treat working edges which would become blunted after 'a few strokes'. For Towle steep retouch on artefacts, including the backing on backed blades, was not intentional blunting but simply an edge which had been re-sharpened to the point of uselessness. He phrased this argument as follows:

This edge would soon become blunted in use and, if the flake were of good material, the aboriginal workman would retouch it sufficiently to maintain its usefulness. This process would be carried on as it became necessary, until, at length, the edge would become too blunt for further treatment. The implement would then be discarded. Developed in this manner, the supposed 'chipped back knife' becomes nothing more than a discarded flake which has served its purpose in use. (Towle 1930: 6)

The application of this argument to backed blades failed to convince other researchers at the time and remains unconvincing, although the mechanism has been applied to other implement types. A similar argument was advanced by Cooper (1954) for the transition of a Tula into its slug form, with supporting evidence in both the morphology of the artefacts and detailed ethnographic observations of artefact manufacture and use (see Horne and Aiston 1924; Roth 1904). This depiction of the progressive reduction of a tula due to resharpening continues to prove useful in archaeological investigations (see Hiscock 1988; Hiscock and Veth 1991). And from the early 1950s onwards researchers in northern Australia, such as Macintosh (1951), debated whether variation
in the form of bifacial and unifacial points was explained as different functional types of different phases of manufacturing (see hiscock 1994b). these perceptions, of extensive resharpening leading to directional morphological change, have been increasingly discussed over the past two decades, as they have been overseas (e.g. dibble 1987). morphological transformations have also been recognised in grindstones as they are used and reduced (e.g. cundy 1985; smith 1985).

since hayden’s paper an equally important, and related, issue has emerged, namely the degree to which conventional typological classifications may have confused unfinished manufacturing forms with end products that have been used. this possibility has been raised in several contexts. for example, a number of researchers, including kamminga (1982: 85–91), binford and o’connell (1986), and flenniken and white (1985) have concluded that horsehoe cores are not implements/tools but simply exhausted cores (see akerman 1993 for an alternative view). identical arguments have challenged the interpretation as implements of other core types (e.g. mcniven and hiscock 1988). another example is hiscock’s (1993) argument that in the hunter valley artefact forms traditionally recognised as burins or scrapers may in fact be equivalent to stages of core preparation and not end-products. these arguments revisit the question asked earlier in the century, about the correlation of regular form and intentionality, and may be seen as a necessary outcome of questioning the interpretation of retouching primarily as a means of shaping an implement to a predefined form. consequently, one trend over the last two decades is the attempt to describe and explain the structure of the entire manufacturing process, rather than the form of the purported end product alone.

an expectation of these processes is that the different phases of manufacture and resharpening might be spatially separated across the landscape, with use and consequent resharpening increasing as artefacts are carried and used. this mechanism was discussed by o’connell (1977), who saw it as a key factor creating assemblage variation in central australia (see below). since the early 1980s a number of authors pursued archaeological studies of the effects of distance to rock source on the frequency of retouch (e.g. Gould and saggers 1985; Bird 1985; Meehan et al. 1985; McNiven 1993). one of the most outstanding was byrne’s (1980) simple yet powerful illustration of the increased frequency of retouch away from a silcrete quarry in western australia. he concluded that this was consistent with the creation and maintenance of usable edges in contexts where replacement stone was unavailable. further studies found comparable patterns where the geological structure of the landscape allowed for estimation of access to replacement stone by distance measurements, and even highly standardised implements, such as points, display this distance-related morphological change in some contexts (hiscock 1994b). hence spatial analyses of assemblage variation have reinforced the proposition that heavily retouched flakes may have been worked, not to a predetermined form, but gradually as required by need. since hayden’s paper this consideration has formed part of a broad consideration of the factors that condition retouch.

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Factors that condition retouch

Publication of Hayden's paper, and articles in the same volume by O'Connell (1977) and Binford (1977), signalled the emergence of a new, and broader, cycle of discussions about the factors that determine the abundance and pattern of retouching on stone flakes, and consequently the composition of assemblages and the structure of assemblage variation. Earlier in the century extensive consideration had sometimes been given to the causes of shape differences within and between implement types. Perhaps the most common explanation offered, besides the assertion that the forms represented predetermined designs, was that the forms were reflections of raw material properties, the size of flakes being retouched, and/or the use of the item (e.g. Kenyon 1927: 282; Spencer 1914: 77; Towle 1934: 137). Mitchell (1949: 4–5, 7, 104) took this argument to the extreme, suggesting that such factors could explain all variation in implement form, removing any need to posit a deep antiquity for humans in Australia or chronological changes in Aboriginal material culture. For Mitchell, all implement and assemblage variation indicated spatial rather than temporal factors. This proposition provoked a sharp response from McCarthy (1949: 307), who concluded that

...the hypothesis that material controls the form of all our implements cannot solve the problems of Australian prehistory, and it must now give way to the broader cultural interpretation. (McCarthy 1949: 307)

This cultural interpretation involved the introduction of new people or new designs of implements from outside Australia on a number of occasions (McCarthy 1949: 306, 316–17).

Re-evaluation of this approach has stemmed from a rejection of the presumed functional implication of interpreting implements solely as a manifestation of preconceived designs. As mentioned above, assemblage differences were frequently interpreted, throughout the 1970s, primarily as differences in site function, with the proportional frequency of a type being taken as a direct indication of that type's function as a site activity. A key challenge to that model was presented by Jim O'Connell (1977) in a paper that specifically aimed to testing and refining White and Peterson's (1969) explanation of assemblage variation as a reflection of seasonal differences in occupation, and hence site function. Working with sites of known season he concluded that the variation in artefact assemblages was not reflecting the pattern of site function or season of occupation, and that

...a substantial amount of interassemblage variation may be the result of differences in access to material used in manufacture of tools and of particular characteristics of these materials as they affect the forms of implements. (O'Connell 1977: 280)
This proposition is supported by Hayden in the paper reproduced here. Consideration of retouching frequency and form in terms of not only raw material properties, but also the economic and logistical context in which knapping is situated, provides a more powerful framework than was available to earlier researchers interested in the relationship between implement form and rock type. Publication of '47 trips' by Binford (1977) in the same volume as the papers by Hayden and O'Connell reinforced the perceived capacity of this economic and contextual emphasis.

From the late 1970s onwards there has been increasing emphasis on issues of access and stone availability as key factors in assemblage variation (see Byrne 1980 and discussion above). Researchers have attempted to relate access to a range of characteristics of settlement systems, including the level and structure of residential mobility, structure of the environment, familiarity with the environment, and environmental and social barriers to access (e.g. Draper 1993; Hiscock 1994a; McNiven 1993, 1994; Veth 1993). This interest in depicting implement form and assemblage variability as a component of hunter-gatherer economies appears to mark a convergence between those employing analyses of artefacts to examine issues of human ecology, and those archaeologists who have been employing faunal or geomorphic evidence to define adaptive processes (e.g. Pardoe 1988, 1990, 1994; Cosgrove et al. 1990; Sullivan 1982).

**Conclusion**

In retrospect it is clear that Hayden's (1977) paper was part of the general re-expression of perspectives that had been discussed earlier in the century. The elements of this re-expression contain many of the features of the propositions espoused by New Archaeology in the 1970s (cf. Binford 1989). For example, the rejection of mentalist descriptions of implement form, and of assemblage variation, the attempt to formulate interpretative principles through ethnoarchaeological investigations, the focus on observations that were apparently anomalous in respect to traditional propositions ('surprises'), and the emphasis of economic/ecological/evolutionary mechanisms, are all features pronounced in the New Archaeology perspective. It is certainly possible to see a direct influence of this paper on some authors in the early 1980s (e.g. Byrne 1980; Hiscock 1983). However, while Hayden's paper was influential, it also epitomises a broader perspective that continues to revitalise the interpretation of Australian artefacts.