Describing and Conceptualizing Minimal Tools in an Ethnographic Setting: Implications for Understanding Technological Systems Holistically

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How should we describe and conceptualize the simplest tools imaginable, especially in relation to distinctions between found, minimal, and repurposed objects? Most ethnographic accounts pay little attention to them, and neither does the organization of museums and the anthropological curriculum. Addressing the literature on the theory of tool use, this paper argues why rudimentary objects observed ethnographically, such as used as containers, scrapers, whetstones and strike-a-lights, should not be neglected. The argument is illustrated with reference to data on the Nuaulu people of Seram, eastern Indonesia. The main exception to this neglect has been archaeological, in the context of understanding the earliest possible human tools, and in animal behavior studies where the very idea of tool use is being interrogated. Holistic claims about tools require that we understand the scale and significance of minimal tools both for modern non-industrial peoples and for ordinary people living and working in industrial societies.

Key words: tools, technological systems, found objects, minimal tools, repurposing, Nuaulu, Indonesia

What tools are, and how tool use evolved, has become an infinitely more sophisticated set of issues since mid-twentieth century archaeology's claim that tool-making is the defining characteristic of the genus *Homo* (e.g., Oakley 1963). Firm evidence for the making of tools has not only been pushed back to pre-*Homo* hominin species living around 2.6 mya, and through indirect evidence to 3.4 mya (Gilbert 2018:2917), but is routinely described for living nonhuman primates (Musgrave and Sanz 2018) and other nonprimate species (Shumaker et al. 2011). Tool-using is not so rare as once thought in the animal kingdom, and tool-making (the modification of found objects) is not always easy to distinguish. Tools themselves are therefore no longer sufficient to distinguish human fabricators from nonhuman fabricators.

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Despite the very considerable literature on tool use and its conceptualization across various disciplines, and although recent studies, particularly in archaeology and of stone tool technology, have gone some way toward demonstrating the importance, function, and context of very simple tools, their significance in contemporary societies has tended to be discussed with reference to abstract and hypothetical cases only, rather than through ethnographic demonstration. In this paper I wish to reexamine some of the conceptual and analytic issues in relation to ethnographic evidence for the simplest tools that we can systematically observe and report. I do so mainly through an exploration of ethnographic evidence from eastern Indonesia, followed by a short comparison with studies of minimal tools in prehistory. The general anthropological problem addressed is the ubiquity and everyday importance of such objects in the human technological system, and why their systematic treatment has been neglected ethnographically. I suggest how their intrinsicality and protean role might be better understood.

TOOLS: FOUND, MINIMALLY MODIFIED, AND REPURPOSED

What makes an object a tool is that it is used to extend what is anatomically possible, not that the object is modified as such. I focus here on found objects used as tools, minimally modified objects used as tools, and repurposed tools. In order to understand the differences implied, we also need to contrast all of them with what I call for convenience *fabricated* tools.

A *found tool*—what Oswalt (1976:18) not entirely helpfully calls a "naturefact"—is an object that is physically unmodified before use, but the process of use may itself involve physical change, such as wear patterns. Lithic examples include hammerstones, strike-a-lights, and heavy objects used as paperweights. Examples drawn from animal products include shell scrapers and containers, and examples drawn from vegetable products include leaf wrappers, thorn hair pluckers, digging sticks, and clubs used for extricating rodents from burrows. In some cases the material sought may merge with the tool employed to utilize it, as where a piece of red ochre, chalk, or charcoal becomes an instrument for applying color to a surface. The process of locating a found object to be used as a tool may be simple, rapid, and ad hoc, or complex and time-consuming. In many cases, minimalist, multipurpose tools might be preferred to complex ones, even in what are otherwise advanced technocultural systems, whether to avoid the effort of tool preparation or because there is an adaptive advantage in different environments and contexts (e.g., Torrence 1983). Some found tools may be immediately discarded after first use—for example, when picking up a stick to clean the sole of a boot, or a random stone used to prise open a bottle top, after which they may no longer be recognized as tools. In other cases, found objects may be used repeatedly and stored over long periods of time—for example, a cherished whetstone (see below).

A *minimal tool* is a found object modified quickly and simply—for example, a few chips on a stone, cuts on a tree branch, or twists of a vine. Layton (1986:24, 28) documents the contemporary Aboriginal use of chopper/wedges as a minimal tool in the

Western Desert of Australia, an object that can be made, used, and discarded in a single use episode. Use of the term "simple" (rather than "minimal") in the literature to refer to such objects is rather ambiguous and may imply objects that involve more than a few operations to make them. In an archaeological context, Andrefsky (2005:30) calls minimal tools "expediently manufactured" or "informal" tools, to emphasize that there are no specific design requirements and that the tool may be discarded as soon as the immediate task for which it was made has been completed. For this reason, they are often very variable in form. Examples include carrying sticks and coconut shell containers. In archaeological terms, this is where we might place some natural flakes retouched as scrapers, Oldowan pebble tools, and, from a cross-species point of view, the Gombe chimpanzee straws and sticks famously first observed by Jane Goodall (1986:536–39), collected and prepared for extracting termites from their nests. But minimal tools are by no means restricted to small, nonindustrial subsistence populations or to nonhuman primates, and they are emphatically part of the technological system of complex industrial and postindustrial societies. In clearing an old outhouse attached to a Kentish farmhouse (in southeast England) in 1986, I noted that although the vacating farmer had removed all complex fabricated tools (such as ploughs and horse bridles), many simple wooden objects remained: an accumulation of used and potentially useful tools based on found objects and evidently employed on an ad hoc basis, as, for example, livestock prods, goads, as well as skewers, brads, or bale hooks, and thatcher's "dogs" (for carrying straw), harvested from forked lengths of ash, *Fraxinus excelsior* (Major 1981:29).

A *repurposed tool* may be a found physical object, a minimal tool, or a more complex, fabricated artifact that is used for a purpose other than that for which it was originally designed. Again, examples can be found in human populations of all degrees of technological and material complexity. They might include using a paper clip to pick a lock, a coin to open a can lid, or a piece of string to serve as a belt or shoelace, a stocking to fix a fan belt, a cigarette packet used to jot down improvised notes during a meeting, or "fossicking" and "rummaging" from rubbish heaps in Aboriginal Australian culture. Layton (personal communication ~~YEAR~~) describes how discarded Western Desert adze blades, of unknown age, were recovered from old campsites in the 1970s and mounted on spearthrowers made to sell to tourists. The same Kentish outhouse described in the previous paragraph revealed some complex examples of harrows made from recycled chains and lengths of timber, and old horse bits repurposed as a gate latch. Layton (2000:230–31) illustrates similar reuses in his study of Franche-Comté during the late 1960s and early 1970s. In this case the examples included horseshoes used to support horizontal poles across fence gaps to form gateways, and a cartwheel hub and axles used to construct a stile. Indeed, once such tools are pointed out to us, we begin to see them everywhere: repurposed from other "exaptions" (Ingold 1986:50) that have arisen for purely contingent reasons. Evidently, people the world over resort endlessly to such imaginative solutions to solve immediate technical problems, but they are seldom recorded and contextualized by anthropologists.

In contrast to all three previous categories of tools, I here understand a *fabricated tool* to be any other physical device that involves design, conscious making and effort, and which may be constituted from one or more physical elements. Examples range from Acheulian hand axes to Ford assembly-line machinery to Apple computers. As tools become more complicated in their construction and use, they are less easily defined as an extension of the human body and have more autonomy as independent sociocultural phenomena. There have been several attempts to classify fabricated tools on the basis of degree of complexity and function, beginning with Pitt-Rivers (e.g., Pitt-Rivers 1906; also see Leroi-Gourhan 1943, 1945; Oswalt 1976). For Ingold (2000), the complexity in minimal tools lies in the skill involved in making and deploying, and in the time invested in learning and acquiring embodied knowledge: operational versatility rather than structural simplicity. Minimal tools often have a diversity of functions, whereas materially complex tools are more specialized. As White and Thomas (1972:278) note for some contemporary New Guinea highlanders, stone flake tools are seldom defined as a single functional type, any one piece of stone being applied to different tasks as long as it is the right size and has a suitable edge. A lump of chert can be a hammer, core, scraper, plane, or knife on different occasions.[1]

The point of this section is not to defend a particular classification or to determine whether any particular object should be assigned to one category rather than another. The boundaries between tool categories defined here are not always firm, and the question as to when tool use becomes tool-making is fuzzy. The categories merge into one another depending on analytic viewpoint—whether the analyst is a directly observing ethnographer, a field primatologist, or an archaeologist who has to infer status from limited material features and from context. Determining where to place a particular tool within any scheme is not always easy. Thus, some digging sticks are found objects, some are minimal tools insofar as a few strokes of an axe to remove inconvenient protrusions may render them useful, and some are repurposed objects, such as metal lengths rescued from industrial machines (e.g., axles). Some found, minimally modified, or repurposed tools may also be incorporated into more complex technical devices, either as deliberate and semipermanent components or as quick temporary fixes.

NUAULU MATERIAL CULTURE

The Nuaulu are a clan-based people and linguistic group of south-central Seram in eastern Indonesia numbering somewhat in excess of 2,000 individuals, who subsist mainly through a combination of sago extraction, hunting, and swiddening in a tropical rainforest environment (e.g., Ellen 2020:2–10). During fieldwork between 1970 and 2015 I assembled and documented a collection of portable material culture objects now mainly lodged in the British Museum, the Museum of World Cultures in Leiden, and the Ethnobiology Laboratory of the University of Kent. Most of the objects were reported and collected between 1970 and 1975, with some additions since that time. The objective was to produce a representative and comprehensive assemblage of all kinds of objects regardless of aesthetic appeal.[2]

Among the pieces acquired were objects used unmodified as tools. I also acquired objects that were only slightly modified, and objects that had once been tools used for one purpose but which had been repurposed for another. At the time, these items raised practical issues as to whether they should be included at all, methodological issues concerning how to record them, and theoretical issues around what we mean by a tool. For example, in collecting a found object that has been selected and used once, there is no way of knowing whether, had the object not been collected by me, it would have been discarded after one use or retained for future use opportunities. Some quite complicated, undeniably "fabricated" tools made of several separate interconnected parts may not be used on more than two or three occasions. One case was a bamboo sago pounder (Ellen 2004: fig. 7), which in 1975 took 15 minutes to make, and which if I had not acquired it may have been used intensively over a period of several days and then discarded as the components began to weaken. The bamboo itself, which also has a restricted use life and which tends to shrink and split, may also be a reason for discarding a pounder, though often it will have been thrown away well before the bamboo has deteriorated to such an extent that this is the reason for discard.

Found Lithic Objects as Tools

Examples of unmodified found objects employed as tools by Nuaulu are depicted in Table 1. These include objects made from lithic, animal, and vegetable materials. In this paper I have chosen to focus mainly on lithic objects in order to facilitate connections with archaeologically recovered prehistoric tools.

Lithic examples include hearthstones, hammerstones, cooking stones, strike-a-lights, anvils, and whetstones (or hones). The latter include both the small kind that can be conveniently carried about and placed in a betel pouch and the larger kind which are either too big to be moved at all or which can only be moved with difficulty, and which are commonly located outside the doors of houses to serve domestic purposes. Portable whetstones that have been retained for long periods may show signs of wear. Sessile whetstones (Figure 1), sometimes pegged into place to keep them stable (Figure 1b), may survive many generations, and constant use produces concave indentations. In these cases the human imprint is very clear—and in this sense they are modified, the wear pattern being a kind of making that actually improves the functionality of the tool. On the large stone in Figure 1a, used to sharpen steel axes, bush knives, and smaller knives and spearheads, the erosion due to constant usage is very distinct, and this particular example probably represents the accumulated and heavy usage of 80 years or more, ever since the nearby village was established. Its use could go back even further. The point to note, however, is that this stone, and many like it, are in situ, sometimes many kilometers from a village. Although they are obvious objects of human modification, they do not necessarily indicate nearby habitation, though they almost certainly indicate settlement in the general vicinity.[3] Although the handheld whetstone is also in constant use, only some hones can be easily identified as such with the naked eye; others are only identifiable when they are in clear-cut cultural

Table 1. Examples of Nuaulu found tools.

	Tool type	Uses	Source material	Reference number	Nuaulu term
A:	Stone				
1	strike-a-light	making fire	iron-stained quartzite	UKC 1971.786	*kinonote putie*
			silaceous rock, chert	UKC 1971.787, UKC 1973.50	
2	pestle	preparing food and, e.g., crushing betelnut for old people with few teeth	fine-grained biotite schist		*rutue, makarutue*
3	portable whetstone	sharpening parangs and knives	fine-grained biotite schist	UKC 1970.61, UKC 1970.275, BM AS1.1972.214	*hatu asinaite*
4	sessile whetstone	sharpening parang, knives, axes and other blades in the village	large block of fine-grained biotite schist	Figure 1	*hatu asinaite*
5	food grinding stone	grinding ingredients in food preparation: e.g., chili, *Canarium* nuts	fine-grained biotite schist	Figure 1	*hatu kapirane*
6	hammerstone	opening *Canarium* nuts and similar	fine-grained biotite schist	Figure 2	*kahitate*
7	anvil	opening *Canarium* nuts and similar	fine-grained biotite schist; also coralline limestone	Figure 2	*hatu unue*
8	washing stone	large flat stone, usually in situ by stream or placed at end of bamboo water conduit, for washing clothes	usually laminate schist		*hatu poo*
9	pot-boilers	stones for heating water	assorted slate gray and white (quartzite) pebbles, each approx. 10 mm diam.	UKC 1970.15a UKC 1970.273	*hatu rerie*

10	stones for cooking food	heated in fire and then placed on either side of food wrapped in banana leaves	broken laminate schist pebble	UKC 1973.33	*hatu maea*
11	tooth file	filing teeth, usually of pubescent girls	lava recovered from beach or brought from volcanic area	RV-4589-447	*kakokine*
12	pumice stone	body hair removal, particularly in female puberty ritual	lava recovered from beach or brought from volcanic area	UKC 1971.448	*akiakae*
B:	Animal Material				
13	spoon	food preparation	seashell (*Periglypta reticulata*)	BM As. 1.43	*sondo*
14	scraper	smoothing arrows and similar uses	seashell (*Tridacna maxima)*	UKC 1970.360	*rana*
15	awl	fine craftwork	made from breastbone of cassowary (*Casuarius casuarius*)	RV-4589-375	*kahate*
16	lure	used when catching needlefish	crushed and rolled web of round-bodied spiders of the genera *Argiope*	UKC 1975.18	*anai*
17	charm	~~treat~~ child sickness	pig's tail (*Sus scrofa*)	UKC 1971.380	*hahu etute*
18	water container	used when sharpening parangs and knives	large clamshell of *Tridacna maxima*		*nunu mua ika*
19	awl	(teeth) used for making holes in fine craftwork	cuscus (*Phalanger* or *Spilocuscus*) mandible	RV-4589-93 UKC 1973.99	*kahate*
C:	Vegetal Material				
20	drinking vessel	used in some versions of male puberty rituals	lining of bamboo internode (*Dendrocalamus* sp.)	UKC 1975.26	*wanate nene utone*
21	bedding	used for overnight stays in forest	*Usnea* lichen	Herb. 1996-0234	*ahane*
22	mop	general domestic use	*Arenga pinnata* fiber from base of petioles	UKC 1971.535	*nahue*

Table 1. (*Continued*)

	Tool type	Uses	Source material	Reference number	Nuaulu term
23	round balls	used to play marbles	fruits of *Calophyllum innophyllum*	UKC 1975.12	*muteli*
24	plug	in base of sago-processing apparatus, removed to drain contents	various timbers	UKC 1996.07	*kai erute*
25	drum peg	used for tightening skin	piece of hardwood	UKC 1971.414	*kalai tihane*
26	spout	on bamboo water conduit	piece of bamboo (*suenie*)	UKC 2003.05	
27	wrapper	usually for food	dried and roughly trimmed banana leaf (*Musa* spp.)	UKC 1970.248	*wola-wola*
28	wrapper	for personal objects, also in ritual	dried and roughly trimmed leaf (*Phrynium pubinerve*)	UKC 1970.249	*wainite, wola-wola*
29	cordage	for binding	climbing fern		*awane*
30	wrapper for sacred shield	dried	leaf sheath of *Areca catechu*		*arate*
31	meat wrapper	fresh	leaf of *Macaranga mappa*		*wola-wol**a***
32	wrappers for smoking tobacco		especially leaves of *Rhodamnia cinerea*, *Melastoma imbricatum*, and *Cheilocostus speciosus*		*wola-wola*
33	wrapping and storing food		leaves of *ai numa hanaie* (Lauraceae), *puane musie* (*Actephilia excelsa*)		*wola-wola, pokonukune*

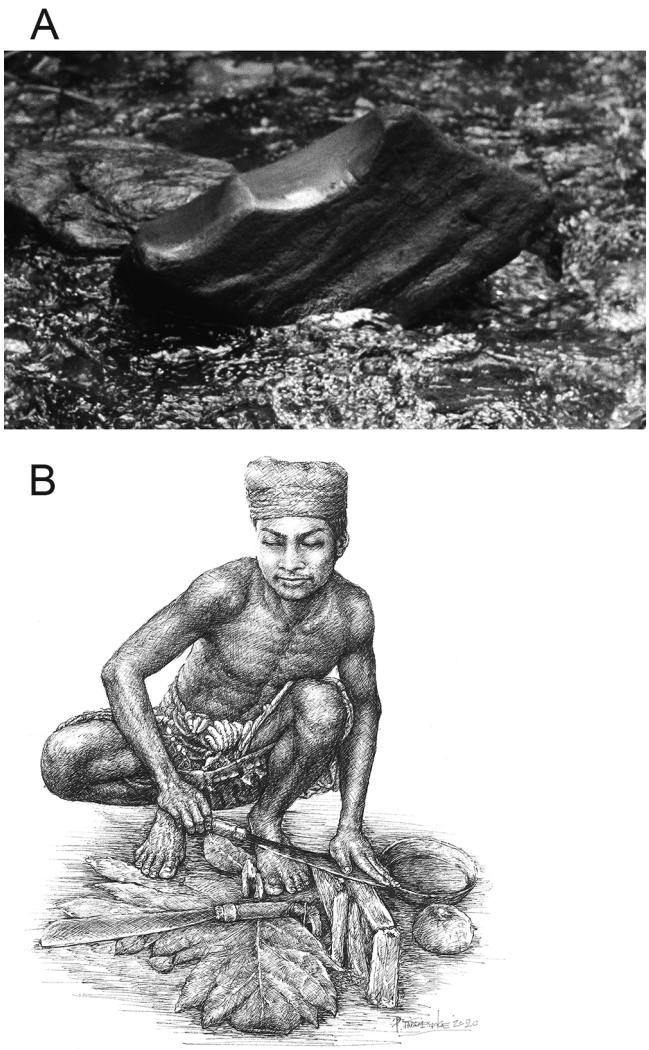

Figure 1. Sessile whetstones: (a) old whetstone positioned at river crossing, August 1973; (b) Menai Sounoue sharpening bush knife, March 1970 (ink drawing). Rouhua, south-central Seram.

settings, or when wear marks can be observed under laboratory light conditions and magnification. Many whetstones used by Nuaulu are simply likely pieces that have been eroded and smoothed by water, picked up from the ground, and thrown away again immediately after use—sometimes less than five minutes after selection. Clearly these are unlikely to be traceable archaeologically, although they are a common means of sharpening blades.

Most hones, particularly if their owners regarded them as being good ones, may be kept for years and carried about before they are disposed of. These do not usually show any clear visible signs of use, though a gloss may suggest this, and confirmation may be obtained through microscopic analysis and experimental techniques to discover the characteristic wear patterns of whetstones. Here we have a case of found tools with a known function, which can be reproduced in the laboratory (or observed under ethnographic field conditions) and the characteristic wear pattern discovered. The occurrence of similar items in archaeological contexts can in principle be confirmed using similar techniques.

The situation is much the same with hammerstones and anvils (*batu unue*), which we might also assume to have distinctive wear patterns, but which are only identifiable when located in distinctive cultural (usually household) settings or accompanied by plant residues. Two Nuaulu anvils and hammerstones used for breaking *Canarium indicum* nuts, the first of schist and the second of coralline limestone, are shown in Figure 2 (see also Ellen 2019:268–74). Like whetstones, anvils found outside the village area are far less likely to be identifiable archaeologically.

Further Nuaulu examples of unmodified found tools include hearthstones and stones heated in a fire and used for cooking. Nuaulu primarily use heating stones for cooking when making *maea* from sago and *Canarium* nut flour, as required for ritual feasts. Another use involves dropping hot white quartzite pebbles into receptacles of coconut oil mixed with the leaves of *Cyperus elatus, Piper caninum*, and *Polyscias cumingiana* to produce a fragrant aroma during early morning performances of *auwoti* war dances. We know something about the characteristics of heated stone, and certainly the presence of carbon on stones in an appropriate context is a reliable indication of use. The formation of hearths and ash patterns, the effects of heat on fire stones, and typical artifact distributions in the vicinity of fireplaces are all features suitable for experimental investigation, although even here circumstantial evidence is always going to be important.

The final lithic example of a Nuaulu found tool is the strike-a-light (Figure 3), collectively known as *kinonote* (Ambonese Malay 'batu api': fire stones) and usually derived from chert found in fluvial soils. Before the advent of matches and reliable cheap cigarette lighters, Nuaulu generally made fire by striking a kinonote against some form of iron (Glover and Ellen 1975:52–53). These materials are kept by many male individuals in betel pouches for use away from the village, when other tools of combustion are unavailable or when they fail. One specimen (Ellen and Glover 1979:239) was stained with red dye from being in a betel pouch.

The repeated striking of these objects produces a distinctive, deliberate edge-battering leading to blunting. The flakes are not fabricated by the Nuaulu themselves, but simply selected from those found on the surface of the ground or in coastal alluvial deposits. Sometimes flakes selected for use are naturally broken pieces. In 1975, of a sample of 95 specimens collected in Rouhua village (Ellen and Glover 1979), 37 were naturally broken pieces, lumps with bifacial battering at one end, pseudo-cores,

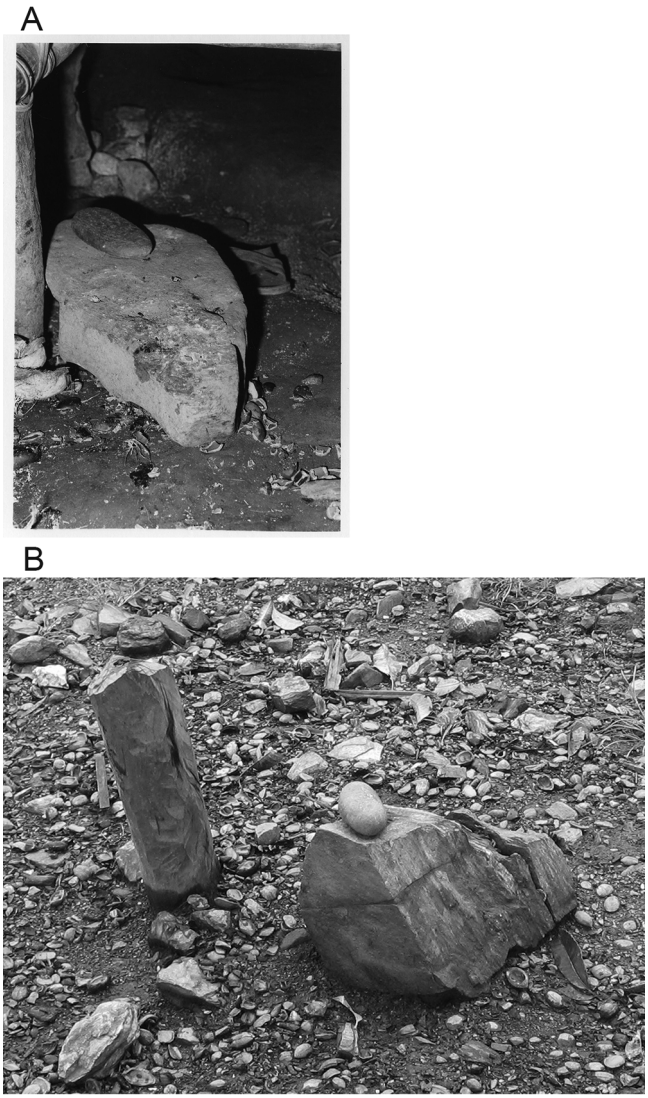

Figure 2. Stones (*hatu unue*) for breaking open *iane* nuts (*Canarium indicum*): (a) adjacent to the house, August 1973; (b) outside the village, August 2003. Rouhua, south-central Seram, showing accumulated nut debris.

pseudo-flakes or small broken pieces with no edge modification. However, the majority (58) were archaic implements, waste flakes, and cores. As far as contemporary Nuaulu are concerned these are unmodified objects, yet archaeologically they were obviously well-defined fabricated artifacts. Unless evidence for human workmanship is

Figure 3. Hotena Neipani making fire using a chert *kinonote* strike-a-light and iron, August 1975.

obvious, Nuaulu assume kinonote to be natural or sometimes supernatural objects. Archaic implements are considered further below as "repurposed" tools.

Found Objects as Tools: Other Materials

As can be seen from Table 1, found and unmodified objects used as tools by Nuaulu are also derived from animal materials. Mollusk shells occur as spoons and scrapers, while large shells of the clams *Tridacna maxima* or *Periglypta reticulata* are used as water containers—for instance, in conjunction with sessile whetstones when sharpening metal blades. A more specialized use is the crushed and rolled web of round-bodied spiders of the genera *Argiope* as a lure when fishing for needlefish. Bone (including pig tusk) is

widely used unmodified for piercers, markers, scrapers, and awls. The incisors of a cuscus mandible (*Phalanger orientalis*) are also used to mark wood and pierce vegetable fiber.

The most common found tools are of vegetable materials, often used in an ad hoc and unpremeditated way: sticks as scrapers to remove mud from the body or to poke a fire, slivers of bamboo used as toothpicks, or dry, unfashioned coconut fiber used to brush house floors, platforms, and benches. The most frequent plant components used in this way are leaves: as wipes (e.g., for a baby's bottom); for body cleansing; to apply paint or cosmetics; in food preparation, containers, or as wrappers; as spouts to divert water from a bamboo conduit; as barriers to prevent water spilling over the side or to plug a leak; or placed over a conduit or sago processing trough to provide protection from falling debris. Loose pieces of bamboo may be used in much the same way. Leaves used in these ways will generally be plucked green and roughly trimmed (e.g., banana leaves as eating surfaces) or may be deliberately dried, as with *wainite* (*Phrynium pubinerve* and related species). Certain species are preferred when they are available, determined by size, shape, texture, strength, manipulability, and waxiness of surface. For example, the proximal end of a pineapple leaf is rigid and provides a V-shaped cross-section, making an ideal spout through which to draw water from a conduit. Where these are deliberately cut with a few strokes into particular shapes to serve particular purposes, they may be considered "minimal" tools rather than found tools, and where elaborately decorated (as with some *wainite* leaves), as fully "fabricated" tools. The same might be said of knots made in a liana to tie a bundle of leaves. Some objects that might be described as found tools are in fact components of other devices, such as plugs in sago processing troughs.

Minimally Modified Tools

Examples of minimally modified objects employed as Nuaulu tools are listed in Table 2. These include many roughly fashioned objects used for a variety of purposes, such as trimmed sticks used as carrying poles and leaves cut and fashioned as containers. A wide variety of containers is created through minimal modification. The most ubiquitous is the half coconut shell (*sahaune*). These are created during the course of opening coconuts to extract the flesh for eating or the copra for drying and onward sale. This produces a huge number of half coconut shells, most of which will be discarded or used as fuel. However, a small proportion are always to be seen around the village being used as dippers, scoops, cups, and other kinds of container. Most are not modified beyond the initial cut made for extracting the flesh, though a few may be trimmed and cleaned and turned into smooth cups by singeing off the hairy coiffure and burnishing.

Just as the boundary between found and minimal tools is fuzzy, so too is the boundary between minimally modified and fully fabricated tools. The key criteria here are design and degree of specificity. A bamboo slashed in order to beat back undergrowth does not require much conscious design or degree of specificity, whereas the bamboo

Table 2. Examples of Nuaulu minimally modified tools.

	Tool type	Uses	Source material	Reference number	Nuaulu name
A:	Stone				
1	toy	thrown for the effect of the trailing tail	stone with attached vegetal fiber trailer	RV-4589-176 UKC 1970.178	*kunarigi*
B:	Animal Material				
2	house hook		deer antler (*Cervus timorensis*)	UKC 1970.53	*tanapaku*
C:	Vegetal Material				
3	digging stick	trimmed wooden stick	hardwood		*lawanka*
4	faggot or torch	bundle of dry leaves for transferring fire	usually coconut (*Cocos nucifera*)		*osi*
5	container	calabash used for water and food	hard exterior of half *Crescentia cujete* fruit	UKC 1970.6e	*kalabasa*
6	container	coconut shell used for water and food	fruit of *Cocos nucifera*	UKC 1970.52	*sahaune*
7	skewer	meat skewer; secondary use as ritual object	stick, trimmed with pointed end	UKC 1970.111	*asunate*
8	measuring device	used to determine correct height when setting trap: different notches marked at different height for different species	suitable small-diameter stick	UKC 1971.645 UKC 1970.318	*sinuete*
9	carrying stick	notched for attachment of carried items	suitable straight branch or sago petiole (*Metroxylon sagu*)	UKC 1971.405	*hahalan*
10	peg	to increase height of sago processing trough	sago leafstalk inner fibre (*Metroxylon sagu*)	UKC 1996.04	*soka*
11	needle, pin	craftwork	slither taken from coconut petiole (*Cocos nucifera*)		*katolote, sisunue*
12	knife	for cutting umbilicus, when is then stored in roof thatch of birth hut	bamboo slither	UKC 1973.99	*kaitimane*
13	wedges	splitting logs	various hardwoods		*kalaite*

knife used by the Nuaulu to cut the umbilicus of newborn babies—however crude it may look—is the product of serious conscious design and considerable specificity. The bamboo—no more than a slither—is used only once and then set apart because of ritual associations and not used again.

A house hook consisting of a pair of young deer antlers removed from a skull, but retaining the connecting portions of the cranium to which the antlers are attached, involves a fair amount of preparatory work but draws on the natural shape of the antlers to provide the hook (RV-4589-514), so it too is difficult to place. The category of fabricated tool would include everything from the bamboo knife to the most complex items in Nuaulu traditional technology—the apparatus for separating sago pith from flour, and that for removing coconut flesh from the shell. Some tools derived from vegetable materials, though minimal in terms of the number of operations required to make them, may be grown to be tools, in some cases grown in particular ways to shape them (e.g., gourds and calabashes). The category of "minimal" tool is always going to be definitionally problematic since it is transitional and also, for this reason, neglected.

Repurposed Tools

Sometimes Nuaulu tools are old and previously discarded objects refound and repurposed, though sometimes deliberately retained and later repurposed. We should also perhaps distinguish between tools made and used by a known person, and later repurposed by that person in a different context, and tools made many years previously, perhaps many thousands of years previously, where the object is reused unknowingly. Of the first type might be an old whetstone used as a hammer, while the second type is conceptually much more interesting and includes ancient stone tools found and repurposed as tools in a present-day context. In the Nuaulu assemblage, the most physically conspicuous of repurposed tools in the early 1970s were bars of metal or axles stripped from redundant machinery, left at logging camps or timber mills, or salvaged from World War Two military debris and redeployed as heavy-duty dibbles (*lawanka*). A close second were stones used as strike-a-lights.

Rumphius (1999:243–44) reports how late-seventeenth-century nearby Ambonese used ancient polished axes ("thunder stones") for sharpening blades. I did not recover Neolithic material used in this way by Nuaulu, but no doubt there are instances. More common were what Rumphius (1999:259) describes as *batu api* (see above), used as flintlock stones and as strike-a-lights. Occasionally Nuaulu will use broken weathered bottle glass (*kinonote potoni*; e.g., UKC 1971.407), but they mainly employ ancient (but post-Pleistocene) blade tools that they do not recognize as humanly made, distinguishing them according to named types (e.g., RV-4589-159, RV-4589-175, RV-4589-221, RV-4589-244; Ellen and Glover 1979; Glover and Ellen 1975; cf. Brumm 2006). Strike-a-lights, whether natural flakes or prehistoric tools, are often kept and used in combination with *kitupane*, repurposed pieces of ferrous metal, such as police-issue rifle cartridge cases.

FOUND, MINIMALLY MODIFIED AND REPURPOSED TOOLS IN PREHISTORY

In anthropological studies of tool use, an understanding of technical practice and context has been achieved through direct observation, participant observation in the form of apprenticeship, and the systematic study of operational sequences (e.g., Keller and Keller 1996). Although in ethnographic situations such approaches are possible, functionality in archaeology is less easy to establish. For this reason, a persistent major problem (especially in the history of early Paleolithic archaeology, and beginning with the discovery of the earliest objects confirmed as human tools) has been to establish that objects found are evidentially tools. In archaeology their status can only be established by examining changes made by humans to raw material (usually stone), experimental techniques, or by resorting to evidence of context and human movement, such as stratigraphic positioning or association with other objects. Despite their potential for shedding light on archaeological tool use, and the progress permitted through the deployment of ethnographic analogies, experimental methods, and ethnoarchaeological approaches in analyzing the procurement, modification, and use of minimal tools, little direct work has been done on the purely ethnographic study of the use of found and minimally modified objects. Since these can be documented for living ethnographically reported populations, we can assume that such tools must have been at least equally important in earlier historical and prehistoric stages of technological development.

In prehistoric archaeology much attention has been historically paid to the earliest stone tools since it is reasonably assumed that these were more likely to be found objects and objects with minimal modification. In addition, during the formative phase of modern lithic studies, much attention was paid to developing diagnostic tests for human modification. One of the most compelling was the identification of the bulb of percussion and related conchoidal characteristics of struck flint (Watson 1956:15–19), but these are not always found on material other than silica. In some cases, only circumstantial evidence and the physical plausibility of objects as tools will identify them as anthropic. In a modern context, Andrefsky's (2013, 2014) work recognizes the functional effectiveness of unmodified tools, though as early as 1872, John Evans (1872:372–79) devoted an entire chapter to found objects used as sling stones, balls, and pot-boilers. The best-described minimal objects inferred as tools for the earliest hominid phase are the so-called Oldowan pebble tools. These were initially dated to some 1.8 million years BP in association with remains of Australopithecines (Oakley 1966:172–73), but the earliest dates for tools of this kind has now be pushed back to 3.3 mya (Harmand et al. 2015). These are usually regarded as simple modified stones, perhaps first used for pounding roots and other vegetable matter; then, after flaking, for cutting meat. In recent years the criteria for establishing the credibility of found and minimally modified prehistoric objects as tools has been extended to the archaeology of nonhuman primates (Haslam et al. 2017). One example from this body of work is the discovery of pitted stone anvils used by chimpanzees to crack oil palm nuts (Goren-Inbar et al. 2002; McGrew 1992:10).

Recent literature on stone tool analysis has tended to move away from complex fabricated tools to focus on the importance of simpler, including what I am here calling "minimal," tools. However, with regard to the history of prehistoric archaeology, the most acrimonious and perplexing episode relevant to the debate around found and minimal tools is that pertaining to eoliths. Eoliths were purported stone tools found in pre-Acheulian deposits ultimately in many parts of the world, but associated in Britain especially with the Weald of Kent and the work of Benjamin Harrison (Ellen 2011, 2013; Ellen and Muthana 2010, 2013). Many of the objects found by Harrison passed the test of being geologically plausible (that is, in the right place for the right time) but were problematic from an "anthropological" perspective. Harrison and others claimed that much of the chipping on eoliths was deliberate, but this evidence did not often pass the bulb of percussion test, and experimental data suggested that the same effects could be created naturally. Harrison and others were also claiming that many eoliths had been used as tools but were at the same time found objects with no modification; rather they purportedly had been deliberately selected for shape, weight, size, material, cutting edge, or because of how they "fitted in the hand." With hindsight, eolithists might have welcomed the support of primate studies in which, as we have seen, found stones are not only used as tools but are the consequence of complex processes of selection and retention. Eolithists at the time used ethnographic parallels to enhance the credibility of their claims. Thus, Bell (1894:277) compared eoliths with the use of shore pebbles by Berwickshire fisherman (southeast Scotland) when making bone needles for net mending. Another example can be found in the argument for "body stones"—stones with shapes reminiscent of ancient Greek strigils used to scrape dirt from the body (Ellen and Muthana 2010:360). However, if all such plausible objects were to be claimed as tools, it was pointed out, the numbers would be absurdly high. On the other hand, we might reasonably expect that a high proportion of objects found in archaeological sites will have been used at one time or another as ad hoc tools discarded after a single or a small number of uses.

As for the role of repurposed tools in archaeology and prehistory, the example of Nuaulu kinonote discussed above suggests that tools of one period may turn up in later levels with entirely new functions. The repurposing in particular of old flakes as strike-a-lights is well attested (e.g., Pawlik 2004), and general evidence of repurposing is widely reported in the history of prehistoric archaeology. Harrison and others had claimed that some eolithic tools had been repurposed by later populations as hand axes or other kinds of more obviously fabricated tool, and there has long been evidence of early Paleolithic hand axes being recovered, retrimmed, and used in later Paleolithic contexts (Smith 1894:116), of reworked flakes knapped from a core (e.g., Shaw et al. 2015), and of "intentional breakage" of some tools to make others (e.g., Anderson-Whymark 2011). Evans (1872:303–4) described how the ends of broken Neolithic stone celts were converted into knives, and there are examples of Paleolithic tools being repurposed during the Neolithic. There is considerable recent literature on chipped tools which have deteriorated during use being retouched, reworked, or resharpened

(Andrefsky 2005:30). Clarkson (e.g., 2007) has explored how and why stone tools are repurposed, and Arthur (2018) has used "life histories" to examine the serial repurposing of simple tools made by contemporary flintknappers.

So, what I call here "repurposing"—whether ethnographic or archaeological, operating over the short-term or over millennia—clearly entails what Lévi-Strauss (1966:16–26; Ingold 1993b:340) describes as *bricolage*, the bringing together of different elements to create something new, ~~in which~~ later users are in effect able to take advantage of selection decisions made by previous users. Indeed, it might be argued that most innovation in tool-making is a kind of repurposing and that therefore the distinction Lévi-Strauss makes between bricoleur and engineer is false (Johnson 2012).

DISCUSSION

Many (perhaps most) inventories of material culture in published systematic ethnographic accounts (classically, e.g., Buck, 1927) pay relatively little attention to either found objects, minimal tools, or repurposed tools, though Oswalt (e.g., 1976:20–22) in his review stresses their importance and ambiguity, giving many examples (e.g., a twig with leaves used as a broom). This neglect is reflected in the organization of teaching and general texts on technological subjects within the anthropological curriculum. Even though such teaching up to the 1960s in Britain was routinely relegated to courses and chapters described as "primitive technology"—consistent with parallel assumptions in social anthropology delineating "primitive society" (e.g., Kuper 1988)—it was not seemingly thought relevant to refer to the most "primitive" tools imaginable. Whether the concept of primitiveness, or, if you prefer, "minimalist," in this context can be said to apply to equipment and objects, or to technology more broadly understood, has serious implications for how we conceptualize increasing complexity over time—in other words, the reconstruction of evolutionary and adaptive processes.

Museums too have tended to avoid such objects, which consequently get forgotten about and peripheralized. Historically, ethnographic collections have been biased in favor of certain kinds of objects, very often those claimed to be of greatest aesthetic value. Where nineteenth-century ethnographic collecting had been influenced by a natural history approach (e.g., Browman 1989:85), and where notions of documenting evolutionary sequences of complexity came into play, methodologies were sometimes more open and decisions concerning the accession of material were made on the basis of "scientific worth." Since the 1960s there have been attempts to control for this bias and rectify the situation. Some museum-based anthropologists have sought to adopt an approach in which the entire range of tool types in the material culture of a particular population was represented and documented, resulting in more rounded and comprehensive collections, including reflecting the widespread use of minimal tools in all cultures, past and present (Sturtevant 1969), and sponsoring collecting trips to acquire holistic collections often justified by appeals to salvage ethnology (Gruber 1970). Some classic ethnographies of material culture have deliberately sought to be comprehensive

and have attempted to exhaustively document and enumerate tool types (Buck 1930; Conklin 1954; LeBar 1964; Osgood 1940). Buck and LeBar, in particular, mention various found objects and minimal tools of the kinds reported here for Nuaulu, such as cobweb fishing lures, coconut husk brushes, unworked stone used for graters, and shell bailers. But such attempts are limited, rarely systematic, and sometimes fall short of the mark. Woodburn (1970:12) claims that his catalogue is a near complete inventory of "most" Hadza equipment, and that Hadza have the least technical equipment of any existing people so far described. Although we might expect the nomadic hunter-gatherer equipment inventory to include a higher proportion of found and minimal tools than populations with other modes of subsistence, Woodburn has nothing to say about these. Even in Sillitoe's (1988, 2017) masterful attempt to comprehensively and meticulously document the material culture of the Wola of the New Guinea highlands, there is little reference to many kinds of tools discussed in this paper. Although counting numbers of tool "types" in ethnographic studies might not seem a useful objective in itself, and although found and minimal tools by definition are not easily classified by modern notions of form and function, both have been clearly underestimated, and enumeration is one measure of establishing its extent. Toolkits especially include a much greater variety of minimal perishable wooden and fiber tools than the limited number of similar stone tools that are more easily recognized.

Part of the problem is simply *practical*: out of context, how do you identify a found object or minimal tool used as a tool? Sturtevant (1969:38) inadvertently signals the marginality of minimal tools when he reminds collectors that they should not confuse the specimen itself with the material it is wrapped in. Elsewhere he is explicit in advocating not only the inclusion of unmodified objects (1969:25–26), but worn items, items at different stages of production, waste, discards, debitage, and refurbished tools made of trash, including industrial waste and impermanent artifacts. But the problem is also *methodological*, in that in order to ascertain the function of found and minimal tools there need to be field methods to document the various and often complex technological circumstances in which even rudimentary, unfashioned objects are utilized. It is also, no doubt, *conceptual*, in that many ethnographers do not regard such objects as "tools," or if they do, then consider them unworthy of documentation.

Recognition of the importance accorded to the use of "natural objects" as tools has been evident in texts of guidance for the conduct of ethnographic work for a long time (British Association for the Advancement of Science 1874; Royal Anthropological Institute 1951), in which a professional need to improve the quality of data collected in the field by other anthropologists encouraged a "tedious minuteness" (Urry 1972:47) and (under the influence of Edward Tylor and later James Frazer) demonstrated a bias toward data particularly relevant to understanding "the simplest societies." The role of natural and minimally modified objects as tools was also clear from the earliest moments of scrutiny associated with the search for the first human tools, and it was for these reasons that Tasmanian "eoliths" were thought to be so significant by Tylor (e.g., 1893) and others in the recognition of plausibly human artifacts from prehistory.

There is a strong association between how we assign an object to one or another of the categories defined here and the time taken to make it. It had been recognized early in the study of technology and material culture that time-and-motion studies, including the time taken to manufacture an item, might provide a convenient index of its complexity, its biological and sociocultural salience (Royal Anthropological Institute 1951), and its comparative significance. This approach has been adopted most assiduously in experimental archaeology (e.g., Coles 1979), and especially in lithic analysis (e.g., Andrefsky 2005:30, Boydston 1989:72; Torrence 1983). A major example of careful reporting of the time taken to manufacture objects in an ethnographic study of material culture is Sillitoe's (1988, 2017) work on the Wola. Of the few found or minimal tools mentioned we find *naenk*, a piece of sandstone used to grind axe heads, and *huwbiyp*, a volcanic rock hammer (Sillitoe 1988:50), as well as rounded rocks picked up to use as hammerstones (Sillitoe 1988:50, 58). Some of the tools inventoried are arguably "minimal" in the sense I employ here, such as *aeray*, an irregular blade knife of chert (1988:55), and animal mandible borers (1988:64) and palm leaf brushes (1988:86–87). Maybe tool minimalism is not explored because found objects used as tools involve zero manufacturing time, while minimally modified tools may take no more than a few seconds to prepare. For example, finding a suitable chert nodule to use as a hammer is indicated as taking 5 minutes, compared with the actual manufacture by flaking, which takes 10 seconds (1988:56). For Sillitoe, bamboo knives and scrapers might be excluded as minimal tools since "three stages" are identified in their manufacture, even though the overall time is short, and perhaps because they involve quite a bit of selection time: in other works, looking for an object that is suitable and selecting the right piece.

Indeed, in terms of time investment in tool-making, selection time may be the greater part, and identifying the right characteristics, which might include size, weight, shape, and strength of material. Shape may certainly involve factors such as how the working part will operate, but also whether or not the object can be easily manipulated. Thus, even preferences for right-handedness and lateralization may be reflected in tool selection (Gibson 1991:261), as we find in Oldowan tools, and as discovered in some primate studies. Despite such constraints, the requirements for a found object to be effective as a tool may be quite straightforward and may admit to a great deal of variation of form and substance. In this respect, minimal tools, perhaps even more than tools in general, permit considerable arbitrariness in selection and appearance (Lemonnier 1992). Thus, planning for purpose is encoded in selection time, influenced by available bodily processes as well as cognitive activity.

One of the reasons for inattention to found and minimal tools may be the difficulty of defining boundaries between found objects used as tools, minimally modified tools, and fully fabricated tools, and knowing where to place an object which as a functional type might be placed in all three categories, and where just one modifying action may make the difference between placing it in one category rather than another. For example, a suitably shaped oblong piece of schist that can be held in the hand might be

selected by Nuaulu as a barkcloth beater. If it has a few incisions across it (to ensure a patterned impression on the piece of inner bark being worked), it is no longer just a found object but has become a minimal tool. However, if an entire series of incisions are made (28 on one specimen), the time taken to produce the incisions will be much longer, and the tool might be considered fully fabricated. Similarly, the life of a tool may have a bearing on how it is defined by the analyst. Some found objects used as tools are immediately disposed of or have a short life, either being deliberately discarded or discarding themselves (leaf spouts in a water conduit). Other tools, found or minimal, are stored and cherished, such as a good whetstone or strike-a-light. Similarly, found and minimal tools can be classified differently depending on how they are repurposed, even if they do not change form. They do not require modification to change function; hence the difficulty of using technical Western classification schemes to make sense of them. Such flexible functionality makes them difficult to place within an inventory.

Whether we accept something as a tool and where we place it in the categories discussed here may depend on whether it is named as a tool by its users. Many found objects and most minimal tools used by Nuaulu conformed to named tool types, and this conformity indicates cultural recognition as part of a recognized toolkit. Other found objects remained unnamed. Sillitoe (1988:14, but see also 2017:ix) provides a comprehensive checklist of Wola tool types, all of which are provided with Wola names, but as we have seen, few of them might be described as found or minimal.

MINIMAL TOOLS AND THE THEORY OF TOOL USE

Finally, we must consider how the data presented here relate to the theory of tool use. Tools are defined as such by the fact that they are used rather than by their being modified. Tool use has been defined in several ways: as a technique for extending, modifying, and protecting the hand, increasing its force, hardness, precision, and reach (Spier 1968:134), as well as generally increasing the strength and enriching the skills of an organism. It is sometimes suggested that parts of the body are "used as tools"—for example, holding or cutting something using the teeth (e.g., Ingold 1986:48), but this is perfectly understood as an anatomical motor function and does not need to be described as a tool. For Beck (1980:10), tool use is "the external deployment of an unattached environmental object to alter more efficiently the form, position, or condition of another object," and tool-making is "any modification of an object by the user or conspecifics so that the object serves more effectively as a tool" (1980:11). A tool is, therefore, an exosomatic object both anatomically and conceptually. In physical energetic terms, all tools are the exosomatic mechanical means by which energy is harnessed and expended (White 1959:53–57), and on this basis we can distinguish between, on the one hand, the simple transformation of energy and, on the other, the concentration of energy, as in levers, cutting implements, and the like. None of these definitions require that the objects used as tools be physically modified in any way. Moreover, although reductionist definitions capture the most general features

of tool use we might envisage when making cross-species comparisons, they are silent on cognitive and other features of tool use that are critical when humans alone are considered.

It has long been appreciated that describing and understanding tool use cannot be reduced to the physical objects we call tools. Tools only make sense in relation to their purpose, and when seen as part of a perceptual-cognitive-motor system of which the physical objects are only one part. Tool use is, therefore, a way of perceiving the environment as well as shaping it—perception inhering in action. In order for the physical objects to be used, an individual or group requires knowledge of both the hardware (the physical objects involved) and the software—knowledge concerning the making and operating of a particular tool, and knowledge about the location of resources. Tool objects are therefore only one (often a very small) part of wider and more complex systems of exosomatic technology linking anatomy, mind, and physical context through ergonomics. Part of this connection is between the visual-gestural and vocal-auditory modalities of communication, with the neural control of language, tool use, and gesture all overlapping to closely link object manipulation and language through complex chains of reciprocal causation. No wonder that tool use and tool-making are inseparable from social behaviors such as sharing, cooperation, teaching and imitation, with which they have coevolved and which they facilitate (e.g., Gibson 1991:255–58, 1993:13; Ingold 1993a).

Pfaffenberger (1992:497, 507) and others have stressed the necessity of understanding tools in the context of an overall sociotechnical system, critiquing the "standard view" of technology as being separate from, logically prior and determinant, and necessarily always evolving from simple to complex. With Ingold (1993c:429), he notes that it is difficult to read level of skill from artifacts alone, and with Lemonnier (1992), that there is a poor correspondence between technological level and overall economic organization. Reynolds (1993:408) too urges us to distinguish behaviors involving tools from emphasis on the material complexity of artifacts, arguing (1993:422) that tool use in humans is always firmly embedded in the social structure of subassemblies and shared knowledge.

By default, we tend to generalize and theorize these linkages in relation to fully fabricated tools since these are the objects that most readily come to mind. If tools are not "made," this certainly has implications for understanding the relationship.

Ingold (1986:40) emphasizes constructive performance, self-conscious design, and the importance of planning, whereas for Reynolds (1993:407), human artifacts are typically of distinct parts that fit together to make a functional whole. However, to ignore found objects and minimal noncomposite tools in these systems and their theorization is to restrict and diminish our understanding of how technological systems operate and evolve. At the same time, in a human context both found and minimal tools must be seen in relation to the wider use of fabricated tools. In other words, once tools had begun to be made, the possibility of "making" became part of the context for the use of any object appropriated as a tool.

Unmodified tools no less than those fabricated are the result of a selection process, by turns intentional and unintentional. This is as important as, if not more so than, the process of fabrication: one object has to be selected for the job rather than another, and this will generally involve reliance on a cultural template derived from experience of what kinds of object have previously been suitable for that purpose. Both hardware and software are associated in different ways at different stages, though not uniformly with every stage. Material equipment is therefore in a dynamic relationship with knowledge. Even a found object used as a tool is accompanied by a lot of software on how to use it and for what purposes. Because there is relatively little evidence from the physical object itself, we might even say that found objects or minimally modified objects when used as tools must especially be understood as parts of complex technological systems, otherwise we risk missing their significance.

A final issue raised by this debate is whether found or minimal tools are cultural objects in the sense of depending on or embodying socially transmitted knowledge. Repurposed tools are clearly wholly cultural in this sense. The appearance of a found object used as a tool does not owe its form to any design principles and rules or skilled practice of manufacture, but it has been selected in terms of a personal and culturally transmitted prototype, following rules or perception and habits of practice. In some cases, a minimal tool will be selected and used only by a single individual, not based on precedent set by other individuals, and the lessons learned may not be passed on or acquired by some other individual. However, in this case both selection and use will be determined by generic possibilities encoded in memory and determined by physical (including anatomical) capability. In such cases, use of found or minimal tools might best be modeled as serial innovations by a single person, the tool and function being rediscovered on each occasion of use.

CONCLUSION

While making and using fabricated tools has been described and analyzed empirically and in detail in both ethnographic and archaeological contexts, close examination of particular cases of found, minimally modified, and repurposed tools are less often discussed, especially in directly observable contemporary contexts. Found and minimal tools appear in the existing literature more as hypothetical examples in discussions about the concept of "tool" and how these figure in the schemes of prominent social theorists and philosophers (e.g., Gibson and Ingold 1993; Ingold 1986, 2000), but there has been less systematic documentation of concrete examples and of particular inventories observed ethnographically.

I have argued here that the overall importance of found, minimally modified, and repurposed tools has been underestimated both for modern, nonindustrial peoples and for ordinary people living and working in industrial societies. In all directly observable work activities, as well as in many of the indirect support activities, found and minimal tools are routinely important. While we tend to associate found and minimally modified tools with the earliest periods of human technological development, we also find

such objects in the technical repertoires and material cultures of all peoples of all ages, in profusion.

NOTES

Fieldwork supporting the data referred to here was conducted mainly in 1969 through to 1971, again in 1973 and 1975 under the auspices of LIPI (the Indonesian Academy of Sciences), and funded mainly through an SSRC (Social Science Research Council) studentship and an SSRC grant. For a summary of the Nuaulu research program, see Ellen 2020:xi–xii, which also contains background data (pp. 2–10) and full acknowledgments of funding since 1975. This paper was completed during tenure of a Leverhulme Trust Emeritus Fellowship, EM-2018-057. I am grateful to Angela Muthana for comments and advice, and to Paradorn Threemake for artwork. The editor and anonymous reviewers of the *Journal of Anthropological Research* have between them helped to clarify and reshape my argument it in way which I hope makes it more useful.

1. Although not all artifacts are tools, as Sperber (2007:125) notes, standard definitions of "artifact" leave us with various problems, especially where it is not clear whether artifacts are intentionally made, where artifacts involve no workmanship or modification, and with respect to nonstandard, nonprototypical tools or objects.

2. The material culture collection was subsequently split between the British Museum (BM As. 1), the Rijksmuseum voor Volkenkunde in Leiden (RV, now the Museum of World Cultures), and the Ethnobiology Laboratory of the University of Kent (UKC). Most of the UKC strike-a-lights derived from ancient tools were transferred in 1975 to the Pusat Penelitian Purbukala dan Peninggalan Nasional in Jakarta and the Museum Siwalima in Ambon. The latter appear to have been lost following a fire during the period of community conflict, 1999–2002.

3. Layton (1986:29, and personal communication) reports that, in the Western Desert of Australia, grindstones would be left in campsites on the family's usual foraging round, and that natural rock surfaces were also used, identified by the polish created by the silica in grass seeds.

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