CHAPTER 29

THE ARCHAEOLOGY OF SPACE EXPLORATION

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29.1 Introduction

Space archaeology is the study of ‘the material culture relevant to space exploration that is found on earth and in outer space (i.e. exoatmospheric material) and that is clearly the result of human behaviour’ (Darrin and O’Leary 2009: 5; O’Leary 2009c; see also Staski 2009: 19). The aims of space archaeology are to illuminate the interaction of technology and human behaviour with a view to understanding a particular technical assemblage on and off Earth, and to promote the inclusion of heritage planning in future space missions such as orbital debris removal and planetary exploration, both of which may cause damage to culturally significant sites and spacecraft.

The methods and theories of space archaeology are shaped by the unique locations and relationships between places in space and on Earth. In this chapter, we begin by mapping the cultural landscape of space, describing material remains from the Earth's surface to the far reaches of the solar system. The methods used to study the archaeological traces of space exploration draw on those of historical archaeology and include the application of remote sensing to observe orbital and planetary features (Figures 29.2 and 29.3). From its origins in the work of Rathje, who coined the term exoarchaeology as ‘the study of artefacts in outer space’ (1999: 108), space archaeology has developed from a marginal field to one demanding attention in a world increasingly reliant on space-based services. The predominant underlying framework is behavioural archaeology, focusing on multi-scalar interactions between people and artefacts in all times and places. The main narrative of space exploration is the tangible technology of things, or a story of how objects construct the subject in the contemporary world (Olsen 2003: 100). Lastly, we include a discussion of the complexities, legal, political, and economic, of preserving this recent important heritage for future generations.

The exploration of outer space relied on the descendants of the V2 rocket developed from the 1930s in Germany, and the growth of associated technologies such as electronics and computing. The historic context of space archaeology is most strongly linked to the Cold War period (1946–89), when the political and social manoeuvres of the western and eastern
blocks were played out in space as well as on the Earth's surface (Gorman and O'Leary 2007: 73). However, while missile and rocket technology were developed in tandem, space archaeology in general does not encompass the military applications of missiles in terrestrial arenas, focusing instead on the geopolitical role of space in structuring the nature of these hot and cold conflicts.

Space archaeology can be regarded as a distinct field because it deals with the recent (i.e. last 50 years) exploitation of a previously remote region, taking place in a period of extremely rapid and accelerating technological change facilitated by social and political structures that did not exist before the Second World War. In particular, military and civil development of space technologies required massive state-sponsored complexes for research and development. Numerous scholars have argued that the Space Age is qualitatively different from preceding periods, and that the launch of the first Earth satellite, Sputnik 1, in 1957, was an historical catalyst which altered the 'very proportions of human power in relation to the natural world' (McDougall 1982: 1010; see also Fewer 2009).

### 29.2 Cultural Landscape: the Distribution and Nature of Space Material Culture

The material culture relating to human engagement with space is distributed across the land surface of the Earth (and, in the case of some re-entered spacecraft, in submarine locations), in orbit around the Earth, and in and around numerous other celestial bodies in the solar system. The most distant extent of material evidence is represented by four spacecraft (Pioneer 9, Pioneer 10, Voyager 1, and Voyager 2) which are currently venturing into the interstellar medium.

Facilities on Earth are inexorably linked to those that exist in space or on the surface of other celestial bodies. The concept of a cultural landscape has been extended by Gorman (2005a) to include the Earth and outer space. Objects and sites in space can be viewed as a much larger assemblage that, until the Space Age—a particular time and level of technological development—were confined to Earth but then entered the archaeological record somewhere else (Staski 2009: 23).

On Earth, there are places related to the development, manufacture, launch, tracking, and administration of spacecraft. Launch sites tend to be confined to former Cold War 'superpowers' and populous nations such as India, China, and Brazil. Tracking, surveillance, and downlink facilities, with antennas of varying kinds, have a far wider distribution. Every space mission has an associated ground segment that supports its function. Launch sites and ground stations are frequently associated with residential compounds and towns, and with support industries. Where they are built in remote locations, launch sites can have long-lasting impacts on the landscape and nature of human occupation as they may involve the construction of roads and other infrastructure that enables settlement.

Space material culture can be divided into (usually) stationary ground facilities and mobile spacecraft and artefacts. Spacecraft include rockets, buses, satellites, probes, landing
modules, and return vehicles. Some rockets, such as sounding rockets or missiles developed for warhead delivery, are not intended to enter orbit although they may pass through regions of the atmosphere technically defined as space. Rockets intended to deliver spacecraft or crews to orbit are frequently constructed in stages. Generally the early stages fall back to Earth before orbit is attained, while the final stage ascends to orbit and remains there after releasing its payload; thus there may be components spanning both Earth and space.

In Earth Orbit, satellites generally occupy one of three regions defined by altitude and inclination. Low Earth Orbit, from about 200–1200 km, is where most Earth observation takes place. Space stations, such as the International Space Station and the now-lost Mir, also use this orbit. Above 700 km, spacecraft must contend with the dangerous radiation field of the Van Allen belts. The Medium Earth Orbit area is, nevertheless, where the constellations of global navigation satellite systems (GNSS), such as GPS, Galileo, and GLONASS, orbit. Between 350,000 km and 37,000 km are the geosynchronous and geostationary (GEO) orbits, used by telecommunications satellites. The so-called 'graveyard orbit', a few hundred kilometres above GEO, is where satellites in that orbit may be boosted at the end of their operational life. In Low Earth Orbit, most objects will eventually be dragged back into the Earth’s atmosphere; however, depending on altitude, orbital configuration, and solar weather, this may take hundreds of years to occur. In higher orbits such as GEO, re-entry will never occur.

A critical problem is the proliferation of orbital debris or space junk, caused by accumulation of non-functioning spacecraft such as satellites and rocket bodies, and their degradation and break-up through exposure to the space environment and collisions with other debris. Over 19,000 pieces > 10 cm are tracked in Earth Orbit, and many millions of smaller fragments, travelling at velocities in excess of 27,000 km/hr (Emhoff 2009: 78). Damage caused by collision with space junk can result in the loss of the satellite services on which the contemporary world depends, and create risk for human space missions. Proposals to use lasers and other methods to 'clean up' the junk in Low Earth Orbit depend on the international community reaching agreement, a fraught area as the same methods may be used to deliberately destroy the space assets of rival nations.

Currently Vanguard 1, launched in 1958 by the USA and the oldest human object in orbit, is circling the Earth every two hours and is predicted by NASA to remain in orbit for the next 600 years (Figure 29.1). In orbit it essentially remains preserved and accessible to future generations of space tourists (Gorman 2005b).

Spacecraft, probes, and delivery vehicles are in orbit around the Moon, Mars, Venus, the Sun, and others. Several celestial bodies also have landing sites of robotic or uncrewed missions: these include the Moon, Mars, Venus, Titan (a moon of Saturn), the asteroids Eros and Itokawa, and the comet Tempel 1 (Gold 2009). These missions, particularly in the case of Mars rovers, often include robotic (i.e. the materials and traces created by robots in the exercise of their artificial intelligence) as well as mechanical components. With the retreat from a human physically present in space, the increasing sophistication of robots with decision-making capacities is likely to add another unique strand of evidence to the archaeological record (see Spennemann 2007).

The Moon currently has over 100 metric tons of material culture on its surface from the Apollo missions and other robotic missions (USSR, USA, and various nations), concentrated mostly around its equator, with some exceptions like the recent Lunar Crater Observation Sensing Satellite (LCROSS) mission which crash-landed on the South Pole on 9 October 2009. The Moon is also the only place where humans have landed.
Tranquility Base, the first lunar archaeological site with human activity, is unique in many ways, besides its location (O’Leary 2006). It was created by two humans landing and working at the site in a highly scripted way for approximately 21 hours. As such it is the ultimate single component site, where much of the behaviour of the site’s participants was documented in print and can be watched on film. The archaeological study of these hours is worthy of pursuit for its own sake. Applying methods used to study more distant periods calls for more conscious analysis which reflects what Fairclough refers to as the ‘apparent obviousness of the material remains that seem to need no interpretation’ (2007: 20). For example, how do these human bodies encased in suits and constantly monitored, dependent on machines for their survival, move around in and negotiate an alien landscape? Their tracks are as evocative as the line of ancient footprints created by ancestral hominids in the volcanic ash of Laetoli 3.6 million years ago. Archaeological study has the ability to focus on the relationships between material culture, documents, and living memory and to accommodate complexities and conflicting perspectives instead of a single knowable past (Fairclough 2007: 21).

29.3 Methods

Methodologically, space archaeology uses historical archaeological techniques in combining the study of the documentary record and oral histories with survey, excavation, and artefact analysis. Some space sites and objects are among the most thoroughly documented of the contemporary era. Nevertheless, secrecy is prevalent and rapidly changing technologies mean document attrition with each new plan so there are substantial lacunae. At present only the terrestrial components can be examined directly; sites on other celestial bodies must be studied from records, satellite imagery, and telemetry, while orbital objects
frequently have prototypes and occasional re-entered fragments which can be directly examined (see Szczepanowska 2009).

Reliance on remote sensing technology, such as aerial and satellite imagery, has increased in all fields of archaeology as the data have become more refined, and this is the case for space as well. The images generated by the Lunar Reconnaissance Orbiter (LRO) of the archaeological sites on the Moon in 2009 and 2011 allowed a remote re-visit to many of the Apollo sites. This mission provided data to help locate sites like the Lunakhod 2 and through digital imaging revisited the Apollo 12 site (Figure 29.2).

This remote sensing technique provides a data-gathering strategy that can be used to understand the nature and extent of use on the lunar surface and the archaeological record, without affecting its physical integrity. Although its original intent was not archaeological, the current scale and resolution of the LRO provides a tool for archaeologists to remotely examine significant sites on the Moon and promises to be even more refined. Patterns of use of the Moon can be seen on a larger scale as current maps can be viewed to see where and when sites and artefacts are located. This kind of remote sensing data is critical to any preservation strategy for significant artefacts which will be revisited by future missions.

For the study of Earth Orbit, optical images taken by surveillance networks provide evidence of the materials present. Orbital configuration and tracking data can be studied in conjunction with technical manuals, engineering prototypes and back-up spacecraft, blueprints and photographs, to interrogate the space object as an artefact. NASA tracks orbital debris greater than 10 cm and archaeologists can look at discard patterns in the trails that they leave while in space, much as archaeologists can investigate historic trails on Earth (O’Leary 2009a: 33).

FIGURE 29.2 Apollo 12 taken from the LRO 2011 (reproduced with permission from NASA)
At the core of space archaeology methodology is the contention that the material culture can tell stories inaccessible from the documentary records, reflecting their function and role within the ideology of the era. It is in the difference between what something is and what it was supposed to be that we can find new perspectives on ‘the archaeology of us’ (Harrison and Schofield 2010).

29.4 THE DEVELOPMENT OF SPACE ARCHAEOLOGY

The antecedents of space archaeology are almost as old as space exploration itself. A kind of space ‘archaeological’ investigation may actually have been done on the Moon in 1969. As part of the Apollo 12 mission, the two astronauts Conrad and Bean landed on the lunar surface on 19 November and observed and recorded information about Surveyor 3, an unmanned probe that had soft landed on the Moon’s surface almost three years earlier (Figure 29.3).

As their NASA mandate was to look at the general effects of the space and lunar environment on the robotic spacecraft, they documented the site by photographs, noted the condition of the vehicle, and collected several artefacts from the previous spacecraft for later analyses on Earth, much as a terrestrial archaeologist would do (O’Leary 2009a: 30). Capelotti (2004: 49) writes that this was the first example of extraterrestrial archaeology and—perhaps more significant for the history of the discipline—formational archaeology, the study of environmental and cultural forces upon the life history of human artefacts in space.

**FIGURE 29.3** Apollo 12 astronaut Alan Bean with Surveyor 3 on the lunar surface (reproduced with permission from NASA)
Archaeologist Ben Finney (1992) first suggested that it might be worthwhile to look at space sites created by both the USA and USSR. Rathje (1999: 108), who pioneered the study of contemporary garbage from an archaeological perspective in his famous ‘garbology’ project (see also Reno, this volume), also identified orbital debris as an appropriate area of investigation for archaeologists.

In what is the earliest instance of funded space archaeological research, in 1999, through the New Mexico Space Grant Consortium, NASA funded the Lunar Legacy Project to document the artefacts on the lunar surface left at Tranquility Base by the Apollo 11 crew and to investigate the relevant US federal preservation laws and regulations (New Mexico Space Grant Consortium/Lunar Legacy Website 2000). Tranquility Base was selected as the lunar site most iconic and worthy of preservation. The project looked at the site solely as an historical archaeological site. The investigation necessitated retrieving all records, photographs, films, and maps of the location. That inventory of the entire lunar assemblage at Tranquility Base is probably not yet complete, because the actual site has never been visited by archaeologists since it was created (O’Leary 2009b: 763).

Gorman (2005b, 2007a, 2009a) focused on orbital debris. Orbital debris has been defined as ‘any human manufactured object in orbit that does not currently serve a useful purpose and is not anticipated to in the foreseeable future’ (Gorman 2009a: 382). Gorman (2005a) perceives orbital space as an organically evolved landscape, as defined by the World Heritage Convention. She argues for a significance assessment framework derived from the Burra Charter (1999), including ‘social, historical, aesthetic, and scientific significance’ for various nations, people, and organizations that have an interest in orbital materials (Gorman 2009a: 382). It is not just the threat of collision and destruction that needs to be managed but the cultural values of this landscape of space.

From the study of iconic sites like Tranquility Base and Vanguard 1, which could be considered to have outstanding universal value in the terms of the World Heritage Convention, space archaeology has moved to consider the impacts of space on everyday life and towards becoming more integrated into mainstream archaeology as well as science and technology studies.

29.5 THEORETICAL APPROACHES

By its nature, space archaeology crosses a number of fields such as historical, industrial, and contemporary archaeology, and science and technology studies (STS). Historical archaeology is a diverse field linked to available written, photographic, and oral documentation of the period. Modern historical archaeology defines itself as the study of the post-medieval colonial world, the growth of industrial, capitalist societies, and social inequality (e.g. Hall and Silliman 2006; Lightfoot and Martinez 1995; Orser 1996). Its strength lies in the ability, through archaeological as opposed to historical techniques, to investigate groups or sectors of society frequently absent or poorly represented in the documentary record, such as Indigenous people, women, children, working classes, prisoners, etc. As these groups are also frequently marginalized in the space industry, this kind of research can open windows into material behaviour that is rarely mentioned in space histories. The impacts of space technology on Indigenous people have been explored by Gorman (2005a, 2007b, 2009b, 2009c) at the launch sites of Woomera (Australia), Kourou (French Guiana), and Colomb-Béchar (Algeria).
If historical archaeology deals with the development of global capitalism within the framework of colonialism, then space exploration and industry represent the next phase of inquiry, as capitalist enterprise and colonization extend into a new ‘frontier’. The ideological construction and material negotiation of this high frontier can also be approached from a postcolonial perspective. Redfield (2002: 791), for example, has argued that space lies at the intersection of postcolonial and science studies, being the last bastion of unapologetic colonialism.

The predominant framework underlying space archaeology is behavioural archaeology, which focuses on the interactions between artefacts and people irrespective of time frame or location (e.g. Binford 1978; Rathje and Schiffer 1982; Schiffer 1976; see also Fewster, this volume). Behavioural archaeological theory links systems of meaning in relationship to material culture. In this framework technology is seen as socially constructed and material culture as evidence of how humans interact with and understand their world. Humans create artefacts, use them, and, in turn, are influenced by that interaction. Schiffer has opined that most social scientists have ‘ignored what might be the most distinctive and significant about our species: human life consists of ceaseless and varied interaction among people and myriad kinds of things’ (1999: 2). One approach is through the framework of life history (Schiffer 1976), which follows the artefact from its procurement to its discard, and beyond to post-deposition processes. A life history approach to space artefacts and materials can be used to look at the evolution of technology over time, and frame questions about technological and socio-cultural change.

Behavioural archaeology therefore has much in common with science and technology studies. Major research questions in STS include the social construction of technology, and the nature and pace of technological change. Debates include the degree to which technology can have a determining or autonomous impact on human behaviour, irrespective of the motivations or desires of those who create and use it, as opposed to technology being solely the embodiment of specific social groups and aspirations (Ferguson 1974; Schiffer 2001; Winner 1977). However, while STS considers ‘things’ to be an essential category of inquiry, the field has rarely engaged with archaeological theories, and has used archaeological data in only a limited way (Gerselewitz 1993; see also Webmoor, this volume). Space archaeology’s emphasis on material culture, combined with deep time perspectives on innovation and technology transfer, can contribute to understanding how the space industry has influenced late modern human behaviour.

### 29.6 Research Directions

Here we highlight some of the research possibilities of space archaeology.

#### 29.6.1 Inventories and Recording

Some have argued (e.g. Rausenbach and Sokolsky 1998) that the history of astronautics and rocketry has barely progressed beyond the stage of collating information, with little critical analysis. Much space archaeology to date has focused on the documentary record and describing the material culture while stressing its technological, physical and locational complexity within a cultural landscape. However, as O’Leary’s Lunar Legacy Project
demonstrates, there is a role for understanding what it is that constitutes space material culture (O’Leary 2009b). O’Leary (2009b: 764–5) has inventoried over 106 artefacts, structures, and features remaining at the Apollo 11 Tranquility Base. Capelotti (2009, 2010) provides descriptions of material remains at other Apollo and other planetary landing sites. There has, as yet, been no comprehensive characterization of the archaeological record in orbit. Clemens (2009) provides an overview of objects in Earth Orbit, and Gorman (2007a) has evaluated extant satellites in Earth Orbit in the period between the launch of Sputnik 1 in 1957 and the launch of the first geostationary satellite in 1963.

Terrestrial space sites may appear sporadically on national, regional, or state heritage registers, but few heritage organizations have undertaken systematic documentation of space sites. In historical research, Rausenbach and Sokolsky identify a bias towards spacecraft and engines, to the detriment of areas such as control systems, instruments, and ground support equipment (1998: 38). Useful research can be undertaken in identifying what survives in different spatial regimes, for example, Earth, Low Earth Orbit, cis-lunar space, and Mars, along thematic lines which may include nationality, mission type, power source, design influences, and technological lineages. Drawing conclusions about what it means must rest on the foundation of understanding what and where it is.

29.6.2 National and Global Technologies

The human exploration of space is deeply entangled with the maintenance of the late industrial nation state. The Space Age takes place at the same time as a decolonizing process, which saw the proliferation of new nations after the Second World War (Gorman 2009c). Because of the financial and organizational requirements of space technology, space programmes tend to be run at a national level, making nation-states the agents of technological change (McDougall 1982: 1022). Until the fall of the USSR in 1991, national prestige was the principal motivating factor in the development of civil space programmes (Hays and Lutes 2007). Particularly in the case of the USA and the former USSR, missions were designed with the explicit aim of demonstrating ideological superiority through technological achievement, and are frequently associated with the use of nationalist emblems such as flags, medallions, etc.

Within the technical requirements of launch, tracking, and data transmission, the construction and operation of space installations of all kinds is stamped with cultural differences and threads of continuity. The space programmes of the USA, USSR, France, and Britain were all seeded by the forced post-war diaspora of German rockets and rocket scientists; from this common origin, each location co-opted local science, landscapes, and visions of the spatial and organizational role of people within industrial complexes to produce distinct traditions of space design. The study of local expressions of this global technology can illuminate the technological and social choices made during and after the Cold War in participating in the appropriation of space.

29.6.3 Embodied Interactions with Space Technology

Human–machine interfaces are common in space technology: the space suit, the spacecraft, the control room, the interpretation and dissemination of signals transmitted to and from
space. The way we perceive the world is moving away from direct experience towards a reliance on ‘physical worlds available to human consciousness only through technological prostheses’ (Fischer 1999: 468) including Google Earth, navigation devices, and television. Many of these inventions begin in the Space Age and are its direct and indirect descendants. Space archaeology can investigate how the existence of space above our heads, and technologies that interface between humans and space, structure human actions and human embodiment on Earth. Mindell has argued that the Apollo programmes ‘exemplified broad changes in human–machine relationships’ (2008: 15), perhaps most specifically seen in the boundary lines drawn between what was seen as appropriate for computers and software to do, and what was appropriate for direct human action: boundaries that were negotiated continually between gender and nationality in the US and USSR space programmes.

29.6.4 Impacts of Space on the Material Culture of Everyday Life and Popular Culture

Globalization is the social and economic correlate of the space technologies enabling telecommunications and navigation. Studies of globalization often overlook the technologies on which it increasingly depends in the late modern world (Hays and Lutes 2007: 208). Access to space-based Earth observation data and telecommunications has changed patterns of resource extraction, production, trade and consumption, which can be studied archaeologically. We can also consider objects and technologies such as televisions, telephones, satellite dishes, navigation devices (such as handheld GNSS receivers), and automatic teller machines as related material culture that depend upon satellite data to function. Hence there are wide-reaching cultural impacts of access to satellite data that can also be considered within the purview of space archaeology.

The Space Age has been translated by commercial entities from the inaccessibility of high technology into vernacular and popular design, manifesting in architecture, furniture, souvenirs, toys, clothes, utensils, food, and even music. The human desire to explore was exploited by vendors to consumers as a vicarious way of being in space themselves. If I eat ‘astronaut ice cream’ it is as if I am an astronaut. The powdered drink product ‘Tang’ was advertised to consumers on Earth as being what the astronauts took to space. As with the grand nationalist enterprises, the ideologies of space were consumed and created at a popular level which reflected everyday aspirations of space and expectations of the future. The ‘type fossils’ of this process might well be astronaut ice cream, or space food sticks (Figure 29.4). The astronaut became the iconic hero of the Space Age in the same tradition as the cowboy on the US western frontier.

Popular cultural expressions of space technology could be argued to demonstrate processes of acculturation and accommodation between state-sponsored technological complexes and the everyday world, outside scientific elites (e.g. Gorman 2010). Public support for monumentally expensive human spaceflight programmes was purchased by the domestication of outer space—creating products that promised participation through their consumption. The echoes of space design in fabrics, foods, shapes, and replicas in the height of the Space Age were explicit; more contemporary manifestations are domestic satellite dishes and GPS units, demonstrating a different kind of consumption.
The directions of space archaeology are multiple. The first is the acceptance of the sub-discipline into mainstream archaeology, to move forward into a new period of industrial archaeology where analysis reflects its unique technological characteristics and to pay attention to what Olsen has called ‘the other half of the story: how objects construct the subject’ (2003: 100). The story of space exploration is visible and tangible in material remains—rocket parts, etc.—and the surprisingly incomplete bricolage of records for this human endeavour. In many ways these artefacts have missed our archaeological gaze. The transmission of knowledge and the skills necessary to get to outer space and other celestial bodies take place in a web that links place, people, and artefacts together. Not just two humans stood on the Moon at the Tranquility Base site; thousands of artefacts and other humans supported them in that endeavour. The very scale of space exploration invites an archaeology of large scale, taking the entire solar system and beyond as its landscape (see Edgeworth, this volume).

29.7 Heritage Management Issues

Threats to space heritage include neglect, deliberate destruction, salvage, or recycling, and future space missions and industries including resource extraction and space tourism. The potential adverse impacts of souveniring on human material in space have been recognized for some time (e.g. Fewer 2002:112; NASA 2011; O’Leary 2003). At present, however, the
remoteness and cost of accessing material culture in space provides some protection from human impacts.

Activity in space is governed by a system of international conventions and treaties, of which the most important is the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (UN Outer Space Treaty or OTS). The OTS specifies that space is a global commons and cannot be subject to territorial claim. It also specifies that material in space remains the property and responsibility of the launching state.

Space sites and artefacts on Earth are reliant on national, state, or regional heritage legislation for protection. Numerous nations have no heritage legislation; many more have legislation that does not cover the recent past. Even where appropriate national heritage legislation exists, it usually cannot yet be extended into space without the risk of it being interpreted as a territorial claim in contravention of the OTS. The World Heritage Convention explicitly does not cover movable objects, nor is space directly addressed. It is possible that the WHC could be extended to cover sites on other celestial bodies, but this is the subject of contention. Nevertheless, it is possible to argue that several space sites, such as Tranquility Base, meet World Heritage criteria. Fewer has proposed that a new heritage convention would be required to apply to planetary landing sites, starting with the compilation of an ‘internationally-funded and publicly-accessible’ record of all sites on the Moon and Mars (Fewer 2002: 119).

Several archaeologists have worked together to address the protection of space heritage, for example on the World Archaeological Congress’s Space Heritage Task Force (Gorman and Campbell 2003; O’Leary et al. 2001). In the case of Tranquility Base, this protection has occurred at the state level by listing the objects and structures on the California and New Mexico State Registers of Cultural Properties (O’Leary et al. 2010; Westwood et al. 2010), at the national level by proposing it as a US National Historic Landmark, and at the international level by working with ICOMOS (O’Leary 2009c). NASA (2011) itself has begun to address the problem of the protection of the historic and scientific value of US artefacts on the lunar surface (NASA 20 July 2011). NASA recognizes the increased technical abilities of spacefaring commercial groups and other nations that will go back to the Moon in the near future and now provides interim recommendations for lunar design and mission planning teams (NASA 20 July 2011).

In the absence of encompassing legal instruments or international conventions that can be used for the protection or management of the cultural values of space sites, the internationally recognized Burra Charter (Australia ICOMOS 1999) can be applicable to space. In terms of management, the principle of ‘do as much as is necessary but as little as possible’ can be used to argue against the deliberate retrieval and return to Earth of significant spacecraft or items on other celestial bodies. The Burra Charter process of significance assessment has also been successfully applied to satellites in Earth Orbit such as Vanguard 1 (Gorman 2005b).

### 29.8 Significance of the Field

Extending the archaeological gaze into space forces us to look back on the Earth from a new perspective and perceive the material culture of the late industrial age as part of a system that reaches into the solar system. We need to understand what is taking place on the surface...
of the Earth by reference to the material culture of space: the information, images, data, and communications that spacecraft disseminate with a rapidity that has changed the meanings of local and global. Increasingly, we are implicated in our own constant surveillance from space and into space, becoming accustomed to using satellites to situate and navigate ourselves on Earth. As outer space alters the nature of our subjectivity, new paradigms are needed to investigate how material culture is used in mediating human engagement with the exoatmospheric realm.

Space archaeology also has practical applications, such as providing input to mission designs to avoid damaging existing significant heritage sites (e.g. on the Moon), and ensuring that proposals for orbital debris removal take cultural significance into account. In particular, archaeological approaches to technology adoption between technologically dominant colonial groups (i.e. spacefaring nations) and hunter-gatherers, pastoralists and non-industrial groups, who are nonetheless impacted by and contribute to the space age in various ways, can promote the inclusivity that is urged by the United Nations in the use of space. At this time space heritage properties in space remain without preservation protection. But perhaps its principal significance is in the ability to tell stories about the Space Age that are beyond the capacity of purely historical approaches.

By the archaeological study of the material record of space, there is an opportunity to look at a system which falls outside the normal spatial and temporal boundaries for humanity. The trails on the Moon and in space can offer insights into how humans carry their behaviour into space (Capelotti 2010: 5). Humanity has placed its artefacts into space and into the archaeological realm. These data are relevant to the migration of human ancestors out of Africa; they are part of human evolution. By its complexity, space archaeology invites all archaeologists to consider the fallacy of a simple, single past. Artefacts in space are the product of many separate minds and large-scale international cooperation in tracking and telemetry to allow, for example, humans to stand on another celestial body for the first time in 1969. It demonstrates humanity’s technological intelligence at a particular historic era of exploration embedded in the Cold War. Some historians argue that we would never have gone into the arena of space without the political destabilization after the Second World War. Space became a military and technological frontier and the Moon a place that was won. This time and place is not well studied. Space is no longer empty as it was before the Cold War: it is now imbued with values encapsulated in memories, histories, objects, and places. As archaeologists, how can we refuse the challenge?

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