Layer 1 INTRODUCTION

1.1

Astronaut Edwin E. “Buzz” Aldrin on the surface of the moon, July 21, 1969. Aldrin is looking down at the systemized list of mission procedures sewn onto the surface of his left sleeve.

Why is this spacesuit soft?

On July 21, 1969, only 21 layers of fabric, most gossamer-thin, stood between the skin of Neil Armstrong and Buzz Aldrin and the lethal desolation of a lunar vacuum.

Most if not all of the functions of these layers could easily have been reduced to one or two hard layers of fiberglass or aluminum; indeed, many such "hard" suits were proposed and crafted during the era of Apollo. Both visually and organizationally simpler than their soft counterpart, such suits were arguably more efficient in their ease of movement, protectiveness, weight, and other measures.[1]

Yet these were not used. Why?

The story of the Apollo spacesuit is the surprising tale of an unexpected victory: that of Playtex, maker of bras and girdles, over the large military-industrial contractors better positioned to securethe spacesuit contract. This book tells the story of this victory, and analyzes both the Playtex suit—a 21-layer, complex assemblage—and its "hard" competitors. It is the clean lines of the latter whichhave traditionally captured designers' imaginations. One noted critic described the AX-3 "hard" suit as "the most beautiful designed object I have ever seen."[2]

In contrast to these "hard" suits, Playtex's A7L has traditionally been seen as a messy, almost embarrassing compromise.[3] Yet, this book argues, we are in dire need of a language to describe, and create, such elegant, adapted "softness." At a time when contemporary design discourse is turning again to a systems vernacular (albeit in a biological guise),[4] the story of the Apollo spacesuit is an essential counterexample.

Against this background, the consideration of alternatives to the A7L leads us not just to the hard, military-industrial prototypes that presented alternative strategies for spacesuit design, but to a deeper kind of system proposal, that for modifying the human body itself to allow space exploration. This earlier proposal, which coined the new word "cyborg,"[5] was rooted not in science fiction, but rather in the same language of systems and control—cybernetics—that was to characterize the space race as a whole.

The resulting systems of military-industrial control, first developed to build the complex nuclear missiles on which NASA's rockets depended, proved enormously successful throughout the space race. Coordinating 300,000 individuals, 20,000 contractors, and innumerable physical systems, the Apollo program's "space-age management"[6] allowed a logistical network of unprecedented complexity to reach the singular goal of landing Americans on the moon.

Yet, despite the optimism of the 1958 "cyborg" proposal, such techniques proved enduringly inadequate when it came to designing for the human body. Again and again, alternatives to the Playtex A7L would propose "engineering man for space," and, again and again, the human body aggressively resisted such encroachments. In the final reckoning, it was only when traditional engineering firms proved consistently incapable of integrating the human body into system requirements that Playtex's proposal, and the company's intimate expertise, was accepted by NASA.

And so, in an unexpected adaptation that recalls recent work on the dynamics of evolutionary change (see Layer 20), the spacesuit worn on the moon was not developed from military-industrial expertise, but rather adapted proficiency in underwear. And, instead of being engineered *de novo*, each Apollo suit was custom-fitted and sewn to fit its occupant alone.

1.2

The organizational and physical scale of Apollo: personnel atop the 402-foot mobile service structure look back at the Apollo 11 spacecraft as the tower is moved away during a countdown demonstration test, Kennedy Space Center, July 11, 1969.

21 LAYERS

The 21-layer A7L has a multilayered history. It was both influenced by, and influenced, fields from haute couture to medicine. To write a single, linear narrative of its creation would not only be difficult, it would deny the very quality of the object that makes it worthy of research: its open-ended complexity. The evolution of the Apollo suit provides a connective tissue to astonishingly disparate, yet individually essential strands of material and visual culture, technology, and design.

This book abandons a linear tale for a collection of 21 layered essays, each addressing a topic relevant to the history of the suit, the body, and technology in the twentieth century. Holding a mirror to the adaptive, additive history of the suit itself, these layers form a sequence of 21 cross sections, or historical samples, that correspond both literally and figuratively, to the 21 layers of the Apollo spacesuit.

Definition of Space

The first subsequent layer involves the discovery—both intellectually and physically—of "space" as an environment hostile to man. Occurring in the late eighteenth century, discoveries of mankind's limitations were tied together with an interest in man's own inner workings, projected to be as machine-like as the clockwork automata that provided a parallel fascination to early aviation.

The New Look

From this backward glance, the next layer serves as a "new look" at the postwar twentieth century. Christian Dior's fashion innovations of 1947 are used to explore a variety of themes that will be referenced throughout the book: the lessons learned by postwar business from the war effort, the focus on surface culture and the fashion cycle as engineered by a postwar consumer economy, and the onsets of new materials and techniques in the manufacture of daily life.

The New Look in Defense Planning

From the world of couture, the phrase "new look" became shorthand for a range of postwar transformations, not least the changes wrought by President Dwight Eisenhower to management of postwar defense. Abandoning the standing army, Eisenhower committed the nation to a "New Look in Defense Planning,"[7] which emphasized nuclear technology, and close collaboration between the military, industry, and academia. We are all too familiar with the legacy of this "military-industrial complex," but attention here is given to its particular institutional origins in the Atlas missile program, and the establishment therein of the standards of systems engineering and management that would serve as the institutional infrastructure of the entire Cold War space race.

Flight and Suits

From the human origins of space-age management, we turn to the humble origins of human protection against altitude, and the birth of the latex pressure suit in the barnstorming aviation culture of the interwar years. Although associated from their origin with futuristic visions, these first high-altitude “space suits” were less technocratic achievements than feats of adaptation. In 1934 such a hand-formed “tire shaped like a man” brought aviator Wiley Post to the limits of the stratosphere.

Cyborg

While primitive suits inspired by Post’s were investigated by the armed forces after World War II, more synthetic notions of man in space gained credence. Notable was the neologism “cyborg,” a man-machine hybrid proposed by Nathan Kline and Manfred Clynes. Clynes, a mathematician and analog computer expert, and Kline, a psychopharmacologist, proposed that instead of carrying an earthlike environment with him, the biochemistry and homeostatic functioning of man should itself be adapted for space travel. Grounded in the same theories of cybernetic control that shaped parallel advances in systems management, the cyborg concept was studied intensively before its eventual abandonment in 1966.

Flight Suit to Space Suit

Soon after, however, came the launch of Sputnik. With the Soviet achievement, the United States accelerated its space efforts, borrowing missiles and management systems from the armed services and hastily adapting high-altitude flight suits to serve in space. In pressure suit design, military green was (literally) sprayed silver, as the iconography of science fiction shaped space-flight’s swiftly constructed facade.

Man in Space

Yuri Gagarin’s 1961 spaceflight catalyzed that battlefield of the Cold War known as the space race, the establishing of missile superiority through the launch of man. However, the Soviet bureaucracy that had enabled the feat suppressed vital facts of the flight, including the fact that Gagarin landed only in his spacesuit, parachuting from the unstable Vostok capsule high above the earth. The particular history of spacesuits in the Soviet context is an essential and incongruous contrast to the American epic.

Bras and the Battlefield

Anticipating the space age, the International Latex Corporation (ILC), known by its consumer brand “Playtex,” conducted basic research on adapting its latex expertise to pressurized suits. Initially ignored, its research gained it center stage in Apollo suit manufacture after startling advances in mobility and comfort.

JFK

In the moment of national commitment to Apollo, the artist Richard Hamilton depicted John F. Kennedy in a spacesuit, essentializing his central role in the space race, as well as his mastery of fashion and image. The image reveals an essential truth: Kennedy’s pivotal decision to fund NASA’s lunar effort, and to give it the urgency that shaped Apollo’s realities, can be ascribed as much to the private frailties of his own body as to the oft-photographed facade it inspired.

Contractual Physiology

Instead of physiologically adapting man for space (as the cyborg model proposed), the groundbreaking research of the space age was into the real, and modest, limitations of the unaltered human body. After literally exhaustive tests, these limits were incorporated into NASA's design systems just as readily as booster thrust or orbital apogees.

Simulation

While the resulting landing on the moon shaped the visual language of our century, a greater influence arguably belongs to the virtual landscapes first crafted by NASA to allow the extensive simulation and training of lunar landings on the tight Apollo schedule. The race to the moon was a massive exercise in parallel real and simulated realities, from necessary advances in computing technology to the huge twin control rooms in Houston that alternately held real and virtual missions.

The Moon Suit Plays Football

Then, in the midst of Apollo's tense timetable, ILC was fired. In the spring of 1965, many NASA engineers, as well as top administrators, favored the military-industrial expertise of the influential Hamilton Standard/United Aircraft Conglomerate, with which ILC had initially been partnered. However, a resulting three-week competition proved the Playtex suit not only the better of its military-industrial competitors, but the only suit that could reliably preserve, and extend, human abilities on the moon.

Handmade

ILC's subsequent effort was one of adaptation, both physical and organizational. Handmade assemblages of fabric, latex, and nylon were hand-sewn to minute tolerances, and custom-fitted to each astronaut. Indeed, the production of the suits met both physical and institutional barriers within the military-industrial complex, from X-ray scans to uncover errant pins, to a spirited debate on whether and how clothing sizes, versus serial numbers, could be used to describe variations in individual suits.

Hard Suit 1

Subsequently, the most serious competitor to the ILC suit for later lunar missions was a hard, one-piece suit manufactured by the stratospherically successful (if ultimately disgraced) corporate conglomerate, Litton Industries. Even as they failed to meet the standards for lunar use, the streamlined suits were staged by NASA as the future of space travel through the 1970s.

"We've Got a Signal!"

As the lunar landing was a media event, so was it a feat of broadcast technology—particularly at the most-viewed American news source, CBS. Designed at the same time as Kubrick's *2001* (and by the same set designer, Douglas Turnbull), the CBS lunar broadcast soundstage incorporated more simulations, asynchronous sequences, and other trappings of modern broadcasts than any other television event of its time. As well as a cultural touchstone, it was the foundation for our contemporary, 24-hour news cycle.

Hard Suit 2

Sharing the sleek geometries of CBS's soundstage, the alternative suits most beloved of design historians are the AX series of experimental suits developed by NASA's Ames Research Center. The suits provide important clues to the culture, and contours, that form the most seductive face of the space age.

Control Space

The visual seduction of space systems leads to another vision of control, provided by the Mission Control Room itself. With its implications and mythologies, the multi-screened environments of Houston offer important clues into the architecture of our own mediated milieu.

Cities and Cyborgs

These lessons regarding the body in space could be extended to larger architectural contexts through a system of analogy alone. Yet important historical links exists as well. Systems engineers and policymakers of the late 1960s sought to literally apply the lessons of Apollo to the pressing problems of cities. In these efforts they followed not the soft surface of spacesuits, but rather what they understood as the hard truths of systems engineering. And so, as with the cyborg, the subsequent failure of these efforts was as systematic as it was superficial.

21 Layers

A vital part of the 21-layered story of the A7L is provided by the idea of layering itself, and the related strategies of redundancy, and interdependence. These qualities, shared by the chemical and physical reality of the A7L's 21 layers, also turn out to be essential concepts in examining the vital distinctions between natural and manmade complexity, and the qualities of robustness and fragility that define and separate them.

This final layer considers the lessons of the Playtex suit for our own age. Like the lessons of evolution that govern physical design in natural systems, they are as much in the possibilities opened up by change, as in change itself. These lessons teach us to see the future in context, as a set of possibilities and not a scripted scenario. Instead of creating spaces in our imagined, often masculine image, we may better create new looks, like Dior, out of second glances at the material we have already to hand. These adjacent possibilities offer an essential catalyst to our complex, and common, future.

1.3

Astronaut Alan Shepard shown in his B. F. Goodrich spacesuit and Mercury spacecraft "just prior to its being sealed," May 5, 1961.

ENCAPSULATED MAN

In his late-life lambasting of "technological organization," *The Pentagon of Power*, urbanist Lewis Mumford considers Alan Shepard in his Mercury spacecraft, dubbing him "Encapsulated Man." "Here," Mumford announces, "is the archetypal proto-model of Post-Historic Man, whose existence from birth to death would be conditioned by the megamachine, and made to conform, as in a space capsule, to the minimal functional requirements by an equally minimal environment—all under remote control."[8] "To survive on the moon," Mumford expands, "he must be encased in an even more heavily insulated garment."

"The astronaut's space suit," Mumford continues, "will be, figuratively speaking, the only garment that machine-processed and machine-conditioned man will wear in comfort."

As we will discover, the silvery, machine aesthetic of the Mercury spacesuit was only a surface, sprayed onto, and hiding, a much more natural interior (in the natural latex pressure bladder, literally so). With due respect to Mumford, therefore, this book makes a contrary assertion. This alternative argument can be understood through a quite different image—that of astronauts Alan Bean and Charles Conrad engaged in one of the innumerable training exercises for their Apollo 12 mission in October of 1969.

The photograph recalls the visual contrasts of *2001*'s final sequence—and, indeed, the 1968 film relied for its set designs on NASA employees recruited after post-Apollo cutbacks.[9] In a white, tightly managed interior, the two astronauts practice tracking and recording lunar samples, incongruously simulated by a field of rocks on the raised office flooring. Deep inside the Kennedy Space Center, we are presented with an organizational cross section almost as extreme as that shown earlier, on the surface of the moon. As on the moon, we see the complex, human body protected against a hostile environment. But whereas in one case it is a cold vacuum that threatens the body, in the other it is the systems and techniques of the military-industrial complex on earth. Yet in each case, the intermediating, 21-layer A7L presents a reality, not quite animate or inanimate, neither entirely natural nor manmade, that mediates the two, allowing the body to suit itself to a, new, historic space.

1.4

Astronaut Charles Conrad, Jr. (facing camera) simulates picking up lunar samples, while astronaut Alan L. Bean simulates their photographic documentation, five weeks before their launch in Apollo 12, October 6, 1969.

Notes

1. See for example Gary L. Harris, *The Origins and Technology of the Advanced Extravehicular Space Suit*, AAS history series, 24 (San Diego: Published for the American Astronautical Society by Univelt, 2001).

2. Michael Sorkin, "Minimums," *Village Voice*, October 13, 1987, 100.

3. See for instance the discussion of the Apollo suit program in Kenneth S. Thomas and Harold J. McMann, *US Spacesuits* (Berlin: Springer, 2006).

4. For example, Michael Hensel, Achim Menges, and Michael Weinstock of the Emergence Design Group at the Architectural Association in London lay forth an explicit agenda of "morphogenetic" architecture, relying on "data, genes, and speciation." Hensel, Menges, and Weinstock, "Emergence: Morphogenetic Design Strategies," *Architectural Design: A.D.* 74, no. 3 (May/June 2004), and "Techniques and Technologies in Morphogenetic Design," *Architectural Design: A.D.* 76, no. 2 (March/April 2006). And in a 2004 essay, Karl Chu, head of the Institute for Genetic Architecture at Columbia, declares: "We are now in a position to articulate a more comprehensive theory of architecture, one that is adequate to the demands imposed by the convergence of computation and biogenetics … a monadology of genetic architecture." Karl Chu, "Metaphysics of Genetic Architecture and Computation," *Architectural Design: A.D.* 78, no. 4 (August 2006).

5. Nathan S. Kline and Manfred Clynes, "Drugs, Space and Cybernetics: Evolution to Cyborgs," in Bernard E. Flaherty, ed., *Symposium on Psychophysiological Aspects of Space Flight* (New York: Columbia University Press, 1961).

6. A term coined by James Webb, NASA's Administrator under President John F. Kennedy. See James E. Webb, *Space Age Management: The Large-Scale Approach*, McKinsey Foundation lecture series (New York: McGraw-Hill, 1969).

7. See Saki Dockrill, *Eisenhower's New-Look National Security Policy, 1953–61* (New York: St. Martin's, 1996).

8. "To survive on the moon," Mumford expands, "he must be encased in an even more heavily insulated garment." Lewis Mumford, *The Pentagon of Power*, vol. 2 of *The Myth of the Machine* (New York: Harcourt Brace Jovanovich, 1970), 14–15.

9. Nicholas de Monchaux, interview with Frederick Ordway III, visual effects consultant to Stanley Kubrick and former assistant to Wernher von Braun, June 20, 2006 (tape recording).