Helen Hester

Space Agency

Automation, Autonomy, and Acid Astronautics

ABSTRACT: This essay looks at the figure of the cyborg via its origins in mid-twentieth century American astronautics. It begins by comparing different approaches to the ›space cyborg‹, helping to situate it within the distinctive cultural preoccupations of its times and places. The discussion then proceeds to consider the American cyborg's roots in two discursive regimes: that surrounding military masculinities, and that surrounding the non-human or de-humanized medical test subject. Via an analysis of the 1976 sci-fi novel *Man Plus* by Frederik Pohl, the essay explores how this dual heritage generates tensions in terms of gender, before concluding with an analysis of the ways in which the cyborg's mutable embodiment runs aground on the perceived fixity of human sexuality. How might we use the historical concept of the cyborg to queer the notion of ›participant evolution‹ today?

KEYWORDS: Cyborg; astronautics; TESCREAL; gender and sexuality

1. Introduction

This essay looks at the figure of the cyborg via its origins in mid-twentieth century American astronautics, as part of a wider effort to explore the mutability of the body and ideas around ›participant evolution‹. It will consider the ways in which the human itself is framed as a kind of building material in these discourses, while also exploring the perceived limits to this in terms of gender and sexuality. Over the course of the discussion, we will draw on debates within and around 60s and 70s astronautics to help situate the cyborg (and/as the astronaut) in the context of broader American cultural preoccupations of the era. This will involve reference to discussions from within the field itself, as well as to science fictional texts informed by this discourse. We will use one novel in particular – *Man Plus* by Frederik Pohl (1976) – as a case study via which to explore how ideas about gender, agency, and the (post)humanity of the cyborg are taken up or textually contested.

The opening half of the essay looks for informative comparisons, first in contemporary debates about human enhancement for space travel and exoplanetary living, and then in the Soviet space programme of the 1960s. These comparisons indicate that the cyborg (as we understand it here) is to some extent a product of both its time and its place, thereby providing a rationale for the temporally and spatially delimited discus-

sion that follows. Despite Donna Haraway's famous claim that »the cyborg has no origin story« (1991, 150–151), we can nevertheless admit that it *does* have beginnings. Considering these beginnings might, as I hope to demonstrate in the course of this essay, enrich our appreciation and deepen our understanding of the cyborg's varied afterlives and ongoing cultural influence.

Having undertaken some of this necessary ground-clearing, the second half of our discussion will turn more directly to the relationship between human agency and cyborgian adaptation. In what ways does the figure of the twentieth-century cyborg express, build upon, and ultimately compromise a specific fantasy of the all-American astronaut? Where does the extension of human freedom, via the flexible and transformable body, run up against entrenched ideas about essence and the unchangeable, and how should we respond to said ideas? Such questions will be considered in due course. We will start, however, by simply introducing the cyborg and by teasing out some of its connections with both the militarized space programme and the pharmaceutical research of the period. This dual heritage, as we will see as the essay progresses, places the cyborg in an ambiguous position in terms of its agential capacity – and raises some particularly interesting questions about the immutability (or otherwise) of gender and sexuality.

2. The Cyborg: A Creature of its Time and Place?

The cyborg – »hybrid of machine and organism, a creature of social reality as well as a creature of fiction« (Haraway, 1991: 149) – has long been an animating figure within technofeminist imaginaries as well as within wider culture. The writer Tim Maly points out that our conception of the cyborg revolves largely around the idea of »non-hereditary adaptation. Technological interventions that change the course of biological existence« (2010: n.p.). This is apparent in many of the earliest articulations of the idea of the cybernetic organism. The cyborg emerged in the era of the space race – the word was coined in 1960, just two years after the formation of NASA – and is inexorably entwined with another significant figure of mid-century cultural fantasy: the astronaut.

At this time, there was great interest in meeting the technical challenges of survival in extra-terrestrial environments. As Maly notes, one possible way to respond to the challenges of being off-planet is to think prosthetically or architecturally: »Using the latest construction techniques, you can build a little bubble of earth, and plunk it down on any old alien world. We can send people off to these environments and so long as the walls don't burst and the air doesn't run out, they've got all the comforts of home« (2010, n.p.). Of course, there's a profound degree of vulnerability at play here, just as there is when humans venture into inhospitable *terrestrial* environments – the ocean floors, extreme heat or cold, and so on. From their »departures to the end of their

missions, [space envoys] are encased within extensive infrastructures of ground and in-situ support, relying upon intricate arrangements of sophisticated technical apparatus, precise logistics protocols, and pools of expert labour« (Damjanov, 2023: 328). The individual is entirely dependent upon these infrastructures for basic, minute to minute survival.

This vulnerability tends to be somewhat obscured in cultural discourses around astronautics – to the point where, as Haraway notes, the image of man in space has become perversely totemic of »an ultimate self untied at last from all dependency« (1991: 151). The people who popularized the idea of the cyborg, however, were very aware of the exposure of the human in space. In a seminal essay from 1960 – widely viewed as the formative text of cyborg studies – Manfred E. Clynes and Nathan S. Kline write that

> [a]rtificial atmospheres encapsulated in some sort of enclosure constitute only temporizing, and dangerous temporizing at that, since we place ourselves in the same position as a fish taking a small quantity of water along with him to live on land. The bubble all too easily bursts. (1960: 27)

As Benjamin Bratton strikingly puts it, making a wider point about the erosion of »life support systems« here on Earth (2019: 49), the space-walking astronaut is »a pink putty sculpture unable to leave its home without bringing an artificial atmosphere with it as it toddles outward« (2019: 48–49). Hence, Clynes and Kline suggest that, rather than creating an environment-bubble to encapsulate and temporarily support the body, one should instead fit the body of the astronaut to his extra-terrestrial environment.

In the words of their 1961 paper »Drugs, Space, and Cybernetics: Evolution to Cyborgs«, if »man attempts a partial adaptation to the conditions of space instead of being insistent that he carry his entire environment with him, a number of new possibilities appear« (Kline and Clynes, 1961: 347). They propose that man »use his creative intelligence to adapt himself to the space conditions he seeks rather than take as much of earth environment with him as possible. This is to be achieved through the Cyborg, an extension of organic homeostatic controls by means of cybernetic techniques« (1961: 370). So, whilst breathing is »an excellent system for metabolism in an atmosphere with adequate oxygen supply and low carbon dioxide content [...] on other planets atmospheric conditions are all wrong for this purpose« (1961: 356). In this situation, one should not resort to the creation of protective architectural complexes. Rather, »an artificial organ should be provided to replace the lung«, making breathing unnecessary (1961: 356). The cyborg, one might say, is a call for *anthropoforming* over terraforming as a means of extending human agency and mitigating prosthetic-technological dependency.

Here we see the idea of non-hereditary adaptation at play: »In the past evolution brought about the altering of bodily functions to suit different environments«, Clynes and Kline declare (1960: 26). »Starting as of now, it will be possible to achieve this to some degree *without alteration of heredity* by suitable biochemical, physiological, and electronic modifications of man's existing modus vivendi« (1960: 26, original emphasis). They propose a range of potential modifications to adapt the individual human to the rigours of space travel, from artificially induced hibernation to regimens of sensory stimulation, yoga, and hypnosis. Appropriately enough for the 1960s, many of their suggested interventions involve controlled substances or experimental drugs. They toy with the idea of using an »anesthetizing substance of the cocaine series« (Kline and Clynes, 1961: 360) to assist with the sensory disorientation caused by weightlessness, for example, and call for the use of »psychic energizers« such as amphetamines to enhance wakefulness and efficiency on long, monotonous journeys (Kline and Clynes, 1961: 354).

Of the cyborg's two originators, it was Nathan S. Kline who particularly specialized in this area; he was part of the American College of Neuropsychopharmacology, and a member of its Study Group for the Effects of Psychotropic Drugs in Normal Humans.[1] The proceedings of the group's 1967 meeting – which features several contributions attributed to Kline – reveals a keen interest in the intersection of neuropsychopharmacology and astronautics, including a chapter speculating on the future of LSD. A specialist essay on the topic argues that one possible application of »drugs or procedures which alter consciousness may be for individuals who are subjected to prolonged periods of isolation and separation from the usual daily activities of man, such as long space voyages of the future or assignment to remote communications stations« (Kurland et al., 1971: 105–106).

This was the era of ›turn on, tune in, drop out‹, of course, as well as ›better living through chemistry‹, and the cyborg can be seen as representative of a kind of acid astronautics – a figure of speculation grounded in an idea of the prosthetically, pharmaceutically, and otherwise manipulable character of humanity. Indeed, as Alex Dymock's work suggests, this relationship was far from unidirectional. Just as 60s astronautics looked to controlled substances to facilitate non-hereditary adaptations supportive of manned spaceflight, so too did the drugs research and advocacy of the period position psychedelics as specifically evolutionary technologies. Within these discourses, human flourishing is »recast as a kind of striving for evolutionary perfectionism, in which the effects of psychedelics are satisfactorily predictable and measurable enough that they have an evidenced utility that might be used to promote the psychedelic experience to others« (Dymock, 2023: 829).

1 I would like to thank Dr Alex Dymock for alerting me to this in the course of our early correspondence about this article.

3. Acid Astronautics, Past and Present

As »radical as these ideas seemed at the time […], the space-medicine community took them seriously« – at least for a while (Kline, 2009: 342). NASA commissioned an 8-month study, the results of which were published in 1963 as »Engineering Man for Space: The Cyborg Study«. By thorough research into »man's systems and subsystems when subjected to the simulated and actual conditions of extraterrestrial environments«, the report claims, »we will be able to make significant progress toward the better understanding of man as a space voyager« (Driscoll, 1963: 78). The cyborg study concerned itself with the determination of »man's capabilities and limitations under the unpredictable and often hostile conditions of space flight, and the theoretical possibility of incorporating artificial organs, drugs, and/or hypothermia as integral parts of the life support systems in space craft design in the future« (Driscoll, 1963: 76). The influence of Clynes and Kline is palpable throughout – including in the focus on pharmaceutical solutions to a range of issues, including »anxiety, depression, fatigue, […] metabolism reduction and motion sickness« (Driscoll, 1963: 76–77).

This was a moment when the American counter-culture and military-industrial complex alike were pursuing interests in altered states of consciousness – the CIA, for instance, was looking into possible applications of LSD and hypnosis in psychological torture during the Cold War. Figures such as Clynes (with his ›far out‹ interests in biocybernetics, human creativity, and the communication of emotion) and Kline (with his research into psychopharmacologic drugs) seem in some ways to span these two worlds. Across the ideological spectrum of mid-century America, there was great interest in the utility and untapped potential of controlled substances. To what extent does this interest continue to shape astronautics today, in the face of the »intensification of space activities« characteristic of recent efforts to »commercialise and militarise space« (Salazar and Gorman, 2023: 1)? We can allow ourselves a few brief comments here, as we seek to understand what of the cyborg is unique to its foundational moment and how much of it has endured across time.

Certainly, the broad idea of cyborgian adaptation remains popular in some circles, with thinkers continuing to argue that »our species, *Homo sapiens*, will likely change, through continued evolution, some self-directed, and through human enhancements« (Rappaport and Corbally, 2020: 6). Researchers still point to the necessity of »unnatural selection« in terms of enabling humans (or our successor species) to become multiplanetary (Abood, 2020: 47), with some even suggesting that a »stage of ›directed evolution‹ […] is an essential step for *life itself* to survive« (Mason, 2021: xii-xiii, original emphasis). We can also detect similarities in terms of the countercultural reference points (and approaches to controlled substance use) coming to inform research agendas within the field, particularly when one looks to the influence of Silicon Valley on contemporary astronautics. Tech companies are very much in the fold of

today's space exploration and resource race, with billionaires »pouring millions into ›disrupting‹ space, NASA, and the space programme of yore« (Morozov, 2015: n.p.). As NASA itself puts it, »We will go forward to the Moon, through Silicon Valley – bridging public and private partnerships to capitalize on the innovation and entrepreneurship« of the region (n.d.: n.p.).

That the cyborg remains very much on the table when it comes to the state's new commercial partners is reflected in the tech sector's so-called Tescrealism. The acronym ›TESCREAL‹ has been developed to refer to a bundle of beliefs spanning transhumanism, extropianism, singularitarianism, cosmism, rationalism, effective altruism and longtermism. As a concept, it has some merit; the »various ›-isms‹ overlap in their history and ideology« (Troy, 2023: n.p.), and the acronym allows us to latch on to an apparent taste for the messianic within Silicon Valley communities. However, a Tescrealist framework also risks overemphasising the points of convergence and crossover between its component philosophies, presenting a loose nexus of ideas as a coherent intellectual framework on the basis of sometimes weak associations and the fact that assorted tech industry figures have expressed them. Certain networks of people mapping onto certain networks of ideas is not, to my mind, sufficiently solid ground upon which to construct a critical edifice. As such, I use the acronym somewhat warily (even if I can appreciate its broad explanatory utility).

As Émile P. Torres (who coined the term with computer scientist Timnit Gebru) would have it, the Tescreal bundle equates to

> a techno-utopian vision of the future in which we re-engineer humanity, colonize space, plunder the cosmos, and establish a sprawling intergalactic civilization full of trillions and trillions of ›happy‹ people, nearly all of them ›living‹ inside enormous computer simulations. In the process, all our problems will be solved, and eternal life will become a real possibility. (2023: n.p.)

For Torres, a Tescrealist emphasis on re-engineering humanity for a high-tech, spacefaring future indicates precisely why this worldview might be ethically problematic. He points to the prospect of our replacement by genetically modified posthumans who might »integrate various technologies into their bodies, perhaps connecting their brains to the internet« (2023: n.p.) – cyborgs, in other words. Silicon Valley's lack of repulsion at this prospect then comes to act as one apparently self-evident basis for denouncing Tescreal thinking.

This approach to Tescrealism leaves something to be desired. While we should indeed be highly sceptical of the forms of futures fetishization the acronym attempts to critique, many of the tendencies nested within it have (as Eli Sennesh and James J. Hughes point out) »a progressive political wing that has been ignored. Moreover, the wholesale condemnation of these ideas has cast a pall over all thinking about hu-

manity's future when we desperately need to grapple with the implications of emerging technologies« (2023: n.p.). That being said, it is nevertheless suggestive (for the purposes of this article) that transhumanism and cosmism are included and entangled within the umbrella concept now thought to be defining the bleeding edge of the tech sector. As the influence of such concepts makes clear, the cyborgian preoccupations of the 60s and 70s are continuing to inform ideas around technical development and American space exploration, but under new economic conditions and in an altered cultural context.

The same might be claimed for the »counter-culture libertarianism« of the period (Barbrook and Cameron, 1995: n.p.). A grain of radicalism has always lurked within Silicon Valley, attributable in part to the so-called Californian Ideology (famously characterized as an »eclectic blend of conservative economics and hippie libertarianism« (Barbrook and Cameron, 1995: n.p.). As Richard Barbrook and Andy Cameron put it back in 1995, knowledge workers in the American tech industry are »both a privileged part of the labour force and heirs of the radical ideas of [...] community media activists«, with the result that the »cultural divide between the hippie and the organisation man has now become rather fuzzy« (Barbrook and Cameron, 1995: n.p.). Given these commitments and inheritances, it should come as no surprise to find esoteric mid-century research agendas making a partial comeback via an avowed openness to recreational psychedelics and the workplace benefits of mind-expanding drugs (to be found most obviously in the discourses around microdosing).[2] A recent article for the *Wall Street Journal* points to the existence of a Silicon Valley »drug movement that proponents hope will expand minds, enhance lives and produce business breakthroughs« (Grind and Bindley, 2023: n.p.). Acid astronautics rides again – this time for profit!

The role of controlled substances such as LSD in the space programme was always marginal at best, however, and the relationship between government agencies and tech sector cultural disruptors continues to be somewhat uncomfortable. There would appear to be something of a cultural misalignment here, particularly when it comes to attitudes surrounding *recreational* pharmaceuticals. This is reflected in NASA's recent decision to conduct a »cultural assessment study in coordination with [its] commercial partners to ensure the companies are meeting NASA's requirements for workplace safety, including the adherence to a drug-free environment« (quoted in Koren, 2018: n.p.). These reviews followed (and were allegedly prompted by) SpaceX founder Elon Musk's public use of marijuana; one can imagine what NASA might make of his recent favourable comments about ketamine. Thus, we have seen that there are continuities

2 »Microdosing – taking small amounts of a substance such as ketamine or LSD – is regularly promoted in Silicon Valley as a way to improve productivity or creativity or treat depression and anxiety« (Titcomb, 2023: n.p.).

between the mid-century rise of the cyborg and twenty-first century astronautics, as evinced by research interests in human enhancement, by the perceived influence of cosmism, transhumanism, and related Tescreal viewpoints, and by a wider work/play drugs movement underpinning the space-facing enterprises of Silicon Valley. Where might we identify *dis*continuities, and how have these changed the tenor of the discourse around cyborgian adaptation today?

Notably, while an engagement with psychoactive substances (from caffeine to ketamine) may now be part and parcel of the corporate culture behind commercial space travel and prospective exoplanetary living – leaving »boards and businesses to wrestle with their responsibilities to a workforce that frequently uses« (Grind and Bindley, 2023: n.p.) – there has been something of a move *away* from such substances within the academic of field astronautics itself. Indeed, there is some obvious discomfort with the idea of the astronaut on drugs, with scholarly commentators often taking particular pains to disavow the idea of participant evolution aiming at increased *pleasure and enjoyment.* NASA researcher Christopher E. Mason's radically optimistic and far-reaching plan for life on other worlds over the next 500 years, for example, sounds an uncustomary note of caution when it comes to recreational enhancement. Noting that epigenetic-editing methods might, at some future point, conceivably enable people to »increase their enjoyment of a drug a hundredfold while taking half the quantity«, he suggests that this could represent an unprecedented and »terrifyingly uncontrolled experiment in cellular disruption and regulatory perturbation« (Mason, 2021: 166).

This would seem to be somewhat out of step with the so-called corporate drugs movement discussed above. Indeed, it may be that such approaches are a reaction not (just) against the spectre of mid-century acid astronautics, but precisely against the Tescrealist currents of contemporary space tech. Some scholarly approaches to space and society seek to explicitly differentiate and distance themselves from a supposedly less reputable transhumanist movement, which is condemned for pursuing changes in human consciousness via »psychoactive drugs« and »physical excess« (Rappaport and Corbally, 2020: 8).[3] An association with Silicon Valley proselytizing may well be seen as something of a liability for those working in less overtly ›disruptive‹ discursive traditions.[4]

3 Indeed, Andrew B. Newburg and David B. Yates explicitly disregard »psychedelic substances« as an approach to managing the »psychological risks of astronaut missions«, and prefer instead to celebrate *wonder* as a »non-pharmacological stimulus for self-transcendence« (2020: 109)!

4 This would appear to be in accord with Dymock's assertion that psychedelics research more broadly has seen a push to recast controlled substances as principally »medicines or biotechnologies […]. The framing of their use as purely scientific gives research credibility in the public imaginary, which undoubtedly has had some role to play in the relaxation of laws around possession in some US states« (2023: 820).

Perhaps the more significant factor behind the de-emphasis on drugs in the reframing of the cyborg lies in the shifting biomedical landscape, however. It is important to note that the mechanisms via which non-hereditary adaptations are imagined to be pursued has changed significantly along with the state of scientific and technical knowledge. Whereas once *pharmaco-cybernetic* frameworks dominated discussions about the future of space exploration, today we increasingly find a focus on brain-computer interfaces and (most particularly) gene editing. The University of California recently received a $20 million grant from the US Department of Defense to use CRISPR technologies to »find a genetic alteration that would protect radiation patients, soldiers, and eventually astronauts from exposure to radiation« (Munévar, 2020: 117), for example. Mason's plan, meanwhile, leans into the idea of »resource-saving genetic protocols, such as reducing the amount of required oxygen for cellular function« (2021: 134). Participant evolution is thus imagined to be pursued primarily via new means, with the emphasis on *recoding* the organism rather than pharmaceutically enhancing its consciousness. This is one reason why it makes sense to limit the temporal scope of one's analysis when discussing the image and impact of the biotechnologically enhanced astronaut.

If *mid-twentieth century* America produced one version of the space cyborg, shaped at the interface of experimental drugs, counter-cultural ascendancy and the scientific-military-industrial complex, *early-twenty-first century* America produces another. Today's cyborg emerges instead from the intersection of recreational and productivity-enhancing psychoactives, corporate libertarianism, and space faring via public-private partnership – as well as from the counter-discourses responding to all of these. These two versions of the space cyborg may be sisters, but they are not twins; commonalities and differences abound. The cyborg, then, is a creature both in and across time. Does this also hold when it comes to place?

4. Agential Astronauts and Situated Cyborgs

As we have seen, the cyborg emerged as an attempt to mitigate some of the bodily vulnerability inevitably involved in carbon-based Earthlings attempting to leave their terrestrial home. This vision of overcoming physical precarity via biotechnologies is of course extremely partial. As crip theorists have long argued, living with technologies »does not always mean an effortless integration between bodies and machines that inherently ›fixes‹ bodies; rather, it is continuously labour-intensive and often a source of pain, requiring adaptation, negotiation, and technological maintenance« (Gál and Armstrong, 2023: 164). Nevertheless, however, the cyborg, in its mid-century instantiations, is imagined to represent an approach to counteracting bodily vulnerability and an attempt to technically intervene in the course of biological existence. This framing

has notable connections with those media images of the all-American astronaut with which it is contemporary – images that position this figure as the very embodiment of human ingenuity and accomplishment, transcending species limits to make new things possible.

Given that the »space cyborg« is a direct continuation, as well as a speculative extension, of the space*man*, it will come as no surprise that both draw from the same storehouse of cultural imagery (Kline, 2009: 340). They have their roots in icons of skill, courage and derring-do such as the test pilot and the military airman – a fact that can be attributed in large part to the backgrounds of NASA's earliest astronauts, all of whom were »military personnel [with] experience flying jet aircraft« (Deiss, 2022: n.p.). Indeed, according to Saskia Vermeylen, NASA selected such personnel precisely for their »daredevil qualities combined with that element of willingness to be in the service of the wider public and country« – hence the « image of the astronaut as the white, male hero potentially sacrificing his life for the benefit of humanity« (2023: 172).[5] It is via this trope that physical risk can be transformed from a mark of vulnerability into a form of self-overcoming that has implications both individual and collective.

Mid-twentieth century journeys into space could thus be presented to the public as

> monumental accomplishments for ›mankind‹ instead of endeavours that magnified our bodies' limitations and our profound physical dependence on the general hospitality of our planet. This is not how we typically project ourselves as humans into the cosmos, even though dependence is the lived reality of all individual members of humanity. (de Paulis and Haramia, 2023: 132)

But to what extent is the symbolic figure of the astronaut a product of its place as well as its time? Is there such a thing as an all-American cyborg, given that the space race has, by definition, been an international phenomenon since its beginning?

We can certainly see some broad similarities in approach between America and its cold war rivals when it comes to framing space travel and national masculinities. Like the US, Russia also traced a line from airman to spaceman, with »iconic representations« of the new Soviet man shifting »from the heroic aviator in the Stalin period to the cosmonaut in the Khrushchev era« (Gerovitch, 2007: 138). Where there appear to be cultural *differences* between these national space programmes at mid-century, however, is in the role attributed to the spaceman in terms of his direct control of the spacecraft – his ability to act autonomously upon and within the vehicle. In general, Soviet specialists conceptualized the

5 As Vermeylen also notes, however, the »whiteness and masculinity of space travel's history in the 1960s« would soon be contested by women and Black people seeking »explicit recognition of the important role they played in the American space programme« (2023: 172).

> spacecraft control system as a ‹cybernetic »human-machine« system›. They defined the cosmonaut as a ›living link‹ in this system, and analyzed this living link in cybernetic terms, borrowed from control theory and information theory— the same terms as applied to the other links in this system. (Gerovitch, 2007: 143, quoting Viktor G. Denisov et al. in translation)

Such an approach serves to highlight the ›cy‹ in ›cyborg‹, of course, as well as the inexorable interconnectedness of the embodied human being in space. In contrast to the supposed lack of dependency that Haraway identifies in cultural fantasies of the astronaut, we here find an emphasis on the life-sustaining influence of extra-individual forces.[6] But this is not so much an acknowledgment of the fundamentally ambivalent agency of the spaceman – the fact that he is not a self-determining figure, made autonomous via his skill, but a particularly vulnerable node in a network of interreliance. Rather, it is evidence of a distinctive approach to communication and control, in which risk is mitigated beyond (and before) the flight deck.

As Slava Gerovich notes in his groundbreaking work on the topic, »the cybernetic framework underlying this approach fundamentally assigned the human operator a secondary role. Ultimately, the function of the human operator was to enhance the operations of machines, not the other way around« (2007: 144). Cosmonauts were thus assigned a comparatively

> limited role on board a spacecraft. Soviet spaceships were fully automated. Although systems of manual control were installed, their functions and use were severely limited. […] The Soviet engineers' vision of a manned flight was that of a cosmonaut flying on board a spacecraft, rather than flying a spacecraft. (Gerovitch, 2007: 137)

Missions were thus to be planned precisely in advance and run almost entirely from the ground. Despite deliberately seeking out »jet pilots of superior flying ability« for the nation's first cohort of cosmonauts (Burgess, 2022: 37), then, Russia's space programme in fact demanded very little in terms of technical skill from its recruits, and the human in space was considered more of a payload than a pilot.[7]

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6 This highlights an inevitable facet of human (as well as cyborgian) existence. Indeed, as Ronald Kline notes, »At first thought, ›cybernetic organism‹ seems like a misnomer because all organisms are cybernetic in that they interact with the world through information and feedback control, the key concepts in cybernetics« (2009: 332). This leads him to stress that the cyborg is really a »cybernetically extended organism – an organism extended by means of cybernetic technology« (2009: 332).

7 There was, however, some variation in attitudes on this matter across the Russian space programme. Lieutenant General Nikolai Kamanin, for example – a leading voice in space policy who was in charge of cosmonaut selection and training – is among those who argued that cosmonauts

This approach was arguably less characteristic of the American space programme, where any such perceived decentring of the human in space would have been markedly at odds with the kind of public image being crafted for the astronaut. Indeed, according to Réka Patrícia Gál and Eleanor S. Armstrong, »engineering choices for US spaceflight were themselves heavily influenced by masculinist worldviews«, which could not countenance that space flight might be so heavily automated as to reduce the pilot to a mere passenger (2023: 163). To uphold the idea of the astronaut as a man of action, he had to be granted a certain amount of agency within the cockpit. It is for this reason that Gerovitch positions the figure of the astronaut as a particularly »American ideal, the quintessential American hero« (2007: 156), and that Vermeylen can similarly frame it as »the all-American hero cultivating celebrity status in the media« (2023: 172).

It is perhaps particularly within an American context, then, that the 60s spaceman had associations with not just nerve, valour, and bravery, but also *agency*. The appeal of this cultural framing has endured arguably to this day. In an era in which – according to Donald Goldsmith and Martin Rees – »our robots can outperform astronauts at a far lower cost and without risk to human life« (2022: n.p.), we remain preoccupied with (and invested in) the prospect and practice of human space exploration. It is precisely the »difficulties and dangers«, they argue, that appeal to us (2022: n.p.). Indeed, it is this kind of thinking which prompts the ecofeminist Greta Gaard to argue that »space exploration is advanced within a framework of masculinist ideology that values […] heroic feats of conquest amid risk-riddled adventure« (2013: 117).

Our discussion so far indicates that any account of ambivalent agency and mid-century cyborgian adaptation might reasonably be restricted to the American space envoy, given the variations in practices and approaches suggested by this brief cross-cultural comparison. In the case of both of the major players of the 60s space race, we find theories of the cybernetic relationship between the spacefaring human and the specialist technologies and machinic infrastructures that keep him alive. Within the culture of American astronautics, however, this interest in adaptation for extraterrestrial environments docks with a particular kind of heroic individualism located within the body of the astronaut himself. In the second half of this essay, we will consider how the positioning of the cyborg both enhances and encroaches upon this figure of the agential astronaut. How does an explicit attempt to extend our collective and individual capacity to act simultaneously work to compromise this same capacity? In what ways can ideas about the cyborg be seen as a culturally specific approach to managing risk and extending control? Where have the limits of this vision of agency been drawn, and where might we seek to redraw them now?

should be »assigned a greater role in spacecraft control« (Gerovitch, 2007: 141).

5. Body (Re)Building: Non-, Post- and De-Human Animals

We can see ideas about militarized masculinities and the space race being explored in detail in some of the works of science fiction that emerged in the wake of the cyborg. Martin Caidin's 1972 novel *Cyborg*, for example – upon which the series *The Six Million Dollar Man* is based – centres on the test pilot and astronaut Steve Austin, who is rebuilt with prosthetics after a crash, and subsequently becomes an agent of the state. The protagonist of Frederik Pohl's 1976 novel *Man Plus*, reissued as an ›S.F. Masterwork‹ in 2000, has a similar backstory. Roger Torraway is introduced to the reader as an established astronaut, »[b]right, healthy, smart, personable, technically trained« (2000: 4). He's »good-looking« (2000: 3), deeply in love with his beautiful wife, and something of a celebrity, having once helped rescue a team of stricken Soviet cosmonauts.

Over the course of the novel, we witness his shift from spaceman to space cyborg, as he undergoes processes of non-hereditary adaptation at the hands of the US Exomedicine Project. This demands considerable bravery and self-endangerment on Roger's part, as he is enlisted into a programme of invasive testing, constant monitoring, and transformative medical procedures in preparation for life on Mars. His lungs are replaced by »micro-miniaturized oxygen regeneration cat-cracking systems«, and his organic limbs are replaced with alternatives »served by motors instead of muscles« (2000: 26). As the narrator puts it, »Man is not bound by objective facts. If they inconvenience him, he changes them, or makes an end run around them« (2000: 25). And so, Roger Torraway's body eventually becomes the raw material in an anthropoformational project bent upon overcoming species limits and remaking the human.

This novel, which we will be discussing in more detail below, has clear resonances with Kline and Clynes's account of participant evolution, in which the bodily changes necessary for space survival »have to be created by man himself, using his acquired knowledge of cybernetics and physiology« (1961: 370). As we've seen, these authors thought that becoming a cyborg in this manner would »free humans from their machines, from all the equipment needed to create an earth-like environment in space« (Kline, 2009: 340). The ambition was thus to take the airman-cum-astronaut from his ambivalent position – as part figure »radiating agency«, part vulnerable organism in a bubble – and lead him more decisively to the position of »executive agent incarnate« (Bratton, 2019: 48). But while NASA's cyborg study strives for »a total man-machine complex with man in the control loop as the forcing function« (Driscoll, 1963: 81), a fuller account of cyborgian agency is more complicated than this perspective might allow.

We get a sense of this when we turn our attention to the role of human consciousness in early articulations of the cyborg. In their 1960 paper, Clynes and Kline are particularly interested in homeostatic biological processes – the tendency toward stability and

self-regulation within an organism, and the tendency to self-monitor and automatically adjust in response to external conditions (sweating when one gets hot, for example). This plays a prominent role in their characterization of the cyborg; the emphasis on biological feedback has clear links with the central tenets of cybernetics. They are interested in »the devices necessary for creating self-regulating man-machine systems«, noting that this »self-regulation must function without the benefit of consciousness in order to cooperate with the body's own autonomous homeostatic controls« (1960: 27). Cyborgian adaptations – while being the outcome of a deliberate process of participant evolution – are thus understood as functioning without the need for ongoing conscious intervention; they can be set in motion and then largely forgotten about.

The aim is to free the astronaut »from the need of conscious attention to the regulation of his own internal environment« (Kline and Clynes, 1961: 370). After all,

> [i]f man in space, in addition to flying his vehicle, must continuously be checking on things and making adjustments merely in order to keep himself alive, he becomes a slave to the machine. The purpose of the Cyborg, as well as his own homeostatic systems, is to provide an organizational system in which such robot-like problems are taken care of automatically and unconsciously, leaving man free to explore, to create, to think, and to feel. (Clynes and Kline, 1960: 27)

What the body can do, or be made to do, *without the mind's deliberate intervention* becomes the site via which freedom is extended. In Bratton's words, »automation automates autonomy« (2019: 35). As we've seen, some elements of this point of view were in evidence within the Soviet space programme – although in this case, the emphasis was on collective control rather than individual autonomy in the cockpit. What is key for our purposes, however, is the idea that exercising agency might be less a matter of the subject persisting as a forcing function, and more a matter of judicious decision-making about where to *cede* versus where to *seize* direct command.

As we've seen throughout our discussion so far, however, any account of cyborg autonomy also has to reckon with the intensified vulnerability of the body and mind beyond planetary limits.[8] As Daniela de Paulis and Chelsea Haramia note, the astronauts who have so far walked on the moon were also, of necessity, »entirely sealed off

8 Colin Burgess reports that the Soviet preference for highly automated space exploration was in fact informed by lingering concerns about just such vulnerability. Of preparations for Yuri Gagarin's historic 1961 launch, for example, he notes that »Some scientists feared that the lack of gravity, combined with disorientation and a strong feeling of isolation, might cause a cosmonaut to become panicky and even deranged. The flight would be fully automatic, controlled from the ground, and there was a reluctance to give Gagarin access to – and possibly allow him to override – the controls in case he became badly disoriented« (2022: 37).

from it. [...] They gazed at this world through the medium of their helmets, their fragile, delicate bodies protected by their high-tech suits« (2023: 130–131). And just as, with such a prosthetic approach to survival, the space-walking astronaut is both a figure of Promethean triumph *and* »a fragile animal in a shell« (Bratton, 2019: 48), so, too, is the pharmaceutically enhanced mid-century cyborg both enabled by his biotechnologies and tethered to them.

Thus, while the figure of the cyborg seeks to reduce vulnerability and increase agency by enmeshing the extraordinary measures necessary to support life firmly within the bodily interior, it does not somehow (impossibly) escape dependence. Rather, it shifts this dependence on to other forces, coming to represent a different type of corporeal jeopardy as it does so. Situated at the experimental edge of astronautics, it therefore offers us a differently coded imaginary to that of the heroic military airman – one, I would argue, that brings with it a very different set of race, gender, and even species connotations that then demand to be managed. After all, »fragility and dependence have historically been characterized as feminine and disabled traits« (de Paulis and Haramia, 2023: 131), rather than as the inevitable facets of embodied existence that they are, and the cyborg is at least as much test *subject* as it is test *pilot.*

Let us return to *Man Plus* here. In the novel, both Roger Torraway and his predecessor Will Hartnett are subject to surveillance, monitoring, and invasive medical procedures the precise details of which are sometimes kept from them; we witness Hartnett undergoing the »slow, laborious process« of having the interface between his ruby complex eyes and still-human brain reset: »Like nearly all of the things that had to be done to Willy Hartnett«, we are told, »it was attended with the maximum discomfort for him. The sensitive nerves of the eyelid had long since been dissected out; otherwise he would have been shrieking in pain day and night. But he could feel what was happening« (Pohl, 2000: 48). It is this experimental process of vision resetting that ultimately kills him, making way for Roger as his reluctant replacement, and which also primes the reader to think about the process of becoming cyborg as a form of post-human vivisection.

It is no coincidence that the pressurized tank in which Roger is kept is described as a »zoo cage« (2000: 30), nor that he is frequently described not only as a cyborg but as a »monster« (2000: 9). As Paul Preciado remarks, many of our understandings of the clinically manipulable workings of the body »were manufactured at the crossroads at which human, the supposedly non-human, and animal meet« (2013: 154). Our biotechnical advances are pursued via the bodies of »rabbits, chickens, bulls, pigs« (Preciado, 2013: 153) – a fact also reflected in the language of ›lab rats‹ and ›guinea pigs‹. This use of non-human animals to pursue human ambitions is common to both medicine and space exploration; Soviet and American scientists alike enlisted »non-human animals—mostly monkeys, chimpanzees, and dogs—to test the effects of rapid

acceleration, prolonged weightlessness, atmospheric re-entry, and other hazards of space travel« (Gaard, 2013: 118).

Indeed, »one wonders how the space race would have proceeded if non-human animals were not available as ›crash test dummies‹« (Gaard, 2013: 119). Astronaut, cosmonaut, and post-human cyborg alike thus follow in the pawprints of their non-human predecessors.[9] The *humans* who have historically been brought most frequently into the category of test subject, meanwhile, have tended to be those most insistently othered (that is to say, dehumanized) by medical discourses. In the words of Alondra Nelson, »medical experimentation with human subjects has historically involved vulnerable groups, including children, the poor and the institutionalized«, while Black people have »disproportionately borne the burden of the most invasive, inhumane and perilous medical investigations« in the US (2007: n.p.).

In the mid-twentieth century, in particular, the position of controlled and exploited test subject had certain associations with poor, racialized women, thanks in part to some of the large-scale clinical trials underpinning pharmaceutical breakthroughs of the era – the first contraceptive pill, for example, which was approved for use in the US in the very year the word ›cyborg‹ first appeared. According to Preciado, the

> pseudocolonial island of Puerto Rico became the most important clinical site for testing the [contraceptive] Pill outside the national disciplinary institutions of the asylum and the prison and functioned as a parallel, life-sized biopolitical pharmacological laboratory and factory during the late 1950s and 1960s. (2013: 177)

Data collection here involved intrusive monitoring, with social workers moving »daily from house to house collecting fluids, recording information, and encouraging women's cooperation with the pharmacological regimen« – a process later repeated in Haiti and Mexico (Preciado: 2013, 188). The more than 200 women who participated in the trial »received little information about the safety of the product they were given, as there was none to give, and no one thought that it might be necessary to provide such information« (Liao and Dollin, 2012: n.p.). To what extent is the imagined cyborg of American astronautics entangled with this history of the medical test subject, and how might this compromise imaginaries revolving around white military masculinities? Could one argue that the forms of endangerment involved in being a test subject work to trouble the gendering of the hybridized cyborg? In order to address these questions, we will first turn to the later thinking of Manfred E. Clynes.

9 For more on this, see Burgess, Colin, and Chris Dubbs, *Animals in Space: From Research Rockets to the Space Shuttle*. Springer: Chichester, 2007.

6. Evolved Beings: Gender, Sexuality, and Non-Hereditary Adaptation

In a 1995 interview with Chris Hables Gray, Clynes argues forcefully *against* the idea that non-hereditary adaptation might destabilise existing frameworks of sex and gender. He declares that »the idea of cyborg (sic) in no way implies an it. It's a he or a she. It is either a male or female cyborg; it's not an it. It's an absurd mistake. The cyborgs are capable of the same emotional expression and experience as an uncyborg« (Gray, 1995: 48). Later in the interview, he further asserts that:

> the cyborg, per se – talking now of men and women who have altered themselves in various cyborgian ways – in no way has that altered their sexuality. In no way has that altered their ability to experience emotions, no more than riding a bicycle does. And even more importantly, it hasn't altered their essential identity. (Gray, 1995: 49)

These comments strike me as curious, in that they labour to uphold an image of an immutable, experiencing, embodied self which runs counter to the ideas of acid astronautics and to any process of becoming-cyborg. If the cyborg is a figure against species boundaries – one engaged in a Promethean refusal to »assume a predetermined limit to what we can achieve or to the ways in which we can transform ourselves and our world« (Brassier, 2014: 470) – then this sudden swerve toward an entrenched stability of identity feels like a move away from the cyborg itself.

While the interview in question took place more than 30 years after the term ›cyborg‹ was first introduced, the perspective on sex and gender it advances is consistent with certain elements of Clynes' earlier views. A belief in the transcultural and transhistorical character of emotion characterizes his solo-authored 1970 article »Cyborg II: Sentic Space Travel«, for example. This piece, later printed by Gray in his *Cyborg Handbook*, asks »How can man be authentic in space?« (Clynes, 1995: 36) – a question that the author explicitly extends to sexual activity and the satisfaction of erotic needs. Clynes argues that the »ability of man to express his emotions in accordance with his nature is indispensable for a prolonged existence in space« (1995: 42) and proposes several strategies to make this possible. He writes that bodily expressions of emotion – and, intriguingly, he lists sex *as* an emotion, alongside anger, hate, grief, love, joy, and reverence (Clynes, 1995: 38) – have »an unconscious origin. They are not wilfully created by each individual – they represent his heritage. […] This unconscious heritage travels with us into space« (1995: 42). We see again that sex is assumed to limit possibilities for participant evolution, serving as an unchangeable fact that we can aspire to manage or mitigate via enhanced understanding, but which we can never hope to transform, reprogramme, or overcome.

It is interesting to note, however, that Clyne's account is somewhat at odds with that of his contemporaries. Other mid-century discourses around space exploration trace

alternative possibilities for the cybernetic organism, as we can see when we look to the work of the cyborg's *other* originator, Nathan S. Kline. In a piece emerging from his 1967 study group on psychotropic drugs, Kline considers how pharmaceuticals might come to alter future life patterns. Several of his suggestions have direct implications for gender and sexuality. By the year 2000, we're told, we may have drugs with the capacity to »*Foster or Terminate Mothering Behavior*« (Kline, 1971: 83, original emphasis). With mothering behaviour »so typical of certain animals«, he suggests, »it appears highly probable that there are ›juices‹ which mediate in the production of this behavior. By enhancing or interfering with their production it is possible that the extent of such behavior could be controlled« (1971: 83).

He speculates too about drugs designed to »*Regulate Sexual Responses*« (1971: 80, original emphasis), »Banking the fires or stoking them biochemically« in an effort to »increase the sum total of pleasure and at the same time allow man to devote more of his time, intelligence and energies to more exclusively human activities« (Kline, 1971: 83) – a sort of intensified libidinal automation. Kline seems to lack his collaborator's squeamishness about gender and sex as territories for technical intervention and challenges the idea that even something as naturalized as maternity might be excluded from Promethean attempts to re-make the given.

Frederick Pohl is similarly interested in exploring ideas around the sexual cyborg. In his work, becoming cyborg means submitting not only to intimate control, monitoring, and surveillance – factors which, even on their own, could feasibly be said to trouble the structures and codes of identity at play – but also to direct interference with the genital organs. The virile astronaut hero of *Man Plus* is castrated, without his prior knowledge or consent, on the basis that (having evolved beyond the elimination of waste) the reproductive organs are now »just a vulnerable spot« (2000: 101). The narrator depicts Roger Torraway's moment of horrified realization thusly:

> There, between his legs, was nothing. Nothing at all of penis, testicles, scrotum; nothing but the gleaming artificial flesh with a transparent bandage over it, concealing the surgery lines. It was as if nothing had ever been there. Of the diagnostic signs of manhood… nothing. The tiny little operation was over, and what was left was nothing at all. (2000: 94)

Reeling from the initial trauma, he experiences »hopeless desolation. He not only had lost Dorrie, he had lost his manhood« (2000: 103). Although Roger's body has been blithely transformed, then, his sense of what it *should* be – his commitment to and identification with a particularly sexed version of his body and himself – remains intact (at least initially).

On the one hand, we could interpret Roger's distress as a fictional demonstration of precisely Clynes's point – that is, as a representation of the idea that essential identity

remains steady despite biotechnologically facilitated change. That the character's physical form has been developed in unchosen ways, in profound violation of his bodily autonomy, while his gendered self-understanding persists is shown to be largely the source of his trauma. The »sexual nature of man isn't just the sex organs«, as Clynes puts it, »It is something very much in the identity of the person« (Gray, 1995: 49). Hence, there may be all kinds of cyborg bodies, but their cyborgian qualities do nothing to challenge the fundamental character of the embodied subjects involved. Participant evolution cannot change those ineffable elements of the self where gender and sexuality are situated or from whence they are derived. This reading is perhaps reinforced by the fact that the »monster« of *Man Plus* also receives a »steroid capsule« to ensure he »won't become effeminate« (Pohl, 2000: 101).

Of course, a person's gender is not determined by their genitalia – Clynes is quite right about that. But it's worth stressing that he is not decentring the sexual and reproductive organs here as part of a trans feminist or genderqueer politics of sexual difference. Rather, he's arguing that technological mediation cannot affect the gendered or sexual self because these things are untouchable, stable, and at the very root of human existence. This is a biologically essentialist approach to phenomena which Clynes associates with a necessarily non-cyborgian facet of embodiment. The »genes and chromosomes already determine sex, and the brain circuitry expresses that sexuality«, he argues (1995: 49), meaning that most forms of non-hereditary adaption, no matter how extreme, have little chance of altering it. The flip side of this reading, however, is that the changes that come along with Roger Torraway's becoming cyborg *are* eventually shown to be suggestive of fundamental shifts – that is to say, Pohl seems to be using the novel to explore precisely the possibility that gender and sexuality can in fact be re-engineered.

The reader encounters this most clearly via Roger's evolving attitude to his wife. For much of the book, he is depicted as both besotted and deeply jealous. »In some arcane way«, we're told, »all the processes of his life terminated in Dorrie. […] The horror of his appearance was that it would offend Dorrie. The tragedy of castration was that he would fail Dorrie« (2000: 138). Roger's »manhood« is to some extent both expressed and constituted by this conjugal connection. The infatuation is so intense that, as he drifts further and further away from the commitments of his previous humanity, the Exomedicine Project starts to use the idea of his wife as a tool via which to manipulate him. It hires a woman called Sulie Carpenter – an aerospace doctor with a passing resemblance to Dorrie – to dye her hair, wear coloured contact lenses, and pose as his nurse so that she can form an exploitable bond with him, thereby extending the project's control over its increasingly unpredictable post-human asset.

As the cyborg's body progressively changes, however, and as his affections start to detach from his wife and transfer to her custom-made replacement, Roger's attitude to sex also changes:

> It's like being told I can't have any caviar […] I don't like caviar. And when you come right down to it, I don't want sex right now. […] it finally penetrated my little brain that I was just making trouble for myself, worrying about whether I could get along without something I really didn't want. It's a reflection of what I think other people think I should want. (Pohl, 2000: 152–153)

Even if the changes in Roger are not undertaken with the direct intention of manipulating his sexual and gender identity, then, there is a sense in which the instrumentalization of the cyborg shifts perspectives both on what a body can do and on what a body is for. Over time, the whole suite of changes to which the organism has been made subject are shown to enact profound shifts in embodied self-understanding.

Towards the end of the novel, while up on Mars alongside the man he knows to be Dorrie's illicit lover, Roger is himself struck by having undergone an attitudinal shift; he no longer feels possessive:

> The situation interested him as an abstract problem. Was it because he was a gelding? There was testosterone circulating in his system, the steroid implant they had given him took care of that. His dreams were sometimes sexual, and sometimes of Dorrie, but the hollow despair and anger he had lived with on Earth had attenuated on Mars. (Pohl, 2000: 196)

Instead, his affections intensify for Sulie Carpenter. He forgets what sex feels like, and dwells upon the sensation of touching her fingertips. Of course, rigid adherence to the heterosexual matrix is maintained here – the stripping away of penis and testicles is offset via the circulation of testosterone, and the disinvestment from penetrative marital coitus is transformed into a libidinized investment in a form of touch that, although non-genital, is nevertheless coded as its straight replacement. But there are at least hints in the text that cyborgian embodiment might open up queer alternatives – that non-hereditary adaptation is seen as a possible route to re-engineering the sex/gender/sexuality nexus. Sulie, while announcing her intention to stay on Mars and establish the first colony, is questioned as to how she will cope without sex, given that her only company will be the monster. She responds that »[t]here are more ways to orgasm than with a penis in my vagina. And there's more to sex than orgasm« (2000: 190).

Of course, the idea of being assigned to the ranks of an emerging post-orgasmic species may not be a particularly appealing prospect for still-fleshy readers – particularly for women, who too often experience a pleasure gap under current sociosexual conditions as it is! And of course, we don't need science fiction to teach us that bodily transformation without bodily autonomy is the stuff of nightmares – it is a fact made painfully apparent in the »disproportionately raced occurrences of non-consensual

sterilization in the twentieth century, […] the exploitation of non-white bodies in medical testing, attempts to impose long-term contraceptives such as Norplant and Depo-Provera upon welfare recipients, and other forms of the racist, classist, and cissexist disciplining of bodies« (Hester, 2018: 121). Nevertheless, however, Sulie's comments *are* suggestive of the potential for new forms of sexual relations – non-teleological, non-reproductive, and non-proprietorial – at just the point at which humanity looks set to become its multi-planetary successor species. Given that, as Clynes puts it, sex and gender are widely assumed to be a part of both a species' and a subject's »essential identity« (Gray, 1995: 49), this suggestion of malleability in the realms of bodily pleasures bespeaks radical transformation. Indeed, it may be as clear an indication of the human transcending itself as the possibility of extra-terrestrial colonies.

7. Conclusion: Everyday Cyborgs

In this essay, we have drawn on mid-century astronautics, a science fictional case study, and two brief cross-cultural comparisons in an effort to better understand what is distinctive (or otherwise) about the all-American cyborg. In the process, we have pointed to the cyborg's roots in two discursive regimes: that surrounding military masculinities, and that surrounding the non-human (or de-humanized) medical test subject. We have considered some of the tensions generated by this dual heritage, particularly in terms of species and gender, touching both on the use of primates and canines in early space flight and on unevenly distributed experiences of clinical suffering and embodied risk more generally. We have discussed some of the problematic ways in which sex and sexuality have been excluded from the perceived mutability of cyborgian embodiment, opposing Manfred E. Clynes's perspective to that of his sometime collaborator Nathan S. Kline and to the visions put forth in Frederik Pohl's *Man Plus*. Throughout the course of our argument, we have discussed a version of the cyborg that emerges distinctively from the astronaut – the ›space cyborg‹ – and as a result, have framed cyborgian adaptation primarily as an extraordinary biotechnical feat.

It is worth remembering, however, that despite its rarefied roots in mid-century astronautics and its speculative representations in science fiction, the cyborg is also a quotidian figure – a fact of life for carbon-based life forms entangled with silicon-based actors. For Haraway, we are all already »chimeras, theorized and fabricated hybrids of machine and organism […] The cyborg is our ontology« (1991: 150). Today, gendered bodies are a commonplace cyborgian achievement. This is the case whether we define the cyborg broadly, as a biological organism engaged in habitual technological tool use, or more specifically, as the embodiment of non-hereditary adaptations that function without ongoing conscious intervention. After all, some technologies of sex and gender – the IUD and hormonal contraceptive implant, for example – can reasonably be

understood as a means of automating autonomy. As Preciado puts it, the »certainty of being a man or a woman is a somato-political bio-fiction produced by a collection of body technologies, pharmacologic and audiovisual techniques that determine and define the scope of our somatic potentialities and function like prostheses of subjectification« (2013: 117).

By this account, becoming cyborg may indeed effect sex, gender, their interconnections and their associated identities, but need not necessarily disrupt or challenge binary gender or compulsory heterosexuality. In fact, one could argue that the prosthetically and pharmaceutically manipulable character of the human subject has, from at least the birth of the term ›cyborg‹, been used to buttress the very regime that it simultaneously appears to dismantle. From the middle of the twentieth century, Preciado notes,

> males are no longer guaranteed to impregnate, females stop menstruating and gestating under the effects of the contraceptive pill, and lactation is provided by food industries instead of female breasts. The heterosexual dimorphic regime of ›sperm and egg cell carriers‹ is going awry. (2013: 105)

We would do well to remember this when tracing out the subterranean emancipatory possibilities of science fiction and acid astronautics.

Contra the comments of Clynes, sex and gender are not facts of pure nature, immune to the influences of technologies and comfortingly immutable (indeed, we need to question for whom this idea of immutability would be comforting in the first place); they are just as much a product of and a territory for participant evolution as any other element of embodiment. The question is thus not *whether* sex and gender can be re-engineered, but rather how they *are already* being re-engineered, by whom, and for what ends. We confront a further, final issue concerning the simultaneous necessity and difficulty of agential intervention here. After all, as today's astronautics discourse attests, »humans are already *accidentally* engineering life and directing evolution«, but are doing so without »volition, direction, and purpose« (Mason, 2021: xiii). If we are to conceive of new possibilities for technology and embodiment, it will be less a matter of *freedom from* cyborgian intrusion, and more an issue of *freedom to* remake – via all means necessary, including the technical – that which we find to be oppressive or unjust about gender and sexuality (and, indeed, the wider social world) as they stand. We can rebuild them. We have the technology.

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