Valentina Tereshkova and Yuri Gagarin as Heroes of the Soviet Union. Official painting, c. 1964.

and via telecommunications as an organically collectivizing system conceived in both extensive and intensive terms. Cosmonaut formation appeared through the terrestrial testing and planning of the evolved cosmonaut body and its perceptual system, and through the attempts at perfecting rocket launched docile subjects, made cosmic heroes on Earth.

This text expands upon an exhibition of the same title presented at Columbia University's GSAPP in Spring 2009 curated by Deane Simpson and Mark Wasiuta. The exhibition will travel to the Architectural Association in London, Spring 2011.

1 A quote from Soviet Premier Nikita Khrushchev, 1963 from an unpublished translation by Nadia Tereshkova in 1999 of: Academy of the Sciences of the USSR, *The First Flights of Man into Space* (Moscow: Academy of the Sciences of the USSR 1963).

2 See Walter A. McDougall, *The Heavens and the Earth: A Political History of the Space Age* (New York: Basic Books 1997), pp. 276–77.

3 See in particular the second Senate Report. The 847 page document updates the first report published in 1962. The description and analysis of the space spectaculars appears on p. 62. Library of Congress. Legislative Reference Service. *Soviet Space Programs, 1962–65: Goals And Purposes, Achievements, Plans, And International Implications; Staff Report prepared for the use of the Committee on Aeronautical and Space Sciences, United States Senate* (Washington: U.S. Government Printing Office 1966).

4 Walter A. McDougall, *The Heavens and the Earth: A Political History of the Space Age* (New York: Basic Books 1997), p. 249.

5 Yuri Gagarin, *Road to the Stars* (Honolulu: University Press of the Pacific 2002), pp. 171–2.

6 Michael Sheehan, *The International Politics of Space: No Final Frontier* (New York: Routledge 2007), p. 31.

7 See Rex Hall, David J. Shayler, *Vostok and Voskhod: The First Soviet Manned Space Flights* (New York: Springer 2001).

8 See Rex D. Hall, David J. Shayler and Bert Vis, *Russias Cosmonauts: Inside the Yuri Gagarin Training Center* (New York: Springer 2005).

9 Wilfred Burchett and Anthony Purdy, *Cosmonaut Yuri Gagarin: First Man in Space* (London: Anthony Gibbs and Phillips 1961), p. 105.

10 Gagarin, *Road to the Stars*, p. 113.

11 Alexei Leonev and Vladimir Lebedev. B. Belitsky (trans). *Space Time and Perception by the Cosmonaut* (Moscow: Mir Publishers 1971), p. 17.

12 Referenced by Svetlana Boym in 'Kosmos: Remembrances of the Future'. In *Kosmos* (New York: Princeton Architectural Press 2001), p. 85.

13 See James H. Billington, *The Icon and the Axe: An Interpretive History of Russian Culture* (New York: Vintage 1970), p. 480.

14 David A. Mindell, *Digital Apollo: Human and Machine in Spaceflight* (Cambridge, MA: MIT Press 2008).

Mumbai as a Spaceship
Compact Living on Earth as in Space

Susmita Mohanty

Technological spin-offs from space design integrate seamlessly into our daily lives but the confined conditions of extraterrestrial shuttles seldom serve as Earthly inspiration. Space entrepreneur Susmita Mohanty profers that living conditions in outer space can inform and exchange with cramped environments down below, such as the worker-housing and informal settlements of Mumbai. And the way one thinks about space living systems can also inform the structure of urban development: the city is a spaceship.

Ever seen the Space Shuttle mid-deck?

It is not very different in size, basic amenities or socio-psychological stressors to a compact home in dense cities like Mumbai, Tokyo, New York or Sao Paolo. The potential shortage of real estate, clean air, water and waste disposal in dense cities present living problems not dissimilar to those encountered in extraterrestrial, synthetic environments. The problems of odor, noise, crowding, privacy, hygiene, maintenance and storage are quite comparable.

There are some differences as well. A 25 square meter home on Earth is equivalent to a 125 cubic meter living space in Earth orbit: in the absence of gravity, the entire room from wall-to-floor-to-ceiling is available for use. In space, the other extreme difference is that you cannot easily walk out of your habitat as on Earth.

The shuttle mid-deck is a tiny space that accommodates a crew of seven, a bank of lockers, equipment bays, a toilet, a galley, an airlock, and a ladder leading to the flight deck. (In the 1980s, it also had bunk beds that were later replaced with Velcro-able sleeping bags.) When empty, the mid-deck footprint is that of a small room measuring 4 meter in length, with a 3.7 meter rear width and a 2.7 meter front width. But with all the necessary equipment in place, you can hardly see the surface of the 2.1 meter curved walls.

Extrapolate the shuttle's habitable space a bit further and you have the International Space Station (ISS). Imagine a floating complex built with ten to twelve meter long coke-can-shaped pressurized modules connected by four-way nodes. The ISS comprises American, Russian, Japanese and European modules. Each module is outfitted differently according to the cultural, design and technical sensibilities of the sponsoring nation. Together, the modules form an integrated housing and laboratory complex.

The ISS can be compared to a Mumbai *chawl*. A *chawl* is an integrated housing complex with four to five floors. On each floor, there are approximately ten to twenty *kohlis*, which in size and function are comparable to ISS habitat modules. Each *kohli* is essentially an all-purpose room (including living, eating and sleeping spaces) connected to a common circulating space. *Chawls* were built to house people migrating to Mumbai to work in the booming cotton textile industry during the late-nineteenth century. As most of the Mumbai cotton mills have now closed or relocated, many of these *chawls* are being erased to make way for modern residential and commercial buildings.

Slums (informal settlements) in Mumbai are also facing severe urban redevelopment pressures. However, unlike the chawl, slum houses are compartmentally different; they are a small cube divided by two floors. The lower deck is usually the living quarter; the upper deck, which usually has a low ceiling, is a sleeping quarter and provides a little more privacy than the lower deck. A ladder connects the lower and upper decks. This two-deck arrangement is not very different than the one found on the Space Shuttle.

The *chawls* and slums of Mumbai occupy prime land in a city where real estate prices are among the highest in the world. With many redevelopment schemes

Photo: Nasa

Three STS-107 crewmembers are pictured prior to their sleep shift in bunk beds on the mid-deck of the Space Shuttle. From the left are mission specialists Laurel B. Clark, Rick D. Husband, and Kalpana Chawla.

under way to shift *chawl* and slum residents to new 'nano-houses' on the periphery of the city, the structural systems that supported the social-mixing of the inhabitants are under threat. With the rampant modernization of Mumbai, city politicians and builders are scheming to 'redevelop' Mumbai's slums and *chawls* to create business districts and residential complexes. They say they will rehabilitate the *chawl* and slum residents in nano-houses built in the far-flung suburbs. These so-called nano-houses being promised to the chawl and slum tenants are a sham; they are of inhuman proportions.

Mumbai is calling out for architectural interventions that address the needs of the displaced slum and *chawl* inhabitants. Due to the compactness of the nano and slum dwellings, perhaps the answer lies with spaceship designers.

Antidotes for Nano Homes

Designers creating comfortable living spaces for a family in a tiny apartment face problems by which approaches used by spaceship designers can be readily applied, including: designing air scrubbing systems to supply clean air in a polluted urban environment (a mix of filtration processing and recirculation), recycling grey and black water, trying to grow fresh produce locally, minimizing waste, etc.

Furthermore, many considerations familiar to spaceship designers – productivity, privacy, assembly, aesthetics, identity, sensations, views, mood, safety, utilities, and adaptive use, to name just some – are increasingly relevant to the design of habitable environments in dense cities. Living both in space and in dense cities brings into sharp focus considerations such as: sustainability, material recycling, and regenerable life-support.[1]

Although to a lesser degree than in extraterrestrial habitats, in the design of urban living spaces, one also needs to consider social and psychological stresses caused by overcrowded public spaces and utilities, cramped living and working conditions, traffic jams, pollution and a near-complete lack of privacy. Often space mission simulators are used to research the effects of long-term isolation and confinement on astronauts. These simulated environments are also useful in developing stress busters and identifying ways to minimize conflict scenarios that can jeopardize the mission. Even in the terrestrial context, we could use environmental simulation to research the effects of long-term living in extreme urban environments – on mental performance, individual well-being, behavioral health and interpersonal relations. As on a space mission, here on Earth too, we need to develop countermeasures that can improve the quality of life.

Islands to Metropolis to Islands

The city of Mumbai is founded on an archipelago of seven islands that were, over the span of five centuries, connected through land reclamation projects to form the area of the modern city. As of the world's densest cities – with nearly 23,000 people per square kilometer – it has an estimated population of around 24 million. Just imagine the logistics and the life support systems that are required to sustain Mumbai on a daily basis. Life support comprises food and water supply, waste management systems, energy grids, air revitalization and pollution mitigation systems. In order to deal with infrastructure of this magnitude, a spaceship could serve as a rather elegant metaphor for city planners.

Imagine decomposing the city, in terms of urban planning, into modular micro-cities that function as self-sustainable islands. Each island can be designed to survive independently with a closed-loop life support system and green technologies such that the waste is minimized and whatever is generated, gets recycled back in. This will eliminate the need for long sewage networks, long-distance transportation of consumables and complicated energy grids.

These notions are outlined in the manifesto, 'The City As A Spaceship' (CAAS). CAAS will be part of a planned urban renewal with a mind to sustainability, security and quality of life. CAAS has been conceived by its founders to investigate the reciprocities between space and terrestrial architecture.

The City As A Spaceship (CAAS) Manifesto[2]

We see the spaceship, and a space habitat, as completely analogous to the modern, densely packed, technology-driven hyper-metros of tomorrow and ideas and technologies for space that can immediately impact the development of these cities. In return, we see these living, thriving, survival-challenging uber-cities as collections of self-contained, super-redundant microcosms that prove themselves to be reliable and hardy over time, to be directly translatable to the space colonies of the future.

We think of a wonderful yet obvious symbiosis – tomorrow's space ideas shape today's cities, and investment in today's cities serves as the vehicle and test bed to both subsidize and implement tomorrow's space endeavors. 'The Earth as a spaceship' is not merely a metaphor – it is a tangible, viable way for the future survival of humankind.

We want CAAS to be a metaphorical movement in urban planning; a new way of thinking about humans and their relationships with their habitats, transporters and environment; an intelligent way of designing cities. Each city is to be composed of small, spaceship like closed-loop ecosystems where most resources the city consumes are produced locally, in-situ, and leveraging the power of technology to reap efficiencies through subsystems that plug into mega grids, to share excesses, while not sacrificing self-sufficiency, or the ability to decouple from 'the city' in the event of a crisis. Most things these ecosystems spit out as waste gets recycled back in. This urban philosophy can lead to the design of future cities that could exemplify what Buckminster Fuller meant with 'Spaceship Earth'.

We can find many different strategies – on one hand these ecosystems could be completely independent systems with even dedicated food supply. On the other hand, they could have strategic interconnections with the inevitable trade-offs. Within a framework of completely self-sufficient ecosystems, there could be certain costs imposed by redundancies, and the lack of scale, minimized somewhat by technology and through the accomplishment of grid-based scale economies, as discussed above. The benefits are those afforded by complete modularity. Resources would never collapse completely. The variety in technologies and ecosystems would play into security where one mode of attack, or failure, could not compromise everything, or effect too large a part of the city ... In the model of selective interlinking, one would sacrifice the benefits of complete closed loops in favor of some scale economies.

The implications for what we seek to address may be very significant, and urgent, especially in the present day context when global climate change is staring us in the face. Two of the most populous nations on the face of the planet – India and China – are urbanizing at a monstrous pace, and doing it in much the same way as the industrialized world did in the preceding decades. These parts of the world need new answers if we are to stand a chance to keep the world habitable, and sustainable.

1 Sherwood, et al., Report of International Academy of Astronautics (IAA) Commission-6 Space Architecture Study Group (SASG) 6.9: 'The Architecture of Space: Tools for Space Development in the 21st Century', Paris, 2009.

2 S Mohanty and S Das, *The City As A Spaceship* (CAAS) Manifesto (San Francisco: 2007).