

OTHER PEOPLE'S UTOPIAS [Slide 1]

"Infra-free architecture." Creating livable environments free from dependence on an existing social, organizational, and industrial infrastructure. Well, you couldn't find a situation that would be more infra-free than going out to colonize new worlds at other stars.

Some years ago, when I lived in California, I attended a weekend seminar on interstellar colonization. It included some bright and interesting people, versed not only in the relevant technologies, but also management, social, and psychological sciences. As you'd expect, a lot of the workshops had to do with technical issues--creating habitats that will sustain life for an extended period in the space environment; energy sources, propulsion systems, materials, structures, and that kind of thing. But one section of the agenda was headed "Types of Social Organization." The team that tackled it included a couple of psychologists, an industrial psychiatrist, and a management consultant, among others. Their analysis was a masterpiece of organization-speak, defining and categorizing, breaking everything down into classes and sub-classes. It reduced all of the diversity, triumph, tragedy, and magnificent chaos of the human drama to three types of society. These, in a leap of breathtaking imagination, were designated "Type A," "Type B," and "Type C."

A "Type A" community, we were told, was "Hierarchical and Homogenistic" [Slide

2]. People in this kind of community believe there is a "best" way of doing everything, which is good for everybody.

Hierarchical

(upper)

[Slide 3]



These are the people who maximize and optimize, pursue efficiency as a self-evident ideal, and see competition as the basis of all progress. Nonstandard behavior and minority groups are to be ignored if possible, or corrected if they become too inconvenient. Because of the belief that differences create conflict, such systems are divided into groups by age and by occupation.

Hierarchical

(lower)

[Slide 4]



Living units would all be identical, and the inhabited areas would be zoned into

residential, agricultural, industrial, and so forth. It seemed to be assumed that all of the above viewpoints and opinions occur inseparably in one psychological package.

A "Type B" community" was . . .

"Individualistic and
Isolationistic."

[Slide 5]



(What is it that makes me uncomfortable about people who want to put "ic" on the end of every adjective?)

Independence and self-sufficiency are the highest virtue. Every living unit in a ship built to this philosophy would be its own castle, isolated from the others, with everything adjustable for individual taste, and privacy the major concern. Decision-making would be as autonomous as possible, with a minimal central command structure.

The presenters disposed of these two categories fairly speedily. It was hard not to feel that they had been included mainly as a token to completeness and impartiality, but the one that the authors were pushing was the third. This was the "Type C community", characterized by being "Heterogenistic, Mutualistic, and Symbiotic" [Slide 6]. Majority rule is considered homogenistic domination by quantity. Competition is

destructive and useless, and is to be replaced by cooperation. The benefits were described by phrases like:

Symbiosis of biological and social process

[Slide 7]

Enrichment, symbiosis and resource diversification

Harmony of diversity

(I'm not making this up.)

The word "harmony" occurred a lot during the presentation.

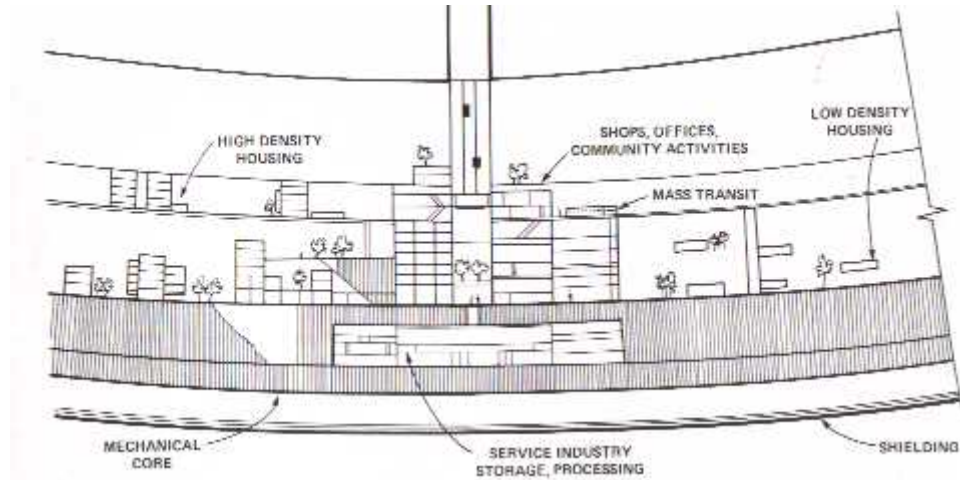
[Slide 8]



There were two methods of combining the elements making up the heterogeneity to achieve harmony : "Localization" and "Interweaving" . . . And so it went on.

The resulting community had every kind of amenity and service imaginable. Nothing had been overlooked by the planners or excluded from their calculations. Residential units were allowed 49 square meters per person: 37 sq.m. of floor area and 12 sq.m. of exterior space. Business districts were assigned 10 shops to every 1000 people, and 2.5 sq.m. floor space per office worker.

Precinct
Plan
[Slide 9]



There were schools and hospitals; halls for community meetings and theaters; entertainments that were educational as well as recreational; facilities for creative hobbies; park spaces for sports and leisure. It was all very harmonious, of course; as well as being balanced, wholesome, healthy, hygienic . . . and so antiseptic, vapid, insipid, and sanitary that my first reaction was a feeling of wanting to throw up. Where were the sleazy bars, night clubs, pool parlors, and casinos--in other words, the things that lots of real, live, flesh-and-blood people, in the real, bustling world--the things that make *real* "heterogenistic" communities--like to do sometimes?

[Slide 10]



Or wasn't this place meant for real, live flesh-and-blood people?

It was an upper-middle-class academic intellectual's ideal of how other people ought to live; a projection of the model suburbia that model families of TV commercials inhabit. But the possibility that the subjects might not be quite so enthralled by it all didn't seem to have occurred to anyone. Perhaps I should amend what I said above: Nothing had been overlooked by the planners except how the unmasked recipients of all this moral guidance and cultural improvement might feel about it.

There seems to be a certain kind of mind that preoccupies itself with social engineering and visions of creating the ideal society. But the trouble with utopias comes when not everyone agrees that they're so utopian.

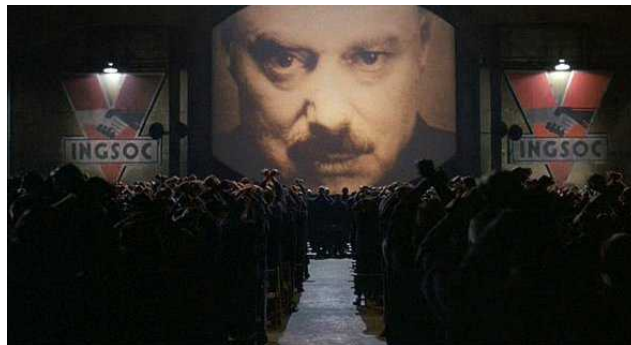
[Slide 11]



On Earth, when some utopian dream experiment eventually collides with reality-- usually in the form of human nature--it might be the end of the utopia but it isn't the end of the world. The disillusioned disperse back into the general run of things, and life carries on. But what do you do with your rebels and dissidents in a generation starship? You can't have them transferred somewhere else or retired from the service as you can malcontents in the crew of an aircraft-carrier or submarine. Or throw them overboard in

the way of a guru expelling misfits from a back-to-basics colony. Shooting them has the drawback that it might start people wondering about the leadership's commitment to the sacredness of harmony. Screening and selection before departure would mean that the spacegoing community isn't representative of the real human condition to begin with--so how can it be expected to cope when real human problems arise? And in any case, since we're talking about generation ships, what do you do about the aberrants who, inevitably, will be born later in the voyage?

[Slide 12]

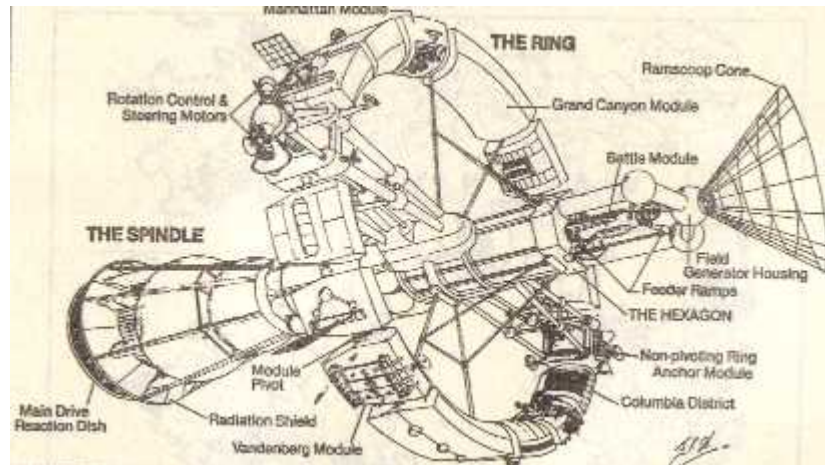


Good reasons can always be found why those who disagree should be coerced into living as others think they should. Once the cause has been identified with furthering the common good, then any questioning of it automatically becomes the mark of the common enemy. Safety and security considerations are crucial in an artificial space habitat. That gives a ready-made justification for imposing a regimented order "for your own protection." Physical resources are limited. The management and allocation of shortages--and their creation, if necessary--have always provided fertile grounds for planning boards and coercive bureaucracies. In other words, a long-duration space experience offers all the temptations and pretexts that the zealots for authoritarianism relish. So how do you preserve the values of freedom and self-

determination that we say we believe in?

Of the proud ship which lifts out of orbit and departs toward the stars . . .

Slide 13]



. . . how do we prevent what arrives, one, two, three, or even more generations later, from degenerating into a spaceborne sheep pen or a human vegetable patch? Or worse, a concentration camp in which all dissent and diversity has been suppressed by force?

(Incidentally, that's an illustration of a starship from one of my books. It has a variable geometry architecture that as far as I know is unique. The modules around the Ring are about a mile across, and can pivot to produce a resultant of the centripetal and thrust vectors that's always perpendicular to the floors for any combination of thrust and rotation. I couldn't get the idea across to the cover artist, so in the end I ended up drawing it myself.)

But getting back to the point:

How, do we design a society whose one, overriding attribute is that it wasn't

designed? [Slide 14]

My answer would be, not to try. It would probably be a waste of time anyway. For the simple fact is that nobody knows, or very likely can even imagine, what the conditions might be of such an expedition ten, twenty, thirty years out, or what kind of social, psychological, or other stresses might have arisen. Even the natures of the people who had come into being by that time could be completely alien to the comprehension of anyone shaped by our planet-bound perspectives. So why not let the society *design itself* as it goes? And since from what we've been saying, one form of community is never going to suit everyone, this means "communities."

Imagine our initial ship . . .

[Slide 15]



--or preferably "ships." Two or three, say, to provide lifeboats in case of emergency. Columbus had the right idea. That was an artist's idea of starships in the 1940s. Depictions today look something like this:

[Slide 16]



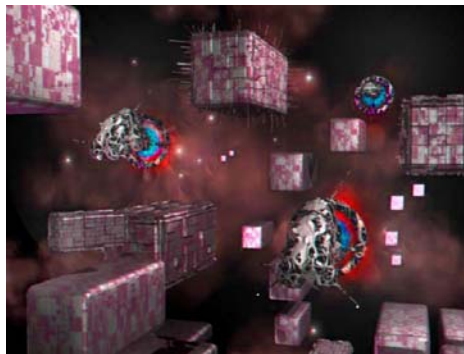
or this . . .



[Slide 17]

. . . lifting out from orbit accompanied by a flotilla of immense cargo rafts and repositories of materials and equipment.

[Slide 18]



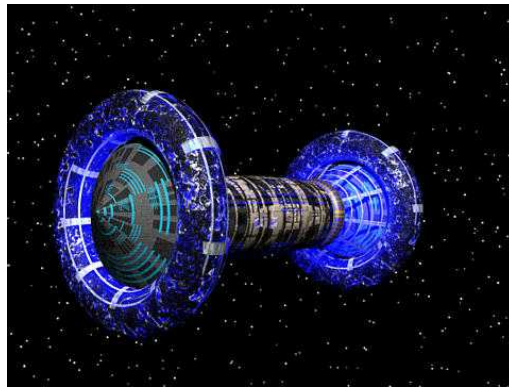
Or the rafts could be sent out ahead at intervals over years if need be, to be overtaken and consolidated as the voyage proceeds. Now there's no need for experts to spell out in advance what kind of places the future descendants shall inhabit, how they shall live, and what they should think. Because as all the unpredictable factors that time will bring unfold, and various groups

emerge with different ideas about the kind of world that would appeal to them, they can simply *go out and build their own!*

Pick your own geometry:

Dumbbell-shaped and compact

[Slide 19]



Open and exotic

[Slide 20]



Sleek and svelte

[Slide 21]



What a great way to cure the boredom and disgruntlements that are bound to surface among any human community shut up for a long period of time in a limited space! And provide an outlet for surplus energies.

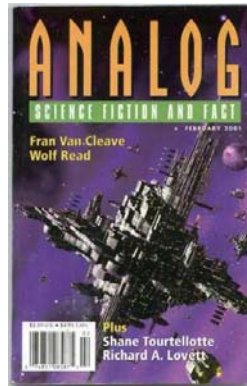
[Slide 22]



Tired of walking through the same mall-like concourses and residential decks every day, and seeing the same patches of hydroponic greens overhead, interrupted by star-filled sky windows?

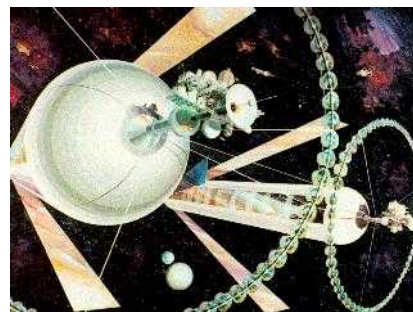
Fine. Get a like-minded group together
and design yourselves a space-going
New York City . . .

[Slide 23]



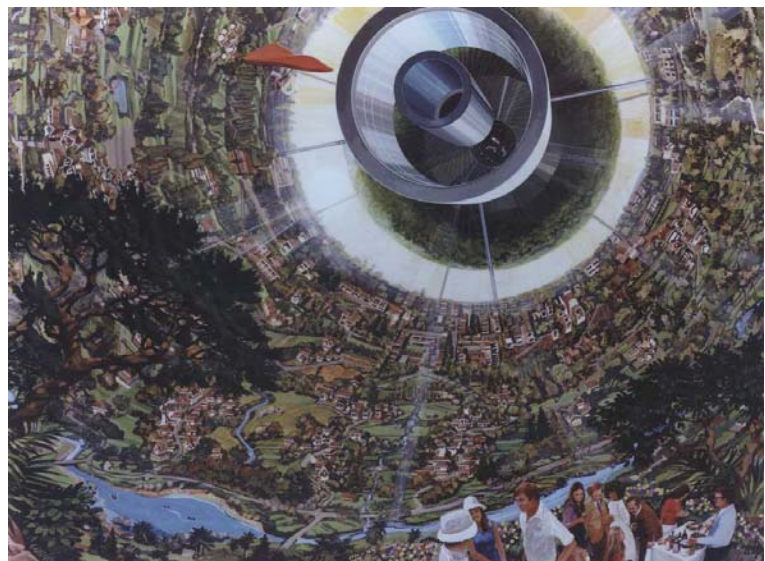
A modular Ferris wheel
farm . . .

[Slide 24]



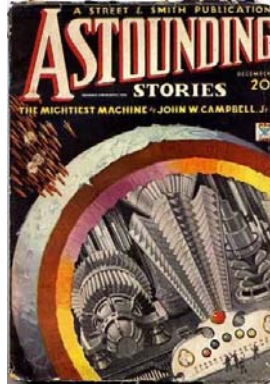
Or anything else you want.

[Slide 25]



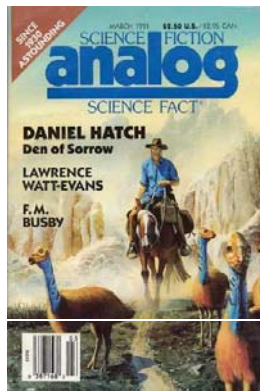
Whether you revel in the hum and power of heavy industry

[Slide 26]



Or prefer a more rural lifestyle . . .

[Slide 27]



Your needs can be accommodated.

But we're also talking about diversity of social and political architectures, not just physical architecture. All those religions, ideologies, and economic theories of living that in the past suffered the drawback of having to share fences with cranky or disapproving neighbors, can set up their own dedicated world.

Cooperative . . .

[Slide 28]



Competitive

[Slide 29]



You can experiment with Libertarian living, or Socialist, Libertine, Monarchist.

A benevolent dictatorship,

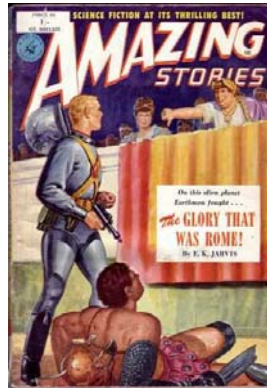
maybe. . . .

[Slide 30]



Or not so benevolent.

[Slide 31]



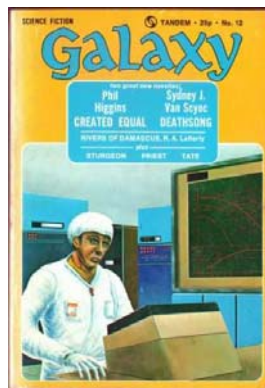
Artistic . . .

[Slide 32]



or strictly utilitarian . . .

[Slide 33]



For tastes that are staid and traditional . . .

[Slide 34]



or bizarrely avant-garde

[Slide 35]



Or I suppose you could even go

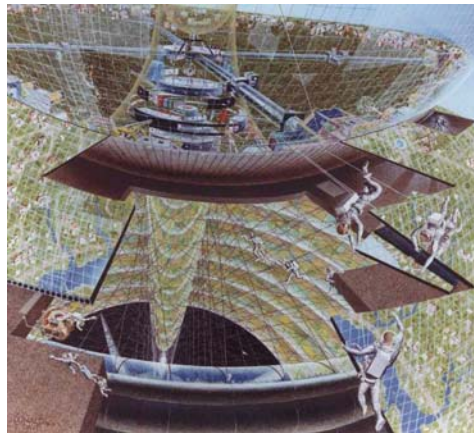
Hierarchical and Homogenistic," or "Heterogenistic, Mutualistic, if it really grabs your fancy.

And the beauty of it is that none of these attachments to a social formula or style of living has to be permanent. As the initial strung-out stockpile of construction materials transforms itself into a formation of liberal-to-tightly-run city states, frontier towns, religious monasteries, pleasure resorts, urban crushes, rural spreads, academic

retreats, and who-knows what else, the changes and contrasts of moving from one to another could provide the variety essential to a healthy life. It could be an invaluable means of education too. For what better way could there be of learning the realities of someone else's utopia than shuttling across a few miles of intervening space and trying it for a while?

This will all involve major construction projects, and ongoing exploration of innovative architectures . And that's a good thing, because it will enable new generations to keep alive the skills and abilities they're going to need once they arrive at the final destination. It will doubtless entail plenty of the traditionally envisioned kind of floating-around-in-spacesuits kind of space engineering and robotics . . .

[Slide 36]



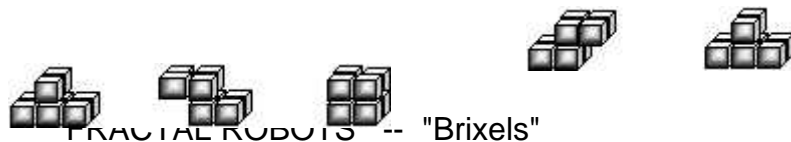
Better than boring gymnasiums for exercise, and a great antidote to claustrophobia.

The major constraint in designing structures on Earth has always been getting them to support their own weight. In space, immensity of scale comes cheaply. We can

expect to see all kinds of innovations and revolutionary techniques that would be inconceivable on a planetary surface. However, we're still talking about an environment in which the mission brings its infrastructure of human organization and supervision with it. But a setting for the deployment of full, infra-free autonomous creation is already there.

What we have is an already-moving launch platform that can send ahead robotic seed packages that will self-replicate from local materials to prepare the destination habitat for human occupation. Our star-faring pioneers of the future would no doubt use concepts and methods beyond anything realizable at present. But we can already see the beginnings of what will surely be some of the techniques that will be developed. A key player will be the employment of Modular Reconfigurable Robots.

[Slide 37]

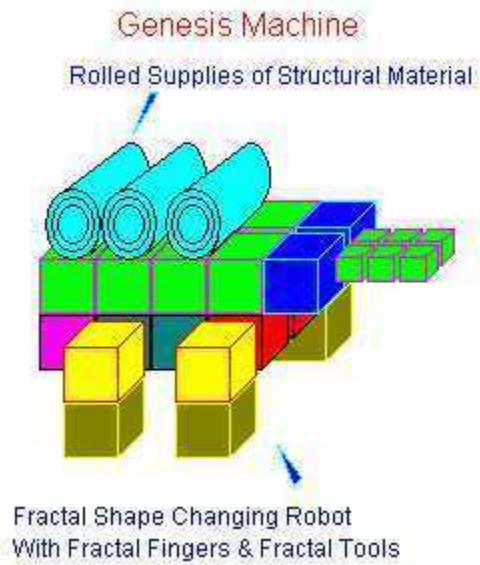


Instead of designing a different robot for each task, you build many copies of one simple module. A module can't do much by itself, but many of them together form a system that can do complicated things. The system can reconfigure itself for different tasks or different working environments.

The slide shows an example of a particular kind of Modular Reconfigurable Robot known as a Fractal Robot. The basic geometry of the module is preserved through progressive orders of scale--in this case, cubical. Here, the sequence shows a 2x2x2

cube reconfiguring itself for walking. It can also do things like form itself into a snake to navigate a narrow space or tube, and reconfigure as a walker when it emerges on the other side. The name comes from "brick" and "pixel".

[Slide 38]

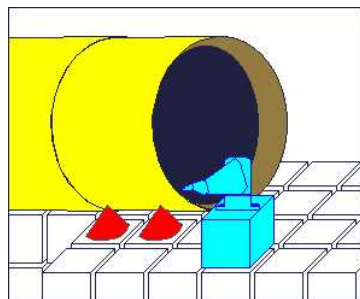


Here are some cubes configured as a general-purpose construction robot.

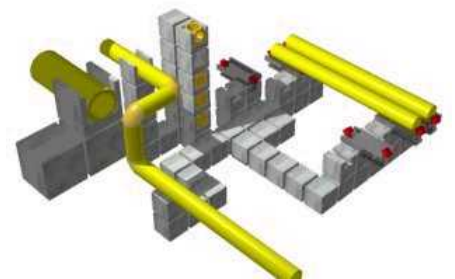
(They've stolen one of my book titles)

Some examples of fractal robot crews at work:

[Slide 39]



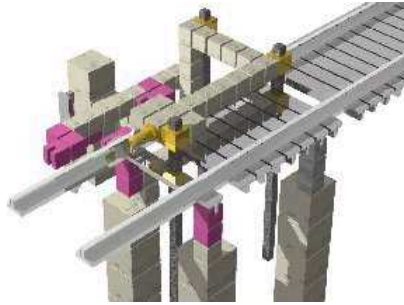
Pipe making



Assembling a piping system

Bridge Building

[Slide 40]

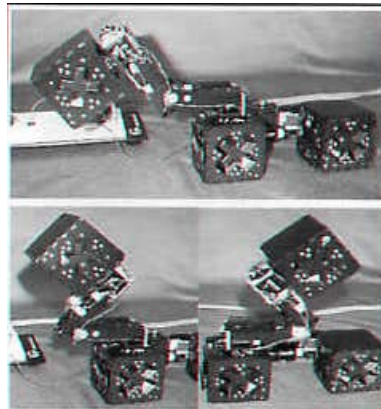


The kind of task we're envisioning is extracting and processing local materials to construct factories to build more robots and prepare the way for human habitation.

Cubes seem to be a popular theme.

Here's Carnegie Mellon's walking "I-Cube"

[Slide 41]



Xerox PARC's sliding "Telecube"

[Slide 42]

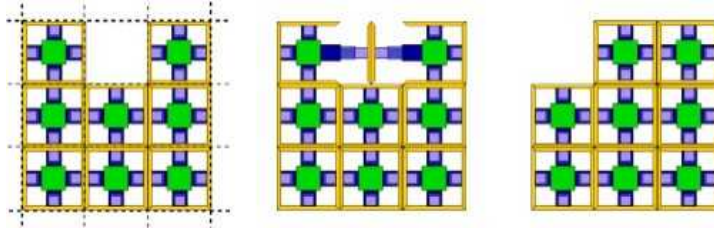


Contracted



Expanded

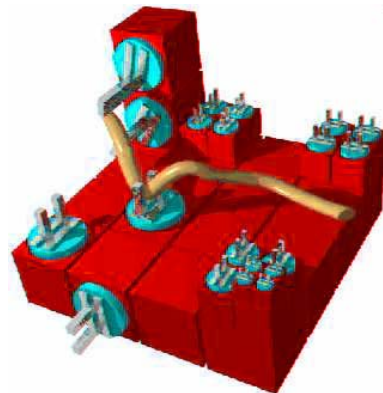
[Slide 43]



Telecubes reconfiguring. The module at the top left extends to meet the module extending from the top right, and then detaches from the array. Their contraction moves it one space rightward to the center.

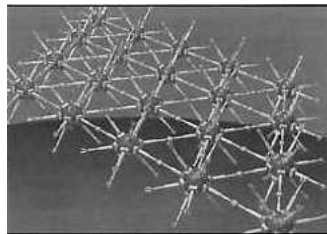
A modular, all-purpose, electrical system based on self-configuring cubes.

[Slide 43]

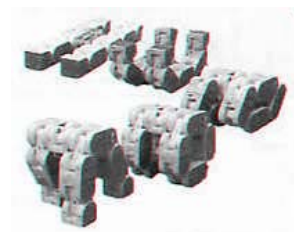


And here are some non-cube ideas:

[Slide 45]



"Foglets"

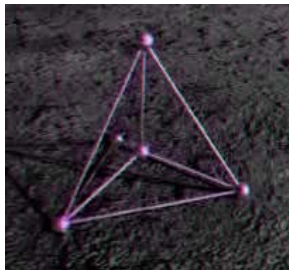


"M-TRAN"

Storrs Hall's "Foglets"--good for strong, lightweight lattice structures and the like. M-TRAN, from the Intelligent Systems Institute. Scott Howe will be talking later about the "Trigon" system that he's been involved in developing, based on triangles and squares that "tumble" across each other to create structures, buildings, and even vehicles.

This is an interesting one from NASA, called TETWalker . . .

[Slide 46]



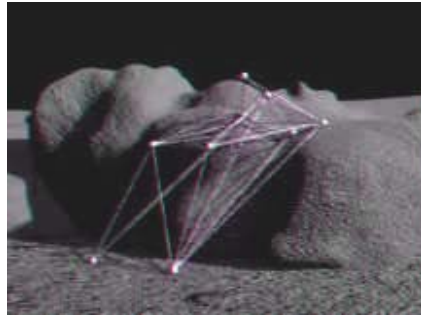
which comes from "Tetrahedral Walker". The tetrahedron pyramid is an inherently strong and stable structure.

[Slide 47]



By deforming it you can move its center of mass to the side until it tips over in that direction--note the weights at the vertices. Repeating this movement results in a kind of side-to-side walking pattern.

[Slide 48]



With telescopic edges they can combine to form a robot that is capable of moving over obstacles. If the rovers that we send to places like Mars today topple over, they're finished. You can't send someone to get them back on their wheels again. TETwalkers move by toppling over. It could be a very reliable way to get around on rough terrain. The idea is that swarms of them could migrate across the surface and assemble into things like structural lattices, communications antennas . . . whatever.

"Polybot"

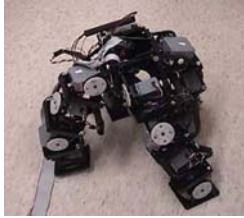
Xerox-PARC

[Slide 49]



From Xerox-PARC again. This is an example of one of their "Polybot" series of modular robots. They cluster together to cooperate in performing complex tasks. A bit like biological polyp colonies. I'm not sure if that's where the name came from.

[Slide 50]



A four-legged Polybot spider. In the center, reformed as a loop that can roll across relatively smooth surfaces. And at the right, fifteen polybots making a humanoid form that can haul itself up from a prone position and actually walks. It won't win any races, apparently . . . but pretty impressive all the same.

[Slide 51]



A 3x3 manipulator array. . . .

And a 4x4 array maneuvering a box.

[Slide 52]

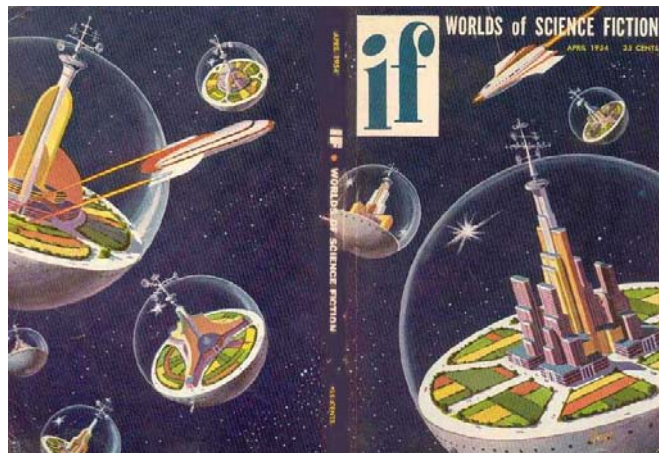


And finally, several of them passing a ball along.

You know, looking at this combination, with its total lack of symmetry and anything we would traditionally recognize as a designed functional form, I can't help being reminded of folded proteins, and the way they morph into shapes like enzymes, able to manipulate and transport single atoms. A lot of work is under way to miniaturize these systems down to scales that would reduce energy needs and weight. Perhaps, one day, we'll them taken down to the level of nano-engineered, artificial "bacteria," able to begin transforming a primitive planetary environment. So you'd have progressively more advanced forms of inhabitant appearing as the conditions necessary to support them are brought into being. (Raising some interesting questions about what the story of evolution on our own planet is really telling, maybe?)

So what kind of societies will eventually drop into orbit to begin surveying that new, far-off abode? Thriving, mutually supportive communities, ready to extend the pattern across a new world?

[Slide 53]



Or mutually distrustful armed fortresses . . .

[Slide 54]



seeking only their own territory to stake out, enclose and defend?

[Slide 55]



I have no idea. But that's the whole point. At our end of the venture, nobody can have. The best we can do is make sure they have the potential to evolve in whatever direction their inclinations and circumstances direct. That's what infra-free design is all about.

Thank you.