Space for Industry

it has been more or less assumed that when Man gets going well enough in spaceflight technology, the planets will be opened for development—that the future pioneers, future investment opportu-nities, will be in the development of Mars, Venus, the Moon, and, later, planets of other stars.

Maybe, eventually, those developments will come. But . . . it looks to me, now, as though we've neglected a major bet.

I think the first major development of industry based on space technology will not be on another planet—but in space itself. I be-lieve that the first major use of space technology will be the devel-opment of a huge heavy-industry complex floating permanently in space, somewhere between Mars and the asteroid belt

In the first place, we're never going to get any engineering use of space until we get something enormously better than rockets.

We can, therefore, drop rockets from consideration; they're inherently hopeless as an industrial tool. They're enormously less efficient as transportation than is a helicopter—and nobody expects to use helicopters as the backbone of a major industrial trans-portation system.

So *any* engineering development of space implies a non-rocket space-drive. Something that can lift and haul tons with the practi-cal economic efficiency of a heavy truck, at least. Even nuclear rockets couldn't do that; the reaction-mass problem requires that even a nuclear rocket start with a gargantuan load of mass solely intended to be discarded *en route.*

So: assume some form of true space-drive. A modified sky hook or an antigravity gadget—anything. It's a space truck—not a delicate and hyperexpensive rocket. It can carry tons, and work for years.

Now; do we develop Mars and/or Venus?

Why should we?

The things human beings use and need most are metals, energy, and food. It's a dead-certain bet that no Terrestrial food plant will grow economically on either Mars or Venus . . . except in closed-environment systems. Metals on those planets might be available in quantities; let's assume that Mars is red because it's a solid chunk of native iron that's rusted on the surface to a depth of six inches.

Who wants it? Why haul iron out of Mars' gravity field . . . when it's floating free in the asteroid belts? If we're going to have to grow our food in a closed-environment system any time we get off Earth . . . why not do it where null-gravity makes building the closed environment cheap, quick, and easy?

And while Terran life-forms may not do well on those planets . . . the local life-forms might do very well indeed living on us. Why bother fighting them off? In a space city, there would be only those things which we selected for inclusion.

And energy?

Heavy industry has always developed where three things were available; cheap raw materials, easy access to markets, and cheap energy supplies. In preindustrial times, that cheap energy supply naturally meant cheap fuel for muscles, whether animal or human. Somewhat later, it meant water power, and now it means fuels.

The current direction of research efforts is to achieve a controlled hydrogen fusion reaction, so that the energy needs of growing in-dustry can be met.

In space, that problem is already solved. The Sun's been doing it for billions of years—and the only reason we can't use it here on Earth is that the cost of the structure needed to concentrate sun-light is too great.

So let's set up Asteroid Steel Company's No. 7 plant. It's in orbit around the Sun about one hundred million miles outside of Mars' orbit. Conveniently close—within one hundred or two hundred miles—are floating in the same orbit a dozen energy collectors. They don't last long—a few months or so—but they're cheap and easy to make. A few hundred pounds of synthetics are mixed, and while they're copolymerizing, the sticky mass is inflated with a few gallons of water vapor. In an hour, the process is complete, and *a* horny-looking film of plastic has been formed into a bubble half a mile in diameter. A man goes in through the bubble wall after it's set, places a thermite bomb in the middle, and retires. A few sec-onds later, the bubble has been converted to a spherical mirror. A little more manipulation, and at a cost of perhaps one thousand dol-lars total, two half-mile-diameter mirrors have been constructed, lo-cated, and faced toward the Sun. A little equipment has to be laced onto them to keep them from being blown out into outer space by the pressure of the solar rays they're reflecting, and to keep them pointed most advantageously.

The beam—poorly focused though it is—of one of these solar mir-rors can slice up an asteroid in one pass. Shove the asteroid in to-ward the beam, stand back, and catch it on the other side. So it's half a mile thick, itself? So what? A few passes, and the nickel-steel directly under that mirror beam boils off into space. Power's cheap; we've got a no-cost hydrogen-fusion reactor giving all the energy we can possibly use—and collectors that cost almost nothing.

The steel—it's high-grade nickel-steel; other metals available by simply distilling in vacuum, of course!—once cut to manageable sizes can be rolled, forged, formed, et cetera, in the heavy machin-ery of Plant No. 7. The plant was, of course, constructed of the cheap local metal; only a nucleus of precision machine tools had to be hauled up from Earth. And those are long since worn out and discarded from Plant No. i.

The plant itself has a few power mirrors to provide the electrical energy needed. After all, with the free fusion reactor hanging right out there, nobody's going to go to the trouble and risk of installing a nuclear power plant.

Plants for food, of course, need light—and they'll get just exactly as much as they can best use. So the direct light's a little weak out there? Aluminized plastic film costs almost nothing per square yard.

And the third factor for heavy industrial development is, of course, easy access to market? How easy can it get! It's a downhill pull all the way to *any* place on Earth! Whatever the system of space-drive developed, it's almost certain to allow some form of "dynamic brak-ing"—and it's usually easier to get rid of energy than to get it. From the asteroids to the surface of the Earth you're going downhill all the way—first down the slope of the solar gravitational field, then down Earth's.

Spot delivery of steel by the megaton, anywhere whatever on Earth's surface, at exactly the same low cost follows. There's easy access to *all* markets from space!

Meanwhile Solar Chemicals Corporation will have their plants scattered somewhat differently. Landing on Jupiter is, of course, impossible for human beings—but it's fairly easy to fall into an ec-centric orbit that grazes the outer atmosphere of the planet. That wouldn't cost anything in the way of power. Depending on the type of space-drive—antigravity or some form of bootstraps lifter—ships would take different approaches to the problem.

The problem, of course, is that Jupiter's atmosphere is one stu-pendous mass of organic chemicals raw materials—methane, ammo-nia, and hydrogen. And, probably, more water in the form of dust in that air, than we now realize.

In any case, if Jupiter doesn't supply oxygen from water, the stony asteroids do—as silicates. And Saturn's rings, it's been suggested, are largely ice particles.

The solar mirrors are less efficient at Jupiter's distance, of course—but Solar Chemicals doesn't need to melt down planetoids. Their power demands are more modest.

With Jupiter's atmosphere to draw on, it seems unlikely that Man will run short of hydrocarbon supplies in the next few megayears. And there's always Saturn, Uranus and Neptune in reserve . . .

We're only beginning to understand the potentialities of plasmas and plasmoids—of magnetohydrodynamics and what can be done with exceedingly hot gases in magnetic fields under near-vacuum conditions. Space is the place to learn something about those things—and one of the things we've already learned from our rocket probes is that the immediate vicinity of magnetized planets is ex-ceedingly dangerous.

Open space might prove to be somewhat healthier than we now realize. And if there are some difficulties—generating our own, homegrown magnetic fields isn't an impossibly difficult matter. Par-ticularly when we've got nickel-steel by the megaton to work with! And it is not, remember, necessary to build our space plants—it might prove wiser to carve them, instead.

The meteorites that reach Earth are, of course, almost entirely composed of common silicates and nickel-iron. However, the Earth is also, to the best of current belief, composed almost entirely of those materials. Nevertheless there's quite a tonnage of copper, sil-ver, lead, tantalum, titanium, tungsten, molybdenum and other metals around here. And, presumably, in the asteroids.

Silicate meteors being common, we can expect effectively unlim-ited quantities of raw material for glassy materials in space. On Earth, vacuum distillation is scarcely a practicable method of sepa-rating the components of a rocky ore; in space, however, vacuum distillation is far more economical than processing in various water solutions. On Earth, high-energy processes are expensive; solution processes relatively cheap. In space, with the energy of a star to play with, solution processes will be used rarely—and whole new concepts of high-energy-level chemistry will be invented. Jupiter's atmosphere will supply plenty of low-cost carbon for constructing graphite processing equipment

We can, effectively, make our own solar flares—our own sunspot vortices—by injecting gas into the focused beam of a half-mile mir-ror, traveling not across, but *along* the beam. The light-pressure effects, alone, should yield a jet of gas at high velocity equivalent to several tens of thousands of degrees.

There's every inducement for heavy-industry development in space.

And against that—what have the planets to offer?

Earth, of course, is a unique situation; we evolved to fit this envi-ronment. The planets do have open skies, instead of walls, and nat-ural gravity, rather than a constant whirling. They are, and Earth in particular will remain, where men want to live.

Sure . . . and men today want to live on a country estate, with acres of rolling hills and running streams and forest land, with horses and dogs around.

That urge is so strong that, at least around the New York metro-politan area, anywhere within seventy-five miles of the city, they can sell a structure that an Iowa farmer would consider a pretty cramped hencoop for forty-five hundred dollars, as a "summer home." All it needs is a pond renamed Lake Gitchiegoomie within a mile or so.

Man, you ought to see the beautiful, uncluttered landscapes in Western Irelandl Lakes that *aren't* ponds, and not even one house on them. They don't have to have water-police to handle the traffic jam of boats on a one by three mile "lake" there.

Only . . . who can afford commuting from New York to Ireland?

Well, there's one sure thing about the space cities. They won't have the smog problem.

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