Infrastructure

As engineers, we understand that every product requires a certain amount of infrastructure for its design and construction. It's often surprising just how much infrastructure is needed. The 1899 patent for a paper-clip-making machine is remarkably complex, while the finished product is rather simple.

As technology advances, the required infrastructure increases. The chips in a cell phone might depend on a billion-dollar foundry. Plus, the innumerable components in the foundry depend on countless technologies in a tangled, looping web of engineering capability. While the marooned Swiss Family Robinson may have met their household needs with application-specific gourds, they could never have e-mailed home like ET did with a makeshift transmitter.

The tangled web of technology suggests the limited value of time-hopping consultants. An engineer thrust into the 19th century would likely be helpless. Without modern tools and a deep infrastructure, it would be difficult to make much impact at all. Although this point could be endlessly debated, consider the task of sending an astronaut to the moon with scarcely any digital technology. Very scary.

Likewise, if we were to beam a modern PC back to 1650, the recipients would find its workings to be immensely mysterious. The levels of technology and intellectual thought underlying the PC's design and construction would be far beyond the comprehension of the times.

For us, we could imagine a distant civilization, so advanced that it would have nothing better to do than ship us a machine of unimaginable complexity. The ability to traverse huge distances might suggest the advanced state of its technology. In true Star Trek fashion, such a machine would be far beyond our state-of-the-art in almost every conceivable way. Our most delicate circuits and most advanced materials would compare to our alien gift as Iron Age implements compare to our most advanced technology today.

What features might such an alien machine possess? Its circuitry would be exquisite, its materials would involve features of unimaginable complexity, and its processing and control systems would be sophisticated beyond our comprehension. And what about the infrastructure needed for such a machine? What trillion-dollar factory, what technological web, and what intellectual foundation would be needed for its breathtaking design and construction?

If we were to encounter such a machine, we would be faced with a reverse engineering problem more monumental than the scientist of 1650 facing a PC. We would learn only by painstakingly unraveling its circuitry, materials, and control systems. We would be awed by its design and its construction and humbled by its complexities as being far beyond anything that our skills have so far been able to produce.

And how advanced might the infrastructure be for such a machine? Perhaps, contrary to our expectations, its infrastructure would not have diverged to the trillion-dollar plus level, but rather its very creation might require little, if any, infrastructure at all. In the most extreme case, such a machine, once constructed, might possess everything, or almost everything, it needs for its own replication, at close to zero cost.

But such a scenario belongs to the realm of science fiction. So, rather than prolong these musings of fantasy, I invite you to turn to the immediate matters at hand, namely, this month's special section on systems biology. Enjoy and marvel.

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Dennis Bernstein visited Boston University in April 2004 to meet with colleagues (from left) Hua Wang, Pierre Dupont, Dennis, John Baillieul, and David Castanon.