

The Machines Above Us: An Overview of the ‘Celestial Mechanics’ New Media Artwork

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Abstract:

At any given moment, there can be 30,000 manmade objects in the sky above us: planes, helicopters, satellites, weather balloons, space debris, and other diverse technologies. They watch, they guide, they protect, they communicate, they transport, they predict, they look out into the stars. In less than 100 years, the deep blue has become a complex web of machinery and an emergent system of technology.

Our lives are closely tied to these networks in the sky, but a disjunction has occurred between us and the aerial technologies we use every day. We rarely consider the hulking, physical machines that have now become core to our lifestyle. By not being aware of the hardware we use every day, we may also not be aware of the social, economic, cultural, and political importance of these technologies. By visualizing them, it may lead to a better understanding of the forces that are shaping our future.

Celestial Mechanics is a planetarium-based artwork installation that visualizes the paths, patterns, and behaviors of manmade aerial technologies—a graphic display of the paths and functions of the machines hovering, flying, and drifting above our planet. By using accurate tracking and protocol data from dozens of government agencies and science organizations, “Celestial Mechanics” mixes science, statistical display, and contemporary art by interpreting the mechanical patterns and behaviors of these systems as culturally significant poetics.

1. Introduction

The mechanical chaos above our heads affects us directly in an astounding array of ways. The technologies we take for granted, as banal as the GPS in our cars and our mobile phones, are nearly all airborne. Our communications, our media, our military, our science, our security, and our safety are all tied to machines above us. Although we can’t see them or touch them, they are also part of what N. Katherine Hayles describes as the *post-human* tendency to physically extend ourselves through technology.

2. Aerial Machines and Everyday Life

The amount of hardware in the sky above us has a direct impact on our daily lives. Increasingly our media and communication technologies are dependent on a superstructure drifting silently above us. We plan our day by weather reports generated in the sky, we map our commute by traffic helicopters, we talk on cell phones that bounce across satellites, our news and entertainment is fed to us from the sky down, we travel in jet-driven busses across the country and globe, our mail arrives by flight, our cars show us location and promise emergency assistance based on navigational satellites. Our entire lives have folded into the virtual networks in the sky.

However, constant use does not equal constant awareness...we use these technologies without being directly conscious of them. Buckminster Fuller explains that “thus has man been advantaged by the few who have thought and acted to produce the instruments, as yet relieving the vast majority of humans from the necessity of having to think and coordinate their sensings with the realities of cosmic mechanics.” [1]. However, there are dangers to being ‘relieved from the necessity of thinking’. Celestial hardware is completely changing our experience with our world and each other, yet doing it invisibly, silently. To quote Fuller again, “The most important part about tomorrow is not the technology or the automation, but that man is going to come into entirely new relationships with his fellow men.” [2].

3. The Problematics of Scale

We profit from these networks, these legion flying machines, and although they are invisible to us, it is important to visualize the data. However, our understanding of these systems is so closely tied to the scale of it all—beyond global—that visualization becomes limiting. Computers can now collect massive amounts of data, but our display systems are struggling to keep up. To show an orbiting telecommunications satellite constellation, smart design can get one to a nice desktop animation, but it doesn’t present any of the phenomenology of the data...that *awe* that scale inspires. Scale is part of data, yet we continue to reduce and enlarge everything in our increasingly well-documented world to 320x240 pixels. Tools need to be found that allow for the emotion in data that comes from extending ourselves beyond our physical presence. Scale creates wonder, and we should not separate our feelings from the statistics...they help us understand them.

The problem of visualizing emergent systems has been increasingly considered by both theorists and designers. Designer Bruce Mau recognizes the difficulties with displaying “quantities on a scale the world had never seen.” [3] Mau feels the core 21st century design problem relates to growth. “Growth is a time-based event, with breaking points and moments of rupture that generate entirely new conditions. Growth is nonlinear and unpredictable....I increasingly believe that the future of design rests in our ability and willingness to develop new practices and theories of form that are inextricably linked to, and informed by, life and growth.” [4] The lack of effective design tools to display complex, mutating data is a unique problem for the new millennium.

The mix of delicate tracking technologies and our expanding computing power suddenly allows us to consider massive amounts of data over vast terrains like this. However, the volume, complexity, and volatility of the statistics make traditional display difficult. On his homepage, MIT’s Ben Fry explains that “there is a space of highly complex systems for which we lack deep understanding because few techniques exist for visualization of data whose structure and content are undergoing continuous change.” [5]

4. Planetariums Re-considered

This particular scientific visualization problem is not new. Planetariums recreate nature for closer study. Although they are often dismissed as a 1960’s fad, their mission to recreate the awe in their scientific data is valid. “Celestial Mechanics” hopes to help reinvent the planetarium as a creative, perceptual, and cognitive environment and offer a new way to experience the emergent system of technologies operating above us. The project investigates the use of planetariums as an alternative form of information display by creating a ‘night sky’ program that, instead of showing stars and planets, shows the various strata of man-made technologies in the sky. The architectural dome display surface is particularly well-suited for the complexity of understanding air traffic.

Planetariums are both architecture and medium...the building is the screen. In a planetarium, visual totality is used as an effect, since domes cause spatial borders to dissolve and suggest total immersion. This wrap-around perception is both thematically and structurally tied to the function of the space—a sphere implies limitlessness, limitlessness implies outer space. The display surface itself is a reference to infinite space even as much as the content of the display. Additionally, frameless viewing creates a loss of perspective that makes the observer’s position unstable. In the absence of the usual cinematic language, without a

frame line, scale can be more easily manipulated. This inherent instability of the viewer's point of view is ideal for representing infinite space.

5. Data Collection on the Technological Sky

Data was researched via the web and through interaction with government and scientific agencies. Actual path data for satellites was retrieved from the SSR Report, a public domain document supplied by NASA. Airplane path data was collected from the Federal Aviation Administration who provided longitude, latitude, and altitude for every commercial plane both airborne and grounded, every three minutes, over 12 hours. Weather balloon data was collected via the National Oceanic and Atmospheric Administration who supplied worldwide launch sites and times. 'Non-path' aerial technologies (balloons, helicopters, model rockets) were collected as protocols. ABC News, Los Angeles Sheriffs Department, Los Angeles Police Department, Los Angeles Fire Department, US Coast Guard, private charter companies, and private medical transport companies were contacted and interviewed regarding steps of action during specific events. Model Rocketry data was researched via user groups and the web.

A total of 46 different technologies were researched and incorporated into the script. Eight different technologies were selected for the prototype presentation, selecting specific phenomena for their potential for visual representation and as a cross section of each altitude level. As the project evolved, it was clear that entropy was built into its design. Within weeks after the artwork had shifted from research to design, new technologies were introduced into the sky, new hardware was launched, other components were shut down. "Celestial Mechanics" is a snapshot of the airborne hardware at one moment in man's history and is almost immediately a historical artifact.

6. Production

Once compiled, the data was parsed into MEL, a scripting language used by the 3D animation program Maya or parsed through the programming language Processing. A virtual dome was created that comprised of a 5-camera rig—looking north, south, east, west, and directly up. A team of animators at UCLA each tackled a different data set, with the artist overseeing the design and making adjustments for aesthetic choices—speeding things up, changing point-of-view, etc. "Celestial Mechanics" was not meant as a scientific tool but an artwork, and creative license was taken to increase the power and emotion of overall piece.

The animations were rendered and then, using a proprietary software courtesy of Evans and Sutherland, the five camera views were 'stitched' together into round dome originals. The resulting artwork premiered concurrently in portable domes at UCLA and Siggraph in Los Angeles in the summer of 2005.

7. Concerns about Emergence and Chaos

The systems above require great cultural, economic, and political coordination yet there seems to be no singular control. The most complete tracking is done by NASA which disseminates some of the data, conceals some, and ignores some. However, tracking these systems is very different than controlling them. Even the frequent launches of communication satellites are 'guessed' to avoid the thousands of space debris fragments. Collisions have occurred, but the sky is still treated with the same cavalier attitude of the American west in the 1800s...the celestial real estate is too big an expanse to worry about congestion yet.

The statistics for "Celestial Mechanics"—air traffic paths, satellite movement, weather hardware trajectories, helicopter protocols—came in separately, in exclusive datasets that eerily ignored the other competing systems that were in the sky. As mentioned before, NASA tracks, but no one controls. The weather service knew where their hardware was, the communications companies knew where theirs was, but both were oblivious to the other. There seemed to be no complete overview, just a myopic focus on one's own systems.

Once the technologies were plotted for this artwork, relationships became visible that were never shown in the datasets supplied by the individual agencies—satellite launches can alter paths to avoid existing space junk, a collision with space junk can destroy a satellite launch. Airplanes capture weather data as they fly, but the absence of airplanes after the 9/11 attacks led to the grim confirmation that the jet trails of those planes are so dense they are changing the weather as well. Technologies are adjusting in relation to other technologies, systems are resetting paths, applications are reinventing themselves, machines are decaying in manners never predicted. The hardware and software in the sky are demonstrating behaviors that were never coded into their original design. The complex generation of patterns and chaos above is symptomatic of some flavor of emergent system. Partially human-controlled, it is a human/emergent hybrid, a gradient system that is evolving both by human interaction and its own intelligence.

Emergence just happens. No one plans it, no one supervises, no one is anticipating a future outcome. Different actors and forces create a greater pattern...it emerges from the interaction of all its parts and becomes much more than the sum of the parts. Steven Johnson explains that “in an emergent system, each element plays a dual role; consciously it is a single agent that looks out for its own interests. At the same time it is part of a larger organism—an association that it is barely aware of. The consciousness of this larger whole is the collected behavior of all of its individual members looking out for themselves.” [6] Science and art are increasingly becoming interested in adaptive behavior, realizing that the perfect system is one that is evolving. The play of hardware above is definitely growing larger and more complex each day, and behaving in unexpected ways. “The majority of actions that are taken on by the individual members are still made from the ground-up and reflect a local self interest, never needing a strong hierarchy or chain of command. In an emergent system, agents interact with each other to produce more complicated behavior, even though the consciousness of the individual agents remains largely unchanged.” [7]

Machines, Media, Mythology, and Metaphor

“Celestial Mechanics” shows a dynamic system of independent yet interacting parts—a manifestation of interactive factors—to visualize the aesthetics of emergence as a collage. Using the technology, architecture, and media experience of the planetarium, the piece attempts to investigate the cultural meaning attached to the machines above us...and find the emotional and social meaning as well. By seeing relationships evolve above us, it becomes an emerging cultural mythology.

Many of the machine behaviors and patterns in the artwork are already part of our semiotic language. The shaky blue circle of light from a police helicopter above is as culturally coded as the military planes flying in perfect V formation, the stacked planes over LAX, and the melancholy dissipation of distant jet trails. Just like the mythologies created centuries ago by seeing patterns in the stars, we again are applying cultural significance to pattern and new ‘phenomena’ and ‘constellations’ are being formed by airborne machinery.

Technology is generating a mythology. “We’re developing all these fabulous hardware systems that soon will make life a process of continual myth-generation for the individual as well as the collective ego.” [8] By applying the patterns, cycles, and trails of aerial technologies in such a radically different context, the planetarium has allowed us to both create and find new meaning in the data.

References

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- [3] Mau, Bruce, *Life Style* (Edited by Kyo Maclear and Bart Testa), Phaidon, 2000.
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