Transforming Oceanography, Transmuting Technology

by Payson R. Stevens

Histoire de la météorologie et des sciences de l'atmosphère et de l'océan depuis l'espace en Europe
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In 1978, Seasat, a remote sensing satellite, revolutionized the study of oceanography and our understanding of the Earth system from space. This breakthrough was concurrent with the revolution of rapidly developing computer/digital technologies also transforming our worldview. Unexpectedly, everything got smaller and larger simultaneously. The Earth became a tiny Blue Marble floating in the darkness of space and Marshall McLuhan's *global village* (1) finally arrived, connecting our home planet in a vast communication web. Within a few decades of Seasat's orbit, more data, information, and knowledge would be accessible to more of humanity than in our entire history (2 billion Facebook users in June 2017).

Digital technology blossomed like the fertility and diversity of an abundant coral reef. Ingenious forms of expression and tools created innovative media where science, technology, education, entertainment, and art all synergistically interacted in fundamentally new modes. Alternatively termed the *Computer/Information/Digital* Age, it was/is a modern Renaissance, with parallels to the previous Renaissance in 14^{th}-16^{th} Century Europe. That period saw an incredible explosion of investigation, rebirth/reinterpretation of Classical Greek culture, and a liberating spirit reflected in the genius of individuals like Copernicus, Galileo, and Kepler in science and by Michelangelo, da Vinci, and Brunelleschi (who invented perspective) in art. Inventions included the printing press, telescope, barometer, and compound microscope, all fundamentally leaving the Middle Ages' insular view behind. Most importantly, the power of printing enabled the rapid dissemination of new ideas and the discovery of the New World further enlarged our place in the world.

With just three months of Seasat observations collected, oceanography was beginning its own renaissance. The difficult and long process of gathering certain data at sea now found revolutionary space sensors looking at vast oceanic regions along with small detailed areas. Suddenly, sensors were providing global views of marine winds, sea

surface topography, ocean surface temperature and structure, sea ice distribution at the poles, and ocean color reflecting biological/phytoplankton abundance and distribution. A tidal wave of observations with data and images ensued (as the many chapters in this book describe): single snapshots of a particular moment, time series with days, weeks, months, and eventually years were depicted and strikingly animated. Processing, understanding, and visualizing this flood of data required new technologies: more powerful computers with faster processors, operating systems and RAM memory; more complex computer algorithms to assess relationships; faster, smaller and more efficient hardware to store and analyze data; new visualization software with ever-expanding digital tools to interpret patterns all shown on increasingly higher resolution monitor displays; sophisticated hardware for rapid storage and retrieval and high quality out-put printing devices. Moore's Law kicked in: dramatic increases in computer power with simultaneous decreases in relative cost: all at an exponential pace.

The Information/Computer/Digital Age had begun: digital industries creating a high-tech global economy and knowledge-based society, driven by ever-increasing computer micro-miniaturization with ever-expanding, rapid-access communication. Our own Renaissance is now in play with accelerating software and hardware innovations: storage capacities, computational power, social media, data products, powerful computers in our pockets, Big data, the Cloud, web servers, the Internet of Things, etc., etc.

At the beginning of the 1980s, the issue was how to share and publicize Seasat's revolutionary oceanographic and digital imagery (see Figures A, B, C, D, etc.) beyond the scientific community creating them. NASA's Stan Wilson (Chief, Oceanic Processes Branch) assumed that charge. In 1981, he hired my company, InterNetwork, Inc. (INI/a science/media/communications company), to develop products to reach diverse audiences. Academic, educational, news media, and the US Congress received these astonishing images with descriptions of their exciting oceanographic discoveries. As part of the image selection process, I spent part of 1981 traveling to some of the research facilities processing Seasat data (e.g., Jet Propulsion Laboratory, Goddard Space Flight Center, Univ. of Miami). Over 750 images were collected, and then edited down to

around 100 images, to further refine for different print products to disseminate all under the “Oceanography From Space (OFS)” slogan with distinct visual branding.

The initial creation was a series of 24x36 inch six posters, *Oceanography From Space*, which showed the main Seasat discoveries. The posters were extensively distributed to a wide-ranging audience and were highly acclaimed (e.g., inclusion in *Graphis Posters 84* with the best international posters in 1984). Over the next few years additional OFS print products were developed by INI. Working with Stan and his staff, INI also produced OFS Folder 1(1984) and OFS Folder 2 (1986) sets, each containing 12 images with detailed descriptions on the back; annotated slide sets; the popular OFS sticker patch (digitizing the famous Japanese 19th Century Hokusai woodblock wave with Seasat flying above it); a TOPEX flyer to explain and support the need for a new NASA oceanographic satellite. Stan also introduced me to Jim Baker, head of the Joint Oceanographic Institutions/JOI and INI designed and illustrated the Executive Summary booklet and extensive technical report/book: *Oceanography from Space A Research Strategy for the Decade 1985-95*, using some of the first desk-top publishing software.

Some of my interactions with the scientific community also included discussions on developing the most effective color palettes for the range of parameters observed and depicted. As a trained oceanographer and professional designer/artist, I was aware of how color relationships (e.g., hue and value) could either enhance or confuse perception of patterns (e.g., sea surface temperature, sea ice, phytoplankton). The new technologies had already developed hi-resolution monitors capable of displaying 26 million colors, which though visually stunning, could also cause confusion if too many were used to depict data. So, in some cases, INI designers worked with researchers to refine the colors and their gradations to ensure clarity of the data presentation. We also took very rough diagrams and figures and reworked them with the best design and typographic standards to create memorable illustrations. Later, these graphics also incorporated the latest computer software to create hi-quality computer illustrations including 3-D animations (e.g., NASA’s UARS and TRMM projects). As the state-of-the-art graphic and design technologies were developing, INI integrated them into our projects. We were recognized

in the growing industry for our cutting-edge work. New Media technology companies gave INI *beta* software applications for feedback to help refine their product development and identify bugs/problems (e.g., HyperCard /Apple, PageMaker/Aldus, VideoWorks, MacroMedia) and hardware to test (Apple: Macintosh Plus, SE, Mac II; HP Laser Jet Printer, Rodime, Seagate, LaCie, etc.).

On a personal note, I believed the *Oceanography From Space* educational outreach was the beginning of a new visual literacy and perception of our Earth coming from higher resolution satellite imagery. It was the next visual "ahaa" after the “Earth Rise” photo from the Apollo Moon Missions. Having studied the Heezen and Tharp bathymetry maps as a graduate student at Scripps Institution of Oceanography (late 1960s), my first viewing of Lee-Lueng Fu Seasat SAR bathymetry image, at JPL in 1981, absolutely blew me away: here was a “picture” of the ocean basins taken from a satellite, not an artist’s conception illustrated map interpolated from ship data. I saw, early on, that the mix of satellite data imagery and the new digital technologies were the start of a media and communication revolution. I jumped in with a great passion, later starting a new company, InterNetwork Media, Inc (INM), whose mission was to produce digital New Media publications and products (CD-ROMs, interactive presentations, websites, books). These products educated and raised awareness on the state-of-the-Earth as seen from space. INI and INM were pioneers in the Digital Age thanks to Stan’s initial vision of how important it was to further oceanography through remote sensing and the OFS program. The ground-breaking CD-ROMs INI later partnered with the US Geological Survey(USGS) and the National Oceanic and Atmospheric Adminstration (NOAA), my coffee-table book, *Embracing Earth: New Views of Our Changing Planet* (1992, co-authored with Kevin W. Kelly), and many high-profile presentations (e.g., TED 2 & 3, US Senate, Doors of Perception), were all part of telling the Earth story with the evolving New Media. INI’s OFS project progressed into working with NASA on *Earth System Science* and *Mission to Planet Earth*, developing print outreach; USGS on a groundbreaking CD-ROMs (*Arctic Data InterActive*/1989-90, a prototype, interactive science journal and the award-winning,

GeoMedia/1991-94 geology for middle schools), and NOS/NOAA's *State Of The Coast* program (with Stan) on two New Media CD-ROMs (1993-5, *Turning the Tide: America's Coasts At A Crossroads*; *Our Crowded Shores*). Like so many of my friends and colleagues (2) working during this early, "golden" period, we found great excitement and meaning in our collective purpose; the high-points of our careers with enduring friendships.

A detailed analysis of the development and interactions between remote sensing discoveries and the emerging digital technologies requires more space than this brief article. But the period from 1980 to 1995 saw the explosion of ***the new***: many satellites and sensors specifically designed to study Earth parameters by many governments and institutions bringing together scientists from many countries. These "missions to planet Earth" opened our eyes to the complexity and beauty of our planet along with the realization that humans were having (and still are) serious impacts on the Earth's geo, cryo, hydro, and biosphere. Concomitantly revolutionary hard and soft digital tools were being created to study, analyze, manipulate, and communicate all the data/information. The World Wide Web (1989) exploded into the global Internet: with it came huge economic and social disruptions and instantaneous (24/7) information that can overwhelm us. We are still at the beginning of this ever-expanding Renaissance that now also includes the Age of the Anthropocene—humans as a force of Nature—with not only climate change impacts but also unknown futures evolving from Artificial Intelligence and synthetic biology. Even the potential evolution of *Homo sapiens* is being debated with speculation that our bodies may co-develop with all this technology to repair/blend/extend what it means to be human (or something else?)…all perhaps in less than a hundred years (3)!

It seemed almost unbelievable, in 1978, that Seasat collected more oceanographic data in three months than a century of sea-going expeditions. Yet it is hardly a drop in today's expanding ocean of digital content. Could we have imagined in 1980 the world we live in now? Can we envision our future in another thirty years? Almost impossible!

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References

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(3) Yuval Noah Horari: *Home Deus, A Brief History of Tomorrow* (2017)

Bio/Blurb:
Payson R. Stevens is trained in oceanography and art/design and founded InterNetwork, Inc (INI) and InterNetwork Media, Inc (INM). For 20 years he worked with NASA, NOAA, and the USGS on global change issues. INI received the John Wesley Powell Award from USGS (1993) and the Presidential Design Award from Bill Clinton (1994) for furthering earth science awareness and pioneering work in digital media. He currently lives half the year in a remote Indian Himalayan Valley where he was an advisor to the Great Himalayan National Park (2000-15) and spearheaded its inscription as a UNESCO World Heritage Site (2014). His work can be seen at www.energylandscapes.com