GIS and the Geospatial Ecosystem: Creating the World You Want to See

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Introduction

I had the distinct honor of delivering a plenary keynote at the 2025 International Federation of Surveyors (FIG) Working Week in Brisbane, Australia, which centered on two of my favorite topics – GIS and the geospatial ecosystem. I'm also a perpetual problem-solver, so exploring how we can leverage these to create the world we want to see was a bonus. This article captures the essence of the keynote in writing. I hope you all enjoy consuming it as much as I enjoyed authoring it!

Our world is changing rapidly – both in positive ways, through technology and innovation, and not-so-positive ways – our physical world is in distress. More on this later.

But first, the innovation we're experiencing can be seen and felt all around us. Through agriculture, our urban environments, transportation systems, energy, healthcare, communication, and computing, we are really transforming how we live and improving our quality of life in many ways.

Exploring the Geospatial Ecosystem

Much of this innovation can be found in the geospatial ecosystem – enabling us to explore and solve problems in a way we could only once imagine. But what exactly is the geospatial ecosystem? We hear so many terms tossed around loosely – GIS, surveying, LiDAR, UAVs, remote sensing, spatial data, and the like, all rolled into this concept of "geospatial."

Which is quite appropriate, because the definition of geospatial according to the *Merriam Webster Dictionary* is "consisting of, derived from, or relating to data that is directly linked to specific geographical locations." It also became apparent to me that we can nicely represent this ecosystem from the word itself (Figure 1).

Figure 1. Word representation of the term "geospatial."

Looking at everything included in Figure 1 can be overwhelming. There's a lot there, which means a lot to keep up with. Perhaps Heraclitus said it best: "Change is the only constant in life." I think that if there were ever an example of this, geospatial would be a good one.

To help put it all in better perspective, we're going to step back in time to examine how this geospatial ecosystem has come together, and whether the change is really accelerating as quickly as it sometimes feels.

Ancient Times – 1960

We have land **surveying**, which has deep historical roots and is foundational to the development of our world, and remains present throughout the decades ahead.

And, interestingly, some early origins of **UAVs** can be traced back to 1849 – in the form of balloons, and by the early to mid-1900s, radio-controlled aircraft.

How about GIS? Does the name Dr. John Snow sound familiar to anyone? Although predating the term "**GIS**," Dr. Snow used the power of mapping and spatial analysis to identify the source of a cholera outbreak in London.

As a side note, FIG was founded in 1878, and ISPRS in 1910.

Positioning and measurement are largely optical and mechanical during this period.

1960-1970

Geographer Roger Tomlinson initiated a national land-use management program for the Canadian government, which involved inventorying natural resources. Tomlinson is credited with first coining the term geographic information system (**GIS**).

It was also in 1969 that Esri was founded.

We are adding a new category during this decade, and that is **computing**. This will be key as we continue moving through our timeline. Throughout the 1960s, computers underwent significant advancements in technology, speed, and design. Early concepts of quantitative and computational geography begin to develop.

1970-1980

Although the decade between 1970 and 1980 appears to be a quiet one, some substantial advancements were made – predominantly in **remote sensing** and **earth observation** as well as positioning.

In 1972, the first Landsat satellite was launched, and in 1978, the first **GPS** satellite was launched.

Computing continues to advance during this period.

Fun fact – the word "**geospatial**" is also believed to have emerged in 1970.

1980-1990

Again, a seemingly quiet decade, but don't be fooled.

Notable progress to mention – in 1983, **GPS** became available for civilian use, but the signals were scrambled.

In 1985, the first **in-car** (digital) **navigation** system emerged, and **computing** advancements began to accelerate.

A big one, for sure, was the invention of the **World Wide Web** in 1989.

1990-2000

Although progress may seem anticlimactic over the course of this decade, advancements in **computing** are significant.

Workstations and efficient data storage have emerged along with **websites for public use**.

From a positioning standpoint, the first **terrestrial Lidar** was introduced in 1998.

And, in 1999, we celebrated our first **GIS** day.

2000-2010

What happened during the 2000s?!? A lot!

In 2000, the U.S. government stopped scrambling the **GPS** signal, making it accessible for innovation. Also, in the U.S., the FAA began debating **UAV** use in its airspace.

The **GIS** community is also picking up speed, with over one million users.

However, it was in the computing space that we really saw some momentum. In 2004, **Web 2.0** was introduced, emphasizing user-generated content and ease of use.

And, in rapid succession, the following occurred: in 2005, Google Maps emerged; in 2006, AWS introduced **cloud computing**; in 2007, Apple released the first iPhone; and in 2009, Uber entered the scene.

Disruption.

Let's pause for a moment – I think we can officially label what is happening here as technological disruption.

Disruption, defined as "radical change to an existing industry or market due to innovation," is what we witnessed beginning in the early 2000s. A number of components in the geospatial ecosystem, as we know it today, began to mature, resulting in accelerated change.

2010-2020

This disruption continued into the next decade. Some notable milestones – in the 2010s, other global navigation satellite systems (**GNSS)** started to mature. As a result, **machine control** accelerates.

In 2016, in the U.S., we saw the formalization of regulations surrounding the use of **UAV**s, resulting in an acceleration of their adoption.

On the GIS front, in 2018, **GIS** and **AI** came together to form **GeoAI**.

Perhaps one of the most impactful was the COVID-19 pandemic and the use of **GIS** in aiding the response. A sobering tie back to the cholera outbreak that Dr. Snow mapped back in 1854.

This decade also saw an acceleration of **IT and communications infrastructure**, enabling much of the real-time capability we now see in the geospatial ecosystem.

2020-Now

Here we are – halfway through another decade.

In **GIS**, big data and big data analytics are prevalent.

From a **positioning and measurement** standpoint, we now have widespread spatial data collection, sometimes referred to as reality capture, and often supported by real-time connectivity.

Another important item to note from a positioning standpoint is the modernization of **spatial reference systems**. I know Australia recently went through one, and we are in the process of a major update in the U.S., and I know there are others underway.

There continues to be accelerated adoption in the **UAV** space.

And when we look at **computing** – **generative AI** has now emerged, a disruptor, for sure.

I can only imagine what we'll be talking about in 2030 when we look back across the decade.

Putting the Geospatial Ecosystem into Practice

What does it look like when we put all these things we've identified as being in the geospatial ecosystem into practice? Perhaps something like what's represented in Figure 2.

Starting at the bottom with geodesy - we must leverage geodesy and geodetic frameworks to integrate all our data and find meaning. They provide the definition of where "where" truly is, and underpin our fundamental surveying and mapping work.

Whether at a parcel, project, or community level, surveying and mapping create the foundational data layers with which we work.

Bringing all of that foundational work together, we can start to manage things like land records and create cadastres.

Which enables us to perform vital Land Administration tasks like valuation and taxation and urban planning. All key elements leading to healthy, vibrant communities.

With a strong foundation provided by surveying and land administration tasks, we can effectively manage both our built and natural environments. I show these two side by side intentionally, because it is really crucial to balance both so that we have resilient and sustainable communities.

Whether we are building new infrastructure systems, such as highways and bridges, or adding homes and schools, there are environmental and natural resource considerations to account for.

And at the top is the digital twin, because ultimately, what the geospatial ecosystem enables us to do is combine all the work below to create a digital twin or model of our world.

What enables it all? GIS. GIS takes the body of work represented in Figure 2 and puts it into action.

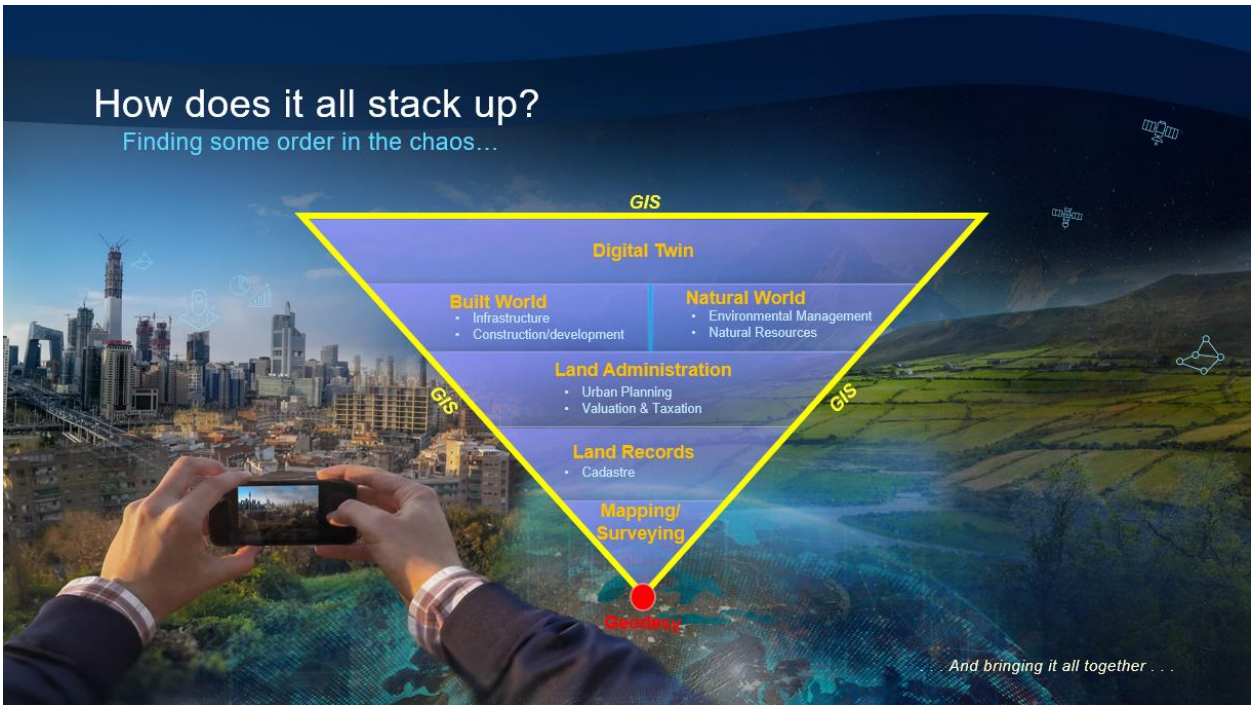

Figure 2. Putting the geospatial ecosystem into practice.

Interestingly, the FIG commissions map quite neatly (Figure 3) to the diagram presented above!

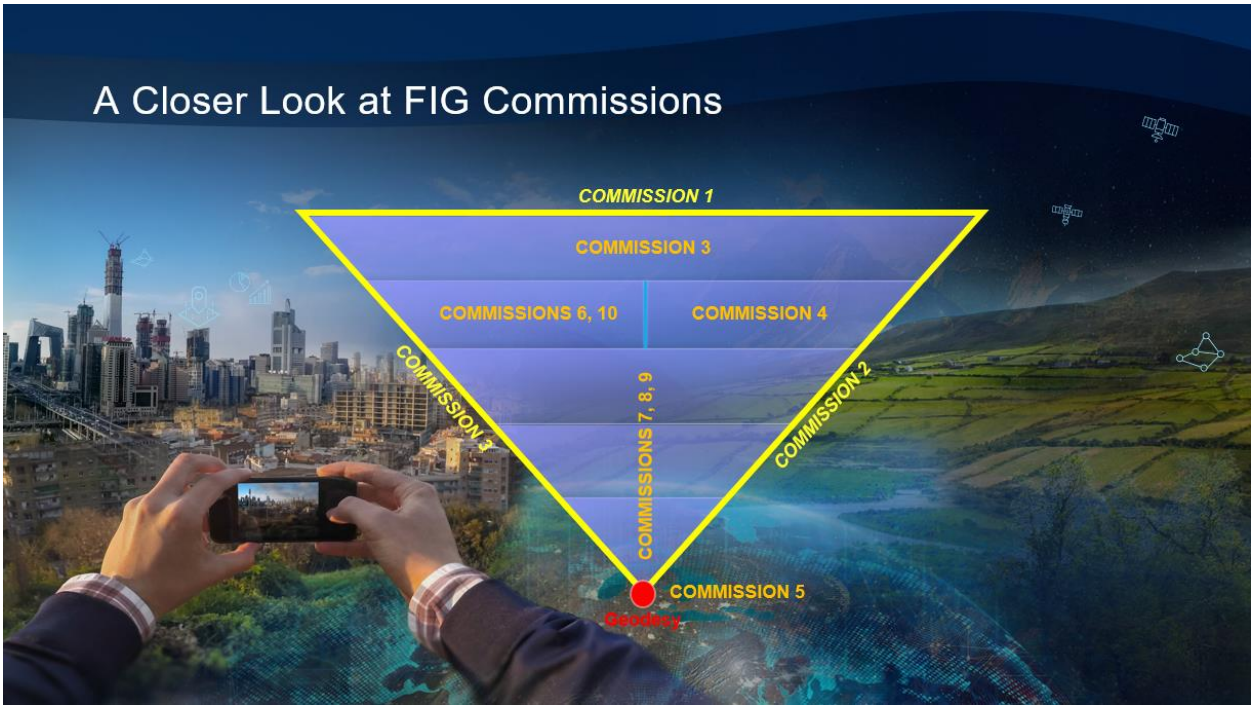

Figure 3. Relating the FIG commissions to areas of practice represented in Figure 2.

GIS and the Geographic Approach

How does GIS put all of this data into action? It's through geography, which fundamentally is the science of our world. It helps us organize everything we know – the what, when, where, and who.

GIS expands the language of geography by making everything we know available to everyone. Anytime, anywhere across the planet.

It's taking the tiniest bits of information and organizing them into systems, and pretty soon we have systems of systems, and we can see how they all interact.

We achieve this through the geographic approach. The framework and processes to integrate all the factors – from data collection to visualization and mapping, through analysis and modeling to decision-making and ultimately action. Many components of the geospatial ecosystem come into play here and are amplified by computing and IT infrastructure.

What's compelling is the speed at which we can now move through all of these processes and get to the action part. Again, that's thanks to the innovation we explored earlier in this talk.

Once we have reached a point of conclusion, we communicate best through maps, because they are a common language that people understand - the language of geography. People are visual beings. Whether they [maps] are printed out on paper or on interactive digital displays, they are accomplishing the same things – providing clarity and making the complexity of our world more understandable.

Creating the World You Want to See

As I mentioned in the opening, our world is evolving rapidly. While innovation has been accelerating around us, so too are the strains on our physical world. It impacts every one of us.

Which brings us to a point of transformation. Transformation is defined as "a thorough or dramatic change in form or appearance." We are currently undergoing a transformation that can be summarized by the convergence of two accelerating forces – dramatic changes to our physical world, in parallel with technological advancements (Figure 3).

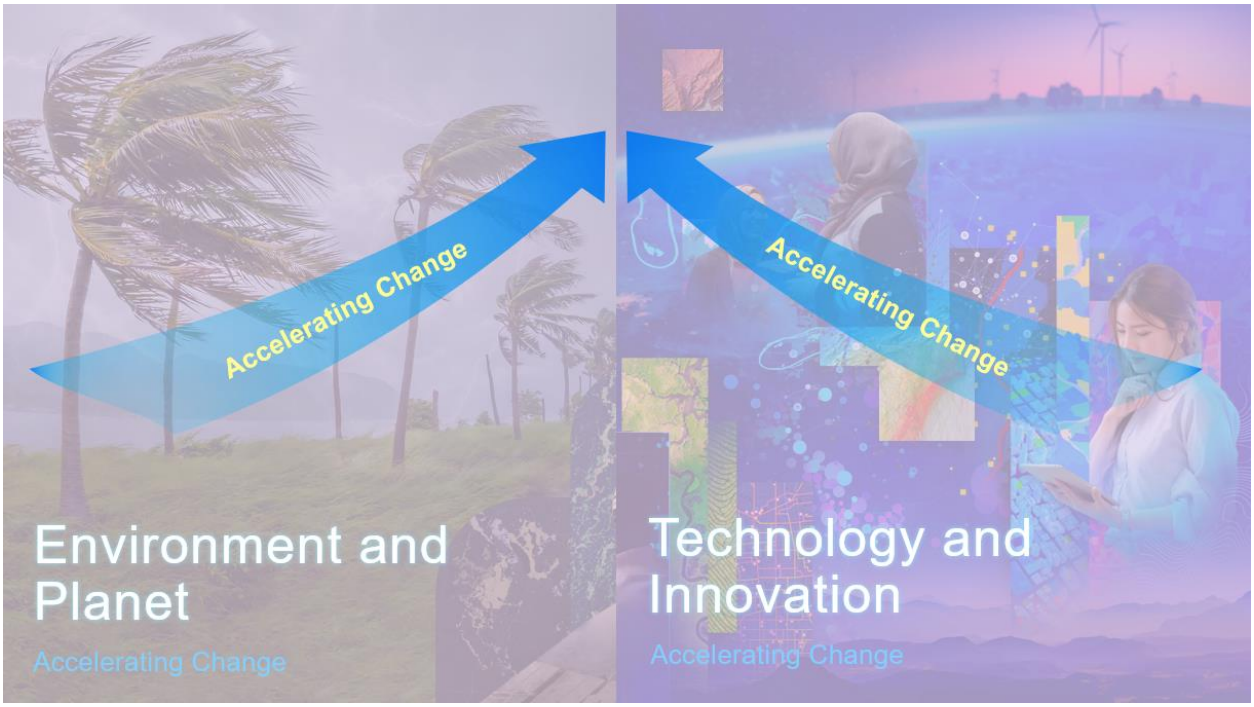

Figure 3. Converging forces of transformational change.

What should this tell us? The work we do every day in the geospatial community is crucial. And I did say GEOSPATIAL COMMUNITY intentionally. It takes every one of us. It doesn't matter if you are a surveyor, a GIS professional, a remote sensing analyst, geodesist, researcher or educator, we must leverage the technology, embrace the innovation, and not fear the disruption because it is our best chance at combating the accelerating change we are witnessing in the world around us.

What else can we do as geospatial professionals to achieve a sustainable and resilient world? As we lean into technology and innovation, we cannot forget some fundamental practices to ensure DATA SUSTAINABILITY. By data sustainability, I mean collecting once and using many times. Protect the investment in data collection. There is too much work to be done in the world to have to repeatedly collect the same data.

By following a few good practices, such as establishing organizational data governance, adhering to industry standards, and capturing basic metadata, our data can be relied upon well into the future

and not become disposable. Data is critical infrastructure, and we must do our due diligence to ensure it remains sustainable.

The Future is Bright

Our future, I believe, is very bright. How, you might ask? Aren't we experiencing attrition, reduced capacity, and fewer young people entering the profession?

Yes – absolutely. However, our young people are bright, passionate, and perhaps most importantly, comfortable with technology and change. I suspect they will feel the disruption less than those of us who are ahead of them in the journey.

Remember the decades that saw the most accelerated technological change, from approximately 2000 to the present? Those individuals are young adults now and don't know a world without data and information all around them. For instance, smartphones hit the scene around 2007 – those individuals are turning 18 this year.

But each generation is vitally important – those who are more experienced have a wealth of knowledge, experience, and wisdom to share with the younger generations as they grow in the profession. Because, as we all know, at the end of the day, it's not about technology. Technology is a powerful tool, but it's about people, relationships, and experiences. That's why we all come together in forums such as FIG Working Weeks. Helping one another grow in our profession, and in turn, helping humanity as we solve problems together.

The future is very bright indeed. So, my geospatial friends, go forth and leverage GIS and the geospatial ecosystem to create the world YOU want to see.