

***Perspectives on the Future for Geoprofessionals in the
Engineering and Consulting (E&C) Business Sector
for
NASEM Committee on Geological and Geotechnical
Engineering (COGGE)***

Rudolph Bonaparte

**Chairman and Senior Principal
Geosyntec Consultants, Inc.**

and

**Professor of the Practice
School of Civil and Environmental Engineering
Georgia Institute of Technology**

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Background to Webinar

- Initial request from COGGE to provide an update to my ASCE GeoCongress 2012 Paper (GSP 226) “**The Business of Geotechnical and Geoenvironmental Engineering**”, including offering my observations about the state of the geoprofessional business sector today
- Subsequently, I had discussions with several COGGE members focused on “the way we do business in the geotechnical field and the tendency for many of our services to be viewed as a commodity.”

The perspectives I offer today are based on 40 years in the business sector, with 35 at Geosyntec Consultants, 20 as President and CEO and 10 as Chairman, and always as a geoengineering practitioner.

Organization of Webinar

- Provide a brief historical perspective on geoprofessionals in the U.S. E&C business sector
- Examine the E&C business sector today and the role of geoprofessionals in it
- Consider the major earth, infrastructure, and environmental challenges facing society and the essential role of geoprofessionals in addressing those challenges
- Recognizing its relative maturity, consider four aspirational goals to help geoprofessionals maximize the future vitality of the business sector
- Identify several challenges to achieving those goals

Historical Perspective

Formative Years (1930s-1940s)

Adolescent Years (1950s-1970s)

Maturing Years (1980s-2000s)

Stagnating or Revitalizing Years? (2010s-Ongoing)

Geoprofessional Business Sector: Formative Years (1930s-1940s)

- Pioneering geoprofessional E&C businesses are formed (e.g., Dames & Moore in 1938, Law Engineering in 1946)
- **Elio D'Appalonia's Perspective**
 - *The engineering of foundations and earthworks as practiced today by private practitioners dates back only to the late 1930s, when it was called "soil mechanics and foundation engineering."*
 - *The practice prior to 1940 had few unifying principles other than those agreed to by successful practitioners.*
- **Ralph Peck's Perspective**
 - *By no means, however, was soil mechanics universally accepted [in the late 1930s]. Many prominent engineers, perhaps turned off by the mathematical formulations and unconvinced that...such variable natural materials could be reliably evaluated by tests, lost few opportunities to belittle the importance or practicality of the subject.*

Geoprofessional Business Sector: Adolescent Years (1950s-1970s)

- **Growth and evolution of the geoprofession after World War II**
 - University soil mechanics and foundation engineering programs became more widely established
 - Technological advances in these programs, and in government agencies, that drove advances in the field
 - Many geoprofessional firms were formed, becoming prominent industry leaders
 - Design theories saw greater application in practice, and monitoring of constructed facilities became more common, as did prototype testing and case studies
 - Post-war public infrastructure programs and industrial and commercial expansion in the private sector drove the need for geoprofessional services
- **Major public/private programs contributing to this growth:**
 - Federal-Aid Highway Act (1956): U.S. interstate highway system
 - Atomic Energy Act (1954): 65 nuclear plants
 - U.S. Environmental Protection Agency (1970)
 - Clean Water Act (1972): wastewater treatment infrastructure
 - Expansion of U.S. water supply infrastructure, dams and reservoirs
 - Urbanization and suburbanization trends
 - Mass transit systems
 - Corps of Engineers, Bureau of Reclamation, inland waterways
 - Offshore oil production, Gulf of Mexico, Trans Alaska Pipeline
 - Ports and harbors supporting global trade

Noteworthy Geoprofessional Firms are Founded and Prosper During the Formative and Adolescent Years (1950s-1970s)

Firm	Founding Metro Location	Year Founded
Mueser Rutledge	New York, NY	1910
Dames & Moore	Los Angeles, CA	1938
Tibbets-Abbott-McCarthy-Stratton	New York, NY	1942
Spencer J. Buchanan & Associates	Bryan, TX	1946
Law Engineering	Atlanta, GA	1946
Soil Testing Services	Chicago, IL	1948
Woodward-Clyde	Oakland, CA	1950
Leroy Crandall	Los Angeles, CA	1954
Shannon & Wilson	Seattle, WA	1954
Greer & McClelland	Houston, TX	1955
D'Appolonia	Pittsburgh, PA	1956
Jacobs Associates	San Francisco, CA	1956
Haley & Aldrich	Boston, MA	1957
Harding Associates	San Francisco, CA	1959
Ardaman & Associates	Orlando, FL	1959
Golder Associates	Toronto, Canada	1960
Kleinfelder	San Francisco, CA	1961
Soil & Material Engrs	Detroit, MI	1964
Goldberg Zoino	Boston, MA	1964
GEI Consultants	Boston, MA	1970
Langan	New York, NY	1970
Earth Tech	Los Angeles, CA	1970

Geoprofessional Practice: Maturing Years (1970s-2000s)

- Many of the larger first-generation geoprofessional firms evolved into “*multi-service*” companies that offered a wide range of services, often including environmental and natural resource services. A few examples include Dames & Moore, Woodward Clyde Consultants, and Golder Associates. They no longer self-identified as “geoprofessional.”
- Small- to mid-sized firms, experienced in local areas to do drilling, materials testing, geotechnical engineering, and construction observation for new projects, faced increasing competition, commoditization, and pricing pressure.
- The founding of ASFE in 1969 and the subsequent development of better contracts, contracting and practice guidelines, insurance instruments, and training abated the existential “litigation crisis” many geoprofessional firms faced in the 1960s and 1970s.
- Mergers and acquisitions became more common in the E&C industry, with many of the venerable first-generation geoprofessional firms being acquired.

Geoprofessional Firms That Have Been Acquired (plus many more)

- Leroy Crandall – 1982
- LeedsHill - 1982
- McClelland - 1987
- Soil & Material Engineers – 1987
- Chen & Associates – 1989
- McBride Ratcliff – 1991
- Kaldaveer – 1992
- Whaler – 1993
- Wehren – 1994
- Lindvall Richter - 1995
- Earth Tech 1996
- Woodward Clyde – 1997
- Dames & Moore – 1999
- Alton Geoscience – 1999
- Emcon - 1999
- Harding Lawson - 2000
- Agra Earth & Environmental - 2000
- Lockwood Singh – 2000
- Harza – 2001
- Ardaman – 2002
- Law Group - 2002
- Tibbetts-Abbett- (TAMS) - 2002
- Spencer J. Buchanan – 2006
- H. C. Nutting - 2007
- STS Consultants – 2007
- Soil Testing Engineers - 2007
- William Lettis – 2007
- Fuller Mossberger – 2008
- Geomatrix Consultants – 2008
- Moore & Taber – 2008
- Parsons Brinckerhoff - 2009
- Jacques Whitford – 2009
- Treadwell & Rollo – 2010
- Bromwell & Carrier – 2011
- ATC Associates 2012
- Coffey – 2016
- Hart Crowser - 2020
- Golder - 2021

Geoprofessional Practice: Maturing Years (1970s-2000s)

- An accelerating pace of university, government, and business research and development (R&D) created a large body of new geo-information (today there are more than 30 English-language geo-journals and magazines)
- Improved and/or new tools, from *in situ* testing to numerical methods, led to a rapidly expanding geotechnical practitioner toolbox
- Environmental regulations drove new opportunities, growth, and profits for many traditional geo firms, shifting these firms' practice center of gravity from geo to enviro
- New career opportunities emerged for geoprofessionals (e.g., specialty contractors, geosynthetic manufacturers, software developers, instrumentation specialists) and geotechnical specialization became common (geoenvironmental, geostructural, offshore geotechnics, mining geotechnics)
- Geoprofessionals were "in-housed" by large engineering and construction firms and by some types of owners (e.g., oil and gas, waste management) in greater numbers than ever before
- Federal/state/municipal procurement set-asides drove a proliferation of government specialty-certified businesses (many small, WOSB, SDB, HUBZ, VOSB, and SDVOSM geoprofessional firms)

Preface from NRC (2006) “Geological and Geotechnical Engineering in the New Millennium”

“In many ways, geotechnology is a mature field....Many serious problems have been solved. We know how to build strong foundations, safe dams, and stable roads and tunnels. We have a good understanding about the behavior and protection of groundwater, how to extract petroleum resources, and develop a geothermal field. We understand quite a bit about the soil conditions that lead to liquefaction during an earthquake or make landslides likely. If there is a major problem, it is that the state of the practice worldwide does not match the state of the art.” (emphasis added)

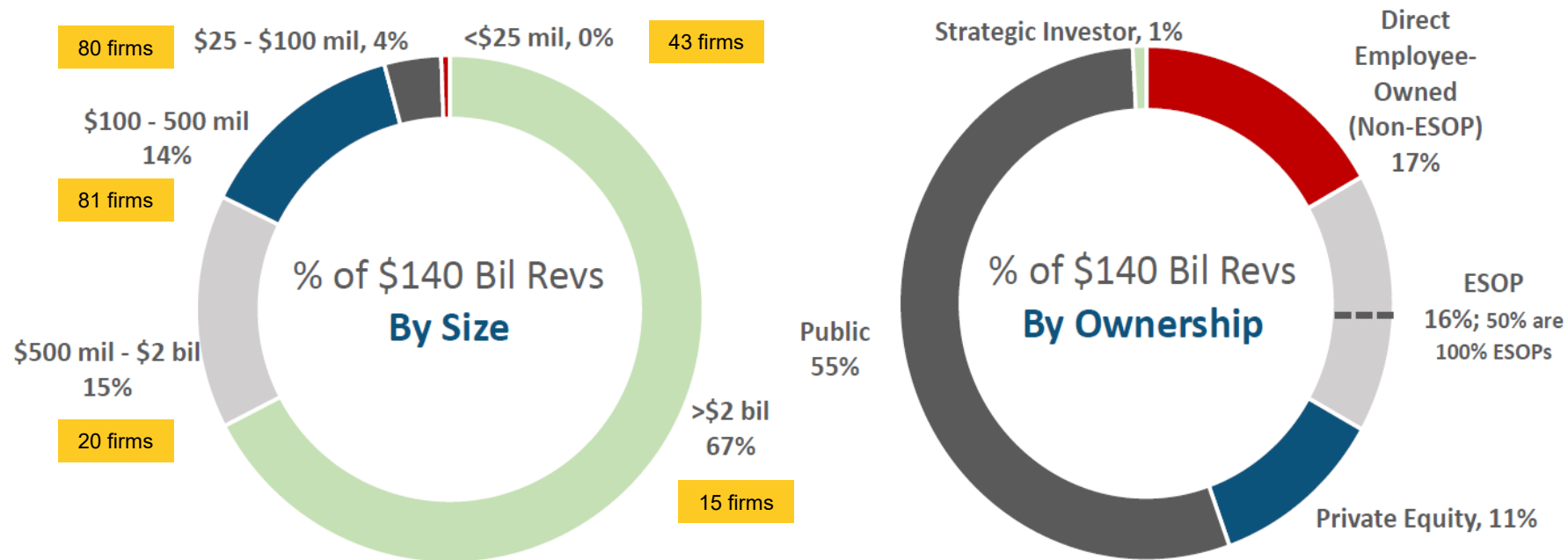
U.S. E&C Business Sector Today and the Role of Geoprosessionals in It

(Are We in a Stagnating or
Reinvigorating Time Period for our
Relatively Mature **Geoprosessional
Business Sector?**)

2020 Survey Results for 239 Mostly U.S. and Canada Based E&C Firms Representing $\approx 80\%$ of the E&C Market

From AEC Advisors, NYC

(Weighted Average, All firms)

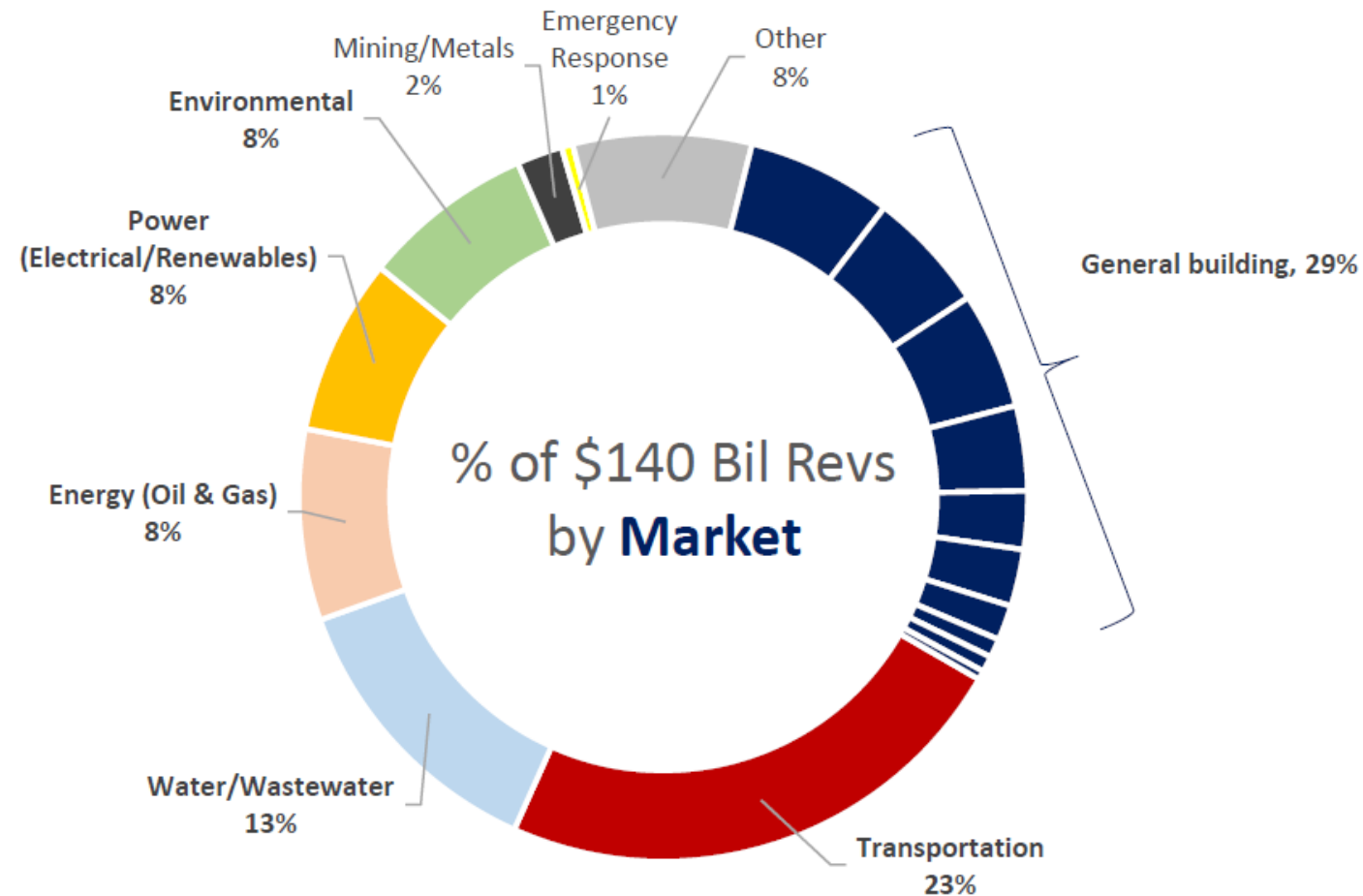


There are roughly 10,000 geoprofessionals active in these 239 firms (out of a total work force of >600,000 people). This is estimated to be about 40% of the total number of geoprofessionals active in the U.S. This means that more than half of practicing geoprofessionals are working in smaller firms, with the majority of those being employee owned and operating in relatively mature areas of the business sector.

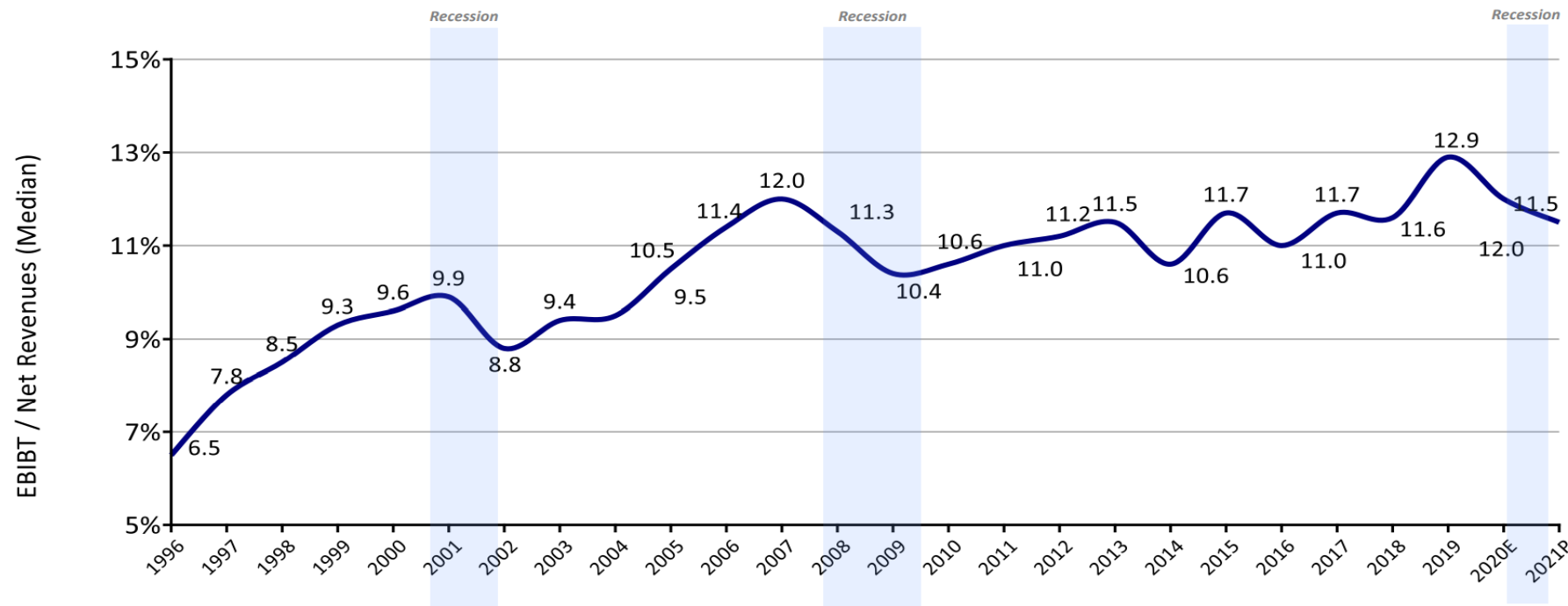
E&C End Markets (\$140 Billion Revenue)

(Weighted Average, All firms)

6 Big End-Markets (~90%)



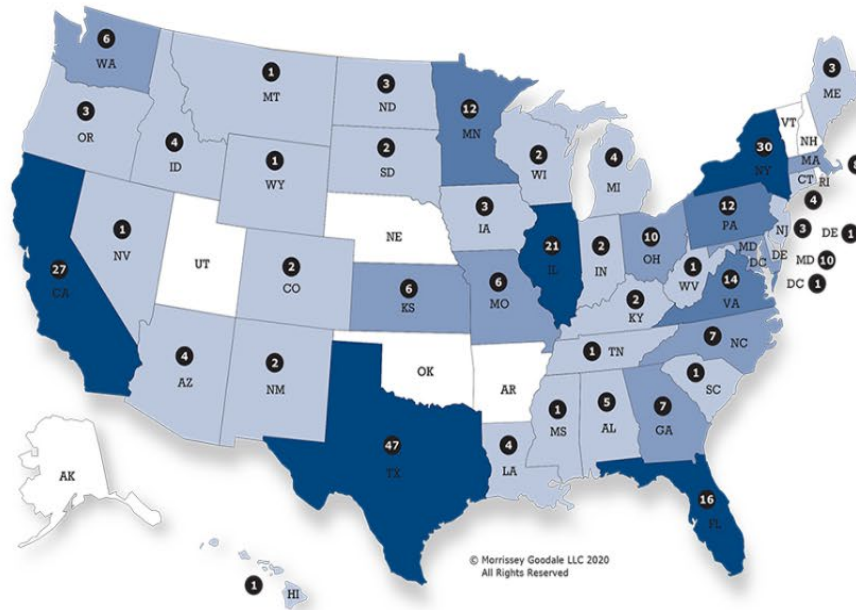
Overall, the E&C Industry in the U.S. has Done Well in Recent Years, Including 2020 (COVID Year)



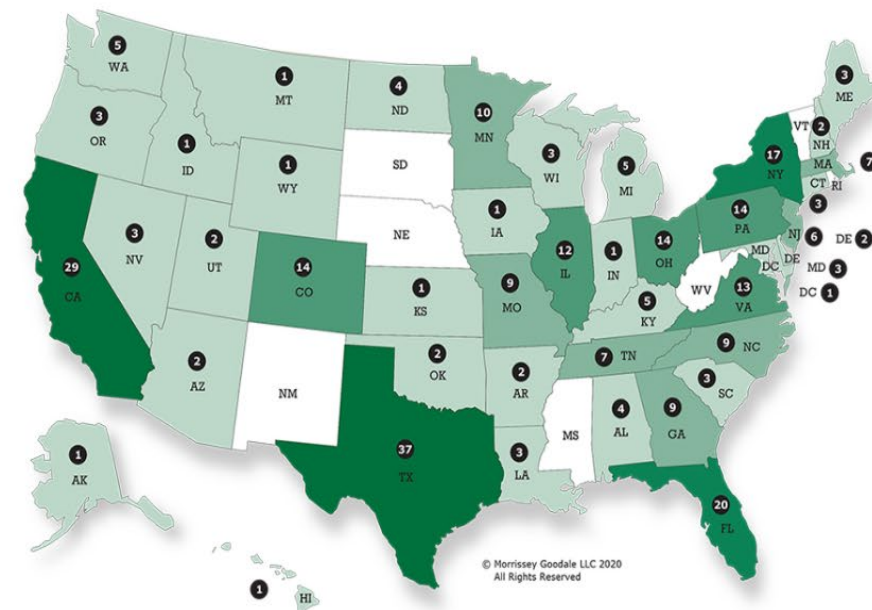
In 2020 (COVID, recession year), median industry profitability was 12%, with 1st and 3rd quartile profitabilities of 8% and 16%.

More Than 300 U.S. E&C Mergers and Acquisitions in 2020 for 3rd Straight Year

Buyers by State

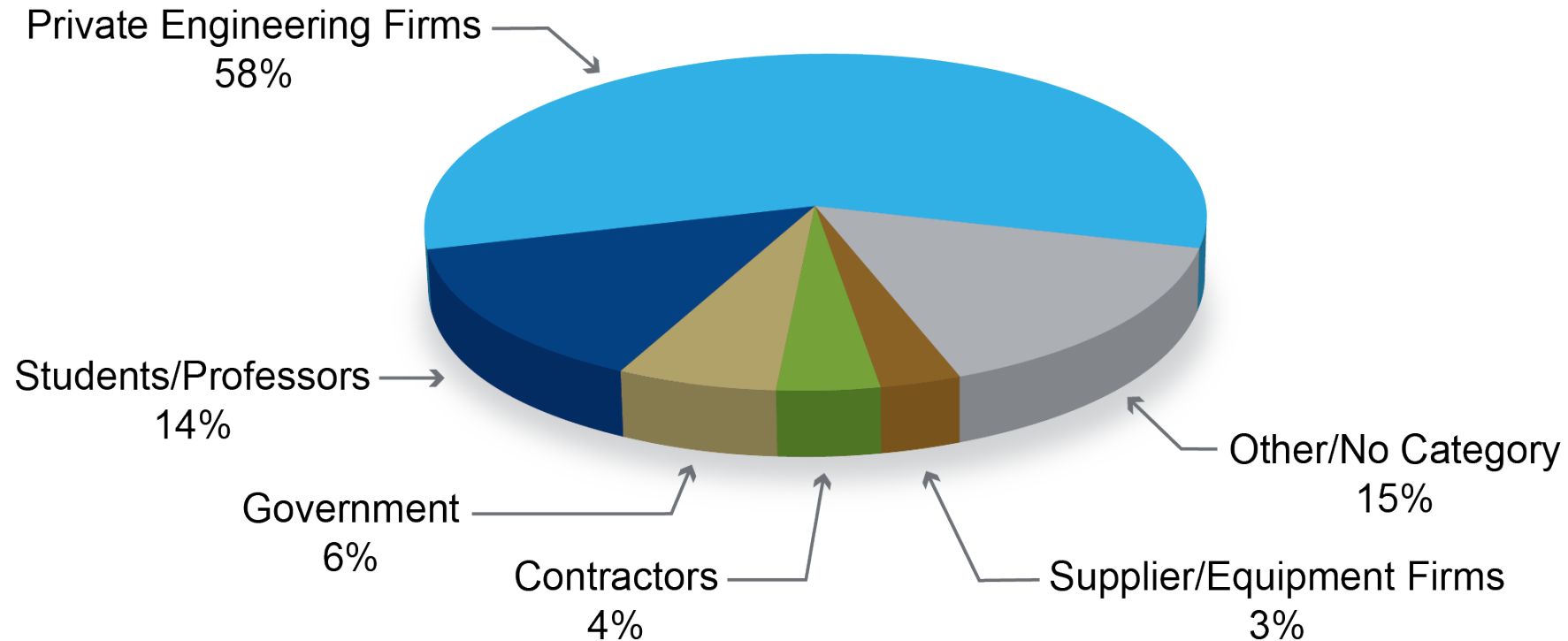


Sellers by State



[Interactive map of 2019 M&A activity: click here >](#)

Where do Geoprofessionals Work? Excluding Academia, About 70% Work in Engineering and Consulting Firms



ASCE Geo-Institute Membership Distribution (10,750 members, June 2011, representing roughly 50% of the U.S. geoprofessional population)

So, What Are the Characteristics of E&C Firms that Employ Geoprofessionals – Five Key Attributes Define Many Possibilities

- **Size and breadth of services** –
 - sole proprietor,
 - small- to mid-sized with limited capabilities,
 - mid- to large-sized with multi-disciplinary capabilities,
 - large to mega with full-service capabilities
- **Client and market focus** – buildings, transportation, water resources, oil & gas, waste management, mining, or combination
- **Practice style** – brains (specialized, SME), grey hair (design, detailed plans and specs), procedures (repetitive, commodity), or a combination of styles (common, but with one dominant)
- **Organizational culture** – practice-centered or business-centered
- **Ownership structure** – employee-owned, partnership, private equity investor, publicly traded

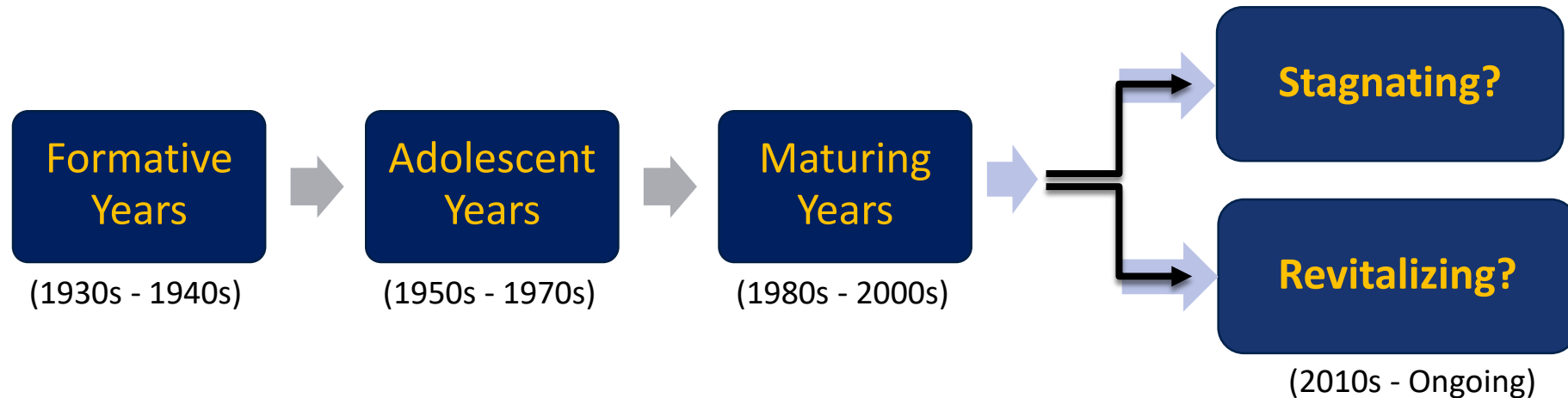
Observations on the Current Status of Geoprofessionals in the E&C Business Center (I)

- In many ways, the first two decades of the 21st century have been good ones for the geoprofession. The business sector in which we work is healthy, growing, and profitable. There is demand for our services and technical and project management career paths are attractive.
- However, as we've seen, the geoprofessional business sector is fragmented by company size and breadth, client and market sector, practice style, organizational culture, and ownership structure. Geoprofessionals in the business sector have a wide range of realities and experiences.
- Some areas of traditional geoprofessional practice are treated as mature by both owners/clients and by the professionals working in them, with little effort put towards innovation and value-creating approaches. Many smaller, procedures-dominant firms are challenged by this market environment.
- Geoprofessionals in larger multi-discipline, grey-hair firms can become involved in landmark projects, but they also seem to be increasingly pigeon-holed into their technical discipline and it appears they often face challenges in maximizing their value to a project through limited involvement at the planning and conceptualization phases.
- Advancement of the practice is often stifled by several factors including limited client budgets, substantial market competition, constraining codes and regulations, and risk aversion.

Observations on the Current Status of Geoprofessionals in the E&C Business Center (II)

- University geotechnical programs appear for the most part to be stable and healthy. Today, the U.S. Universities Council on Geotechnical Education and Research (USUCGER) has roughly 140 member institutions which annually produce more than 500 graduates at the MS/MEng and Ph.D. levels.
- These programs are highly productive, with a large amount of high-quality and useful research delivered monthly/quarterly to the profession – however, geoprofessionals in the business sector struggle (or don't even try) to keep up.
- There does not seem to be an effective process for bringing research into the mainstream of geoprofessional practice. To the extent it occurs, the process appears ad hoc and lagging, relying on individual champions rather than a systematic process. Are there lessons to be learned from other engineering disciplines?
- Most early-career geoprofessionals possess a strong technical education and problem-solving skills. However, we can do more to help them learn other skills important in the business sector. These include becoming better multi-disciplinary problem solvers, leaders, managers, and communicators, and developing the many “soft skills” that contribute to effective leadership.

Given the Status of Geoprofessionals in the E&C Business Sector Today, Is the Geoprofession Headed Towards *Stagnation* or *Revitalization*?



Geoprofessionals Have a Role to Play in Addressing Earth, Infrastructure, and Environmental Grand Challenges Facing Society Today and in the Coming Decades

Climate Change Impacts, Mitigation, and Adaptation (Whittle, 2020)

Responding to Climate Change Through Geotechnical Engineering Research

Andrew J. Whittle

Massachusetts Institute of Technology

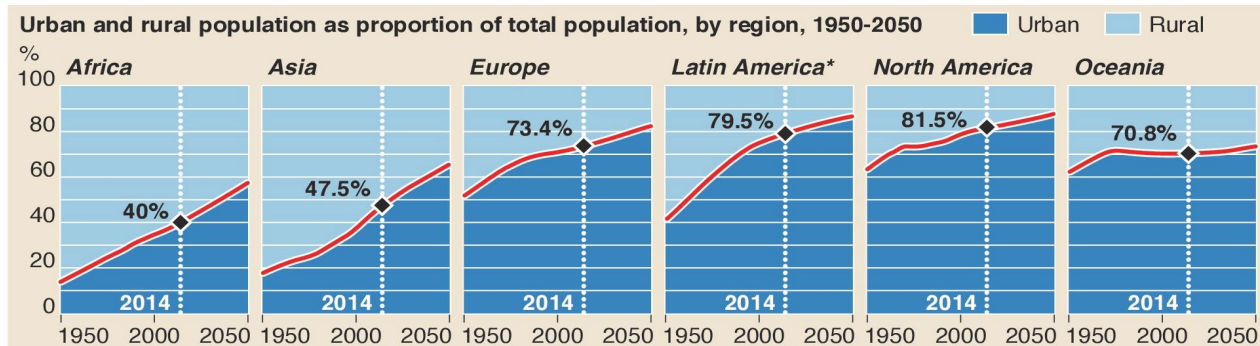
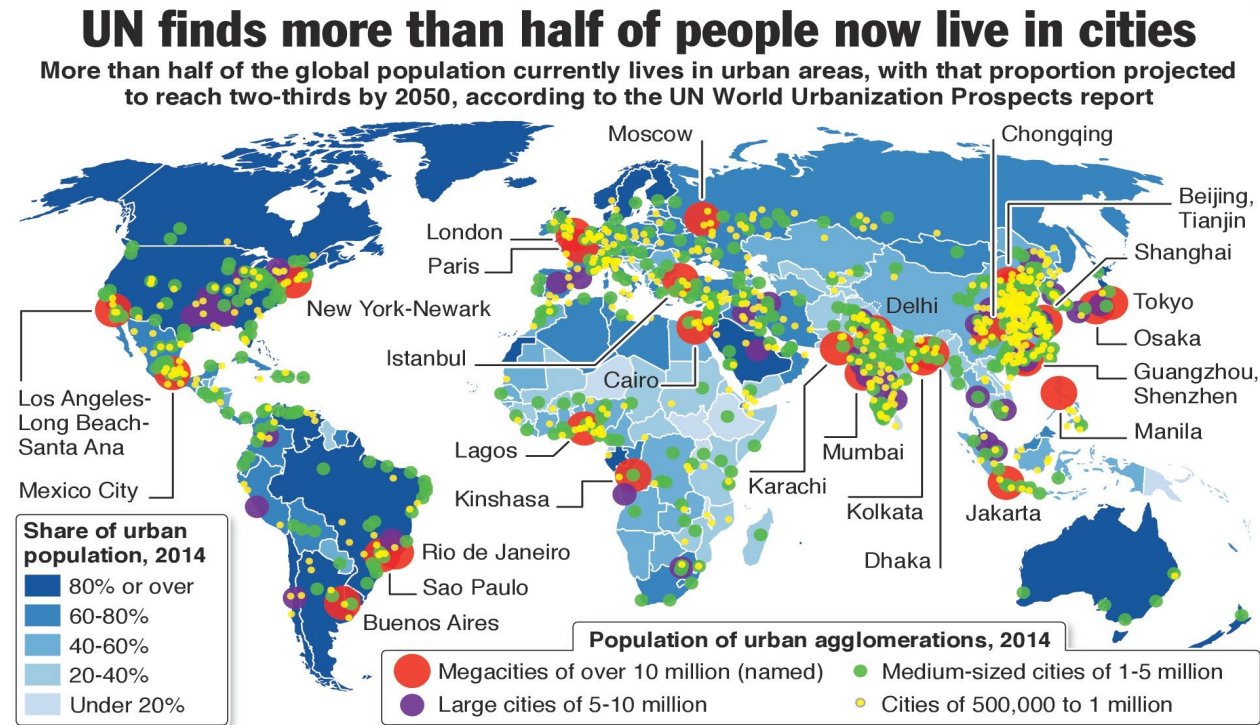


Webinar for NASEM Committee on
Geological and Geotechnical
Engineering (COGGE)

December 2020

- Renewable energy
 - offshore and onshore wind
 - Shallow/deep geothermal
- Geological sequestration
- Sea level rise
 - mean, regional, and local rates
- Coastal erosion
 - natural and anthropogenic subsidence
- Tropical storms and cyclones
 - storm surge
 - extreme precipitation
 - greeter frequency
- Extreme rainfall and landslides
 - more intense
 - greater frequency
- Groundwater depletion
- Climate change in the Arctic
 - permafrost thaw and methane emissions

Resilient and Sustainable Cities to Accommodate Increasing Urbanization of the World's Population

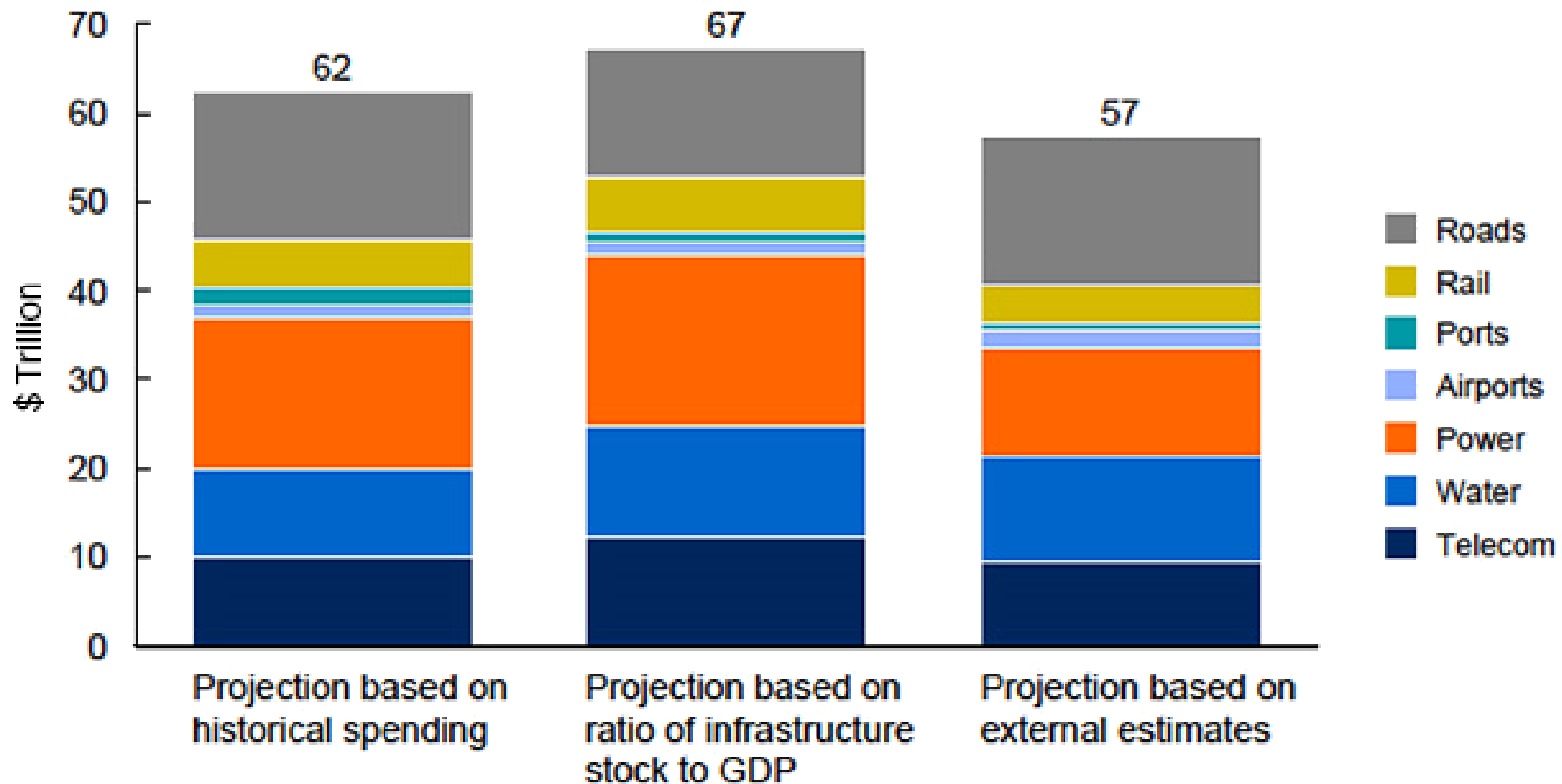


Source: UN World Urbanization Prospects: The 2014 Revision

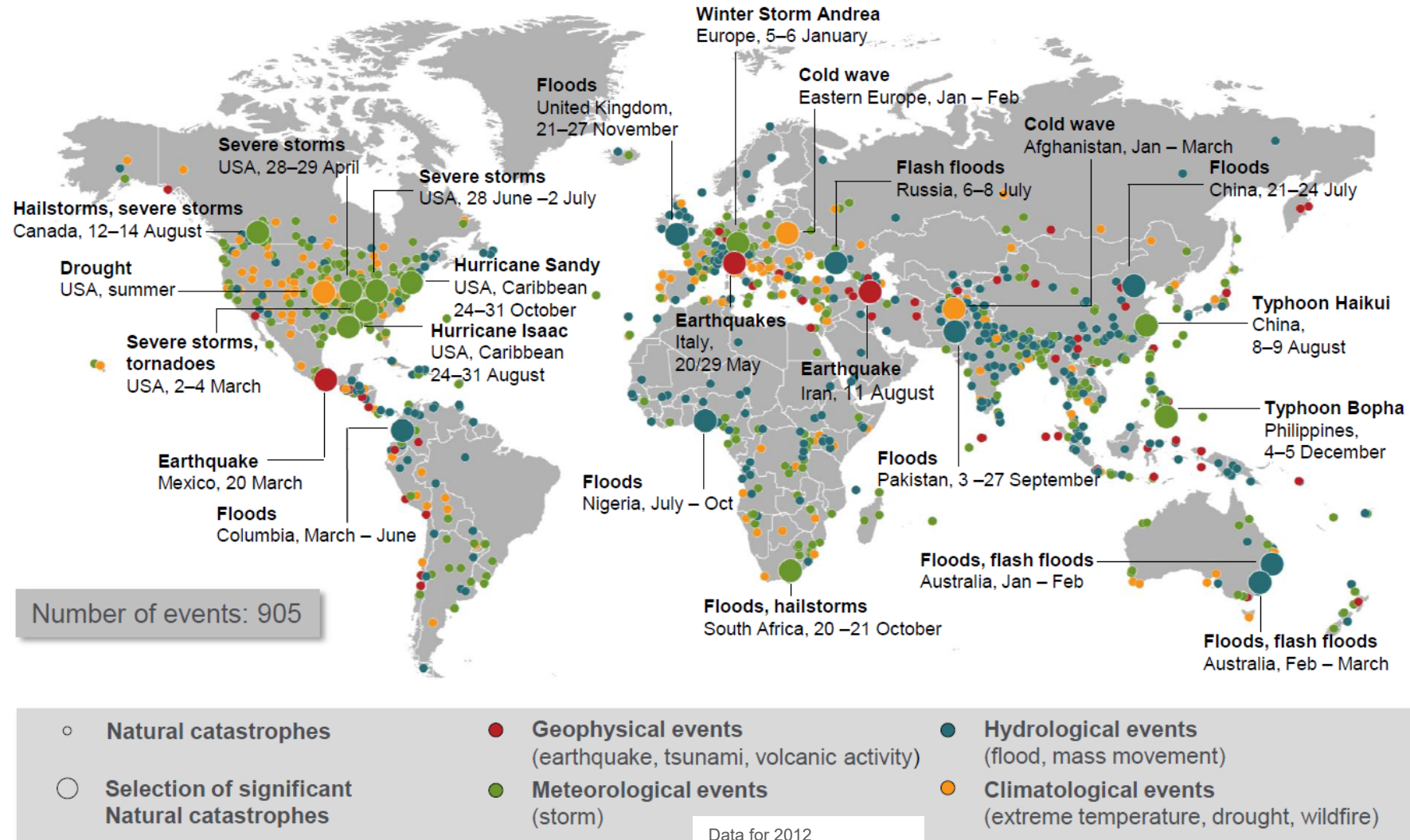
*Includes Caribbean

© GRAPHIC NEWS

Resilient and Sustainable Infrastructure – World Needs \$60 Trillion in New Construction and Repair/Rehab by 2035 (McKinsey 2016)



Natural Disasters Will Continue and, for Some Types of Disasters, be More Frequent and have More Extreme Consequences in an Increasingly Built-up, Urbanized, and Coastally Developed World



In Summary, There are Numerous Grand Challenges for which Geoprofessionals will be Essential to the Study, Design, Construction, and Monitoring of Solutions

- Climate change mitigation and adaptation
 - sea level rise/coastal flooding
 - numerous other impacts
 - carbon emission reduction and carbon sequestration
- Resilient and sustainable cities to accommodate increasing urbanization of the world's population
 - resilient and sustainable infrastructure
- Natural disaster prediction, adaptation, and repair
- Clean water and sanitation for the world's population
- Fresh water scarcity in large portions of the world
- Sustainable, low-carbon energy production and distribution
- Sustainable natural resource extraction (mining) and land reclamation
- Environmental protection of our earth
 - land, subsurface, groundwater, surface water, oceans, and atmosphere

Aspirational Goals Maximizing Vitality (and
Minimizing Stagnation) for Geopprofessionals in the
E&C Business Sector

Four Aspirational Goals to Help Maximize the Future Vigor of Geoprofessionals in the E&C Business Sector

- Achieve substantial, high-level geoprofessional involvement on the pressing earth, infrastructure, and environmental grand challenges of today and the coming decades
- Develop an improved paradigm for traditional geotechnical projects that is conducive to practitioner innovation and value creation for owners and clients
- Develop improved processes for bringing the fruits of geoprofessional R&D to the business sector and mainstreaming them in the practice
- Obtain a seat at the decision-making table with project-owner organizations where projects are conceptualized, planned, and prioritized, and where threshold decisions are made about project design, contracting, and implementation

What Can the Geoprofession Do to Increase Its High-Level Involvement on Pressing Grand Challenges?

- **Promote the importance of lifelong learning to practitioners** – geoprofessional knowledge applicable to addressing the grand challenges is being generated at a fast pace; practitioners need to keep abreast of this new knowledge and bring it into their projects
- **Develop workshops and other forums designed to accelerate adaptation of emerging technologies into grand challenge projects** – e.g., remote and embedded sensing technologies, geophysics, mega-data, advanced numerical methods, information management
- **Embrace and promote the multi-disciplinary nature of the grand challenges and champion geoprofessionals as multi-discipline literate, technology and solutions integrators**
- **Conduct outreach and education to stakeholders focused on the grand challenges** - government agencies, owners, politicians, and others responsible for addressing the grand challenges; advocate for the role of geoprofessionals and the value they bring
- **Recommend and encourage evolution in graduate school curricula** – to better teach a more holistic, multi-disciplinary approach to complex problem solving, coupled with more emphasis on essential business-sector skills such as leadership, team-building, and communications

What Can the Geoprofession Do to **Achieve an Improved Paradigm in Traditional Geotechnical Projects?**

- **Develop better processes for identifying technical advancements that can benefit traditional project performance** – project performance measured in terms of cost, schedule, reliability, sustainability, and/or resiliency
- **Develop better processes for mainstreaming technical advancements in practice** – how do we get technical advancements into widespread practice (no organized process for this in the geoprofession, see subsequent slide)
- **Overcome organizational risk aversion, fear of litigation, and inertia to keep doing things the same way to find a path to innovation and value creation** – this will require better training, contracts, risk management processes, and owner/client engagement
- **Better understand the project economic, schedule, and risk criteria that are important to the owner/client** – what is driving owner/client decision making – what keeps them up at night – how can geoprofessionals integrate responsiveness to these criteria into their services
- **Develop improved value propositions and compelling ways to articulate them to owners/clients** – we need to demonstrate we provide the value our clients want - we need to elevate our standing to one of trusted advisor

How Can the Geoprofession **Better Mainstream Technical Advancements and Get Them into Widespread Practice**

- **Encourage and support individual champions** – there are a relatively few already leading the way, but can we encourage more (e.g., professional recognition, new ASCE awards)
- **White paper a systematic approach** – circulate throughout the geoprofession to obtain input and build support (COGGE lead? Geo-Institute lead?)¹
- **Investigate whether other CEE disciplines do a better job at this** – what are existing best practices
- **Solicit support for initiatives** - can NSF, ASCE, USSD, DFI or others fund and support new-technology mainstreaming initiatives²
- **Engage E&C firms in embracing and supporting this effort** – they should have altruistic, professional, and pecuniary interests

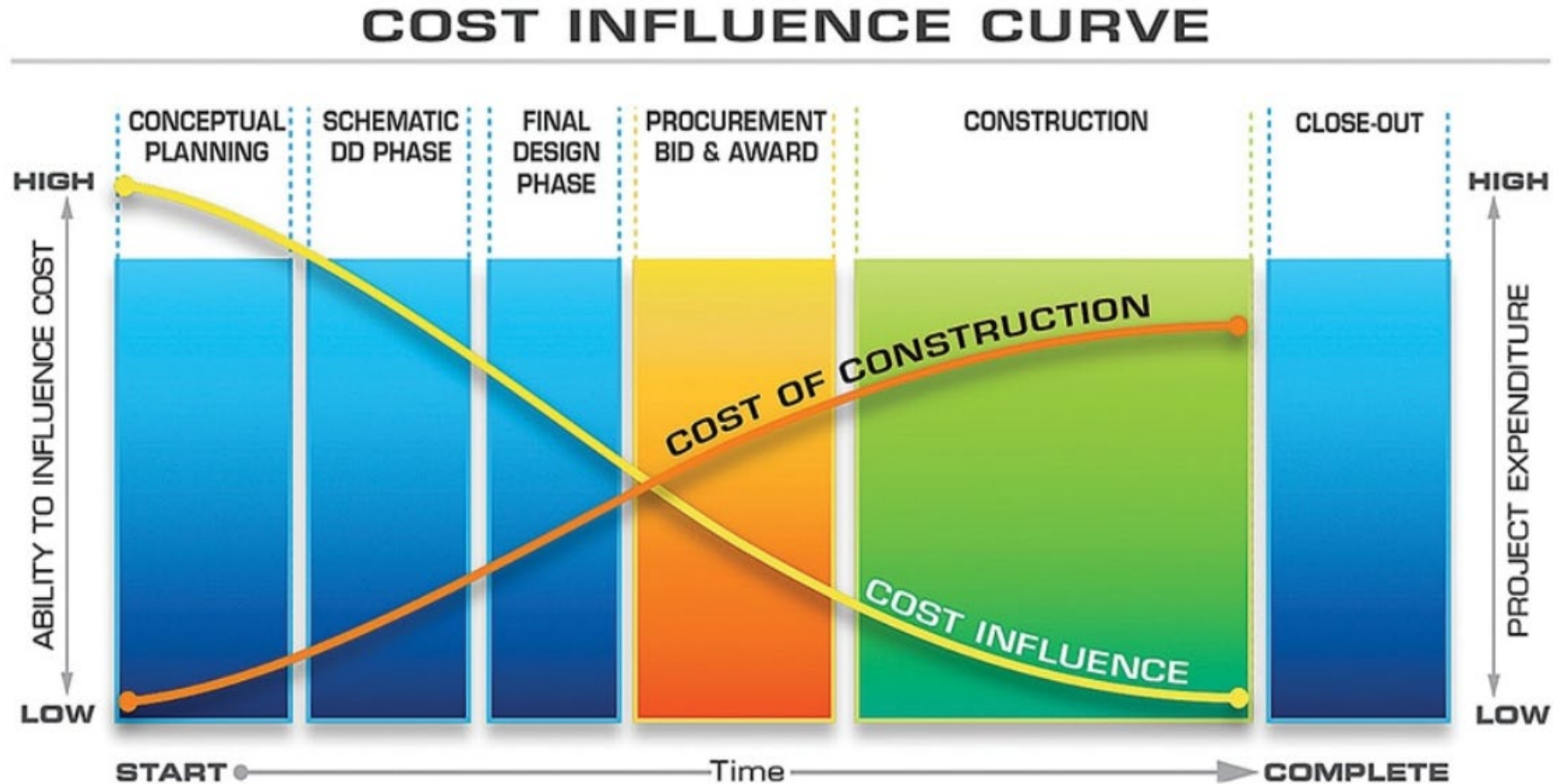
¹White paper should include value and cost/benefit considerations, as well as industry acceptance, standard of care, and risk aversion considerations - to the extent they can be defined

²Initiatives could include practice guides, videos, training, field demonstrations; some of these things are being done by FHWA, DFI, CGPR (VT), CERGEP (TAMU), and others

How Can Geoprofessionals Achieve a **More Substantial Seat at the Decision-Making Table?**

- **Promote our uniquely diverse skill set and multi-disciplinary technology integration capabilities to solve major problems** - Geoprofessionals are the only technical discipline with training spanning science and engineering related to the physical, hydraulic, chemical, biological, and thermal characteristics of the Earth's anthroposphere
- **Further develop leadership, management, and communication skills** – related to planning, organizing, and executing complex projects that have limited precedent with highly diverse, multi-disciplinary teams
- **Become active in new organizations where decision-makers congregate, and volunteer** – chambers of commerce, planning commissions, ACEC political committees (other professions do this much better than us)
- **Take a leadership role in projects, be proactive, and become engaged at the outset** - don't wait until someone asks "is there a geoprofessional in the room" – raise your hand and say "I'll lead the entire effort, not just the geo-tasks"

Advocate for Early Project Involvement It is Key to Maximizing Our Ability to Contribute and Bring Value to Projects



Challenges to Achieving Aspirational Goals – E&C Business Sector Leadership

- Practice-centered engineering leadership is essential if we are to make progress in achieving our aspirational goals
- Accordingly, as a profession, we should be encouraging up and coming geoprofessional leaders to embrace a leadership role that goes beyond geo-practice leadership to organizational leadership
- We should be encouraging these leaders to build value-creating, practice-centered businesses with a strategy that includes aspirational thinking – *this is a noble professional mission*
- However, a very substantial challenge to this vision is the current dynamics of the E&C business sector. As we've seen in this webinar:
 - a large percentage of engineering work in the U.S. (and around the world) is performed by large- and mega-sized firms
 - larger firms tend to be business-centered versus practice-centered and they may not see the aspirational goals as relevant to their business success
 - a very substantial amount of public sector and private equity money is flowing to firms in the business sector – these investors are focused on financial returns
 - there is prolific M&A activity in the sector fueled in part by the infusion of this money - this is disruptive to the development of coherent and sustained sector-level strategies

Challenges to Achieving Aspirational Goals – Additional Considerations

- Most geoprofessionals already work hard, many putting in long hours – where do they find the time to undertake the initiatives described in this webinar
- Many geoprofessionals see their identity as being engineers and they may not have an interest in the advancement of the profession in the ways contemplated in this webinar
- The geoprofession has organizations whose mission includes advancing the business interests of their members (e.g., the GBA, DFI, CalGeo, and others). However, these organizations have not had great success with that part of their mission, and the success seem to be more tactical than strategic/aspirational in nature
- Considering the foregoing comment, would the profession be willing to provide sustained annual funding to support a full-time team of people whose sole mission is to work with geoprofessional organizations and individuals to advance the aspirational business goals?
- Would there be resistance to increasing geoprofessional involvement as described in this webinar by other project stakeholders (e.g., politicians, government personnel, attorneys, community groups) who want to protect their current influencing and decision-making roles?

The Geoprofessional Business Sector is Healthy and Has a Bright Future, But it Could be Even Healthier and Brighter if We Make Progress in Achieving the Aspirational Goals (Maximizing Vitality)

Unfortunately, There is No Easy Path to Achieving These Goals. As the Saying Goes, *“If It Was Easy, It Would Have Been Done Long Ago”*

Thank You for Your Attention