
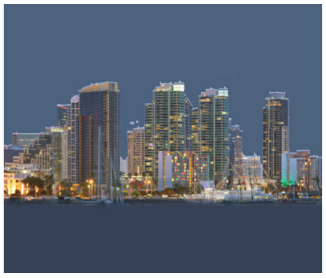

THE BROAD DIMENSION

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In this Edition:

Constructing Climate Solutions

We are already noticing disruptions in weather patterns resulting from changes in the climate and, according to the best well-tested models, this is only a small taste of what is likely to come. Here in California, we have suffered years of drought, then the rain tried playing catchup by dumping everything on us in one go, leading to landslides and some reservoirs overflowing, but the bulk of the water flowed directly out to sea before it had time to fill the depleted underground aquifers. Consequently, we got drenched but

much of the state is still in a drought condition. What can the construction industry do in the face of climate change, with the changing effects affecting different regions to varying extents?

With California's drought situation, plans are belatedly underway to implement measures to divert rainwater runoff to top up the aquifers, but generally the effects of climate change on the construction industry are seen as going in two directions. Firstly, there is the issue of designing sustainable buildings and ensuring that the construction work itself is not contributing more than necessary to the greenhouse gasses in the atmosphere. Secondly, we have the impact that climate change is having on the way that construction work is carried out and the issue of how much that is going to cost.

In our Spring/Summer 2021 newsletter (available from our website) we discussed many of the issues related to reducing the carbon footprint of construction. That included looking at steel and concrete, two very important building materials, both of which contribute significantly to greenhouse gasses. Ways of reducing that impact are available, but more innovation in this field is still desperately needed. Recycling of materials is already a common practice, but more should be possible, and even more useful regarding the climate is the repurposing of existing buildings rather than replacing them.

And it's not just the construction of a building that has to be considered, but also its effects on the climate caused by its use throughout its lifetime and its ultimate demolition. Consequently, life cycle analysis is needed to fully assess the design against its environmental impact. Life cycle cost analysis can also be used to show building owners how a bit more investment upfront can lead to a lot more savings during the life of the building.

Again, here in California, and particularly in the San Francisco Bay Area, last year showed another aspect of the climate change/construction industry connection. Air conditioning of houses in the Bay Area has been seen as an optional extra because being close to the Bay and the ocean has kept air temperatures nicely moderated. But the heatwaves last year led to strong sales of fans and portable air conditioners, and more permanent AC systems are starting to be retrofitted into houses and other buildings, adding load to an already hard-worked grid. Other areas of the nation have experienced far worse effects from adverse weather. There has been flooding from sea-level rise and more intense storms, along with extremes of hot and cold. Building codes and practices will have to take all of these changes into account.

Moving onto the way climate change is affecting the site practices, construction sites will have to adjust protective measures related to the heat, rain, and winds. It is hard enough to find suitable labor resources already, and excessive weather can make labor even more reticent to work under such conditions, with the strenuous work exacerbating the effects of heat changes. Overtime work may be needed to compensate for excessive heat that makes working outside nonviable for parts of the day, and there is a potential for increases in workers' compensation claims. Robotics offer a potential for offsetting labor heat problems and the labor shortages in general.

The need to create the safest possible jobsite has always existed, but additional warning systems regarding potential events (using speakers and phone apps) could be required, along with an evacuation plan. Tracking and recording weather for extension of time claims, etc., will become very important. If modular/prefabrication methods can be used it will reduce the need for onsite labor and move most of it indoors, out of the weather.

Climate change around the world is disrupting populations and we can expect supply chains to be affected as a result. We learned the hard way what problems supply chain disruption results in. The lessons learned from the Covid-19 disruptions could prove to be very valuable. The supply of materials may not be the only issue because extreme weather can affect things like the curing of concrete and compromise other materials.

Construction equipment also has to negotiate extreme weather conditions, and improved fuel efficiency of such plant, avoiding plant sitting idling, and the use of renewable power sources where possible will be needed. Electrical heavy equipment is becoming available. Regarding construction overheads, insurance rates are already rising as weather-related risks increase, and that's liable to compound. The growing fire risks in California have made it hard for some homeowners to even obtain insurance, leading to the question of whether insurers will cover incidents related to climate change. Changing delivery methods from the traditional design-bid-build option can allow for earlier contractor input — helping to mitigate such risks.

Climate and weather changes will be ongoing and have unanticipated effects, so organizations are going to need to remain adaptable to change. However, there will be potential gain for those companies that succeed in facing the challenges. A viable "green" future isn't going to appear by itself – we have to build it.

Quantum Construction

Quantum computers have made some significant advances recently. In 2019 we had Google claiming to have achieved "quantum advantage" and last year IBM announced that they had built a quantum computer with 433 qubits, both developments being significant steps on the path to practical quantum computing, but they do not mean that we'll all be using quantum computers in a year or two. "Quantum advantage" is said to be achieved when a quantum computer can solve a problem that a traditional

digital computer couldn't solve, at least in a reasonable time period. Google's claim was that their quantum computer solved a problem in a second or so, that a digital supercomputer would take at least 9,000 years to do. IBM suggests that 2.5 days is more realistic, but that's still a lot more than a second. And IBM's 433-qubit machine (Osprey) is impressive, but a truly general-practice quantum computer would need something like a million or more qubits (qubit is an abbreviation of 'quantum bit' and it is roughly equivalent to a 'bit' in a digital computer).

We can expect the pace of development to accelerate as the technological problems are solved. Today's quantum computers are said to be "noisy" and "error prone." The noise issue may need a year or two to get under reasonable control and good error correction/mitigation abilities will probably take about 15 years. Nevertheless, a commercially useful quantum computer may only be about 5 years away, and Google recently announced a significant advance in tackling error correction.

Whenever a truly practical quantum computer is available it will not be replacing your desktop or laptop computer. The companies working on quantum computers are already offering public access to their prototype machines through the Internet, and that is the way that they probably always will be accessed because they need to be kept cooled to close to absolute zero and protected from stray electromagnetic radiation or the qubits can become unstable. That will undoubtedly lead to the construction of buildings and infrastructure, not totally dissimilar to data centers and widely distributed the same way, in order to

provide convenient access to quantum computers. We'll have what can be called a Quantum Internet.

When quantum computers are available for common use, they are not expected to be used for watching ultra-cute cat videos or even for preparing spreadsheets. The fields where quantum computers excel are in specialist areas involving very complex calculations, and one of the first algorithms designed for them showed that the encryption methods currently used will be fairly easy to break when quantum computers are used on them. So, one technology that construction companies, and companies generally, will need to use quantum algorithms for is protecting the security of data and communications. Practical quantum security methods have already been devised and are being used.

Buildings are getting taller and more complex as the Internet of Things (IoT) brings us smart-homes and smart-cities. And that's even without considering the 106-mile single-building city project being planned in Saudi Arabia. That complexity is moving some of the engineering and optimization problems into the realm where quantum computers could be useful. However, this would probably be carried out via a program running on a traditional computer that accesses a quantum computer for the more complex calculations. In that way, the whole process would be seamless and probably controlled by AI (artificial intelligence) algorithms.

AI has itself been showing its usefulness this past year, with DeepMind's AlphaFold coming up with models for all the human proteins. That should revolutionize the biotech industry, and it gives some indication of what the combination of traditional computing, AI, and quantum computers could achieve when fully developed and integrated. On the other hand, we have been seeing how AI can come up with seriously erroneous results when tech companies tried incorporating it in their search engine software without thoroughly testing it first.

The biggest issue facing us at present is that of climate change, and any technology, including quantum computers, will have an impact in that regard. The question is whether the positive impacts can outweigh the negative. On the negative side there is the cooling needs which, because it means getting down to near absolute zero, involves added power consumption and use of helium that is a scarce resource. On the positive side, they have the potential for carrying out complex computational problems in minimal time, and those problems can include issues affecting climate change. However, we can't wait the 15 to 20 years until fully general-purpose quantum computers are available to find solutions for us.

Luckily, even current quantum computers, and certainly the near-term ones, can act as quantum simulators for modeling atomic and molecular reactions and interactions. That can help with things like finding improved refrigerants that don't react adversely with the atmosphere, improving the efficiency of solar cells and batteries, and possibly making "green concrete" more of a reality by finding the chemical changes needed to reduce the CO_2 that cement production generates and increasing concrete's CO_2 absorption during its lifetime.

We may not see quantum computers appearing in contractors' site huts, but they are a technology that is likely to revolutionize how the construction industry operates.

What's Happening?

We are seeing market swings and analysts' predictions changing almost daily. Some think that we are headed for a

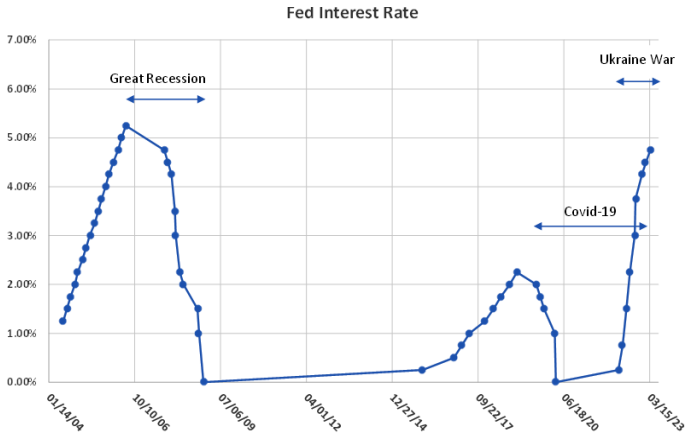
recession, others expect a soft landing, and another group looks forward to dynamic growth. The idea of recession seems to have the majority vote, but when and how that will happen varies a lot.

Earnings season at the start of the year showed S&P 500 companies being down an average of 1.3% on the quarter, but different sectors showed vastly different results. Tech companies as a whole fared badly, for example, while energy companies had record profits. Companies were predicting that future earnings would mostly be down, and more cautious consumers were expected. However, that didn't affect markets adversely, with investors seeing gloomy news as meaning that the Federal Reserve would likely pivot on the question of raising interest rates. It seems likely that the investors might need to be the ones to pivot.

Inflation may be softening a bit, but strong economic data indicate that interest rates will keep rising. It seems that we might have to learn to live with inflation and Covid for a while. The labor market added over 500,000 jobs in January, bringing unemployment to its lowest point since May 1969. That is bad for labor cost inflation and makes it look as though the Fed's interest hikes are not over yet.

Consumer spending makes up over half of US GDP and it had risen in January after a rough holiday season. However, it has been noted that consumers are spending more on services and less on nonessential goods as inflation hits their budgets.

Consumer debt has been rising although consumers' bank accounts still look good. Meanwhile, retail bankruptcies have been making news, as has the US debt ceiling. The Federal debt limit was reached in mid-January and consequently the US can't borrow more to pay its bills. If the debt limit isn't raised, we could see the US default on its financial obligations over summer, which would likely have the value of the dollar dropping and cause borrowing costs to rise even more.



The Fed's interest hikes resulted in the collapse and Federal takeover of two banks as the bonds that the banks had been holding lost much of their value and companies tried accessing more of their deposits to avoid high borrowing costs. The government had to step in to ensure that everyone got their money and stem the panic, but that doesn't help the Federal debt limit. The banks' problems did encourage the Fed to keep increases on the low end.

And, of course, we still have the war in Ukraine and sanctions on Russia, and the questions about what China will do. That leaves the health of globalization looking questionable.

We're interested in the construction market, of course, and architectural billings showed an improving situation through March, moving into solid growth conditions for most regions (the northeast being the softest). Work on infrastructure will remain strong, assuming government funding continues, but it has been suggested that we could see an overall 4% decline in the construction industry in 2023 because uncertainty and high borrowing costs make businesses wary of investing a lot in new developments. The real estate slump has led to layoffs at banks and mortgage companies as mortgage applications hit a 28-year low in February, but available housing remains in short supply so there is still good potential for the single-family construction market.

Things really seem to depend on what side effects the economy gets from the medicine that the Fed is prescribing.

Geoff Canham, Editor, TBD San Francisco

Newsletter designed by Katie Levine