January/February 2021

SPE Review London

The official e-magazine of the Society of Petroleum Engineers' London branch

London Section

London Net Zero: Tomorrow's next and future generations

Also in this issue:

- C-level talks SPECIAL: Nathan Meehan
- Perspectives on the upstream energy industry
- SPE YP London: Past and future plans
- The energy transition and ESG
- SPE Leeds: Road less traveled
- Reservoir simulation in reserves estimation

SPE SECTION EXCELLENCE *** AWARD *** 2020

50 YEARS

BEHIND THE SCENES LETTER FROM THE CHAIR

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ABOUT US

The Society of Petroleum Engineers (SPE) is a not-for-profit professional association whose members are engaged in energy resources, development and production. SPE is a non-profit professional society with more than 156,000 members in 154 countries, who participate in 203 sections and 383 student chapters. SPE's membership includes 72,000 student members. SPE is a key resource for technical knowledge related to the oil and gas exploration and production industry and provides services through its global events, publications, events, training courses and online resources at www.spe.org. SPE London section publishes SPE Review London, an online newsletter, 10 times a year, which is digitally sent to its 3000+ members. If you have read this issue and would like to join the SPE and receive your own copy of SPE Review London, as well as many other benefits – or you know a friend or colleague who would like to join – please visit www.spe.org for an application form.

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SPE SECTION EXCELLENCE *** AWARD *** 2020

In this issue

FEATURES

Behind the Scenes: SPE Review Editorial Board

Elizaveta Poliakova, Editor in Chief

Elizaveta is a Reservoir Engineer at Trident Energy Management Limited. She has a Master's of Science in Petroleum Engineering from Imperial College London and a Bachelor's in Petroleum Engineering from the University of Leeds.

Elizaveta has been with SPE for more than five years. She was the President of SPE Imperial College Chapter and the President of SPE Leeds Chapter. Previously, she was also on the committee of SPE YP.

Josh Beinke

Graduated from University of Adelaide in 2008 with a Petroleum Engineering degree. Moved to Europe in 2016, and working as a Production/ Exploitation Engineer with Vermilion Energy.

Ffion Llwyd-Jones

Business editor and writer. Finding, explaining and sharing stories that people can understand and relate to. International experience in technology, environment, and animals as therapy.

Mark Beleski

Experienced engineer, with deep understanding of industry practices, trends and challenges. Energy Loss Adjuster with AqualisBraemar, in London.

Justin Reynolds

Business writer focused on the energy and finance sectors. Currently writes for financial journals, has worked as communications officer for an oil & gas start-up, and features writer for The New European.

A big Thank You! to all the organisations that support the SPE London section

GeoScience

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NEPTUNE ENERGY

OPC

Letter from the SPE London Chair

Dear SPE London members and colleagues,

We are already well into 2021 and I hope that you are all remaining safe and well as the Covid19 pandemic continues to affect our daily lives. Although it's only February when I write this letter, it is over half way through my tenure as chair – it feels to me as if a great deal has happened during the past 7 months and it has!

To say that 2020 was a significant year for the oil and gas industry will be an understatement. The changes that we have been subjected to and witnessed have been profound and I believe some will remain with us permanently. The way we work and where we work, the increasing emphasis on the Energy Transition and its consequences are obvious examples. When the history of the oil and gas industry is written, 2020 will be seen as a watershed year.

To get a really good insight on the thinking within the SPE technical disciplines I recommend that members read the SPE Technical Directors Outlook – here's the link: **https://jpt.spe.org/spe-technical-directors-outlook-the-industrys-transformation-in-2020-and-what-it-means-for-the-future**. There many thought-provoking addressed by the technical directors. However, what struck me was the increased need for collaboration and knowledge sharing / transfer. In my opinion, if the oil and gas industry is to be central to shaping the energy landscape of the 21st Century, a break from previous behaviours will be necessary. I would be interested to hear your thoughts, so please contact me through the SPE London website to share your thinking.

For the remaining time of my tenure as Chair, the section will continue to offer virtual events. As a community, we are now used to connecting virtually. This is now becoming the 'new normal' and I can share colleagues' views that we do suffer from virtual overload. To remain engaged with the membership, we do need to make the virtual events as appealing as possible, content not withstanding. Please share your thoughts on how we can improve our virtual formats. It's critical that we remain relevant to our membership and I believe that the wider SPE has great material available on its website. Nevertheless, looking to the future, it is likely that previously held physical events will have a virtual component running in parallel, possibly opening them up to a wider audience who can access content at more convenient times.

During my last letter, I addressed the importance of sustaining membership to the SPE. If you are still thinking about 'what's in it for me' then please consider how the SPE has reacted to the events of 2020 in such a positive way. The depth and breadth of the knowledge management, and the opportunities to learn, are significant and I believe offer great value for money.

The section board has struggled over recent years to fill the membership lead position. However, I am pleased to welcome Mehdi Alem to the board as he takes up this key position. Mehdi will be supported by Andrew Quinn, and I know both are keen to improve our membership numbers and to ensure that the section offers relevant events across all levels of experience and offers a more personal service to you, the membership. Thoughts on how the section can improve its offer to the membership can be directed to Medhi through the Section website: **www.spe-london.org/**.

Our regular monthly evening presentations have got off to a flying start, with over 100 attendees at our January event, the first of a series of events focusing on Net Zero / Sustainability topics. During that event the SPE's key Sustainability brand, GAIA, was shared with the membership. This brand will be launched officially during the first quarter of 2021 and I encourage you to get behind this important initiative. Through the GAIA

Letter from the SPE London Chair continued

program, the society will be able to demonstrate – not only to its membership, but to the wider industry and public – how it is central to providing safe, cost effective and sustainable energy.

The February evening program continues in this theme, and I am encouraged that we will once again see a significant level of interest in attending.

The section is a volunteer-led and industry-supported organisation so it's great to welcome a new annual sponsor – Neptune Energy. Thanks to Neptune Energy for supporting the section in providing a diverse program to our membership.

If you believe your business would benefit from sponsoring or supporting the SPE London Section, please contact me at **Oleumventures@icloud.com**

As I look to complete the second half of my tenure as Chair, I continue to look forward to sharing our 2021 SPE London journey together.

Adrian Southworth, SPE London Chair

Letter from the Editor

Dear SPE members and colleagues,

Happy New Year! Welcome to our first publication of SPE London Review in 2021.

Although the UK has been in full lockdown since our previous publication, Brent Crude price has exceeded $60 and countries around the globe have started rolling out vaccination programmes. This gives me hope that we are on the way to returning to our normal lives!

In this publication, you will find our third article on Energy Transition and Net Zero, on **page 33**; an outlook for upcoming events from SPE Young Professionals Chapter and from SPE Leeds Student Chapter, on **pages 27** and **32** respectively; and an article on the Application of Reservoir Simulation in Reservoir Estimation by Fauzan Syarkawi and Ivan Ignatov, on **page 28**.

In this first issue of 2021, the format of our C-Level Talks is slightly different. Nathan Meehan, President at CMG Petroleum Consulting and previous President of SPE International, has shared with us his personal and career stories, which you can find on **page 11**.

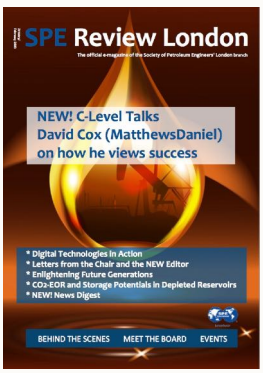
The SPE Drilling Conference will take place in March – please see **page 7** for registration details.

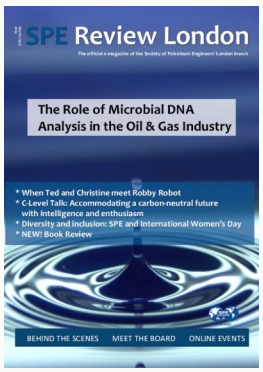
On behalf our Team, I would like to give a warm welcome to our new partner, Neptune Energy! Neptune Energy joins our other sponsors: Anadarko, GeoScience, CNOOC, Imperial College London, OPC, Premier Oil and Serica Energy.

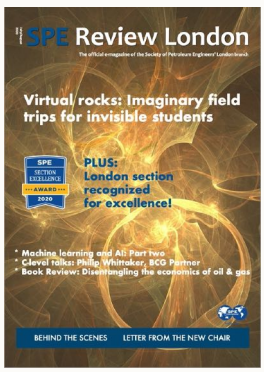
Finally, I would like to thank our SPE Review Team for their ideas, energy and drive, and SPE London Board for their support.

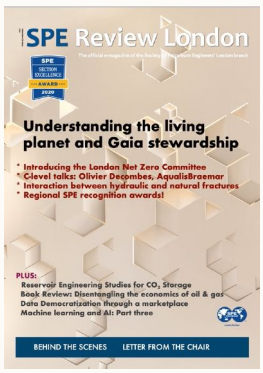
Please share your thoughts and feedback here: **spelondon@spemail.org**
I hope you enjoy this publication.

Stay safe and take care!
Elizaveta Poliakova









NEWS DIGEST... NEWS DIGEST... NEWS DIGEST

Elon Musk: Real story is not a battle against the evil entity

Tesla's CEO, Elon Musk, explained why the O&G sector should not be portrayed as wicked: "The real story is not a battle against an evil entity. The real story is how fast the world could shift to sustainable solutions."
Elon has highlighted the necessity of current and future usage of fossil fuels, pointing out the need to increase the rate for the energy transition.
Read more. And here.

Oil and Gas majors announce bids to assure rights to build offshore windfarms in UK, including Wales

Ground-breaking auction has the potential of delivering £8.8bn to the Queen and the UK Treasury over 10 years. The auction, run by the Crown Estate, BP and Total, has secured projects that together could power over 7 million houses.
Read more. And here.

Oil and Gas Authority assigned North Sea Buchan Area block

Jersey Oil & Gas was awarded a merged license (P2498) block in the UK's territory of the North Sea. The agreement includes a part of the block 20/5e within the Greater Buchan Area and an extension of J2 discovery.
Read more. And here.

Independent Oil and Gas appoints new Chief Operating Officer

Independent Oil and Gas' new Chief Operating Officer is David Gibson. David has nearly 30 years experience in the energy industry career relevant to North Sea engineering and project management.
Read more.

Implementation of the reviewed strategy from Oil&Gas Authority

Revised strategy from OGA puts in place obligations on the North Sea to facilitate the energy transition. The new strategy calls on the industry to collaborate with the supply chain, increased efforts to reduce emissions, and support CCS projects.
Read more.

SPE Net Zero Gaia talk: SPE members addressing the Energy Transition and ESG

Johana Dunlop, Chair of our SPE Gaia Sustainability Program gave the virtual audience a very clear and insightful introduction to this new member-driven program. Initiated by the SPE HSE & Sustainability, this program is to enable and empower all SPE members who wish to engage in the alignment of the future of energy with sustainable development, that is socio-economic development and that ensures human activity does not breach planetary boundaries. SPE members are supported in this ambition through a 9-element Sustainability programming framework; a committee support structure; a Gaia community on LinkedIn; and a new unifying brand as well as other resources.

SPE Gaia Sustainability Program has the ability to mobilise and provide our whole membership with the means to co-create activities and action plans that rise to the scale of urgency of the planet's sustainability challenges – reinforcing existing efforts and introducing new. Through the Gaia Principles to collaborate, engage and aggregate we can help to secure innovation, measure what matters, listen and communicate the opportunities along Gaia Pathways on Gaia Priorities such as the Energy Transition, the importance of Biodiversity while having due regard to the UN Sustainability Development Goals and our collective Social Responsibilities.

Johana reminded us of the Lunar Men of the late eighteenth century, whose conversations and aggregations help launch, or at least kick-start, the early days of the industrial revolution. She drew a parallel by reformulating the opening lines of Jenny Uglow's book of the same name:

"In the early 21st century, the meetings of the many fertile minds of SPE members changed an age. The original Gaia men and women gathered virtually and physically in sections and chapters in 140 countries… and they imagined a future where oil and gas is the most admired business sector for its amazingly efficient and reliable energy and petrochemical products that afford all of humanity great comfort, safety and progress and all this without harming nature or breaching planetary boundaries and in collaboration with other forms of energy."

Lunar aspirations or not, Johana and several of the Gaia core team created a very communicative answer session to rival any meeting of collective minds. Energy is certainly something Johana has in abundance – and to get the Gaia Program to be ready for launch is no mean task with the challenge of creating program resources that provide both latitude and framing in order to ensure we can answer a key question: "Are we doing enough, fast enough?"

Johana took us through the history of how Sustainability became a discipline in the SPE, making it the only professional society in our industry with a stand-alone discipline for Sustainability professionals that is also an enabling discipline serving the 7 others. Some of the finest Sustainability practitioners in the industry are members or associates of the SPE.

The first distinguished lecturer on Sustainability goes as far back as 2004, in the person of Lyn Arscot, the 1988 President and former Director of the IOGP. Seeds were sown bearing fruit in 2010 with the 'Engineering Solutions for Sustainability Workshop' in Lausanne where two other SPE Presidents [2010 and 2022] had their 'lightbulb' moments. Behrooz Fattahi, the then HSE Technical Director, engaged a Task Force to develop a strategy, resulting in 2012 with the formation of a 'Sustainable Development Technical Section'. This ground

SPE Net Zero Gaia talk continued

work naturally led to the first 'Gaia Summit', where the DNA of the now fully-adopted SPE Gaia Sustainability Program was co-created.

Figure 1 (below) shows how the SPE Gaia Sustainability Programming framework has been built around the 3Ps: Principles, Pathways and Priorities. Aggregation is perhaps the most powerful of the three Principles as it addresses the tendency of the industry to generate fragmentation due to a complex and competitive value chain of many actors, in many countries, with many very smart people taking initiative. Yet a time when our industry is viewed from outside in a bubble as a monolith, all tarred with the same negative brush, what our community needs is aggregation not fragmentation, with a unity of purpose and action such that we can

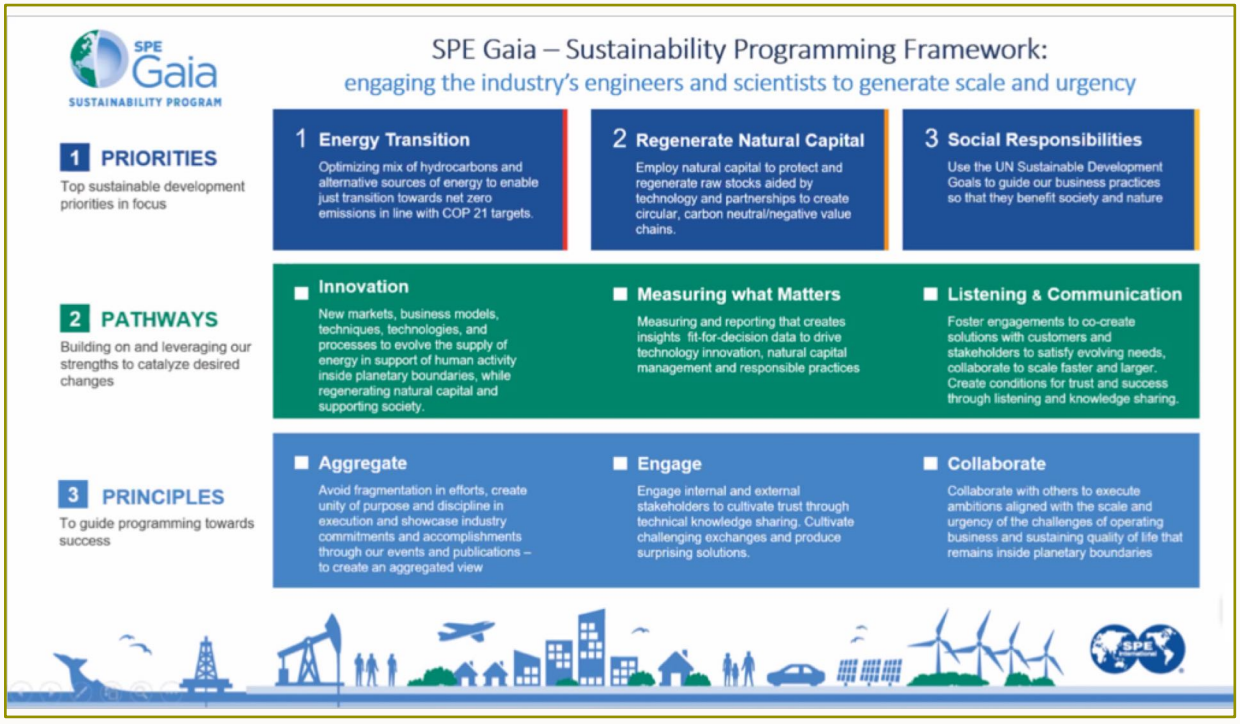


Figure 1

SPE Net Zero Gaia talk continued

answer the question – "Are we doing enough - fast enough as a technical community" – for ourselves and foremost for those outside expecting so much. The Gaia framework and brand combined with the SPE community provides the conditions to generate Aggregation, to answer that critical question.

This 'event' programming framework (with "guide rails") creates a cross-discipline approach with future meetings building on each other, but, with a latitude per sector/chapter to choose the elements that are most relevant to their ambitions and members. The Pathways play to SPE strengths: Collaborate and Engage are concepts we all understand but within Gaia it's about collaborating and engaging in a manner that is consistent with the scale and urgency of the challenges. Listening & Communication pathway is about elevating our capacity and to foster confident collective engagement. Listening being particularly important as not to lecture but to create a safe context for collective engagement and learning. Listening to outside minds is key as 'bubble' thinking does not generate aggregation.

Measuring what Matters has been highlighted. Engaging and directing the technical capability and ingenuity of SPE members toward the improvement and development of metrics that produce fit-for-decision data that informs operational and R&D decisions; that lead to improved sustainability of performance. Today many activities are measured but not 'materiality focused' to value, impact or effects. The challenge of measuring impact remains vast - developing 'Standards of Performance' become key, often because such measurements are so hard to achieve. Sustainability 'behavioural change' will be even more important now, more than our collective successes in the past from our institutional Safety 'behavioural change' achieved and now embedded across all petroleum activities, E to P. Ingenuity, innovation and developing the future capabilities of our technical community will challenge us all. New business models are evolving and are now being practiced.

There are many sustainability challenges embedded within the seventeen UN SDGs to guide. Not all are relevant to our sector being goals to aspire, though all seventeen require substantial STEM contributions, with priorities linked to 'materiality' of activities and actions. The Gaia Sustainability Priorities were selected as most relevant to our industry and to the SPE community, ones on which we can have an impact through our mission and strengths.

The first priority is, of course, the Energy Transition – transition toward a diverse energy mix that includes fossils fuels and renewables and provides energy for all and needs good stewardship. Optimizing the mix of hydrocarbons, managing alternate sources of energy is what Petroleum Engineers are good at designing for. Net Zero emissions require footprints to be effectively re-engineered, guided by the science.
The second priority is Regeneration & Natural Capital - about learning to value nature's ecosystem services, integrating our impacts into our financial models through the Triple Bottom Line at all levels including asset/ project level; managing our local and our global footprint and helping the customers of our products to do so too; what nature can teach us for innovation based on biomimicry; Circular Economy models etc – all have roles to play. Our technical community has a lot to contribute and lot to learn because these topics are fundamental to the future health of our planet and therefore of our industry which will thrive if the planet thrives.

Social Responsibilities is the third priority, well within the comfort zone of the HSE&S cross-discipline but up to now less so for other technical functions. Enacting a just transition; ensuring diversity & inclusion; respecting human rights; and not leaving communities behind, especially technical communities -- all need collective priority.

Johana and her Sustainability peers want to shatter the 'sustainability glass floor' – to reach all operations in the field and support them in integrating practices aligned with sustainable development, reaping the rewards of doing so.

Is this the beginning? … at least the 'means' signal the end of the beginning; new experiences where remarkable and definite victory is still the end to be engineered – Sustainability.

Give it a try! A mantra for man with a well-lived life, yet who still seeks the future with gusto.

Dr. D. Nathan Meehan is President of CMG Petroleum Consulting, an energy advisory firm founded in 2001 and Senior Technology Advisor for Petro.ai, a leading oilfield data analytics firm. He was formerly President of Gaffney, Cline & Associates, and a senior executive at Baker Hughes.

He served as the 2016 President of the Society of Petroleum Engineers. Previously he was Vice President of Engineering for Occidental Oil & Gas and General Manager, Exploration & Production Services for Union Pacific Resources.

In this version of his background, Nathan explains how he got into the oil and gas industry, describes some of his (mis)adventures, and speculates on the future of the oil industry.

From South Georgia to grad school

Of the fifty states in the United States, only thirty-one produce any oil or gas and eight of those states produce more than 90% of the country's oil and gas. I was born in Georgia, a state without a single oil or gas well. As a high school student, I was unchallenged academically and found a way to leave high school a year early by attending Georgia Tech, an engineering-focused school in the state capitol of Atlanta. I jumped at the chance. As a seventeen-year-old, I packed my suitcase and, while leaving town, filled up my 1967 VW bug with gasoline. I remember the price. It was 0.199$US/gallon. That is $0.047 euros per litre. Oil prices were $3.60 per barrel, but no one knew anything about oil prices then. Gasoline was cheap. Energy was cheap and it had fueled unprecedented growth in America.

General map of Georgia, U.S.
Map courtesy: Nations Online Project.

There were no petroleum engineering students at Georgia Tech. I studied Physics by default. The program that allowed me to leave high school early was a "joint enrollment" model in which I was technically still a high school student and also a Georgia Tech student taking regular college classes. The professor in charge taught physics and was to be a big influence on me. By default, we were all physics majors for the first year and I was hooked.

I loved Atlanta. Compared to the small towns I had lived in before it was so alive. Theater, opera, major league baseball, great restaurants! I loved them all and enjoyed it. But I was on a budget and one peculiarity of the university system was that tuition was based on the number of courses taken, up to a maximum of 18 hours. Beyond that was a flat fee no matter how many classes were taken. So I took a lot of classes, typically 23 hours each quarter. This led to me finishing college in two and a half years. I did take one summer off and drove from Georgia all across America and up into Canada with my two younger brothers. When we ran out of money we would stop in the next town, go to the employment office and ask for work. Incredibly, there was never any problem. In Kansas, we worked on the wheat harvest. We scraped tar from a K-mart's external walls. In Wyoming, they asked if I could run a bulldozer. Now, I had never run a bulldozer, but I had very briefly operated a backhoe. The two pieces of equipment are hugely dissimilar but I was not short on self confidence. "Sure, no problem," I responded. That is how I saw my first oil (or maybe gas) well. I went to the location where there was a bulldozer. Stakes in the ground outlined a large rectangle. The man in charge told me to dig a pit at least 6 feet deep. Then he cautioned: "But whatever you do, stay away from over there."

Give it a try... continued

He was pointing to what I now recognize as a wellhead. I was digging a frac pit and started on July 30, 1974. It took most of a day to learn how to operate the bulldozer and two more days to dig the pit. I suppose a real bulldozer operator could have done it much faster and mine wasn't very pretty. During my breaks, I would go (on foot) to look at the forbidden steel object. A stack of valves and a few gauges, and there were a few tanks nearby along with some flowlines. I finished on August 1 and the man in charge gave me a compliment I suppose... "That's not the ugliest frac pit I have ever seen, but it's close."

On my paycheck, I learned that I was a 'Roustabout I' and worked for Chief Oilfield Services. My brothers and I made our way back to Georgia and I started in on my last two quarters at Georgia Tech. By this time, I was in love with the girl who would be my wife and I started to think about what I should do after college. I got accepted into a law school and a medical school. I applied to some of the best law and medical schools but didn't get into those. I got into 'decent' schools as well as graduate school in geophysics and social science (long story). I was leaning to medical school, but I decided to interview for a few jobs just to see what was out there.

I had to put a resume together. I had quite a few jobs growing up, including operating a jackhammer in a pulp mill construction project. For the most recent summer, I added: 'July- August, 1974 Chief Oilfield Services, Roustabout I, Dug frac pit with bulldozer, miscellaneous duties.' Technically, I did work from July to August, I suppose. I had job offers from several companies as a physics major, but none were exciting to me. I had more or less decided on grad school.

One day after class one of my professors said: "Some guy from a French company saw your resume. He said he wanted to talk to you about a job because of your oilfield experience. I didn't know you had any oilfield experience. Anyway, you can meet at the placement center at noon if you're interested and he will buy lunch." Lunch sounded good, but I didn't know I had oilfield experience either. The Schlumberger recruiter was enthusiastic. At one point he pulled out a well log. With the benefit of hindsight, I can tell you it was a resistivity log with an SP. The log was 'railroad tracks' for most of the length, but in the middle was a well-developed sand with high resistivity. I didn't know what it meant but my physics training taught me that if there are a lot of constant signals and then a changing signal followed by constant signals that the changing bits were probably the most interesting. So, I pointed to the high-resistivity interval and offered: "So I suppose this is the interesting part?" He replied, happily: "You found the pay!" This would be the easiest bit of petrophysics I would ever do.

Along with a group of engineering students I was invited on a multi-day job interview. We saw an offshore rig, went on an onshore logging job, saw a variety of the company's services and were all offered jobs with generous salaries. Finally, they left us in a room with several experienced, but relatively young, engineers to ask questions. They regaled us with stories about how hard they had to work, what great salaries and opportunities lay ahead and a bit of skepticism about whether we could 'cut it'. I wasn't asking any questions, so the most senior guy asked me if I had any questions. I recall saying: "I like this business. But isn't there another job that pays pretty well where you don't have to work quite so hard?" They all laughed, but the senior guy said: "You know, those petroleum engineers make plenty of money and they mainly stay in the office and tell us what to do."

Meehan is well known for his #SPElfies with members and volunteers – this one at OTC Asia.

Back at Georgia Tech, I looked at the recruiting statements for all the oil companies. None of them were looking for petroleum engineers since we didn't have any at Tech! So, I signed up for an

Give it a try... continued

interview with an Amoco recruiter looking for geophysicists. He asked me at the beginning of the interview: "So why do you want to be a geophysicist?" I said I didn't. I wanted to be a petroleum engineer. (Of course, at this time I was pretty unsure what those were, but gasoline was costing me $0.75/gallon, almost four times what I had paid when I started college. The OAPEC embargo had driven up oil prices dramatically, supporting my interest in oil and gas.)

The Amoco recruiter smiled and said: "Well, now is a pretty good time to be a petroleum engineer," and gave me the name and address of a man in Denver to contact. I went on to graduate from Tech on March 15, 1975, and was working in Denver as a production technologist by early April. I spent four months there and began to learn about the oil and gas industry.

Within a few days, I learned from the boss that I couldn't get a job as a petroleum engineer without a degree in engineering. They encouraged me to get a Master's degree in petroleum engineering and most suggested the Colorado School of Mines. I moved to an apartment in Golden, but I also applied to the University of Oklahoma where my father had gone to college. Mines offered me a research assistantship, but OU offered me a full fellowship. I was off to OU as soon as my internship was done. I had also saved enough money from my internship to buy my girlfriend an engagement ring.

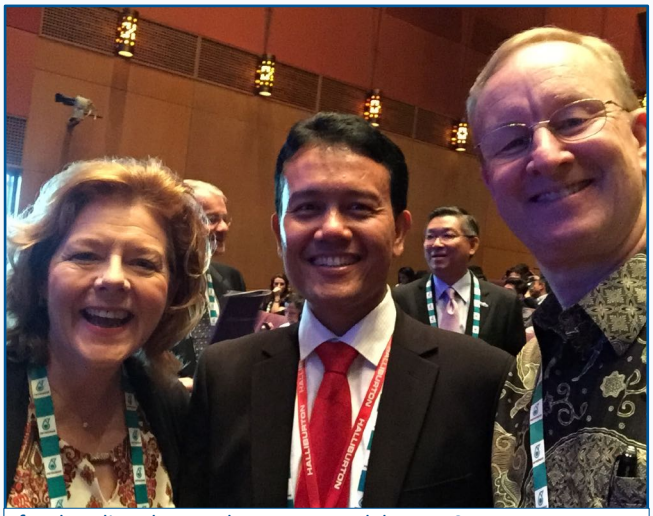
OU and joining SPE

Graduate school in petroleum engineering was very different from studying physics. My first class was petroleum fluids with Martin Chenevert. At the beginning of the class, he passed out forms to join the Society of Petroleum Engineers. He said: "If you are going to be a petroleum engineer you have to join SPE". So, I did. Then I was in for my first surprise as he started talking about the "real gas law" and put up on the board:

$$PV=znRT$$

Now, as a physicist, I knew about real vs ideal gases. So, I said: "Wait a minute. P, V, n, R and T are old friends of mine. I also know that real gases have extra terms to address molecular attraction or at high enough pressures hard sphere corrections to deal with their non-zero volumes and so forth. Where are those terms and who is this 'Mr Z' guy?" Professor Chenevert replied: "Oh, in the oil business we don't worry about all those extra terms. We just use this z-factor as the multiplier that takes care of all those." I was a little surprised. A few years later I would get some fame by writing the first program for the HP 67/97 that calculated the z- factor.

At OU I went to the monthly SPE meetings in Oklahoma City and met Mike Fetkovich and Hank Ramey. They would be friends and sources of inspiration throughout my life. I attended my first SPE ATCE and met the current and several past presidents of SPE. My M.Sc. would take a year and a half, and I was planning on getting married in the summer of 1976 (before I finished my degree.)


After handing the gavel to Janeen Judah at ATCE.

I would need a summer job, so I interviewed a couple of companies. I didn't hear from any until one of them (Cities Service) offered me a summer job in a gas plant in Plaquemines Parish Louisiana. The reader may be unfamiliar with this part of the state, but it is very far south and has been described as 'too thick to navigate but too thin to plow'. They needed an answer and I said yes. In the next 48 hours, all the other companies I interviewed offered me jobs. One seemed ideal. A reservoir engineering spot in Oklahoma City for Union Oil Company of California. I called the Cities recruiter

Give it a try... continued

and explained my dilemma. I said the other job was a much better match. I was planning on getting married and my fiancée worked in Oklahoma City. It was more in alignment with the career I wanted. I left out the higher pay part but told him that if turning down the summer job he had offered would make me ineligible to work for Cities I would still go to work for them. He was very understanding and said: "Son, if you turned down that job for the one in the swamp you wouldn't be smart enough to work for our company." The summer with UNOCAL was great and they let me take off time to get married.

Meehan and his 'gf'engagement photograph.

Working full-time

At the end of the summer, UNOCAL offered me a regular full-time position. So did every other company I interviewed, plus two I had not interviewed with based solely on my CV! Demand was astronomical, but I chose to work for Champlin Petroleum Company, an independent owned by the Union Pacific Corporation. They let me work part-time until I finished my thesis and then worked in Oklahoma City at least until I finished my coursework that December. I really enjoyed the work. After six months I bought my house, a modest three-bedroom affair for which I paid $23,500.

There were no geologists, geophysicists or landmen at our office. There had been very little drilling activity before I arrived and the opportunities were plentiful. I recommended more than 100 wells to be drilled plus many workovers in my first year. And just before we celebrated our first wedding anniversary we welcomed our first child into our home. After one year I would be transferred to Houston. Over the next twenty years, transfers and new children would become routine!

I worked in Houston for several years and improved my skills in reservoir studies, economic evaluations, hydraulic fracturing and simulation. I had published one SPE paper during my first year at the company based on my Master's thesis, but continued to present papers and attend conferences.

In Oklahoma, I went on a lot of frac jobs in the Mississipian formation where we pumped high rates of a fluid containing 10 pounds per 100 gallons of uncrosslinked polymers. This 'slick' water couldn't support a lot of proppant so we might add up to 1.0 pound per gallon (ppg) of sand. In other areas, the frac jobs were far different. The gel loads were much higher, 40 to 50 pound loads of crosslinked polymers with far higher viscosity. These gels would transport 8-10 ppg of sand resulting (perhaps) in much better frac treatments. The realization that this might not be true would change the industry decades later.

Meehan and his friend Khaled Al-Buraik getting ready to board a helicopter to inspect the Manifah field offshore Saudi Arabia.

One of the most embarrassing incidents of my career happened about a year after I graduated from OU. I had just moved to Houston and my annual salary was $25,300. I was contacted by the Wall Street Journal about how I became a petroleum engineer. He called me back and asked about my salary which I was reluctant to disclose. He asked if I was making "In the 30s?", to which I said no. Then he said: "Upper 20s?" and in a moment of weakness I said: "Well, you could say that." And he did. On the top article of a highly visible part of the Wall Street Journal. It came out on the day of a Union Pacific Board meeting with Drew Lewis as the Chairman and CEO.

Our VP figured out what happened and, eventually, I

Give it a try... continued

received a personal instruction from Drew: "If the Wall Street Journal ever calls you again, even to subscribe, get company permission to talk to them." This was a time of rapid salary compression. Entry-level engineers were getting large raises and often catching up to more senior engineers. Over the next few years, I got 'thank you' notes from around the globe. I suppose I can take credit or blame for some of those raises.

After a few years in Houston (including the birth of my second daughter), we moved to Fort Worth, our company's corporate headquarters. I did a stint in Corporate Planning and got exposure to a far broader view of the industry including evaluating refining and petrochemical projects. By far the most enjoyable project was writing the company's first economics manual. I worked with a Harvard MBA and our tax and accounting professionals and developed the standards we would use and extensive examples. I also got exposure to our top executives. And one more child, a third daughter.

My next assignment was out in the field. It was also my first supervisory role. We operated a lot of mature wells with dozens of pays and a lot of opportunities. We also developed the company's first offshore discovery. I became the company's youngest District Engineer, the job I had coveted since I went to work. My new boss John Applegath had come from Exxon and had expertise in gas plants and facilities but little downhole or reservoir expertise. We didn't move from Fort Worth to Corpus for several months, so I came home on weekends. During the week, I put in some very long days. John also put in long days and we soon struck up a deal. He would buy dinner if I would teach him petroleum engineering. After hours, we studied everything I had learned and, as John was a fast study, I wound up needing to do some research just to stay ahead! It was during this job that I met our new VP in Houston, Scott Kraemer, the 1972 President of the Society of Petroleum Engineers. Scott was a very senior Texas A&M grad who had been an executive at Amoco before he joined Champlin. Scott would become my mentor although not in any formal way.

One fun activity for me professionally started in Fort Worth innocently enough while analyzing a well test. One fluid property needed for gas well test analysis is cg, the isothermal compressibility of gas. This is, of course:

$$c_g = \frac{1}{z}\frac{\partial z}{\partial P}$$

The common practice at the time (and this may surprise young readers) was to calculate the pseudo-reduced temperature and pressure and look up the z-factor on a chart (Standing and Katz). I would then look up the z-factor a bit above and below the desired pressure and calculate the derivative. This was a bit of a pain and I was looking for a simpler approach. There was a correlation for z-factor (Dranchuk and Purvis) and I wondered if I could just take the partial derivative at constant temperature. My old college roommate and I worked it out and, to test it, I wrote a program on the HP-67 calculator, which had just been introduced. I decided to publish an article and (as I recall) I had some elaborate title like 'A new method of calculating the isothermal coefficient of gas compressibility'. Not exactly an eye-catcher. In the last few lines of my article that was replete with equations I casually mentioned that the calculations were simple enough to be programmed on a handheld calculator. The editor asked me to revise the article to include the program. He changed the title to 'Z-factor programmable on calculator' and the article was a huge hit.

Meehan's favourite thing as SPE President was meeting with students around the world.

Such a hit that Hewlett-Packard would contact me to find out why so many people in oil and gas were buying their calculators! Thus began a relationship in which they would give me calculators, even well in advance of their public release. I wrote plenty of articles on

Give it a try... continued

decline curve analysis, log analysis, etc. They eventually gave me an HP-41 emulator more than a year before the calculator's release. I would work with one of their programmers (Eric Vogel) and the legendary Stanford professor Hank Ramey to develop the HP-41 fluids pac. I am quite proud of that accomplishment and Eric and I would go on to write a book of applications using that pack. The code and descriptions we wrote ultimately worked their way into many Excel spreadsheets, computer programs and even reservoir simulators.

After my turn as District Engineer, it was back to Houston, initially as a more senior but still staff engineer. It was during this time that I first became very active in SPE as a volunteer and as an author. I moved up the technical ladder and Scott Kraemer began to mentor me more actively. I was able to do reservoir simulation projects on tight gas fields leading to massive increases in drilling activity as I justified infill drilling. I learned Monte Carlo simulation and risk analysis tools. These were great days and, even in the mid-1980s, we were quite busy. I was promoted to Division Engineer and finally had a fairly large staff.

By 1985, with less than ten years' experience, I became the Region Engineering Manager reporting to the VP. Scott began teaching me in a unique way. I would be called into his office and he would just tell me to sit. Some group would come present a proposal and then he would say: "Meehan, what do you think?"

Scott's voice was gruff and a lot of people were scared of him. I loved him. Once when asked my opinion I said: "I don't like this idea at all. I think we need to retain this for reasons a, b and c…" Scott just said: "That's right," and threw the presenters out. While I often agreed with him, the times when I didn't he would listen to why and (rarely) change his mind. This was better than any school or training I could have imagined.

One day I asked Scott about serving on the SPE Board of Directors. He said: "You'd be a good candidate, I'll nominate you." I asked if he wanted me to get any other letters and he said: "If my recommendation isn't good enough to get you in, you don't deserve the job." I became an at-large Director!

By the late 1980s, and into the early 1990s, the years of low oil prices began taking their toll. Now I had all the engineers in the Region reporting to me and we were facing layoffs and office closures. I would either select the engineers to be laid off or approve them. To be honest, the first round of layoffs was painful but not difficult. We had never had layoffs and we had some engineers whose performance was not meeting expectations. The second round was much more difficult as those engineers were performing well. By the third round, we were cutting deep into the staff, including many first-rate engineers who I would gladly have rehired. It was one of the more painful parts of the job.

I remained active in SPE and particularly enjoyed participating in SPE Forums where I met industry experts in a way that allowed me to get to know them. Heber Cinco and Fernando Samaniego became friends as did many of the well test community. At work, I was increasingly concerned over the impact of low oil prices. The company's drilling activity slowed and I got tired of laying people off. I had thought about getting a Ph.D. before and then had a serious discussion with Scott. He told me: "Meehan, I've sent a lot of people back to school to get a Ph.D., and I always ask them the same question: 'If you are forty years old and didn't go back and do this would you regret it?' Life isn't worth having regrets. If the answer is yes, you go and do it and we'll do the right thing."

Meehan's commitment to safe hydraulic fracturing extends to his license plate.

This lead my wife and me to some serious reflection and prayer. I thought about schools and only applied to Stanford based on how impressed I was with the only two professors I knew well, Hank Ramey and Bill

Give it a try... continued

Brigham. I let Scott know my decision and UPRC made me an offer that changed my life. I would stay on the payroll at a greatly reduced rate but still eligible for benefits. By this time, we had four daughters. We lived in a large house and had become comfortable with the corresponding lifestyle. At Stanford, we would move into a tiny apartment with one small bathroom. The best years!

Stanford years

I was ill-prepared mathematically for Stanford. I started in January without the benefit of the Fall classes. I had never seen the campus. I did not even look up where it was located as we loaded a tiny subset of our furniture (most of the rest in storage!) and just headed west on I-10. At one point, we were in heavy rain and I could barely see. I was nervous and slowed to a crawl. One of my daughters said: "We need to say a prayer." After her earnest and heartfelt prayer, the rain almost immediately abated, and we saw a gas station and gladly stopped for a break. I would need many more small miracles for the next few years.

The night before my first class I had a dream. In the dream, I was in a classroom and the professor was drawing unintelligible symbols all over the board. A few Greek letters, some Hebrew. Runes? Symbols from an alien civilization? In the dream, I turned to the student next to me and said: "I thought this was Advanced Reservoir Engineering?" He responded: "Oh, it is but he is just reviewing the basics." I woke up in a cold sweat. The next morning at 9:00 I sat in Professor Avrami Sageev's Advanced Reservoir Engineering class. It was the second in a series and I had missed the Fall class. He said: "Let's look at the simplest case, the line source solution," and wrote:

$$pD = \frac{1}{s} K0(rD\sqrt{s})$$

I leaned over to the student next to me. "OK, pD and rD are the dimensionless pressure and radius, right?" "Yes." "Now s … is that skin?" "No, that's the Laplace space variable." "And K0? That's the modified Bessel function."

My nightmare had come true. I am pretty confident I had done Laplace transforms before. OK, I had at least heard of them at least. But this was a new adventure as I had no recollection of this nightmare come true.

We had great times. My wife did a Master's degree in Administration and Policy Analysis. She hasn't used that degree professionally, but it was a great investment for her. I became the Student Chapter president of SPE. We had a great time in a program full of graduate students and I developed friendships with many of the faculty members. I reached out to learn more in geomechanics and took three classes in the business school. We put in a soda machine as a moneymaker for the student chapter. As a student, I traveled to China to participate in an SPE conference. I learned about geostatistics and, eventually, my dissertation would have pages and pages of Laplace transformations. I went back to work at UPRC during the summers just as we were beginning to drill horizontal wells in the Austin Chalk.

SPE members show the visiting President great hospitality, including experiencing local culture.

My children were growing up fast and I think they enjoyed Palo Alto and the environment at Stanford. It was completely different. My wife had purchased several 'Cabbage Patch' dolls for each girl before we came to Stanford. At some point, they began to realize that the neighbor kids didn't have as many nice things as they had. The girls 'sold' all but one of their Cabbage Patch kids to neighbor parents for five dollars each, and at Christmas were delighted to see them distributed around Escondido Village to other little

Give it a try... continued

girls.

Stanford was a safe place. One day, we had a horrible scare as we could not find our youngest daughter. We looked everywhere and finally went door to door (we had previously gone to all the apartments with children anywhere near her age). A few apartments from us at a Korean student's apartment we found her happily eating cookies and talking with the lady who lived there. Her husband worked incredibly long hours and she was left alone and spoke almost no English. Our daughter related to us that she would go visit, and the lady would have magazines and pictures and she would tell her what things were and they would practice saying the words, such as 'refrigerator', 'elevator', 'pepperoni'. She was teaching English at age four.

The best result of going to Stanford was the birth of my first son. We were thrilled, but there just wasn't any room in that tiny apartment. We would be glad to move!

Back to work for UPR

By this time, the Houston office had been consolidated to corporate headquarters in Fort Worth. We moved back with our four daughters and young son. We lived in a nice suburban location and I commuted to downtown. I had always been an opera fan but now we could get season tickets.

My job was initially unclear. I had come back with a PhD, but no one immediately knew what to do with me! I started looking to be useful. I visited with some of the East Texas team and a production engineer mentioned that a recently drilled well wasn't kicking off and producing very well. I casually suggested dropping soap sticks (which would lower the interfacial tension of the water and potentially allow the well to clear such fluids). Miraculously, they worked well and the well started producing at a good rate. This happens less frequently than you might imagine and after a month or two they came back to me and said: "How did you know which one to drop soap sticks in? We've put them in about thirty more wells with no impact." A PhD in engineering and my first technology recommendation is a lucky guess application of a super low-tech solution. Fairly soon though I was doing projects that required much of what I had learned, including advanced PVT modeling, geomechanics and even my dissertation (without the Laplace transforms).

One of my Stanford professors (Khalid Aziz) had suggested me for the Board of Directors at the Computer Modelling Group, a not-for-profit research group in Calgary that developed reservoir simulation models. The position didn't pay any money but I really enjoyed that opportunity. I finished a three-year term just as they were going to go public.

I did a lot of things initially. I helped pick furniture for new offices. I helped the horizontal well groups do some stimulation designs. Increasingly, I focused on horizontal wells and on hydraulic fracturing of tight gas. After a few years, UPR led the way in horizontal well technology and I had the opportunity to become an SPE Distinguished Lecturer. It was great. I traveled all over Asia and Australia and then to Alaska.

Meehan inspecting the asphalt at Pitch Lake in Trinidad.

We spent a lot of time developing ways to improve hydraulic fracturing treatments and I hired some real-world experts in what would later be called 'fracking'. In the process, we reintroduced 'slick water' fracturing, which was what I had initially done in the Mississipian wells when I joined the company in 1976. But this was for tight gas wells. Normally we would pump very viscous cross-linked gels and try to cram 8+ pounds per gallon (ppg) into the large cracks we would create with this fluid. The cross-linked viscous gels were required to transport the huge amounts of sand designed to

Give it a try... continued

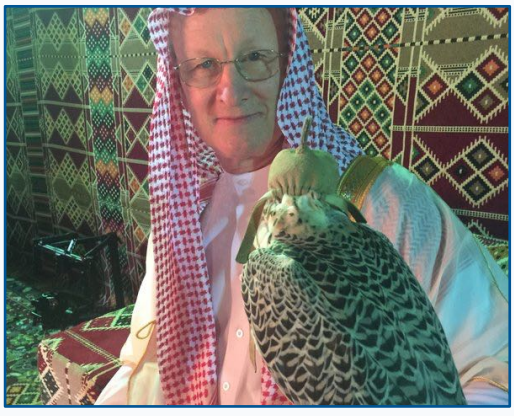
create highly conductive propped fractures. With slick water, we used small amounts of uncrosslinked polymers and could transport no more than 1 ppg of sand. The fractures would be narrower but the costs would be lower and the fractures would be easier to clean up. Our calculations showed that the cleaner fractures coupled with some geomechanical differences in fracture propagation could potentially perform as well or better than the old design.


Meehan and the GF off Alaska.

Theory is one thing, but the team tested these designs out and we were astonished by the results. The services company (Halliburton in particular) were very skeptical and tried to talk us out of it. But it was doing too well to give up. Ultimately, I presented a paper called 'Proppants, we don't need no stinking proppants', and the industry tested this approach around the world. It worked in many places and, eventually, would become essential to unconventional developments. Along the way, I invented a job title. Senior Scientist. I had seen that role at other companies and talked the company into it. Eventually, we formalized it into the Petrotech Fellows program which was named for our former CEO Bill Adams. My fracturing experience and reputation gave me a chance to sit on the Board of Pinnacle Technologies.

Along the way, I was trying to figure out what I really wanted to do longer term. Armed with a PhD I had a chance to teach, and both Stanford and Texas A&M offered me opportunities to do so. I told my then boss (George Lindahl) that I wanted to quit and go teach and he said: "No, first check it out and make sure you do. Come up with a decent idea and we will support a little experiment." That turned out to be a great call and I really appreciate it. I called Stanford and asked to teach one quarter each year (for free). The company would leave me on payroll and I would commute to Stanford. I did that for two years and understood more about the teaching and research role. But by that time, drilling activity in both horizontal and tight gas had exploded and I was having too much fun working!

My small petrophysical team was as good as any group anywhere. They developed a brilliant new approach to direct the bit in horizontal wells called geosteering. There were other approaches to geosteering, but this method was excellent for our primary target and we decided to patent it. None of us had any experience in patents and (in retrospect) we didn't select a particularly good patent attorney to draft the patent. It was a real innovation but as multiple trials would demonstrate, the wording of the patent could have been better. Our competitors saw our success with it. They started using the method leading to lawsuits that dragged on. And on. Ultimately, we lost the patent but I gained a lot of experience. I had many opportunities to serve as an expert witness over the whole time I had been at UPRC. This experience, which would prove helpful, included writing expert reports, giving depositions, assisting attorneys in depositions and testifying at trials.



I finished up the teaching experiment and was promoted to the corporate Manager of Engineering position and ultimately to General Manager, Exploration and Production Technology with Drilling, Reserves, Construction and Facilities, Geology, Geophysics, Engineering, Petrophysics, Land, E&P Technology Services, Safety and Field Training. I loved that job and would probably still be doing it today if the company had not been sold.

Occidental and consulting

In my role at UPR, I reported to the CEO and assisted with the sale of the company to Anadarko. Before the Anadarko deal, we spoke with Occidental about a potential deal and met some of their executives.

Give it a try... continued

While Anadarko prevailed and offered me a position, Occidental offered me one as well. I thought the OXY offer was better and I took it as soon as the deal to sell the company was concluded. My time at OXY was fairly brief, but I really admired many of their leaders, technical professionals and assets. I hated the long commute and it was clear to me that it was time to leave. I stayed a bit longer than my minimum commitment but was happy to be in a position to take a chance on my own. I did get a chance to serve on the Board of Vanyoganeft Oil company, a Siberian oil and gas operator headquartered in Nizhneyvartosk, Russia. The Computer Modelling Group also asked me to come back, this time on the Board of the public company and as Chairman of the CMG Simulation Foundation, a non-for-profit group that held much of the stock of the public company. I had been asked to negotiate a solution to a problem and was very pleased with that resolution.

Know where this is? Meehan and the GF show what happens when east meets west.

I stayed very active in SPE on committees and participating in workshops and Forums. I was thrilled to be recognized for my technical and service accomplishments receiving the Delgoyer Distinguished Service Medal and the Lester C. Uren Award. My SPE involvement gave me the confidence to strike out on my own.

Initially, I thought it would be a good idea to buy oil and gas properties. I had flirted with the idea and thought I could apply horizontal well technology. I knew several potential investors and looked at some deals. I never came close. I guess I was too conservative in my evaluations or my estimate of future oil prices. However, I met a lot of people who knew my skill sets and asked me to look at their properties. I advised one group that had only drilled vertical wells that horizontal wells were a must for them. I don't think they drilled any more vertical wells after the success of the first horizontal well. A friend needed some help in China, so I went there. All of a sudden, I was no longer looking for assets to buy as much as I was a de-facto consultant. My SPE contacts and experience meant that I didn't have to look too hard to find work.

I ultimately left the CMG public company Board and (after I left) bought a lot of the stock. When I decided to actually become a consultant I looked at many options. Ultimately, I formed my own consultancy. CMG invested in this company and I named it CMG Petroleum Consulting, Ltd. I was given the right to use the CMG logo and rented office space from them. This gave me the opportunity to get some very large projects given that I was technically a one-person company. I developed many relationships with other independent consultants and would use several dozen people as contractors to complete my consulting jobs.

Consulting was fun. I mainly did very technical work, but often included arbitration or legal work with large technical components. I was named by the Permanent Court of Arbitration in The Hague to be an expert to resolve a complex matter between an international oil company and a national oil company. Some readers might be curious as to how to get opportunities like that. It started when I got a call from another consultant who wanted to discuss a topic I knew well. At the end of it he said: "Thanks, send me a bill for your time." I told him: "No need; just keep me in mind the next time you get a big project and need some help." A few months passed and he

Give it a try... continued

called, asking me to participate in this arbitration. Ultimately, he was conflicted out of it and I got the job.

Other consulting gigs were also really enjoyable. I worked extensively with Chevron on a field study and renegotiation of interests' case. I worked with lawyers defending Shell in a reserve write-down litigation. I worked directly with Shell for field studies in Oman. I did simulation studies and expert cases around the world. It was great and I planned to do it for the remainder of my professional career until two close friends called me and both said I needed to go talk to Baker Hughes.

I had no interest at the time in getting a 'job, and much less in working for a service company. Baker Hughes mainly had products and services immediately tied to near wellbore activities (mud, bits, logs, packers, etc.) and wasn't really a reservoir-focused organization. But I respected these two friend's opinions and went for an interview. I went back for multiple interviews. They were trying to fill an important job and ultimately I said: "Look, for 20% of this job I am probably the best candidate in the world. But for 80% of it I am hopelessly unqualified. Maybe I should just do some consulting for you." That worked, and BHI became another client. I supported them as they needed reservoir support and then I recommended that they 'get in' the reservoir more with some acquisitions. I coordinated with a team and we ultimately recommended buying Gaffney, Cline & Associates and Geomechanics International. I knew the principal players in these groups and introduced them to BHI. I had to take a break from consulting for BHI for a few months as I had other clients with urgent needs.

I still had no plans to go to work for BHI until my wife met their CEO at a fundraiser for United States presidential candidate Mitt Romney. She was really impressed by Chad Deaton and told me: "It would be fine to work with those people." I got a call a few months later telling me BHI was buying both companies and they wanted to hire me to run them. Now, my wife and I had planned to take some time off to serve as senior missionaries for our church (The Church of Jesus Christ of Latter-Day Saints) at some point but they said: "No problem." In retrospect, the people of Baker Hughes are the reason I have stayed there. They are truly fine people.

Baker Hughes

Ultimately I said yes to Baker Hughes and went on to buy other consulting and software firms including JOA, Epic, Meyer & Associates and RDS (from Helix). The group was large and I was looking for someone else to run this organization. So many engineers want to be the boss and be in charge of a large company. Not me. I really enjoy being an advisor to the most senior executives and doing special projects. Of course, the other reason I needed someone to take over for me was that my wife and I had been planning that mission for a long time.
Fortunately, major companies are full of would-be managers and I was able to find a successor rapidly. There was never a shortage of things to do at Baker Hughes and I was very active in SPE as always. I started a **reservoir-focused blog**.

After three years at Baker Hughes we 'put in our papers' and got a call to serve for eighteen months as Area Welfare Specialists. We would move to Hong Kong and serve all around Asia coordinating our Church's humanitarian efforts. BHI was good on their word and I found it easy to relocate to Hong Kong with my wife.

Hong Kong

It is almost impossible to summarize our activities during these eighteen months, but I will say they were the best eighteen months of my life. My wife and I moved from a large, comfortable home to a tiny apartment in Kowloon. We commuted to an office job and sat side-by-side working on

Give it a try... continued

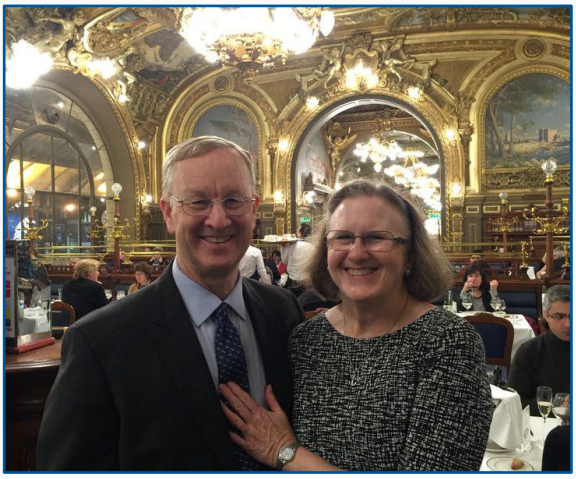
projects together. We coordinated with other volunteer couples in India, Viet Nam, Malaysia, Laos, Cambodia, China, Indonesia, Sri Lanka, Taiwan and Thailand. We traveled to all these countries and to Singapore and trained new couples as they arrived and supported them as they identified, got approved and implemented projects. We did projects involving wheelchairs, vision care, providing clean water and toilets, emergency relief and much more. We got to work with NGOs and other volunteers. We interacted extensively with the three leaders of the Asia office who were General Authorities of the Church. We were able to work as volunteers in the Hong Kong temple and support Filipina church members living in Hong Kong. I (tried to) learn Mandarin Chinese and when non-Chinese speakers hear me speaking it they generally think I speak it well. Chinese speakers know better of course. My wife and I summarized our experiences every week with plenty of photos **on this blog**.

While we were away, my youngest daughter took care of my house. My wife and I focused almost entirely on our work. It was fulfilling work, and I am grateful for the donors who made the projects possible along with the huge number of volunteers. We had so many wonderful experiences there and traveled about one week a month.

Back to Baker Hughes and becoming SPE President

Eighteen months comes and goes all too quickly. I was back in the saddle at Baker Hughes and working to figure out how to best support the organization. I was also interested in doing something I had more or less dreamed of my entire life. So I allowed myself to be nominated as the President of SPE. I got turned down when they selected my friend Helge Haldorsen. I did receive the SPE's Public Service Award and membership in the Century Club (for recruiting more than 100 members over my career). Not to worry, I was plenty busy with my job and a growing horde of grandsons. The next year was more fortunate and I was selected as the 2016 President. It is a three-year assignment and in September 2014 I became President-elect. The next year I served as President and I serve a final year of past President through October 2017. During the first two years, I traveled at a crazy pace and probably visited more colleges and universities than any prior President. I logged air miles equivalent to going to the moon and back.

Unfortunately, oil prices began to fall before I took over as President and have remained quite low. The impact on the industry has been extreme; our society has also felt this impact. We have had two rounds of layoffs and have cut back on many activities. Our membership peaked at 168,000 during my presidency and may not reach that level again for a few years to come. Nonetheless, our volunteers continue to support high-quality programs throughout the world and I have been honored and humbled to have this opportunity. My travel has been fun and I summarize my travel on **yet another blog**. I continue to have an 'embarrassment of riches' when it comes to recognition, having received the World Oil Lifetime Achievement Award. I also received the Petroleum Economist magazine's 'Legacy Award', and finally received SPE Honorary Membership, the association's highest award.



Shortly after becoming past-President, the announcement of our merger with GE Oil and Gas made most BHI employees pretty happy. Much happier, I think, than they had been when they heard about the now-aborted attempt to merge us with Halliburton. I was asked to head up Gaffney, Cline & Associates again and enjoyed working with this world-class group of consultants. As I approached age 65, I knew I was going to retire so I gradually stepped aside from the Gaffney, Cline role and began working more and more on energy transition topics. I remained very active in SPE, and in 2019 I wrote a paper that would be the most downloaded paper of the year: "The End of Petroleum Engineering as we know it".

After retiring, I resurrected my long-dormant consulting

Give it a try... continued

company and began doing consulting work. Mainly litigation-related consulting, including a couple of international arbitrations, and patent disputes, etc.

Personal note

I have nine grandsons and FINALLY a granddaughter. Playing with them is one of my real favorite things. I love to barbecue, especially beef briskets! I am a beekeeper and collect custom knives. I also like to shoot long-distance (out to a mile) rifles. Finally, my wife and I love opera and travel the world to see the best opera companies and opera houses. We also like to visit the LDS temples around the world and while I doubt I will be able to go to all of them, I am going to give it a try.

After nine grandsons, #abigiggles is Grumpaw's new favourite.

The oil industry today

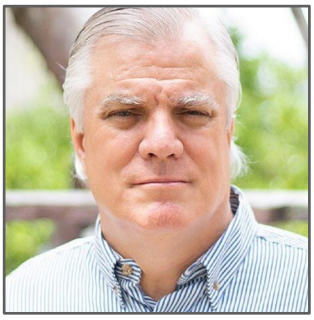
I watch rig counts, crude prices, crude oil inventories and related statistics today as closely as I ever have. I am convinced that oil and gas will remain relevant for us for many decades to come. However, the energy transition is real and the days of year-after-year of demand growth are over.

No one really anticipated COVID-19 and the impact of the pandemic on demand. The world went from using just over 100 million barrels of oil daily to about 80. That number has partially recovered, and I expect that by late 2021 we will be back close to 100. As prices recover to levels just above current prices a lot of pent-up demand for activity will return. Not to the 2014 levels, of course, but enough that some hiring will return. Not robust hiring, but some. I expect oil demand to remain relatively flat for a long time as oil demand decreases modestly for transportation, partially offset for increased uses in petrochemical and other industries.
I am afraid that hiring new University graduates will never go back to the 2014 levels. We probably have too many PE graduates and too many Universities offering petroleum engineering degrees. I was astonished by how many SPE Chapters there were in London alone. I only knew of one PE program, but it turns out there were about eight chapters when I visited as SPE President, almost all at schools I had never heard of. Around the world, even the 'old school' petroleum programs are struggling with how rapidly they will embrace the energy transition. Stanford led the way in changing the name of the Department and has not looked back. In their case, it was an excellent although difficult decision. It will take more than changing names.

PE programs are going to have to change their focus. Data analytics is a huge part of our discipline and will need to be part of the education. Petroleum engineers might join geologists, geophysicists, biologists, chemists, and other disciplines in not having the Bachelor's degree as the typical terminal degree before employment. Frankly, having most petroleum engineers get a master's degree could be a very good thing indeed.

We currently capture and store a tiny fraction of the industry's (much less the world's) carbon emissions. Only petroleum engineers are well trained to work with geoscientists to model subsurface reservoirs for the volumes of storage we will need to achieve Paris goals. The level of investment needed is roughly on par with the maximum capital expenditures the industry has ever spent. Drilling, injection, monitoring, modeling projects that inject as much CO_2 as today's global oil production. Wow. If this is really going to happen, we must be a major part of it. I am personally spending time with a data analytics firm trying to find a way to consistently forecast carbon intensity of reserves and ways to lower CO_2 and CH_4 emissions of our industry.

Perspectives on the upstream energy industry



Thomas A. (Tom) Blasingame is 2021 SPE President. He is a professor of Petroleum Engineering at Texas A&M University.

Tom has been active in SPE since the early 1990s, serving in a wide variety of roles. He also served as a Distinguished Lecturer, was named a Distinguished Member, and received SPE's highest honor of SPE Honorary Member.

Note: This article was prepared by request of the SPE London Review (SPE London Section) in January 2021, with a revision on February 17 2021.

Pride in what we do

We provide hydrocarbon resources to a world with an insatiable thirst for energy and an ever-growing need for processes, materials, and products in the form of fuels, lubricants, plastic feedstocks, power, medicines, and medical equipment, shampoo, clothing, etc. In short, we are an essential industry, and what we do matters. We are also an industry in transition. Not only the transition of the 'energy mix' that will inevitably include more renewable energy, but also the transition to proactively engage the public and provide confidence that our industry is an essential part of a sustainable and low-carbon future. None of this should come as a surprise to this audience, but we must start with a clear understanding of our purposes and challenges.

Purposes:

To provide sustainable, secure, and economical energy and feedstock resources.
To access financial capital to ensure necessary exploration, production, and development.
To serve as a mechanism to alleviate and mitigate poverty and improve health and well-being globally.

Challenges:

To renew our 'license to operate' by engaging and partnering with those outside our industry.
To build a reputation as a vital partner in the transition to a low-carbon future.
To serve as a facilitator for the 'Energy Transition' process. How do we do this effectively?

As the dominant energy resource provider globally, we in oil and natural gas are responsible for reforming the energy landscape to ensure fair access and encourage innovation across all energy resources. Stated simply, oil and natural gas are the "natural battery" for reliable global energy storage. Based on all we know and can estimate, this battery can last for several centuries and perhaps even longer if we include resources such as oil shale and gas hydrates. Oil and gas are essential resources — beyond necessary — the world needs the security and reliability of oil and gas now more than ever. However; we must acknowledge and facilitate the use of other energy resources — an energy mix is not only rational, but it is also desirable, we must take advantage of every reasonable and suitable energy resource. Diversification is critical in the global energy mix — but we also know that our 'natural battery' of oil and gas is sustainable, and that oil and gas are ultimately the most reliable resources currently available.

Lives improved by our industry

This leads to the outcome of 'lives improved'. There is no easy way to quantify 'lives improved' without drawing the ire of those who believe our cause is not just. Personally, I would prefer to avoid those kinds of arguments, mainly since perception can often become a reality for the person holding a particular belief. Instead, I prefer to try another tact, specifically, what I'll call the 'It's a Wonderful Life' view after the 1946 movie by the same name. In this view, imagine life without oil and gas, not merely the products and services that oil and natural gas provide, but also the lives positively impacted. There is no doubt cases exist where oil and gas have adversely affected certain societies (indigenous populations, theft/corruption, pollution) and its role of being a 'higher carbon-emitting' fuel compared to renewables. However, the overwhelming reality is

Perspectives on the Upstream Energy industry continued

that oil and gas do mitigate poverty and improve lives by providing an essential resource that is secure, affordable, and reliable. Again, I respect all beliefs, but I would rather not argue on that basis. Instead, I would like to imagine what life would be like without oil and gas.

'It's a Wonderful Life' — Oil and Natural Gas

Imagine our ability to produce food	(*without oil and natural gas*)
Imagine transportation	(*without oil and natural gas*)
Imagine consumer and essential products	(*without oil and natural gas*)
Imagine medicinal and food products	(*without oil and natural gas*)
Imagine electrical power generation	(*without natural gas*)

Transformations I have seen in my career

As part of the request for this article, I was asked to address 'the most significant transformations I have seen in my career'. Innocent enough, but this may be one of the most difficult questions I have ever been asked. As a petroleum reservoir engineer, I was initially tempted to list the breakthrough technical innovations and presumed-impossible transformations I have witnessed in my 30 plus year career. In fairness, I believe the 'societal' transformations I have or have been a part of are comparable or exceed the impact of the 'technical' transformations. I have itemized a sampling of these below.

'Technical' transformations

Software has completely transformed Petroleum Engineering. Some of us "old-timers" can still do (almost) everything by hand, but the time saved by advanced software is undoubtedly greater than 95 percent (probably to a factor of 20). I am sure some would comment that many problems cannot be solved without software (modeling, optimization, etc.). Forty years ago, I could not have imagined such a transformation. Thirty years ago, I saw it coming and did write software for a while, but I never thought its adoption would be so pervasive. Twenty years ago, I became a 'middle adopter' (not early, not too late), and ten years ago, I gave up calculators, pens, paper, etc. Yes, I am joking…sort of.

What we called 'telecommunications', everyone under the age of 50 calls 'the internet'. Again, a near-total transformation, and while we certainly wanted something like this 40 years ago, no one could have imagined that we would be completely dysfunctional when the internet goes down. In all seriousness, the ability to communicate, access, compute, monitor, and intervene in almost any task or function is beyond essential. The future will have enormous bandwidth, access to more information and procedures, and of course, all of this will be facilitated by Artificial and Augmented Intelligence. My only concern is 'the learning curve' required to understand and implement such systems. From the user's perspective, there will be access to an enormous body of information and functionality, which will be critical for the future workforce.

As a disclaimer, 'equipment' is not my specialty, but I believe that the transformation of oilfield equipment has been (almost) as significant as software and the internet. Measurement and control systems are extremely precise and, of course, linked to databases and application software. Physical moving equipment is safer and more functional than the early pioneers in our industry could have ever imagined. Autonomous, semi-autonomous, and aided systems used primarily in drilling and production, have become a mainstay of modern operations.

'Societal' transformations

To me, the most obvious (and positive) 'societal' change is the progressive and diverse nature of our modern workforce. Diversity is critical, and I genuinely believe that. As an industry and as individuals, we understand this now better than ever: the value of diversity is multiplicative, not additive. It's the progressive nature of our workforce that surprises me, and, no, I am not referring to political affiliations/preferences. I am referring to our industry's need to engage and partner with the public in order to function. Some have said we were arrogant in the past that being an essential industry meant that we did not need to engage the general public in our mission. 'Trust us' would generally suffice. I will say it loud and clear: public engagement and trust are essential elements to our ability to operate in modern society. This can be said of every industry, but now more than ever, we must make our role clear to the public. We are an essential and progressive partner in our evolving society.

Perspectives on the Upstream Energy industry continued

As a corollary to my comments above, I am pleased that we have 'transformed' away from 'the network' and more towards a meritocracy in terms of hiring and promotions. I am not naïve enough to believe that this isn't still an issue, but I do think things are much more transparent today. I would comment, and I say this as an academic, my philosophy is that 'grades-are-not-everything'. True, if you are a well-below-average student, there will be consequences, but historically, and again speaking as an academic, average and below-average students are often the most successful. There are several reasons for a less-than-stellar academic performance, such as 'enjoying' school too much, being unprepared for the course load, working extensive hours to pay for school, etc. Ultimately, I observe that these people not only 'learn how to learn' but are commonly those willing to take risks and have a better sense of what they can and cannot do.

For certain, my comments in this section are a mix of experience and opinions, but I am pleased that we have moved more towards a meritocracy as an industry over time.

Future perspectives

I was also asked to address 'the future of the oil and gas industry' and give my perspectives on the 'evolution of the energy industry' in developed and developing regions. That's a pretty tall order, but here goes:

Future of the oil and gas industry:

Our best years are ahead of us. We are an essential industry; our role is crucial to the future.
The industry will continue consolidation as financial and competitive pressures remain and potentially increase.
In the next 5-10 years, investments in equipment-related technologies will lag.
In the next 5-10 years, investments in automation and artificial and augmented intelligence will surge.
There is likely to be a 'pinch-point' in supply in the next 18-36 months due to a lack of exploration and development.
In the next 20-30 years, natural gas will emerge squarely as the transition fuel, surpassing oil demand by 2060.

Evolution of the 'Energy industry' (my thoughts are in random order):

Energy sources are essentially our 'batteries'. The denser the energy, the better. Ultimately, hydrogen wins.
Oil and gas are THE essential transition fuels for the 'Energy Transition.'
Wind and, in particular, solar will win the 'renewables' race. Tidal could, and should, be very competitive.
The cost of geothermal wells, completions, and facilities must come down by 50-75 percent.
The energy market in 30 years will be more diverse, but hydrocarbons will still dominate by 2-3 fold.
Oil and gas 'energy companies' are best poised to lead the 'Energy Transition'. But will they?

While I am often asked to talk about the future of the discipline and the industry, I also want to remind everyone reading this article that we have to focus on the tasks at hand as well in 2021:

We will need to produce approximately 97 million barrels of oil/day.	(IEA-oil, 2021)
We will need to produce approximately 4,370 bcm/year (or 0.42 tcf/day).	(IEA-gas, 2021)
We will need to transport more than 500 bcm/year (or 0.0484 tcf/day) as LNG.	(IEA-gas, 2021)

Also, the US DOE Energy Information Agency (EIA) 2021 Annual Energy Outlook predicts "that petroleum and other (petroleum-based) liquid fuels will remain the most consumed fuel in the US before 2050." I realize that such predictions are 'regional' (in this case, the US) and replete with uncertain factors and assumptions.

Still, the reality is that oil and natural gas will remain an essential resource for a very, very long time, especially in regions where conventional and unconventional oil and gas are both abundant and secure.

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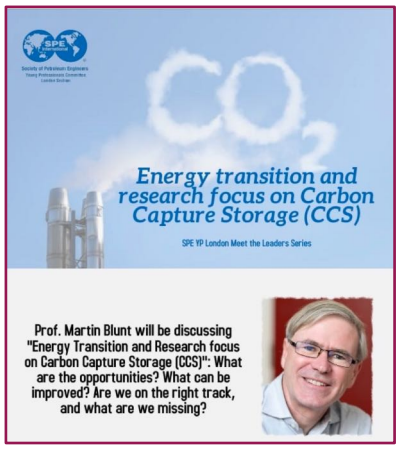
2021 Annual Energy Outlook – US DOE Energy Information Agency (EIA): **https://www.eia.gov/outlooks/aeo/**

SPE YP London: Past and future plans



For 2021, SPE YP London is targeting a busy calendar with a new series of events that will serve the audience's demand to engage with the current climate of the oil and gas industry.

What have we been doing?

We had an amazing start for 2021 with our successful ''KAPPA Engineering's Plug and Abandonment virtual technical event', which was held on the 26 January. Nicolas Kotlar, KAPPA Engineering's Cased Hole Logging Product Champion, talked about the main cased hole logging techniques, their interpretation and impact on plug and abandonment process. As expected after the interesting discussions during the Q&A session, the event feedback was very good and people from the industry seem to always have an interest in attending technical events concerned with day to day oil and gas operations.

Within our 'Meet the Leaders Series' Professor Martin Blunt strongly connected with the attendees by sharing stories about his background, family and his start in the oil and gas industry. We had around 60 participants from different companies and universities. The energy transition topic encouraged a fairly long discussion, as Professor Martin also explained how the Earth Science and Engineering department at Imperial College London are designing a new petroleum engineering/geoscience course that will follow the industry's current trend and focus on data science applications, geothermal energy and Carbon Capture and Storage (CCS).

What will we do next?

Energy transition and digitalizing the industry are the current drivers of the oil and gas business and, as SPE YP, we love to stay up to date in our events. We will be hosting Mr Tito Perdana regional manager from SLB Geothermal Company who will join us on 4 March within our 'Meet the Leaders Series'. As for YP technical events, Mr Alejandro Primera from Primera Resources will be sharing new AI, machine learning and digital innovations projects.

Providing networking opportunities to help young professionals advance their career is one part of our mission, and we are successfully achieving that with our big network of speakers from various major oil and gas companies. However, as SPE YP, we are also concerned with helping young professionals and recent graduates to acquire professional and soft skills. We have started achieving this by introducing our new series 'Meet the Young Professionals'. Yasir Thara, Wintershall DEA 2020 SPEAD Program Reservoir Engineer, spoke about 'How to market yourself in front of an audience' on 19 February. This event was attractive to recent graduates looking for opportunities within the industry, and we are expecting this series to gain big popularity among university students and initiate a good collaboration with SPE student chapters from different universities.

Reservoir simulation in Reserves Estimation

Niek Dousi, Senior Petroleum Engineer, holds an MSc in Petroleum Engineering from Delft University of Technology, The Netherlands, and has over 15 years of relevant professional experience. He is an employee of the SGS subsurface consultancy. He participated in numerous integrated field development studies, asset valuations, reserves evaluations, UGS- and Geomechanics studies, both as a seasoned reservoir engineer and as project manager.

In the past six years he has managed more than six large reserves certification studies on Dutch, Gabonese, East African- and Omani assets, among smaller reserves audits. In 2019, Niek was part of a special team to support a large middle eastern NOC in building a detailed country portfolio model. Contact: Niek.Dousi@sgs.com

SPE-203290-MS
The Application of Reservoir Simulation in Reserves Estimation; Methods To Estimate the Range Of Technical Uncertainty.
Co-authors: Fauzan Syarkawi, Associate, Ivan Ignatov, SGS

According to SPE (2018) PRMS guidelines, reservoir simulation may be applied in reserves estimation. However, the literature does not provide full guidance on how dynamic models may be used in reserves estimation. This article aims to provide an overview of reserves evaluation techniques that may be applied, in which reservoir simulation plays an important role. The content of this article is based on the authors' experience, complemented with relevant materials from other publicly available sources.

Some relevant guidelines are presented in SPE (2011). A dynamic model may be used in four ways during reserves estimation:

1. To generate production forecasts based on a consistent physics-based model containing geology, assuming different subsurface realizations to establish a range of technical recoverable resources (TRR). The predictions should be in line with approved reservoir development plans and/or work programs
2. To provide an estimate of ultimate recovery factor (URF) to validate the forecasts from other prediction techniques such as decline curve analysis or material balance modelling
3. To act as an analogue to establish oil/gas decline trends or initial oil/gas rates in analogous reservoirs in the application of DCA
4. To provide insights into the dynamic behavior of the reservoir (e.g. Monitor OWC, assessment of channeling effects, determination of water breakthroughs, sweep efficiency and material balance behaviour).

The methods presented in this article are not meant to be regarded as official guidelines, but suggestions for using reservoir simulation in reserves estimation.

Although decline curve analysis is very commonly used in reserves estimation, it has some limitations. In summary, DCA should only be applied for periods when the operational parameters are stable. Simulation models can properly capture production mechanisms and can link static uncertainties to resource uncertainty as opposed to DCA. Complex subsurface realizations, EOR processes and fluid systems can only be properly modelled by reservoir simulation to generate reliable forecasts to assess the range of technical uncertainty.

Full scale reservoir simulation is required, in for example:

1) Depletion of a rich retrograde gas-condensate reservoir. At low pressure, some of the condensate will re-vaporize and some condensate of the secondary oil-rim may be produced.

Reservoir simulation in Reserves Estimation continued

2) Complex faulted low permeability reservoirs.
3) Heterogeneous gas reservoirs with strong edge drive.Implementing material balance or DCA would not be appropriate.

Reservoir simulation is most commonly applied in the pre-development stage when there is little or no production history. The physics-based model can better represent the dynamic behavior of the reservoir fluids. Reserves assessors can generate low-, best- and high forecast cases based on input data such as petrophysical, PVT, structural and relative permeability information, provided they are reliable and cover the range of technical uncertainty. These data can be integrated with the reservoir development plan & associated well counts, well- and reservoir constraints.

The most common practice is to adopt a multi-realization or a deterministic approach, honoring PRMS guidelines, e.g. the lowest known hydrocarbon (LKH) rule for proved reserves.

In a multi-realization approach, different uncertainties (STOIIP, aquifer strength, relative permeability, horizontal permeability, fault transmissibility etc.) are varied simultaneously and production forecasts are made. A P10, P50, P90 forecast can be selected and used, together with commercial aspects, in the calculation of reserves. Under SEC regulations, for proved reserves, a forecast close to the P90 can be picked which has a corresponding LKH as input. (See Figure 1.)

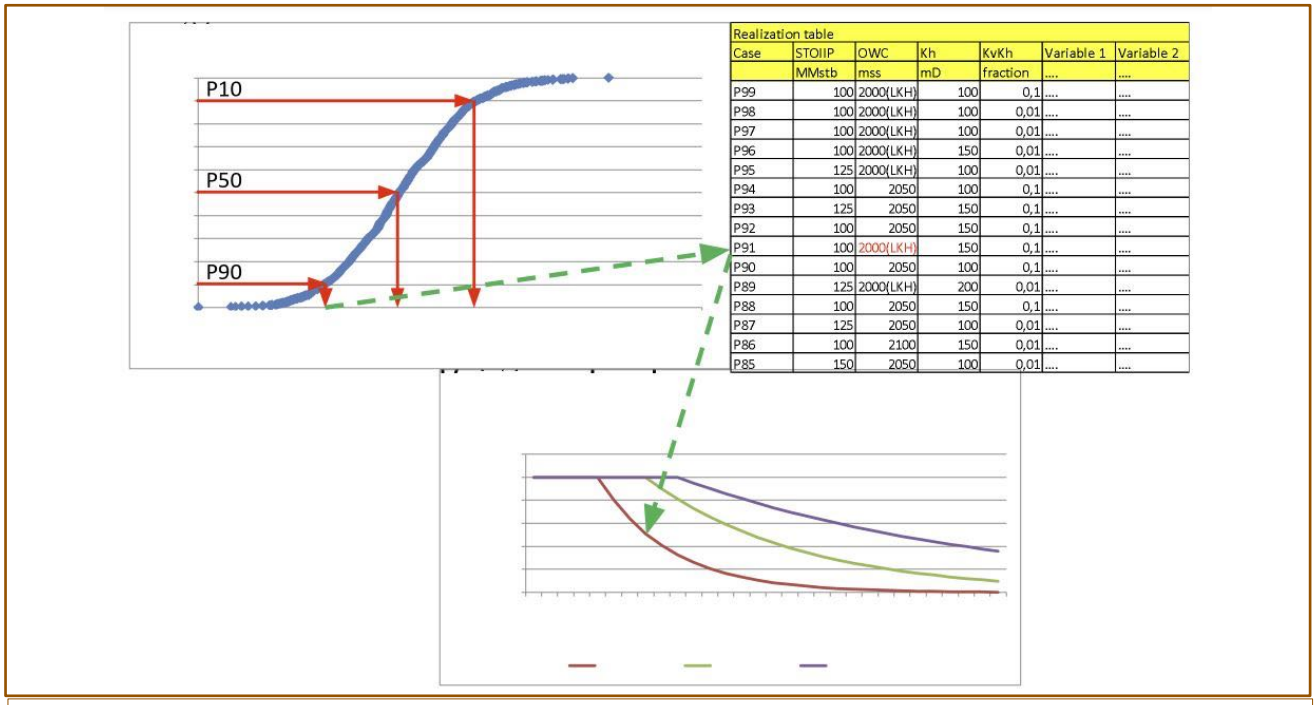


Figure 1. Synthetic example showing P10, P50, and P90 production forecasts from multi-realization exercise.

In a deterministic assessment, a realization table is generated to illustrate which key uncertainties are carried forward in the low, best and high estimate discrete reservoir simulation forecast cases. A typical realization table for a gas reservoir is shown in Figure 2 (on page 30).

For depleted reservoirs, it may be challenging to find suitable analogues that can be used to obtain a reliable ultimate recovery factor estimate. Instead, properly calibrated reservoir simulation results can be used from less mature analogue reservoirs to obtain ultimate recovery factors for reserves estimation. Results from DCA should be consistent with the geological subsurface realization and depletion mechanism. If the TRRs are overestimated, either the declines will have to be steepened (provided there is still significant uncertainty in

Reservoir simulation in Reserves Estimation continued

GIIP	Compartmentalisation		Drive mechanism				Heterogeneity	Well productivity				
Corresponding GIIP (Total)	Intra fault/geological features sealing	kv/kh	Relative permeability	Sgr	FWL	Aquifer size	Heterogeneity	kh	High permeability layer(s)	Liquid loading rate	Skin (mechanical)	Rate dependent Skin
TCF	-	-	Krw', CoreyW		m TVDss		-	-		MMscf/d	-	[MMscf/d]-1
	2 large sealing faults leading to 3 compartments of which 1 gas bearing	0.01	pessimistic	pessimistic (0.35)		High aquifer volume (Vaq/Vres=67)	More hetergeneity	k-mult = 0.5	6 infill wells penetrate a High perm layer	9	10	~1 (welltest)
	Some which are not laterally continuous and de-risked by infill well spread	0.1	as modeled	as modeled (0.2-0.35)		Medium aquifer volume (Vaq/Vres=24)	As modelled	Match welltest permeability log	8 of infill wells penetrate a High perm layer	7	5	~0.5 (Geertsma)
	None	1	optimistic	optimistic (0.2)		Low aquifer volume (Vaq/Vres=8)	fully layer cake	k-mult = 1.5	all 12 infill wells penetrate a High perm layer	5	0	~0.05 (Noman)

low case
mid case
high case

Figure 2. Synthetic example of a realization table of a gas reservoir.

the decline trend), or the STOIIP range will need to be revisited. Modifying the URF and/or STOIIP is dependent on the knowledge of the reservoir, i.e. with a sound understanding of which uncertainty is largest.

When some production history is present, calibrated reservoir simulation models will usually provide the reserves auditor with a best estimate only. In the low- and high case, it is common to use DCA based on a decline factor (Di) from reservoir simulation, only altering the b-factor to obtain a low- and high case, based on the spread in b-factors observed in the analogous wells in the simulation model of the reservoirs or from analogue more mature nearby reservoirs.

If an up-to-date history matched model is not available and the wells do not show a clear oil decline trend, the well DCA analogy approach may be adopted. This involves the use of a decline curve from an analogous well. Alternatively, if no suitable analogous wells can be identified, well decline parameters may be obtained from a properly history matched analogous reservoir simulation models.

A novel statistical approach has been devised to estimate the range of technical uncertainty in oil recovery for reservoir(s), present in a much larger complex. It is based on the notion that the technical uncertainty decreases when the reservoir becomes more mature. This approach can be adopted if information from many analogous reservoirs is available.

For example, a complex may consist of many small hydraulically separated reservoirs. The oil-water-contacts (OWCs) are well defined. Sufficient well- , production- and structural data are available, which are all used in the development of static- and dynamic reservoir models. History matched models should be available for all reservoirs. An oil production forecast is made using the dynamic model, considering present and future well, facility and reservoir constraints. Results from the updated models are subsequently used in a statistical procedure to aid in estimating the range of technical uncertainty in TRR.

For the statistical approach, a subdivision of the reservoir groups is made based on plotting the spread in simulated ultimate recovery factor (URF) as a function of reservoir maturity (current recovery factor divided by ultimate recovery factor from simulation). Then a relationship is established between reservoir maturity and URF uncertainty (one standard deviation in the spread seen in the groups) to establish the range of uncertainty in the remaining oil recovery.
The low-, best-, and high case oil rate declines can be generated for the subject reservoir, where the uncertainty range is dependent on the maturity of the reservoir. Two resulting reservoir oil production

Reservoir simulation in Reserves Estimation continued

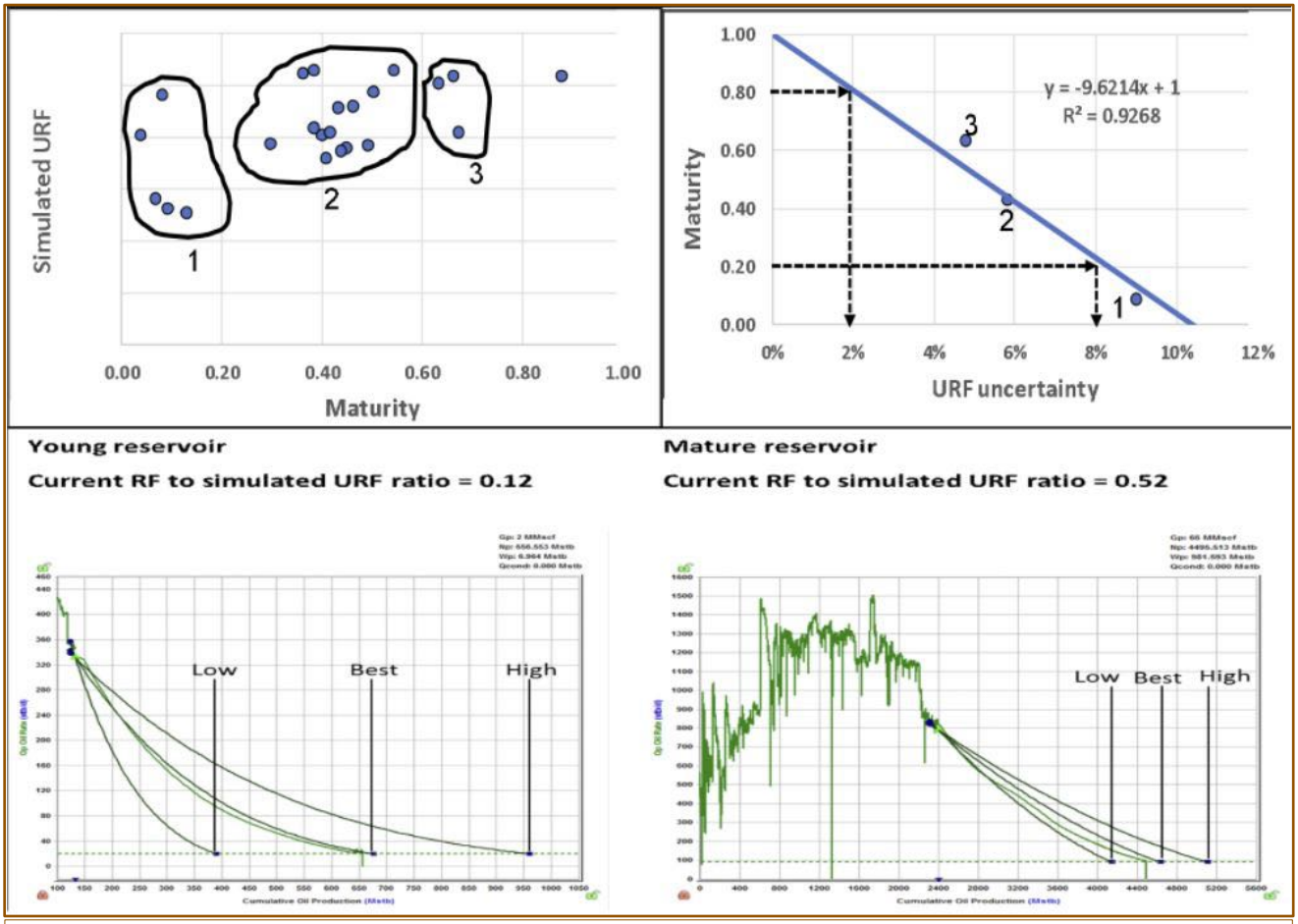


Figure 3. Example of using reservoir simulation, a statistical approach, and DCA to estimate the range of uncertainty of a reservoir oil decline.

forecast examples are presented at the bottom part of Figure 3. The oil production forecast from reservoir simulation is included, representing the best technical estimate. Subsequently, based on the reservoir maturity correlation, the low- and high case production forecasts are generated.

Considering dynamic models have become more sophisticated and much more reliable and realistic than one or two decades ago, and that there is a desire from the industry to provide more realistic reserves evaluations, reservoir simulation has grown to become a more important tool for reserves assessors. It is shown that dynamic modeling can be used in many ways in reserves estimation.

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SPE Leeds student chaper: Road less travelled

Davis Bigestans is the current President of the SPE Leeds Student Chapter. Davis is completing his final year of Petroleum Engineering BEng at the University of Leeds. At the same time, he is volunteering with SPE London Net Zero committee and is interested in the energy transition, smarter energy solutions, and sustainability.

The last 10 months have been a road less travelled to many of us. Social and economic challenges have illuminated themselves from the inside out. It is something that we would rather have preferred to avoid. But, as in every crisis, there lies an opportunity, and Covid has been no exception at all. One might ponder how exactly can there be an opportunity if the oil and gas industry is suffering from one of the worst downturns while facing immense scrutiny of any of its steps from the stakeholders, governments and society?

Well, earlier in 2020, many well-known and leading professionals in the energy industry suggested putting green recovery at the heart of Covid-19. For instance, **Dr. Fatih Birol**, the Head of IEA, urged the acceleration of the energy transition; **Darcy Spady**, former SPE president, outlined the need to stop the conventional practice of a petroleum engineer to 'just vent the gas if there is no market-share for it' during one of the Gaia SPE webinars, and **Anders Opedal**, the newly appointed CEO of Equinor, pledged to steer the company towards net-zero status by 2050. These actions have not come out of the blue. There is a reason for this, as there is an opportunity for any who elects to be open-minded about the unfolding change. Creating a more sustainable oil and gas industry as the global energy industry was lifted and weighted in many discussion panels and articles well before 2020, but Covid-19 has 'gently' forced us to acknowledge it harder and, even more importantly, to act on it.

For the SPE Leeds Student Chapter, energy transition has been the forefront theme in this academic year, because equipping its members with greater environmental and energy awareness can be as equally important as lecturing about the latest advances in sand control or artificial lift.

At the start of 2020/21 academic year, the SPE Leeds Student Chapter decided to focus on the unfolding energy transition, with the aim to enable the voice of each member through the ongoing energy transition. Holding webinars on the potential outlook of the oil and gas industry in the post Covid-19 world, hydrogen and its role as the missing link to energy transition, as well as the importance of carbon capture and storage in the near and long-term future have been the key themes throughout the past four months. For a common student chapter, this might not be the usual approach, but we believe wholeheartedly that being aware of the current trends and possessing a business-savvy mindset can only do good. The downturn will eventually come to an end, and the need for petroleum engineers who are willing to address unsustainable practices, and who are willing to contribute towards making a more diverse energy mix, is largely undisputable. Our members, who are part of the class of 2021, will have a chance to shape a cleaner future of energy, and it is our responsibility to help them.

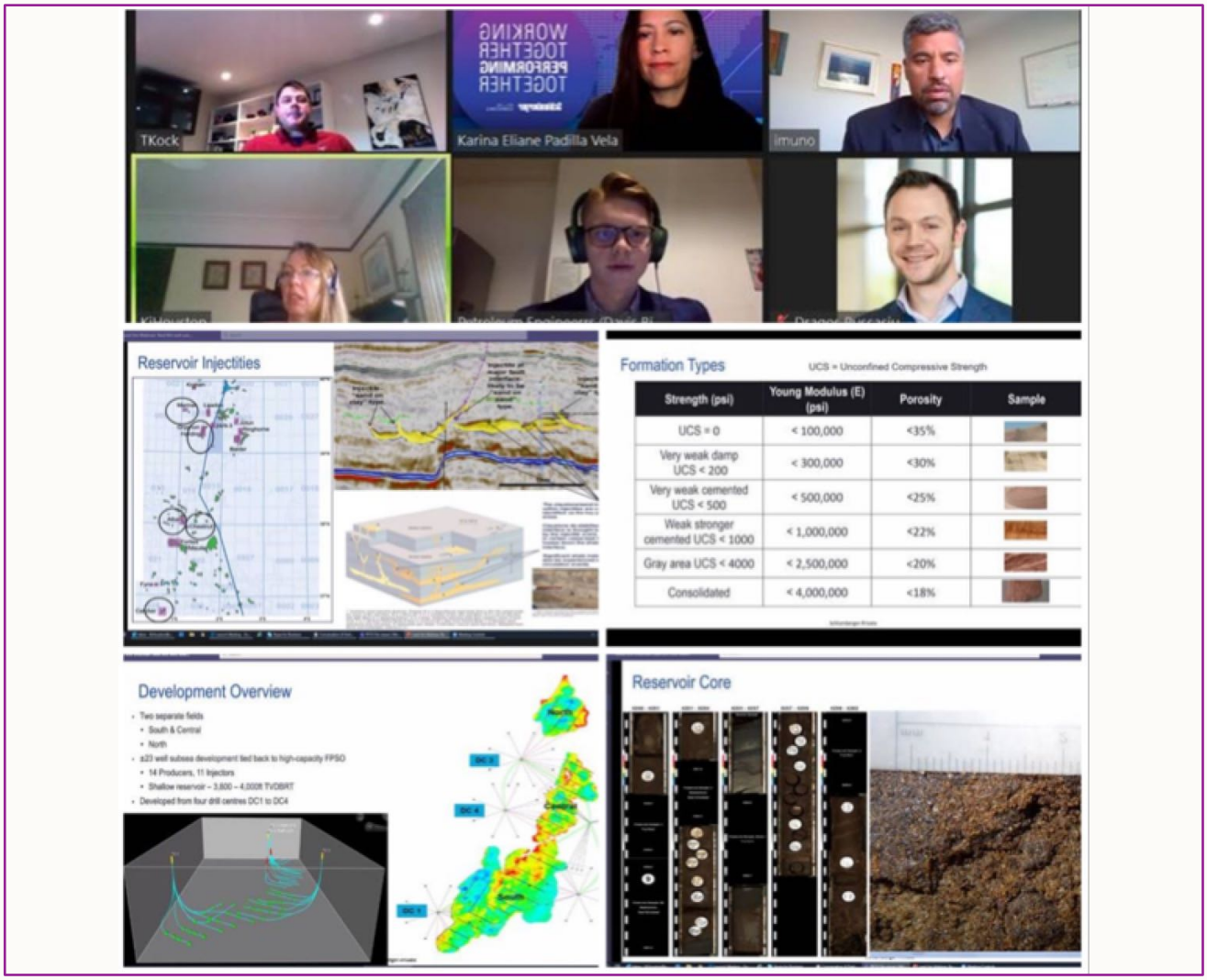
Throughout the webinars, we have emphasised that a transition to a renewables-based energy mix will inevitably take place sooner or later, but the oil and gas industry will have a vital role to play. Enabling blue hydrogen, carbon capture and storage or even wind energy business on a commercial and global scale, requires well-established infrastructure, human resources, and available capital. Oil and gas can provide this, and that is why we should embrace the industry as a key player in the ongoing transition. We hope that our members have recognised the potential of renewable energy or carbon capture within the current energy companies enabling them to shape a cleaner world that is in line with the triple bottom line thinking.

With equal importance, we recognise that disseminating the 'know-how' knowledge of petroleum engineering is highly important. With the current emphasis of extending the life of any given well and ensuring its integrity for long-term production, we thought that sand control would be a topic worth exploring

SPE Leeds student chaper: Road less travelled continued

more. In collaboration with Schlumberger and its Reservoir Performance Team, we organised an extensive four-hour long “Sand Control Webinar – From General Overview to Real Life Example”. The webinar was focused on key topics of sand control: The importance and need of sand control, its common techniques and their optimization, respective fluid selection, as well as the completion design of a real well. We would like to immensely thank **Ivan Jose Munoz Gonzalez**, **Kirsty Houston**, **Tertius De Kock**, and **Jonathan Roche** for their wonderful presentation and vivid examples throughout the webinar. On top of that, we were grateful to collaborate with the recruiting team of Schlumberger to help informing our members about the career opportunities within Schlumberger. **Karina Padilla Vela** and **Dragos Puscasiu** held an amazing presentation about the potential career paths in Schlumberger, and we hope that some of our members can one day become a part of Schlumberger. SPE Leeds Student Chapter believes that it has developed a good relationship with the company, and we look truly forward to the upcoming wireline webinars in March.

Going forward, the SPE Leeds Student Chapter will keep on educating its members about vital energy topics and issues. Energy transition will likely remain a core theme within the Chapter helping its members to cultivate a broader understanding of the potential net-zero solutions and the need to implement them in every sense. Apart from presenting talks on energy transition related topics, we plan to touch on another important area – digitalisation. In particular, we plan to educate our members about the modelling and computer-aided problem solving on both large and small scales. Overall, it has been a true joy for this year’s committee to support its members and help them to grow professionally. This is the real beauty of SPE, and we are grateful to contribute towards it.



Tomorrow's next and future generations

Welcome to the London Sections' Net Zero Committee section of the SPE Review London where we will present and discuss a range of topics associated with Energy Transition and Net Zero. We hope these articles will be informative and help readers understand some of the significant changes in the oil and gas industry.

This is the third in a series of articles for the SPE Review covering Sustainability brought to you by Adrian Gregory who is a subsurface and wells engineering consultant. Adrian is excited to be part of and contributing to the new London SPE Net Zero Committee and will be writing future briefing articles broadly focusing on sustainability strategy, frameworks, principles, delivery and performance.

Sustainability: Governance & Governess, endurance of Systems and Processes

This article will be covering both 'governance' and 'governess', the thinking about tomorrow's next and future generations – a core bedrock principle of Sustainability. 'Materiality', 'needs' and 'limits' will be covered, introducing the landscape of Sustainability and how frameworks and principles have been key in its evolution.

The domain of Sustainable Development and the Circular Economy will be put in context so the reader can decide their true place. You decide. Back in the early 1990's there was a lots of huffing and puffing over where Enhanced Oil Recovery (EOR) 'sat' – only to find that it was simply a subset of Improved Oil Recovery (IOR). Primary Recovery is and always will be a very well-defined process. So Reservoir Engineering solved that problem: 'There is Primary Recovery and IOR, with EOR a subset of IOR'. As it happens Sustainability has a lot of similarities with Reservoir Engineering, such as effecting and predicting the future. "The landscape of Sustainability incorporates the domain of Sustainable Development, with the Circular Economy just one of the key tools in the Sustainability tool box." Discuss.

Governance and management are two activities that do need more clarity in the landscape of Sustainability. Governance is organisational, 'corporate board-led' command, as exampled in the 2004 GHG Protocol (*Sustainability, Article 2*) and organisational performance and priorities. Management is about activities' control and decision making. So 'Carbon Governance' is organisational; 'Carbon Management' is asset or activities-led. Governance therefore includes 'materiality' – value, impacts and effects, as well as accountability, strategy, business model, opportunities, performance, and outlook as laid down in annual Financial Reports, Sustainability Reports and other internal and external communications, strategic reports. All necessary for effective enterprise, rule and collective action.

ESG is becoming a large part of Corporate Governance reporting with corporations not only publishing an annual Sustainability Report but also TCFD, GRI, IIRC<IR>, SASB and Climate Change Reports – all highlighting organisational risk, sources of risk and judgement. These practices start to form the bedrock of **Financial Sustainability**. Through ESG, Corporate Governance now has a chance to win society over. The role of business in society is an ancient matter. Up until now there has been no agreement but this may be finally starting to change – business and businesses are changing.

That is enough of the 'now' – ESG only covers Environmental, Social and Governance. Sustainability is also about governess and integrated thinking about the perspectives of Technical Sustainability, Financial Sustainability and Political Sustainability – where the 'future' opportunities and risk reside, **Prosperity**. Governess provides the integrated thinking about tomorrow's next and future generations. The Sustainability landscape has evolved to encapsulate today the simple framework of People Prosperity Planet. Prosperity that the Planet is capable of supporting indefinitely, ie Sustainability of People, Prosperity and Planet – biodiversity, climate to deliver nature's ecosystem services.

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Value is very much a Technical Sustainability process, funded by wealth's accrued value (i.e. stock or reserve) through Financial Sustainability, constrained and expensed by Political Sustainability. Whereas values are human and social concepts, these 'values' are too often not 'valued' effectively by just business activities and actions – hence why the role of business in society is an ancient matter. Business needs to be oriented to value everything, all capitals including human and social. Economics determines 'worth' of a good or service by the price paid at the marketplace, but, the consumer sees 'value' of that good or service hence economics is a social science – built on behaviour and preferences.

Technical Sustainability is therefore complex, built from producing value through enterprise activities built on enduring systems, processes and practices. Mariana Mazzucato[1] book 'The Value of Everything' considers these 'technical' activities in an economy as being 'productive' and some 'unproductive'. These activities and their interdependence have influenced economic thinking and 'Political Governance' over the centuries. The 'business', or 'just business' focus, has a conceptual fence or boundary – the production boundary[1] where inside activities create profits; the boundary shifts with social and economic forces to help sustain 'productive' activities. "A green transformation (economy) requires not only green infrastructure but a clear vison of what living a green life means"[1]. Today, all sectors, agriculture, industry and energy, must transform to a low carbon economy – a massive technical transformation. The creation of value is collective within the production boundary, but also co-shaping and co-creating markets. Human Capital needs to focus on the problems societies are facing and to dream for a better future means we need to care about 'value', and to invest wealth wisely to ensure future economic rent. We need 'Prosperity' with economic growth but with reduced footprints – an Urban World with complexity to match the Natural World, honouring the Planetary Boundaries, protecting the Commons.

To have this Sustainable future: "We need to engineer the future, guided by the science." We cannot, in English: 'Science the future, guided by the engineers'. So engineers have to be at the 'table' and taking a leading role, particularly in Technical Sustainability. Petroleum Engineers understand system and process complexity, building endurance. We are good at innovation: IOR, complex wells and reservoir management supplied 100 million BOPD in 2019 – what society demanded. In the future, we can deliver Carbon Capture and Underground Storage (CCUS) at scale, some 10,000 to 15,000 injection and observation wells are needed by 2050 based on current climate science. That future needs just governance to deliver on the CCUS business model.

The landscape of **Sustainability** can be defined by these book authors, encapsulated by this equation:

Sustainability = Locke + Dolan + Lovelock + Stead & Stead + Elkington + Porritt
[Equation 1: Landscape of Sustainability]

These authors have been directing, with supporting actors (e.g. William Lloyd: *Tragedy of Commons*, 1833; Dr Mark Carney: *Tragedy of Horizon*, September 2015; Tim Jackson: *Prosperity without Growth*, 2009; David Zetland: *Living with Water Scarcity*, 2014) too numerous to mention all. Over such a time frame, their ideas have added 'principles' that have been consolidated by many co-actors and ancillary content thinkers – even more numerous to ever consider mentioning here, even if that was possible. But this 'framework' equation of Sustainability's 'directing authors' will give you at least the core understanding of People Prosperity Planet. Locke & Dolan were introduced in Article 2. Lovelock, Stead & Stead and Elkington need to now be considered more in-depth. Porritt 'capitalism', capitals and resources stocks, is over-arching and will be considered later.

We need to develop Lovelock[2] – considering the future implications of Gaia, endurance and governess. Gaia has a metaphysical presence which for scientists at that time was not well appreciated. What Lovelock was demonstrating was the Natural World's complexity and how poorly humanity, the Urban World, understood Nature in 1979. Some say even today most of humanity do not understand the importance of the Planetary Boundaries, respecting them and guarding them (Guardianship). Hopefully COP26 will start instigating those

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principles completing the set of Sustainability practices: Citizenship, Stewardship, Custodianship and Guardianship, built on succession.

Our planet is our responsibility – the nineteen seventies' 'aliens' from out-of-space have still not shown up. Jeff Wayne is still playing tennis, his music still enduring, timeless. Humanity learns, we have been through five great extinctions as the scientists keep telling us engineers. But as Lovelock pointed out, our stable planet, which we enjoy, is only possible because of the complexity of Nature; the more complex – the greater the guarantee of humanity's endurance if our systems and process 'needs' can be delivered not at the expense of Nature, building on Dolan's thinking. Scientists and Political Governance keep focusing on the 'Two minutes before midnight'. Engineers need to focus on the equivalent 'Two minutes past midnight'. Volcanic natural sources of atmospheric carbon dioxide are beyond humanity's control, but industrial, agricultural and consumption emissions are not. Tipping points like methane release from thawing arctic tundra could be – hence the Tragedy of the Horizon[3]. To take a step back is necessary before taking a step forward. Humanity is good at scale and resilience. In the last fifty years, we have consumed one trillion barrels of crude oil and felled some four trillion trees. Getting through Covid has made everyone more resilient.

In Article 1, the question was poised: What constitutes life? James Lovelock's[2] 'life' is a process found wherever abundant flow of energy exists, characterised by a tendency to shape or form itself as it consumes – excreting low grade products to the surroundings. This suggests that there is a boundary, or interface, between the 'factory' area where the flow of energy or raw materials is put to work and entropy is consequently reduced, and the surrounding environment receives the discarded waste products. The flux of energy must be above some minimal value in order to get going and keep going – bit like a 'spark' followed by 'doing-work'. Basically, Lovelock proposed that planet Earth, Gaia, was a self-regulating 'organism', organisation of activities – within the 'factory'. He shows that ecological thinking helps improve the understanding of the complex interactions and dynamics between people, planet, production and manufacturing, consumers and Nature's ecosystem services. Today, Industrial Ecology, Natural Resource Ecology, the Performance Economy and the Circular Economy all have made massive contributions to modern day Sustainability integrated thinking. Lovelock has therefore provided the 'needs' to sustain life, a flourishing Natural World and to protect Planetary Boundaries between the Urban World, the Commons and that Natural World.

Assuming Lovelock's living 'organism' has a capacity for 'information transfer' – a specialisation in structure and form that can endure leading to mobility and biological differences in scale, and development of cognitive responses -- the ability for succession would then be present. Therefore, Gaia too is also about governess: looking after the next and future generations to ensure Lovelock's 'life' endures. A core bedrock principle of Sustainability.

Lovelock's factory 'organisational' concept is so similar (if not the same) to Mazzucato economic 'business' or 'enterprise' production boundary[1]. Mazzucato, through the history of economics (social science) discusses the 'needs' of business and individuals to value everything – the means to do so described by Porritt[4]. Porritt's book lays out a new way of doing business enterprise by applying the essence of capitalism (the productive use and reinvestment of the capital stocks) thereby the need for wealth stock stewardship. In 1992, Jean Stead & Edward Stead[5] published their seminal work on Sustainable Organisational Management (SOM) and co-evolution with the (small) Planet and its People, now and in the future. "Evolution of species and the evolution of their environment are tightly coupled together as a single and inseparable process." [Lovelock, 1988 p12]. In 1992, there was a definite 'happening' regarding the health of our planet and the people who inhabit it.

Stead & Stead's book *Management for a small planet*[5] is a seminal read as it starts to define the need for 'Prosperity', at least its foundations and the organisational thinking necessary for enterprise to start to address **Business Sustainability**, building on the Planet's Environmental Sustainability and the Natural World's ecosystem services. The Steads believed that Business Sustainability is achieved through the principles and practices of SOM. SOM and 'Business Stewardship' are synonymous. Their 'economical thinking' incorporates economics, commercial and organisational best practice – all in such a 'small' book. SOM provides the means to achieve Business Sustainability providing the integrated thinking behind the importance of Sustainability

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Strategy (and Strategic Change); nurturing and developing sustainable goods and services (Product Stewardship); organisational management of People to gain sustainable performance; and lastly the need for investment – 'novel investment' as comprehensively discussed by Tim Jackson[6], delivering hope for our children.

As Stead & Stead point out, our Planet "belongs to our children and our children's children", which we can all help through governess. In 1992, Stead & Stead suggested we were rapidly reaching a crossroads. Jackson, twenty years later, explains 'at that crossroads' shows why Sustainability is so important, very much like Darwin pointing out the step change in thinking in 1859, his Origins of Species providing the foundations of evolutionary biology contesting the thinking of ancient scriptures of Christianity. Scale is driven by human population, which has no thought of slowing. Population consequences are driving 'happenings' – creating tensions between species and the planet. Future growth is now at risk, some saying we are or even have reached the natural 'limits' of our finite planet. 'Prosperity without growth' was Jackson's supporting 'actors' contribution. What is certain is that production efficiencies and reducing carbon intensity are not sufficient alone with our current scale of carbon footprints and cumulative industrial and agricultural revolution emissions. Focus must switch to 'footprints' and 'cumulative emissions', as Jackson pointed out 10 years ago, but which is still contested or disregarded by many today just as Darwin was in 1859 and there afterwards.

Corporate Responsibility is about businesses having responsibilities and taking actions beyond their legal obligations and economical aims. These wider responsibilities cover a range of areas frequently summed up as Social (or Societal) and Environmental. This then sums up to the Triple Bottom Line (TBL) framework: Economic, Social and Environmental, accredited to the genius integrated thinking of John Elkington[7] as published in *Cannibals with Forks* (1997). The TBL framework is often used to evaluate corporate performance in a broader perspective to create greater business value.

Economical dimensions of TBL can in the management accountancy arena be seen to be replaced by the 'Financial' perspective when referring or linking traditional measures of profits, return on investment, and shareholder value to these specific aspects, including the other Social and Environmental dimensions. In traditional business accounting the common usage, the 'bottom line' refers to either the 'profit' or 'loss', which is usually recorded at the very bottom line on a statement of revenue and expenses. By focusing on these more comprehensive investment results – that is, with respect to performance along the interrelated framework of profits, people and the planet – triple bottom line reporting can be an important tool to support other Sustainability frameworks, aims and objectives. The 'Economic' dimension can also be looked at as Economic 'Prosperity' as introduced by Elkington and developed more by Porritt[4]. From around 2005 (similar timing to the emergence of ESG), these two approaches merged with TBL becoming synonymous with **People Prosperity Planet**. The framework of TBL has also been credited with focusing the demands that the Sustainability's 'responsible business' theme which incorporates integrated thinking on their stakeholders, local communities (i.e. Social & Human Capitals) and even environmental considerations (Natural Capital) rather than simply their shareholders (Financial Capital) in just business.

Elkington's *Cannibals with Forks*[7] (Page 20), following on from his Triple Bottom Line framework, when he defines **Sustainability** as **the principle of ensuring that our (activities and) actions today, does not limit the range of economic, social, and environmental options open to future generations**. Therefore, Elkington interestingly is defining Sustainability as the test over time for the endurance of his Triple Bottom Line framework. Very much like Technical Sustainability is the endurance of systems and processes, as defined earlier, over time. Elkington's Sustainability is very much like a destination, some co-actors describing this as **True Sustainability**. 'Sustainable Development' by contrast is not as concrete in terms of 'vision, mission, journey (performance and audit) and destination' ideology, but, based on 'goals' (to which humanity should aspire) and ideology 'guides' (such as governments' core function is to enable societies to prosper) often with no clear specific stewardship or succession pathways.

To complete the 'landscape of Sustainability' equation above, Jonathon Porritt in 2005 published *Capitalism as if the World Matters*. His book lays out applying the essence of capitalism – the productive use and

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reinvestment of the 'capital stocks': Natural Capital, Social Capital, Human Capital, Manufactured Capital and Financial Capital, everything having a positive dividend contribution to the TBL. If that is achieved, companies will also benefit from Reputational 'Brand' Capital, the intangible capital of having competence (e.g. Intellectual Capital, Risk Management), resilience. Positive dividends improves prosperity, quality of life and wellbeing of citizens all through integrated commerce in a flourishing society. One of the best ways to determine the endurance of a business is to understand the cumulative value created through commerce such as economic rent, the associated accumulating wealth capital stocks and their re-investment in value creation. Hence the overarching relevance of Porritt's thinking to Sustainability, as defined by Elkington. That completes the introduction of the 'framework' landscape equation of Sustainability by 'directing authors', which should at least give the reader a core understanding behind People Prosperity Planet. But we know with Natural Capital, from Locke, 'work done' is necessary to claim your 'ownership' of this super discipline. 'Cooking' these books in an 'alchemy cauldron' will not create the elixir of Lovelock's 'life' without the act of 'doing work' – probably best enacted by our Goddess Nigella. Bewitching as Nigella is, the sparkle or 'spark' of entrepreneurialism is additionally needed to ensure a 12/10 elixir; the invisible hand of humanity, innovation and ingenuity. So those new to True Sustainability – be warned.

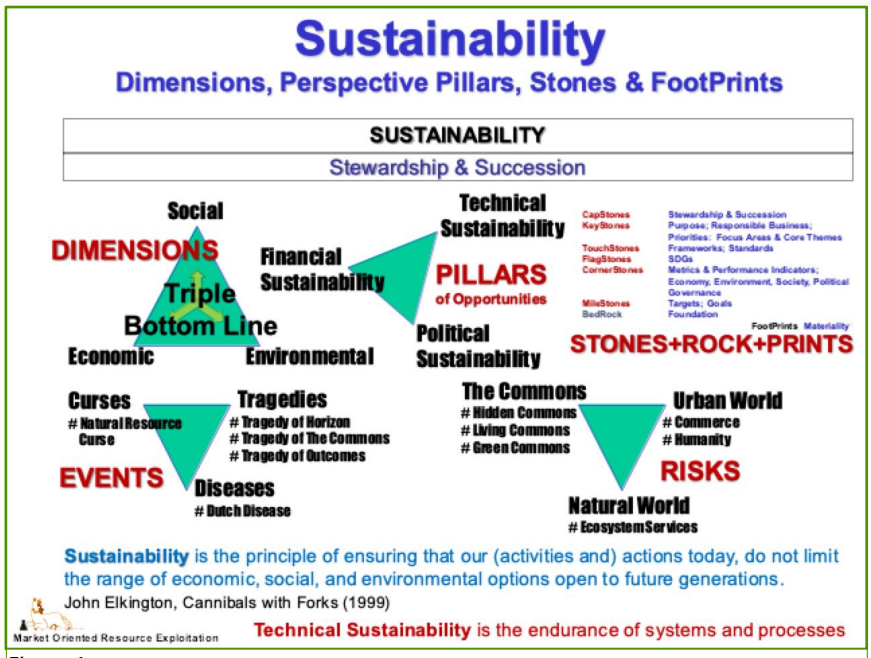

Figure 1

Figure 1 (left) illustrates modern day Sustainability: its three dimensions from the Triple Bottom Line; the opportunity pillars based on the perspectives of Technical, Financial and Political Sustainability; and the risks to the Commons, Urban World and Natural World's ecosystem services. Sustainability purpose, principles, practices, priorities, performance, progression seem to be more often links to 'types of stones' (capstone, keystones, flagstones, cornerstones, milestones), bedrock and footprints; and taking footsteps. All part of the burgeoning associated new terminology of this emerging and re-focused urban 'life'. Remember, we live currently in an unsustainable world, Sustainability is not yet achieved so everything is still being stress tested. When some events happen, negative outcomes such as in Natural Resource Ecology have been given descriptors linked to 'curse' and 'disease' such 'Natural Resource Curse' and 'Dutch Disease'. 'Tragedies' are also popular with Tragedy of the Commons[8], Tragedy of the Horizon[3] and Tragedy of Outcomes[9] all having been defined to date.

So, finally having introduced some 300 years to arrive at modern day Sustainability, we should now think about: "The landscape of Sustainability incorporates the domain of Sustainable Development, with the Circular Economy just one of the key tools in the Sustainability tool box." Discuss. So where does Sustainable Development, as popularised today by the UN seventeen Sustainable Development Goals, and the Circular Economy reside?

The **Sustainable Development** domain can be defined by events and authors, encapsulated by this equation:

Sustainable Development = Club of Rome + Brundtland + Sachs
[Equation 2: Domain of Sustainable Development]

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These works and texts start to form the bedrock of **Political Sustainability** (*Figure 1*) along with Political Governance, constraining and expensing.

The Club of Rome meeting of 1971 was immortalised in Donella and Dennis Meadows[10] book *Limits to Growth* (1972). The Club of Rome was formed by a small international group of academia (scientists, educators, economists, humanists), national and international civil servants, UN administrators, and most importantly industry business leaders. Shame no engineers (?). *Limits to Growth* was their first publication. In this book was a paragraph that said:

"It is possible to alter these growth trends and to establish a condition of ecological and economic stability that is sustainable far into the future. The state of global equilibrium could be designed so that the basic material needs of each person on earth are satisfied and each person has an equal opportunity to realize his individual human potential."

Hence, 'sustainable' ideology and 'material needs' or 'materiality' were cast together to try and solve humanity's 'limits to growth' by an ever-increasing population. Materiality is central to all 'Sustainability Performance', the particular focus of 'Sustainability Audits'[10] and crafting 'Sustainability Strategy' – hence the relevance of *Limits to Growth*'s integrated thinking within the landscape of Sustainability. In 1972, this work was published to bring their new understanding to the attention of policy-makers and the public worldwide, promoting new policy initiatives and action.

In 1798, Thomas Malthus believed that population growth would eventually surpass nature's replenishing of natural resources – these thoughts were expanded into a book in 1803. Malthus' thoughts on environmental degradation and resource overuse were well in tune with *Limits to Growth* and later that of the Brundtland commission. In 1987, the Brundtland Report[11] was published, entitled 'Our Common Future'. Gro Harlem Brundtland, the Norwegian Prime Minister, chaired this commission in Oslo. The World Commission on Environment and Development (WCED) introduced the concept of **Sustainable Development** with the event sponsored by the United Nations (UN). The meeting explored the causes of environmental degradation attempted to understand the interconnections between society (social equity), economy (economic growth), and environment (environmental problems) – developing policy solutions that integrated all of these three areas.

At this commission's Oslo meeting, 'Sustainable Development' was defined later as "development which meets the needs of the present without compromising the ability of future generations to meet their own needs". This is sometimes confused as the most popular definition of 'Sustainability'. The published text actually said:

"Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs. The concept of sustainable development does imply limits – not absolute limits but limitations imposed by the present state of technology and social organisation on environmental resources and by the ability of the biosphere to absorb the effects of human activities. But technology and social organisation can be both managed and improved to make way for a new era of economic growth. The Commission believes that widespread poverty is no longer inevitable. Poverty is not only an evil in itself, but sustainable development requires meeting the basic needs of all and extending to all the opportunity to fulfil their aspirations for a better life. A world in which poverty is endemic will always be prone to ecological and other catastrophes."

This 'domain' of needs and aspirations clearly has to sit in a wider context governed by the interactions of the three complex systems: economy, society, environment; plus (political) governance.

In 2015, Jeffrey Sachs[12], with the foreword from the Secretary General Ban Ki-moon of the United Nations published *The age of Sustainable Development*, including the final 17 Sustainable Development Goals (SDGs)

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adopted by the UN General Assembly on September 25th , 2015. A historic day for humanity. These SDGs further the Brundtland commission's work on economy, society and the environment, but, most importantly add 'Political Governance'[12] explicitly to 'the age of Sustainable Development'.
Based on these works, which are central to the last 50 years of Sustainable Development, they actually form the bedrock of **Political Sustainability** (*Figure 1*) along with Political Governance, constraining and expensing. Sustainable Development is all about understanding the complex interactions of economy, society, environment and political governance focused on the four central ideology of human equity: environmental justice, realignment of opportunities, and redistribution of wealth. So the evidence is there (in black and white) that the domain of Sustainable Development sits within the landscape of Sustainability.

So what about Ellen Macarthur's Circular Economy – one of the tools of Sustainability? The **Circular Economy**[13] (CE) has been very successful since its publication in 2012, but is predominantly focused on 'flows'. For Natural Resource ecosystems, the Circular Economy toolbox mainly helps to contribute to a sustainable supply chain. In the North Sea, this is very timely with lots of companies now trying to optimise the holistic CAPEX – OPEX – ABEX life cycle. The Circular Economy 'wings' focus primarily on organic process flows (environmental) and inorganic process flows (social) so have great synergy with Lovelock's TBL analysis.

A more recent proposed concept, oil ecosystem specific, is the Circular Carbon Economy[14] (CCE). CCE is more about resource flows, so understandably Saudi Aramco is a very keen promoter with support from the G20 in October, last year. Replace (e.g. creating blue hydrogen) and Redefine (e.g. creating carbon neutral products) should be added to CCE then making this fully complement the carbon 'flows' in this additional toolbox. But we soon get back to **Carbon Governance and Carbon Budgets**, which is a more about 'stock': Repair, Renew, Regenerate, Rehabilitate, Remanufacture/Refurbish, Repurpose. So a lot of 'R's to think about, therefore back to school for many subsurface engineers. There is one 'D' which comes naturally to engineers – **Design**. IOR – recovery is full on bespoke design, and 'design for prevention'[15] should actually contribute as much in the future as these other more 'circular' tool boxes to help reach True Sustainability.

David Attenborough's[16] latest book *My Witness Statement* provides great insight on the history of our small planet – providing a monologue of planet wilderness and carbon dioxide atmospheric concentrations over the last some 80 years. Growth in humanity's population was also provided but is obviously not reversible without the next great extinction. But in 1971, the time of Dolan and Limits to Growth – our modern day origins of Sustainability and Sustainable Development thinking, had 58% planet wilderness and 326 ppm respectively. These are still achievable by grand design, CE, CCE and particularly with true governance (technical, environmental, corporate, financial, political and societal) and governess over humanity and entrepreneurialism (Goddess Nigella) and nature and ecosystem services (Goddess Gaia). It most likely will take more than 50 years to achieve. To have the dream – we have to cross the stream, we can take (or make) the future (Abba, 1979), and deliver through more engineering, guided by the science.

That covers the introduction to Sustainability. Without the mastery of governance and governess, Sustainability is not mastered. Without mastering Sustainability, it is hard to value your values[7].

Article 4 in the next issue of SPE Review London will cover societal purpose of commerce, enterprise and industry, more than just business – thinking about the principles of Sustainability that need to be applied to guide Performance and Priorities – Social Oriented Business Purpose, Profitability 301.

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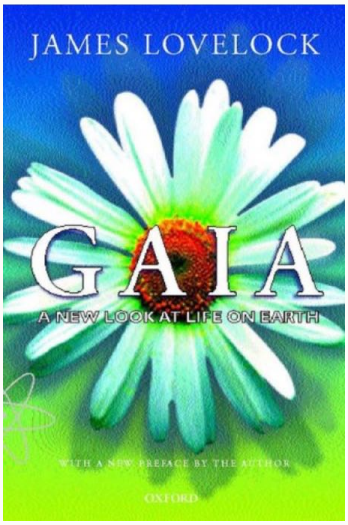

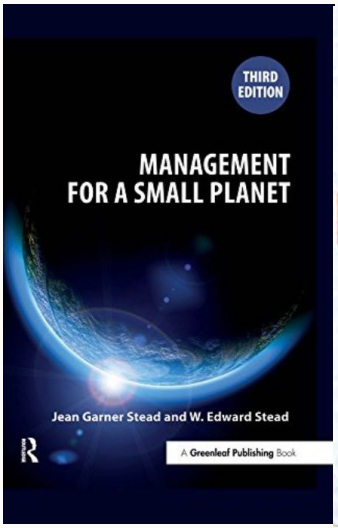

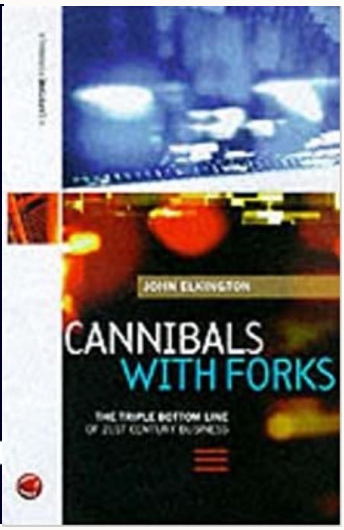

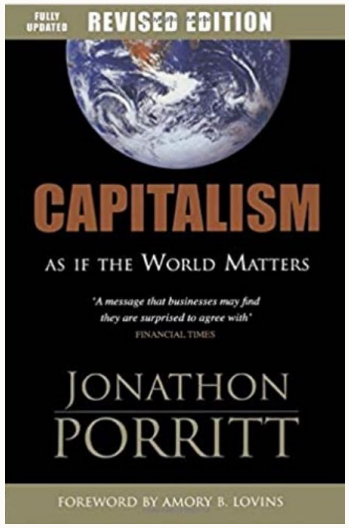

Meet the SPE London Board

SPE is a non-profit professional society with more than 156,000 members in 154 countries, who participate in 203 sections and 383 student chapters. SPE's membership includes 72,000 student members. The SPE London Section, with an average 2,000 members and seven associated student chapters, is an active section with an aim to connect, engage and promote the exchange of knowledge within the London energy community of technical and commercial professionals. The SPE London board is the governing body for the SPE London section. The different committees oversee the chapters various activities including the evening programme, various SPE events, Young Professionals, Women in Energy and associated student chapters.

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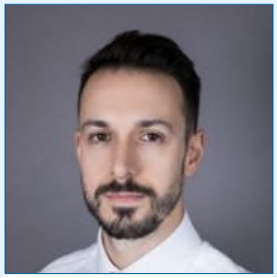

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FIND OUT MORE!
Get in touch with our Editor, Elizaveta Poliakova via LinkedIn