* 1. **These are three experimental demonstrations of quantum simulations. Noting its relative date of publication, describe your chosen paper's impact in the business trade press. Do you feel it had the largest influence of the three? Why or why not?**

Nature was always one of the most thrilling phenomena in our world, and understanding the laws that are driving it is very inspiring in the way that it can open us the clues to life. Quantum simulation gave us the opportunity to be one step closer to understanding nature. An excellent way to start exploring is to look at how it all started, that is, to look deeply at molecules, atoms and their interactions. A great example is a work done by the Google Research Team on simulating energy levels of the hydrogen molecule in their work “Scalable Quantum Simulation of Molecular Energies.”

The real question is, what kind of influence can quantum simulation of molecules have on the world? By understanding how certain materials behave, we can solve problems in fields like medicine, chemistry and material science. In [this](https://www.sciencealert.com/google-s-quantum-computer-is-helping-us-understand-quantum-physics) article by David Nield, the author concludes the breakthrough done by Google Research Team in collaboration with several institutions and compares the power of quantum simulation with classical computers stating that it would take days to simulate even the simplest molecules. The graph represented in the article shows how the VQE algorithm has performed almost identical to the ground state of the hydrogen molecule energy level. The [article](https://phys.org/news/2016-07-scalable-quantum-simulation-molecule.html) by Bob Yirka introduces the real motivation for using quantum computing to simulate molecules. He mentions Google Quantum Software Engineer Ryan Babbush, who notes that this is a good challenge for quantum computers to overcome the limits of classical computers and simulate any kind of complicated molecules. What I liked, especially in this article, is that Bob Yirka also compares the VQE algorithm with neural networks stating that the “VQE approach translates well as a quantum equivalent of a neural network.”

If we look from the business perspective, simulation of molecules can help us to create new catalysts, new fertilizers and make us use materials more efficiently and more wisely. Development of better and longer-life batteries is another advantage of quantum chemistry and, of course, most importantly, the creation of new types of medications for the treatment of incurable disease. This list can be continued, and all these advancements can bring to the reduction of costs in electricity, in the production of different materials and drugs. This all can dramatically change the future of industries and companies and introduce new business opportunities.

What concerns the other two papers, both have gone even further and tested the full potential of quantum simulation that can be reached nowadays. “Hardware-efficient Variational Quantum Eigensolver for Small Molecules and Quantum Magnets” paper has tried to simulate the energy levels of molecules other than hydrogen by introducing more qubits and “Observation of a Many-Body Dynamical Phase Transition with a 53-Qubit Quantum Simulator” paper has used an astonishing number of qubits, which are represented as trapped ions, in order to simulate the Ising model of magnetism. They have proved that by increasing the number of qubits, we could increase the precision of any quantum simulation.

**2. Two of the papers employ superconducting qubits, and were from research at large corporations, while one paper describes research using atomic qubits, performed at a research university. Based on how these results were received in the news press, can you see how the technology, and the research institution, made a difference in expectations for future developments?**

Every time you hear or read the word quantum, something big, exciting and promising you are expecting to follow that word. Each research, each experiment and each paper published, is getting us closer to the quantum revolution. Scientists and engineers are always trying to approximately predict when that revolution will happen when we are all going to have our own quantum computers. However, time has shown us that the progress of the development of technologies is rapidly increasing and our predictions almost every time were happening earlier than we were expecting. That is why every achievement in the quantum field makes us rethink about what is waiting us next.

Having a ready and working universal quantum computer is of interest to a lot of organizations, research institutions and overall to countries. As a result, there is a big competition between nations to be the first ones who will accomplish the goal of the quantum revolution. Just like there is a big race to conquer the market of self-driving cars and AI, the same can be said about quantum computers. Developed countries such as the USA and China are especially interested in harnessing the power of quantum computing. Maybe it would be a rough comparison, but this all kind of reminds the times when there was a massive competition of who will build the first atomic bomb and be at the top of others. Surely, this engagement shows us that the demand for quantum computers is very high and that we are approaching the quantum future every day.

Reading these three papers, were the potential of quantum simulation is tested, we can already see what really can be achieved with the help of robustness, efficiency and speed of quantum computers. In my opinion, the paper published by Google Research Team has the most social and business impact compared to the other two papers. As their experiment was done earlier than the others, they have proved the efficiency and power of the VQE algorithm, as well as the effectiveness of quantum computers to simulate molecules. Surely, a lot of works and published papers have followed after their achievements, like the one done by Watson Research Center in their “Hardware-efficient Variational Quantum Eigensolver for Small Molecules and Quantum Magnets.” This is why I think Google Research Team’s work has contributed socially as they initiated a chain of diverse experiments to explore the power of quantum simulation. Their effort also has a long-term impact in a business perceptive since every work done and every paper published brings us closer to the quantum revolution, which can create many business opportunities.

**3. Imagine that you are responsible for investing the money of a company or a funding agency interested in the further development of quantum computation. Would you invest your money in your chosen paper's project? Why or why not?**

It is genuinely mind-blowing every time you think about what can be done by using quantum computers. This is why a lot of big companies like IBM or Google are spending a significant amount of money and time on creating quantum computers. The experiments done in these three papers have proved that quantum simulation can actually simulate nature very precisely. This is why I think it would be the right choice to invest in my chosen paper done by Google Research Team.

Investing in the Google Research Team’s work means, first of all, to invest in the development of quantum computers. For sure, the accuracy and power of quantum simulation are directly related to the capability of the quantum computer and number of qubits it is using. Thus, part of the investment should be concentrated on improving the performance of quantum computers, making them noiseless and trying to manage a high number of qubits. Google is one of the leading companies that are working really hard to create functional quantum computers and are showing promising results. That is why I believe you can undoubtedly invest in their projects.

In addition to working on quantum computers, the primary purpose of the investment would be to continue the experiment on simulating more complicated molecules other than hydrogen. What can be noticed is that they have tested how two algorithms (PEA and VQE) would behave during their experiment. They concluded that the VQE algorithm is more robust and precise. The continuation of their work would be a good chance to work more with the VQE algorithm and examine its accuracy on high-level problems. It would be even possible that new types of algorithms can be discovered while trying to simulate new molecules efficiently.

The crucial part of investing in the work done by Google Research Team, in my opinion, would be its long-term impact on the world. As I have already mentioned previously, quantum simulation of molecules and materials can allow us to dig deeper into physics, chemistry and biology. Discoveries of new types of materials that are cheap to produce but are very useful and unique, as well as the creation of new medications and even some answers to the questions that we are unable to answer, can be achieved using quantum simulation. This is what really drives a lot of investors and big corporations.

Overall, I think it is worth investing in the Google Research Team’s work for the reasons mentioned above. If you think about it, several years ago, one could not imagine that quantum computing could be possible sooner than they were expecting. Of course, we still have a long way to go to have a full working universal quantum computer, one that is available to everyone just like classical computers are.