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40 Years of Technology and Research Evolution

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Sadly (for us, not him) Jim McDowell is retiring after 40 stellar years in the technology and research industries. He has kindly penned his closing thoughts below. I am sure you will enjoy reading his take on the past, present and future. Thank you and all the best to you Jim; it's been a pleasure working with you.

When I started in the clinical and research worlds in the 1970s, computers were just beginning to be available to average medical centers and researchers outside of the most elite universities. I remember our exuberance when we got our first DEC PDP-8 mini-computer. It was the size of a refrigerator and had a whopping 64K of addressable memory and a large floppy disc drive for storage and program loading. Fast forward 40 years, and we've all seen the many comparisons of how today's cell phones have more computing power than the greatest supercomputers did a relative few years ago. Imagine, today's biggest supercomputers run over 35,000 processors, with transaction speeds of over 200 petaflops.

Certainly interesting, but… *SO WHAT?*

There are a few answers to "So what" that I believe have been most important to the research community – and more importantly – to society overall.

Underpinning Big Data Advances

First, data is exploding all around us, and will continue its exponential growth until the end of time. With this massive accumulation of data, analytical tools and methods have necessarily evolved to allow exploration of data relationships - not only in massive data sets - but importantly, on wildly disparate data types, and by users with lower levels of technical expertise. The deeper importance of this set of developments should never be overlooked. The ability for highly trained scientists in medicine, engineering, plant science, or business – to explore data relationships within large pools of disparate data types, without the need for lengthy and expensive data "cleansing" and normalization projects, or a team of PhD Data Scientists at their side for even basic exploration, is huge. It allows for people with the deepest knowledge of a science area to do initial exploration of data relationships that could lead to new discoveries, at a pace hundreds of time faster than past methods would allow. Without the massive computing power that has become available, these advances would have been impossible.

In the medical world I've spent most of my career in, the development of "Big Data" analytic methods and the computing power to support their practical use has been particularly important. They are driving discovery of new treatments and improved care models, and really anchor our hopes of genomics-driven new cures in the future. The sheer computing power now available in the cloud, is also driving incredible new developments in areas like molecular modeling and drug design. Take a couple of minutes to learn about the amazing work done by the Centre for Computational Chemistry at the University of Bristol.

In the physics world, the value of this evolution in computing power can probably be no better-framed than the work CERN is doing in particle physics. CERN's 27-kilometre-long Large Hadron Collider contains over 50,000 sensors and monitors, and the experiments on it generate around 50 petabytes of data every year. Their work has yielded many new discoveries, including the famous Higgs boson particle – and their worldwide network of thousands of research collaborators – promises many more important discoveries in the future. However, without the continual advances in computing power, storage

efficiency, and analytic tool prowess – the pace of that discovery would be severely limited.

Improving Collaboration and Study Design

The second place I believe all this computing power (coupled with the evolution of the internet) has had a profound impact on research – is in collaborative data access. And it's not just access to raw observational data from worldwide sources, but equally important – access to the vast body of findings from current and past studies, again with extraordinary text-mining and other tools – to more fully inform researchers on what is known about their targeted research to-date and how to sharpen study design. And the ability to compare and analyze results of numerous prior studies, including textual documentation of very old observations – has led to some interesting new discoveries already, and will certainly yield more as this evolution continues.

Speeding the Application of Research

The third place we in the medical world expect this evolution will have an impact in the future, is in a drastic reduction of the research to clinical practice time cycle (*or so-called "bench-to-bedside" time*). Today's computational and collaboration tools allow for far more rapid identification and recruitment of subjects, gathering and analysis of study data, faster collaboration among researchers, and ultimately faster publishing of results. Undoubtedly, the

growing application of artificial intelligence will act as an accelerant across many of these dimensions.

As exciting as the above benefits are in their own rights – the thing I am most intrigued by in medicine - is the potential for big data analyses on (*still developing*) massive EMR data sets, to allow for discovery of diagnostic and treatment advances – purely from spotting relationships on mass volumes of patient data. With the growing access to reliable data and the tools to analyze it faster, this new approach to discovery needs to be exploited, rather than relying solely on traditional research processes that take years to yield clinical benefits. This change will be difficult in the current medical ecosystem – but the benefits are potentially enormous.

Enabling AI and ML

Finally, the massive growth in computing power, along with the continually lower costs required to deploy it – is fueling the incredible growth in artificial intelligence and machine learning that promise to literally change the world. Whether in medical breakthroughs, improved cyber security, a myriad of smart cities applications, or finally letting us elders watch TV without learning 4 remotes – the benefits AI will surely bring are beyond current imagination.

Signing Off

As my generation prepares to pass the baton of driving further advances to our younger colleagues, I am extraordinarily excited to watch the next decade or two of our progress. I'm particularly encouraged that the current generation of talent in all the key disciplines required to drive continued advances - is truly exceptional. Better trained, more informed, and better equipped than all generations before them. Quite personally, I'm counting on them to at least defeat cancer and Alzheimer's - so I can write another 40 year observation down the road!

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