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Slide 1: Title -- Enhancing Innovation and Competitiveness Through Investments In Fundamental Research: Measurement, Instrumentation and Applications

It's a great privilege to be here today. Together we have the opportunity to build on the excellent work by the Association of American Universities, the National Academies and the Task Force on the Future of American Innovation. Investments in fundamental research can strengthen U.S. innovation, competitiveness and leadership in science and technology.

Today I will talk about three areas for us to consider: innovation fundamentals, trends in electronic and bio-analytical measurement, and interdisciplinary opportunities that transcend traditional boundaries.

Slide 2: Key Point – Endorse innovation fundamentals

I encourage us to endorse innovation fundamentals. These are critical … although there's no easy formula or measure to make them happen.

1. *(click)* Innovation today depends much more on teamwork than on individuals working alone.

2. *(click)* Innovation requires multiple disciplines. Think about any problem that matters today – energy, the environment, food and water safety. These significant issues require many areas of expertise. They also require collaborations with other organizations and research labs to share expertise.

3. *(click)* Innovation requires a supportive environment that tolerates failure. Innovation is risky for innovators who do their best work in a community that's free from fear and provides a psychological safety net to encourage bold new approaches that question the status quo.

4. *(click)* Innovation requires competent, enlightened leadership. Leaders can command obedience, but not respect or passion. Solving the really tough problems requires character and passion.

Slide 3: Innovation Requires Invention and Implementation

These requirements span the breadth of innovation. It's a long way from research to inventions to their implementation.

Click – People/ ideas & products/ contribution & profit

Just consider all the education and hard work needed to get inventions out of the lab and into the hands of people around the world where they make a real contribution. Completing an invention is only the beginning. Manufacturing people have to build it in volume production. Sales and marketing people have to communicate the benefits to multiple audiences, and the finance people have to fund the entire process … with profit left over for future contributions.

Click – Invention through implementation equals innovation

Innovation includes the entire process from invention through implantation, including successful collaborations with people whose skills and perspectives may be very different from ours.

Click -- All are critical to contributions and competitiveness

The greatest discoveries only have impact through applications that make real contributions to the way people live and work…and enhance competitiveness. That's not easy.

A scholar once said, "Whenever science makes a discovery, the devil grabs it while the angels are debating the best way to use it." (writer and scholar, Alan Valentine)

We don't want our research investments to stay in the lab. Enhancing innovation and competitiveness requires the entire innovation process – from invention to significant contribution with profit to continue research. This process is continuous.

Slide 4: Waves of Ongoing Innovation

This slide illustrates the disruptive waves of technology and the on-going need for innovation.

Stepping back, HP and Agilent have done very well through these waves.

In the 1950s, from our roots as a test and measurement company, came the transistor, integrated circuits, the PC and computational devices... And then to electronics and computers -- the next wave with its low cost lasers and fiber optic components.

Today with the sequencing of the human genome, we are in the heart of the biotechnology revolution, on the cusp of bioelectronics and bioelectronics.

To keep making contributions, organizations must continually reinvent themselves – but it's difficult. We can't just keep doing what we've always done, but this reinvention can be a challenge, especially in large companies.

In 1995, the median age of a Standard & Poor's company was only 12 years because many companies have failed to reinvent themselves. Clayton Christenson, author of the Innovators Dilemma, claims that many large companies routinely are not able to look beyond the existing market and anticipate new and disruptive technologies.

Re-invention and even successful innovations by themselves won't enable us to enhance innovation and competitiveness. We have to be willing and able to evolve with these technology cycles, anticipate where they're going, make bets, follow through, and win.

Slide 5: Agilent Technologies

Here's a quick overview of how Agilent is organized to support the entire innovation process… from invention of breakthrough technologies through successful commercialization… and back around to further invention for our existing businesses...and technology that creates new businesses.

Agilent Labs: 7% of Agilent R&D; U.S., Europe, Asia; open innovation

Applied research, Technology leadership, New business directions

Slide 6: Breakthrough Agilent Products, Fueled by Labs

This slide shows some examples of Agilent products – fueled by Labs – that have made significant contributions to our customers. They address the waves of disruptive technologies and solve important problems for our customers in communications, electronics, life sciences and chemical analysis. New products like these drive new technology innovation and open new areas for discovery.

For example, today a single experiment with DNA microarrays can result in hundreds or thousands of molecules of interest. In the past, biologists usually studied only a few molecules – such as genes or proteins – so it was easy for them to search scientific journals.

Slide 7: Key Points

Pursue research opportunities based on trends in electronic and bio-analytical measurement

Slide 8: Trends in Electronic Measurement

In electronic measurement, we see several major trends:
<u>1. Faster and less invasive measurements.</u>

- Electrical and optical signals that our customers want to measure have increasingly higher frequency content.
- Speed also very important because total measurement time translates into customer cost;
- And minimally-invasive probing and signal acquisition mean more efficient and more accurate measurements.

<u>2. Growing availability of high performance data converters leading to greater digital content in measurement solutions of all kinds.</u>

- Agilent is driving this trend which is also increasing the volume of digital data, highlighting the growing importance of digital signal processing and data management.

<u>3. Increasing integration of measurement science algorithms and modeling into the measurement solution</u>

- This is based on domain specific algorithms and decision technology to provide customers with clear and actionable information – not just a set of spectra or numbers.

4. The convergence of communications and measurement network technologies, enabling us to put measurement intelligence into things like cell phones, driving telecommunications network provides into a new realm of quality customer assurance

5. Finally, emergence of modular architectures for instruments and sensors
- Driven by their size, flexibility and potentially lower cost of ownership, esp by the aerospace/defense industry

Slide 9: Innovation That Changes the Game – ADCs

Data conversion is a key requirement in today's instruments. A Labs technology breakthrough resulted in the world's fastest CMOS analog-to-digital converters. ADCs enable the highest-performance instruments by converting high speed signals from analog waveforms to digital bits for computer analysis.

Traditional ADCs are based on bipolar transistor technology that's fast and accurate but expensive and takes a lot of power. The brown line shows technical performance over time. Triangles represent capabilities of Agilent, squares our competitors.

With a different approach, we gained speed and precision with the slower, less accurate CMOS technology. The first chip –Talon – is 1/3 the cost and 1/3 the power of bipolar technology.

Peregrine, the world's fastest 8-bit ADC, put Agilent in a strong leadership position in our oscilloscopes, for example, and we're continuing to extend the performance of this disruptive technology.

Slide 10: Paradigm Shift for Test Systems

To solve a problem or make a measurement, customers increasingly need multiple instruments working together in a test system. The key question is how do we coordinate the joint action?

(click) One option is to send a trigger signal from one instrument to the other. This would be like your manager stopping by your office and telling you to attend a meeting right now. Upon receiving the signal, you change your behavior. You drop what you're doing and run to the meeting.

(click) Another option is send a message over the network to both instruments. For example, Mark Wrighton sent us an e-mail message with the time, location and agenda for the meeting.

We're all here because we know Mark's watch and our watches are set to the same time. It is routine for us in our everyday lives to use synchronized clocks to coordinate joint activity, but instruments haven't been able to do this.

(click) Agilent's collaborations with standards bodies enable synchronized clocks inside instruments. Now customers can design and integrate complex modular test systems -- quickly and easily.

Agilent's modular instruments are designed around LXI (LAN eXtensions for Instruments), a standard led by Agilent and a consortium of companies. The LXI standard defines small, modular instruments using low-cost, open-standard LAN (Ethernet) as the system backbone.

While the convenience of time-based measurement and plug-and-play instruments may be obvious, what may not be obvious is that this technology solves the problem of the speed of light. Say we're 1,000 kilometers apart, and whatever I'm doing now, I want you to do it too. If I tell you, you'll be late by whatever time it takes the speed of light to go that distance. But if I know your clock is time synchronized with mine, our clocks can operate at the same time. Now instruments can work together from separate locations.

Slide 11: Trends in Bio-Analytical Measurement

1. In Bio-Analytical Measurement, these are exciting times, as the revolution in biotechnology and the life sciences is driving new understanding of living systems. In many ways, if you compare the maturity of the life sciences industry with that of the electronics industry, our ability to understand and control disease today is very much akin to where we were in the 50's for understanding and controlling silicon.

2. More and more, performance and ease of use are being differentiated through biochemistry (molecular recognition), sample prep (simplifying a complex sample to focus on what you want to measure), and informatics – enabling customers to gain biological meaning from their arduous and expensive experiments.

3. Key technology drivers are miniaturization (biological samples can be very precious, esp when they come from you!), massive parallelism to gain as much experimental information as possible, and automation and speed in order to reduce labor and cost.

4. On the horizon we have personalized medicine and molecular diagnostics for improved diagnosis and treatment of disease, enabling us to better classify and treat complex diseases with more highly tailored drugs – drugs with higher efficacy and reduced side effects.

5. And finally, we are just on the cusp of systems biology which will enable understanding of living systems in terms of the complex and dynamic interplay of many biological pathways.

The field will rely heavily on computer tools to understand the enormous volume of measurement data and to predict the behavior of biological systems under perturbations of disease, diet, or administration of therapeutic agents. A whole industry of software tools for modeling and simulation of pathways and networks will emerge. In the long term, these will enable a predictive power previously unheard of in biological systems.

Slide 12 - 14: Agilent DNA Microarray Solutions/animation

One of our key platforms in Life Sciences is the DNA microarrays.
Researchers use our microarrays to identify multiple and missing pieces of chromosomes in cancer cells compared with normal cells … and to profile messenger RNA, which codes for the proteins that work in our cells.

Our Labs researchers were intrigued when a new type of regulatory nucleic acids – micro RNA's - was recently classified. We're exploring ways to extend the capabilities of our microarray platform to measure microRNAs .

The following animation will show you the key role that microRNAs play in protein regulation.

ANIMATION -- courtesy of Rosetta Genomics. You're looking inside the nucleus of a cell. The cell is copying DNA into RNA. A single strand of RNA forms a hairpin precursor of microRNA … leaves the cell nucleus and becomes microRNA. Here you see messengerRNA forming a protein. The microRNA comes along… binds to the messengerRNA and stops protein synthesis.

SLIDE: You can see that microRNAs act directly to regulate protein synthesis. Because of this important function, microRNAs play a key role in many diseases. Two years ago leading cancer researchers were taking a wait and see attitude about the discovery of these molecules, but now they're telling us that measuring microRNAs is essential.

Slide 15: Towards Systems Biology . . .

This slide shows the modeling of protein-protein interactions in yeast.
You can see the complexity required of systems biology to understand biological interactions.

This particular map contains more than 1500 proteins (the boxes) and close to 2500 interactions (connecting lines).

The ability to visualize pathways and understand the molecular basis for disease is the holy grail of biology. We're still decades away, but many of us believe that this understanding is within reach and that it will happen.

These examples demonstrate the research opportunities available from current trends in electronic and bio-analytical measurement.

Slide 16: Key Points

Explore and exploit emerging interdisciplinary opportunities that transcend traditional boundaries of discipline, organization, industry and geography.

Slide 17: Strategic Future Research Themes

Agilent Labs identified a series of strategic themes, areas that represent potential future market opportunities for Agilent on the time scale of Labs research.

Our goal is to explore and exploit emerging business opportunities, especially those that transcend boundaries.

- Formed by powerful demographic, societal and technology trends
- Where Labs multidisciplinary skills can create high customer value.
- All of these areas have the potential to draw on important Labs competencies and synergy.

These areas include (list them):

Slide 18: Nanoscale Measurements

The future will depend on our ability to understand, manipulate, and measure devices, systems and living things on the molecular scale.

Slide 19: Agilent 5500 Atomic Force Microscope (AFM)

The realms of electronic and bio-analytical measurement converge at the molecular level. I attached 2 pictures for you, one is the well known endothelial cell image from CHO cells (Chinese hamster ovary cell line) where the cell structure and nucleus area is very well resolved, the second picture (also in my presentation) is a kind of transistor (FET) with a small silicon nanowire closing the gap.

Slide 20: An Increasingly Digital World

Our increasingly digital world provides more opportunities to transcend research boundaries – and more opportunities to enhance innovation and competitiveness.

For example, physical analog measurements of a cell and a printed-circuit board – shown on the left on this slide -- are very different. But the processing of these analog signals is actually quite similar once they're converted to digital signals.

When measurements are in digital format, the opportunities for leverage are huge. Following data conversion, the tools to generate insight are the same: increasingly fast digital signal processing and complex measurement systems software.

These digital tools can address trends across electronics and life sciences for measurements that are faster, higher throughput, integrated, multiplexed and increasingly automated.

Organizations have a lot of opportunities to share fundamentals and tools across this digital domain… to make breakthroughs and transcend traditional boundaries.

Slide 21: Summary of Key Points

Endorse innovation fundamentals: teamwork; multiple disciplines; supportive environment; competent, enlightened leadership.

Pursue research opportunities based on trends in electronic and bio-analytical measurement.

Explore and exploit emerging interdisciplinary opportunities that transcend traditional boundaries.

Enhancing innovation and competitiveness requires the entire innovation process – from invention of breakthrough technologies through to making significant contributions.

I hope I've provided some ideas to guide decisions on research investment. Together, our recommendations will make bigger contributions than any of us could do alone.

Thank you.

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Slide 22: title slide