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HP has from its very beginning been a company defined by innovation.

Change has been good to us. Imagine the original Hewlett-Packard company in 1939 – it was a very specialized company selling electronic test equipment to a relatively small audience – and think about how it's grown, along with the whole electronics and high-tech industries, to what we have today, a Fortune 11 company.

For FY05 we reported $86 billion in revenue and we generated $7 billion worth of organic growth. That means not counting mergers and acquisitions, just growing the core. We have about 150,000 employees doing business in 170 countries directly, and we do business in other countries indirectly through distributors.

HP spends about $3.5 billion a year on research and development. That's about five percent of our revenue. Of that $3.5 billion, roughly five percent goes to research; it's reserved to look ahead of where the businesses are.

HP Labs was founded by Bill Hewlett and Dave Packard, who knew that thinking about what customers might need in the future can be very difficult to do in a business. The pressure on any business is always about allocating scarce resources. The firestorm of competition that every business manages is something that never changes.

Because of that, Hewlett and Packard chose to reserve a certain amount of the R&D budget solely for looking ahead of the market, looking at emerging technologies, at emerging opportunities, at industry changes, and at changing customer needs. At HP Labs, we wake up every day all around the world thinking about those types of questions.

**Roles of Labs**

Now, a bit about our mission. Our number one role is contributing to the strategy of the company. Most people don't naturally think that's what research does but, as a high-tech company, having a forward-looking view of technology is critical to setting the direction of the company.

We engage at every level in the company, from the key technical staff all the way up to senior management. That engagement is bi-directional. We're trying to understand what's going on in the business, what's going on in the customer base and what's going on in the marketplace, along with understanding where new technology is emerging and where we can drive new technology to change things.

All of this is critical. In some sense, we're trying to create a new type of research and a new type of research person, which is somebody who is expert in their field but who also understands what matters, what technologies are likely to have important impact. That's quite different from the traditional model for research, where it is science-led. Our belief is that it has to be an intersection of science and technology, focused on solving real problems.

Another key role for HP Labs is to help HP win in its existing businesses. We're always trying to create new value for customers. If we can do that with new technologies, we believe that will create value for the company.

A third role focuses on going beyond the existing company strategy. We're constantly thinking about where the company is going to have new opportunities. Where can we take the assets we have as a company and move into new areas?

HP started out building electronic test equipment to be used by electrical engineers in manufacturing and engineering. Now we're providing systems for multimedia, telecommunications and high-security banking applications, to name a few. We didn't get there by just staring at the same customers and the same technology all the time. In fact, the history of HP is really one where we've been very forward-thinking in recognizing new opportunities. So HP today, and clearly after the Agilent split, is an IT company.

We moved into IT because people realized that computing technology was becoming cheap enough that it could be used to control HP's test and measurement instruments. Not long after that, the people who were working on the computers thought, "gee, there's a lot of other things we could do."

And here we are a few billion dollars later. We've gone through that pattern over and over again. Many times that movement has been led by the Labs. HP's first computer architecture came out of HP Labs. All three HP printing technologies – laser, inkjet or our new commercial printing technology – were either led by Labs or jointly developed with the businesses. So across the board, HP Labs has helped drive a lot of that change.

Finally, one of our roles encompasses what everybody expects to find in a research lab. We have deep investments in science and technology, which are very much like a cutting-edge academic program, really at the forefront of the field. We've picked a few areas where we wanted to have people inside HP whose expertise was equal to that of anybody in the world because we believed that competence in these areas could be leveraged into areas that are important for HP.

Earlier, I talked about strategy in terms of the company. What we've done in HP Labs is apply our thinking about what's going on in the world – whether it's in technology, in markets, or in the industries in which we operate – to devise a strategy. It may not be the strategy you think of when you think about a research lab, because a lot of times people talk about pervasive computing or large-scale computing or maybe specific technical disciplines like artificial intelligence. The way we formed our strategy was thinking about what the big challenges are going forward that are important to HP.

**Reinventing the economics of IT**

I'll start with strategy number one: We call it Reinventing the Economics of IT. We chose that because our belief was that the IT industry (and that includes HP) was going through a transformation. During the 1970s, 1980s and the early 1990s, there was a huge push in terms of price performance. People got excited when you brought out a new microprocessor.

We saw a couple things going on. One of these was a move toward industry-standard building blocks. From a customer's standpoint, this was great because you're seeing lower prices and you're seeing more standardization, which makes it easier to manage IT.

From our point of view that meant we could reduce our R&D spending in that area and shift it into areas that were becoming more important to our customers. At the same time, our customers realized that most of their spending was not on 'boxes' or servers – it was on the people and the software to run all this stuff. Specifically, the cost that keeps growing is people.

In the late 1990s, we shifted our focus to looking at how we could start attacking what is truly the major cost of IT for our customers and, at the same time, make IT more valuable to customers. The sheer complexity of IT, certainly in the enterprise, but even for consumers, is becoming a bigger problem than the technology itself.

Our research program involves working on our next-generation data center. It's all about management software – software to help automate IT operations and take a lot of the labor out of IT, and, in the process, also make it more robust and reliable. Most of the outages you see in IT today are actually caused by people. It's not because people aren't diligent. It's just that the sheer complexity of IT means there are so many potential ways to cause problems.

This is also reflected in the difficulty of delivering IT projects. The complexity of these projects means they proceed quite slowly because there's a tremendous amount of testing required.

We're attacking those issues in a broad way. We're working with some of HP's largest customers to get a detailed understanding of what problems we need to solve, and we're working with HP's internal IT. Although we have delivered some technology, this is a decade-long project to get to that 'lights out, 24/7 data center' which runs reliably with a small number of people.

When we started this program, one of our team made a joke that our goal was to get to a data center with one person and one dog in it. And the reason for that is the dog guards the data center to keep people out. The person's job is to keep feeding the dog. While I don't expect we will ever see that outcome, that vision encourages the team to think boldly.

Part of that vision involves storage. Storage has become the fastest- growing component of IT. It has all the same issues in terms of complexity as management. How do we automate it? How do we build models? How do we virtualize things? Instead of managing individual computers, we're now managing whole data centers as a single object. It's a tremendous push and one in which we've had a lot of success.

There's also a grid element of this, because the grid, while originally a scientific computing idea, is migrating into the idea of how do you tie multiple data centers together using grid-like technologies. And so we've been working with the grid community to bring commercial-scale management practices to the grid so that it could be used to manage multiple data centers.

**Printing and imaging growth**

Another key research priority for us involves printing and imaging growth. I'm sure you're all aware that HP is very successful in the printing business. Our success has been built on the desktop – in the office and at home. But years ago we were looking at the total print opportunity for HP and realized that, for all of our success, we were addressing only four percent of the available print market.

So we started looking at areas where we could bring the same sort of digital revolution we brought to the desktop into other segments of printing. Specifically, we looked at commercial printing – typically, the kind of printing you'd see in a magazine or catalog. It's high-quality printing with a high visual impact, but it is currently limited because it is a mass-production technology. Basically, you cannot change information on a per-page basis.

We saw an opportunity with something called liquid electrophotography, which is a bit of hybrid technology. It uses a laser writing system like a laser printer, but it uses real ink, or actually a very special kind of ink, so you get the kind of visual quality you expect in commercial printing. HP is building a very large business around this technology now. We have a long-term program of continuing to make that technology available at higher performance and lower cost.

**Industry solutions**

A third key area we're working in is delivering solutions for specific industries. Our largest single area is mobile rich media. We've been working in telecommunications for about 15 years, originally focused on how to manage the wired voice telecom network.

The telecom network has been through several big transformations. Originally it was, basically, wires connecting your phone to somebody else through a switch. Then we had the intelligent network where there was a second channel alongside your voice, which essentially is a digital computer network that controlling what's going on. Capabilities like toll-free numbers, credit-card calls and caller ID came out of the creation of this parallel network.

HP is at the core of this telecom network. The majority of the world's phone calls go through systems that run our software to help manage the network.

The next big transformation was in mobility. Most of that development, in terms of digital mobile phones, took place outside the United States. So our labs in Europe and Japan took a lead role in helping develop technologies to prepare us for that big shift to digital, which is just now starting to happen in the U.S., but occurred in Western Europe and Asia-Pacific first.

The next step is moving from digital mobile to digital mobile with media streaming and interactive services. Our team has played a lead role in the company in creating the technology required to do that. We've worked with some of the largest mobile operators in the world to understand what drives them so we could develop technology for their future needs.

This is, again, a new way of working in research because in these complex areas you can't just sit in your office and look at it from a science standpoint. You can't just look at what's going on in the market today. You have to get beyond that and find the people who are reshaping industries and get inside those organizations, get inside their thinking, so you can understand what they're going to need in the future.

There's an adjacency to the telecommunications industry in terms of media and entertainment. Digital multimedia is becoming a huge industry. All of it, whether it's radio, television or film, is being transformed by digital technology.

We're looking at the future structure of that industry so we can build the IT infrastructure they're going to need. In digital entertainment, we participate on both sides. We make many of the devices people use to consume digital entertainment. But at the same time, we're working with people who own and create content, and deliver that content to consumers.

**Services innovation**

Our fourth big research area is in services, which are becoming a much larger part of the IT industry. A lot of our customers are asking HP to take responsibility for certain parts of their operations.

Traditionally, people have thought about services as a sort of 'pipe,' a means by which we deliver technology to the customer. About five or six years ago we began thinking that maybe we could make that pipe better. Our model was based on considering what happened in manufacturing in the 1980s. Manufacturing used to be about labor, capital and material. Today if you talk about manufacturing without talking about IT, and the ability to control inventory and just-in-time materials, people would think you were living in the stone age.

So our question was, how could we apply that same intellectual discipline to the services practice, shifting it from something that today is driven by labor and labor cost – labor arbitrage is the hot topic right now – and start thinking about how technology could make labor more efficient and change that whole equation.

Over the past five or six years we've started to find powerful ways to impact the services business. Using technology to transform the services business has become core to HP's strategy. It's something our team is very excited about. We now have a wide range of engagements that look at the whole business process from end to end, at how services are acquired and delivered.

**Thinking about "what's next"**

Our fifth strategy is the not-strategy. It's about what's next. In this area, we're looking at devices, software and markets. In devices, our most prominent work is in nanotechnology – specifically, molecular electronics. When we started this program about ten years ago, it was clear to us that what has been the foundation for the whole IT industry will end – that is, Moore's Law does expire. We are reaching those limits, probably sometime in the next ten years. We are working very aggressively in that area. I believe we have one of the strongest programs in the world.

In software, we are looking at questions about how Web technologies are going to evolve. The Web has evolved from the basic html or http technologies to XML and higher-level description languages and Web-based services.

The problem we've been focused on in recent years is really something called the Semantic Web, which recognizes that eventually all of these things have to connect. It's really an unaddressed problem. We have a very strong team, one of the leaders in the world, working on that.

In the area of markets, we're considering how the IT industry is going to grow from a geographic perspective. Specifically, we're looking at emerging economies around the world.

Sometimes we describe that program as aimed at HP's next billion customers. We currently serve an available market of a little under a billion customers. But then the potential market opportunity falls off dramatically because of issues around the affordability of technology.

In many of these regions, people's incomes are rising considerably. Meanwhile, the cost of the technology we deliver continues to go down. The combination of those forces means we have many more opportunities around the world.

Our question was, are there non-financial obstacles that will limit the adoption of IT? For example, one issue is language. Once you get beyond the core languages the IT industry addresses, there are many more languages in the world that aren't addressed at all. There's also the problem of infrastructure – or the lack of it – in many developing countries.

In some cases, even ownership models are worth exploring. We tend to think about individual ownership, either on your desk at work or personal ownership. These are models that are not going to work in large parts of the world.

We have a program driven out of our lab in India that is looking at questions like these. In fact, we just announced a keyboard that we developed for phonetically based languages like Arabic and many Indian languages, which are quite difficult to work through a standard keyboard. We've come up with a simple, low-cost way to do data entry into those languages.

**Future data centers**

Now that I've discussed our overall strategy, let me tell you more about our work on next-generation data centers. We're looking at automation and virtualization technologies to reduce the number of people required to support IT. Some of the impetus for this comes from our experience in the telecom industry. That industry is more mature in terms of automation; a very complex system can be run by a few people. More automation also means fewer errors.

Another key element of the next-generation data center is security. More centralized IT potentially creates more vulnerability. How do we manage that? HP is going beyond the traditional security model in which people are creating viruses and worms on one side, and IT companies are constantly trying to catch up, and customers are constantly having to apply updates and patches. Our approach is proactive security, where the security system has more of a biological model. Your body can recognize diseases it's never seen. We've been working on an IT security system that can sense the symptoms of an invasion of a new type of worm or virus and locally contain that, which gives the human operators time to respond.

Another area I want to tell you more about is our work in mobility. One of the problems we're investigating right now is this convergence question – looking at an architecture that allows us to unify and interoperate across the now-separate worlds of mobile telephones, the Internet and videoconferencing.

**Automating, customizing commercial printing**

In commercial printing, what we're doing is no less revolutionary than what we did on the desktop. Today, people think the minimum production run is thousands of copies of a document or booklet or magazine. With our technology, we can make every single page different at no extra cost.

That's in part due to the digital-press technology itself. But a lot of what we've been doing is working with graphic artists and designers, the people who do page layouts and designs, learning the rules they use so we can develop an automated workflow.

Imagine a news magazine you receive at home that is customized to what you're interested in, with maybe a few random things that you might want to get exposed to. There's a lot of turmoil in newspapers, magazines and advertising right now, much of it driven by the Internet. The very same technology that's causing a disruption in those industries could actually create a whole new publishing model.

**Portable, plastic displays**

It's clear to us that the visual impact of paper is still quite unique. We continue to look at alternatives, but as long as we're using paper – and we think that's going to go on indefinitely – then the question is, how do you transform printing with digital technology the same way we've transformed the office? That's what we're setting out to do with the Indigo presses.

At the same time, we're investigating whether we can build an alternative that has the kind of visual impact and portability and robustness of paper. In this area, we've developed a plastic display. The kind of technology it takes to manufacture this is not what you see in today's computer flat panel screens or large-scale TVs, which have precision glass and electronic assemblies.

This display is literally built from pieces of plastic that can be made on something that looks like a printing press. It's a startling technology. We still have a ways to go, but our thinking is that if something is ever going to replace one of our businesses, we'd like it to be done by us.

**Nanoelectronics**

Earlier I mentioned our work in nanotechnology. Electronics have shrunk from their first form, the first computers, by five orders of magnitude. We think there's that kind of room to go, where computers could be as small as grains of sand or dust. We've gotten a lot of recognition for our work in this area from places like MIT and *Scientific American*.

We're also looking at the question of what happens when you shrink to the dimensions where you can see the individual atoms, which is where we are. You're not going to be able to think about developing integrated circuits in the same way you think today. At that scale, computing has to operate like other things in nature, which means it will have to tolerate errors.

We started our work based on the idea that, unlike traditional electronics where the focus is always about being perfect, this has to be more like something like DNA, or other life processes, which has the ability to correct itself. We talk about coding theory as ways to build things that can suffer statistical errors, random errors and still function perfectly. We've demonstrated that.

Another piece of what we do in HP Labs involves our work in open source and our collaborations with universities. One collaboration we've been involved in is a program we refer to as Gelato. In Gelato, we are developing scientific computing applications for Linux on the new Itanium chip, which we co-developed with Intel. HP provided the leadership for it, but Gelato really is operating as an open-source community.

The design objective for that chip was not just to create an industry-standard chip, but to create one that replaces what's done today with proprietary RISC chips. This chip was designed, from the beginning, for high availability and ultra-high performance. We're just at the beginning of that lifecycle, and many universities have signed on to help us drive that forward.

**Collaborating with customers**

One of the things I talked about earlier was how we're working with customers. In the traditional model, HP Labs worked with the product businesses of HP to either sell an idea or to listen to a problem they haf. That idea worked its way through the R&D community and eventually gots to the business managers. Ultimately the technology became something HP sold, often in the form of something delivered through services to our customers.

That model worked for most of the last 40 years. In the last five years, we started looking more at software businesses, where the pace of change is much more rapid than the old serial process can accommodate.

The model we've been using increasingly over the last couple years is working directly with our lead customers. Earlier I talked about trying to understand our customer base, what companies are leading their industries. Who are the people that are really the cutting edge?

Doing this is beneficial for our customers because they get early access to technology. But it's beneficial to us, too, because we get early insight into what that industry is going to be needing going forward. We then frequently develop a 'first-of-a-kind' system. We'll work with the HP Services organization to deliver this unique offering.

If we're right, we'll do it more than once and we'll have repeat business. And if we are really right, then eventually our solution will find its way into a standard product. We've gone down this path a few times in the last few years. Increasingly, we believe that in fast-moving areas, this is a much better way to develop technology.

That's the end of the formal remarks. At this point I'd be happy to take questions about anything.

**QUESTION:** How has the recent change in leadership affected the vision and the strategy of the company in general and the labs?

**MR. LAMPMAN:** In terms of the labs, our strategy has been in place for about six years and actually has not changed. What has changed is that our top two programs – future data centers and commercial printing – have become the core for HP's two big growth initiatives. So we made some good bets on behalf of the company, but that's our job – to try and look ahead.

In terms of CEO Mark Hurd, he's put priority on two things. One of these does not affect HP Labs directly, and that has to do with coverage – meaning, do we have enough people out in the world talking to customers about what we have to sell? The other big priority for Mark is R&D. He understands that R&D is how a company creates new value, creates things that customers care about.

**QUESTION:** HP's top management has been under tremendous pressure in the marketplace to improve the near-term performance. That apparently would translate into the policies and actions of the CEO. I wondered whether you sense a friction or difference of opinion or vision in terms of allocating strategic funds into long-term innovations which may not translate into near-term performance, either top line or bottom line. And then I wonder whether you enjoy a certain level of autonomy so that you could probably manage this huge budget in a spectrum fashion or a portfolio fashion so that it will sustain the company going forward rather than respond to the relatively short manageable horizon of the CEO or top management?

**MR. LAMPMAN:** In the past five years since the bubble economy vanished and the IT industry has been under all this pressure, it would be very natural for the resource balance to shift more toward short-term R&D and away from something like HP Labs. We actually track that, looking at HP Labs as a percentage of overall R&D.

If the company really wanted to shift to a shorter-term focus, our percentage would go down and the rest of R&D would go up. But, in fact, that number has tracked within a tenth of a percentage point over the last six years. There is certainly a natural pressure, but it's one that HP has resisted. Mark (Hurd) certainly continues on that path; he's a very strong supporter.

As for the second component, which is the level of independence, the way research is managed in different companies is quite different. Sometimes research receives negotiated funding from individual business units. At HP Labs, we get one check every year and we're told to spend it wisely. When we allocate funds, we have a tremendous engagement with the company, but we're held responsible for making the decisions about allocation. So we retain quite a bit of independence. Obviously we don't ignore what's going on in the company, but ultimately we're held responsible for the decision.

**QUESTION:** I want to get a sense of how you think about failure in R&D. What is your overall reaction to failure? Is there an acceptable level of failure? And do you quantify that in any sense over the course of the year?

**MR. LAMPMAN:** As Mark Hurd likes to say, our job is to be out in front of the road map. So failure is something we have to deal with. The way we think about it is if you don't fail sometimes, you're not trying very hard. But it's not failure in the sense most people think about. It's not just a question of whether researchers can prove their idea works; it's a question of whether it's important. Most of the time the 'failure' is actually a team redirecting itself.

We do a lot of reviews and it's not a hands-off environment. But the recognition that we're on the wrong course usually comes from the teams. We have a set of people in the Labs worldwide who are very much thinking about both achieving technical success and having impact. And they're much closer to that and see it much earlier than the management. And that's really where the culture of the organization and the strength of the team comes in; it's pretty rare that we actually fly right into the wall.

**QUESTION:** I'd imagine that there's a lot of challenges in taking a one-of-a-kind solution and getting that into the more production-oriented R&D teams. Could you tell us a little bit about the processes and team structures you use to make that successful?

**MR. LAMPMAN:** The truth is, there is no standard process. It's different every time. In some cases, the right thing is for it to stay in services where it tends to be a semi-custom offering. Other times, if we've had a lot of success with it, typically we're also engaging with the potential business host to help create a standard product.

More than process, the key to technology transfer is building the human side of the equation. We work with people from the businesses at every level – the business general manager, the R&D manager, the marketing manager. Occasionally we have projects we want to move along more quickly at the corporate level, so we'll put in some incubation funding and scale up the business. That might occur when there is still a pretty high risk level involved in the work.

The question in any business is, how do you balance top-down initiatives, which allow you to move more quickly, with the more entrepreneurial, bottom-up activity. That's one reason I say these things move in different pathways. Some of the work we've done in digital media got CEO-level recognition, so there was a big infusion of money to jump-start that. Then it migrated into a business much more quickly.

In any real business, along with all of the organizational-chart considerations, there's the individual leadership, trust and confidence you have to build in the organization to make the innovation process work. If we wait until we're asked, or if businesses wait until it's clear that there is a market, it's already too late because somebody else has occupied that position.

The thing that is not written about the innovation process is the importance of the human fabric, and how you create a risk-taking culture – not foolish risk, but measured risks, so you pursue new opportunities as they emerge and not be late.

**QUESTION:** Many times when you ask companies whether they're being innovative enough, they'll reply with the number of patents they filed last year, and certainly HP has an amazing patenting engine. But that doesn't necessarily translate into commercialization. As the director of the labs here, how do you measure whether you're being innovative enough?

**MR. LAMPMAN:** The patent numbers war is something I have mixed feelings about because, at the end of the day, patents are a very weak indicator. Whether you have seminal patents – things that redefine a field – or incremental patents, both count as one patent. We have a strict program for monitoring what kind of patents we're filing out of the labs.

For us, the real measure is impact. We look at transformational things we've done, things that have changed the industry and HP. You can't measure that by putting a dollar value on it. We can't claim credit for a $20 billion business based on something we did back in the 1980s. But most people in that business would say that we wouldn't be in it if we hadn't done that initial work, and if we hadn't followed it up for a couple of decades of continued refinement.

Yet thousands of other people deserve credit as well, which is why we go for the qualitative measure rather than saying every dollar there belongs to us.

We engage enough with the businesses so they can see what we're doing. Sometimes it's obvious because there's good alignment; sometimes they're skeptical. Sometimes we invest in things that are not viewed as strategic by the company. But that's part of our responsibility. Enough of those have become strategic that we get a little bit of room to do that without criticism.

I'll give you the most spectacular example of that. The inkjet technology, which powers a substantial part of HP, was viewed as counter-strategic within HP. We got fairly intense criticism for working on it. At that time, the company was betting on laser technology as the engine for digital printing, personal digital printing and office printing. It turned out that thermal inkjet was a good bet and, in the end, we found people in the businesses who shared that belief and something very nice happened.