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Wacko WYKO

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The WYKO Corporation was founded on Dec. 27, 1982, to design, manufacture, sell, and service metrology instruments for many applications, with the largest market being in the magnetic data-storage industry. In the next few pages I will discuss the formation, growth, and eventual selling of the WYKO Corporation to Veeco in 1997. For me, this was an unbelievable experience that was more fun than I ever dreamed anything could be.

11.1 Technical Innovative Years

WYKO grew out of the research my students and I did at the Optical Sciences Center at the University of Arizona, but it actually began at the Itek Corporation where I worked after getting my PhD in optics at the University of Rochester in 1968. For a few years, my job at Itek was nearly ideal. We had freedom to do whatever we wanted to do, we had plenty of money for equipment, and we had very smart people to work with. Most important, we had marketing people who brought us interesting problems we could work on if we wanted to. One problem they brought us concerned correcting for aberrations in optical systems and correcting for atmospheric turbulence so we could obtain better images of Russian satellites. This led us to develop what is now called adaptive optics (then called active optics). In the process, I developed ideas for what we now call phase-shifting interferometry. For the purpose of this story, interferometry is a good way of getting interferogram data into a computer. It turns out that phase-shifting interferometry had been invented earlier by Carré, but it was several years later that I became aware of Carré's French paper. At the time, we built some adaptive optics systems, but they were very primitive because we did not have the solid state detector arrays, computers, and electronics that later became so important for high-quality adaptive optics systems. Phase-shifting interferometry could not be implemented well with the technology present at the time, and it was essentially useless, so I nearly forgot about it for several years.

11.2 The Product Idea

In 1974, I joined the faculty of the Optical Sciences Center at the University of Arizona and began building a research group. About seven years later, I visited the Union Carbide Y-12 plant in Oak Ridge, Tennessee, where they were making diamond-turned mirrors and parts for the atomic bomb. I saw they were using several interference microscopes to determine the surface finish of the diamond-turned parts. They took Polaroid pictures of the interference fringes, then several people analyzed the interferograms using a ruler and pencil to determine how straight the interference fringes were. I figured there had to be a better way of determining the surface finish.

Figure 11.1 First (almost) phase-shifting interference microscope.

When I returned to Arizona, I contacted two friends at Los Alamos Scientific Labs, Tom Stratton and Walt Reichelt, to see if they would fund the development of a better way of measuring the surface finish of the diamond-turned mirrors they were having made for their laser fusion system. They almost immediately gave me funding. I found a brilliant student, Chris Koliopoulos, to work on the project for his PhD dissertation. By this time, some Reticon detector arrays were available, and the Z80 microprocessor had just come on the market, so after a little fumbling and borrowing some interference microscope parts, we were able to put together a crude phase-shifting interference microscope system. Photos of the first system do not exist, but Figure 11.1 shows a photo of a system similar to that first one. We thought it was fantastic! The only problem was that the measurement results were complete garbage. The system was essentially a random number generator, but we were so excited about it we didn't care. While we knew optics fairly well, we did not know electronics, and we were not good at interfacing the detector to the computer. We took it to one Optical Society of America (OSA) meeting and showed it to a couple hundred people. Only one person realized the results were garbage. I guess what was saving us was that if you measure surface roughness, you get results that look rather random. One company approached us about buying the idea, and we offered to sell it to them

for $10,000. They agreed, but after they studied the system more, they realized our measurements were useless, so they backed out of the deal. They did not realize that, while our implementation was not good, our basic idea was excellent. We were so lucky!

We continued to work on the system at the university, but we were having trouble getting good data for any period of time. Then we had two gifts from heaven. The first gift was actually our first of many gifts from IBM. The upper management at IBM felt there must be some technology at the University of Arizona that would be of use to them, so they sent a wonderful engineer, Bharat Bhushan, to the Optical Sciences Center to see if we had any technology to help his work. Bharat was involved in measuring the surface roughness of magnetic tape and asked me if we could measure the tape for him. I told him we could and described the phase-shifting interference microscope system we had. I forgot to mention that the measurement results were generally useless and looked more like random numbers than surface roughness.

He gave us some tape samples to measure, and we measured them for him. Fortunately, the surface roughness of magnetic tape was pretty random, and by some miracle our measurements correlated somewhat with some other measurements he had done, so he became very excited about our system and nearly worked us to death doing measurements for him. He once gave me some samples at 10:00 PM Sunday and said he needed the results Monday morning. He got them.

He then decided he wanted to buy a system. We told him we did not want to build another system at the university, but we had started a company called WYKO (WY from my name and KO from Chris Koliopoulos' last name) and that we would sell him a system for $100,000, but we needed $60,000 up front to buy the parts. He said OK. (Note that we should have worried about the university owning the IP and gotten permission from the university to sell the system through our company, but in 1982 we didn't worry about such things.)

The second gift from heaven was a letter from a recent PhD graduate from Sheffield University in England, Keith Prettyjohns, who wanted a post-doc position. The great thing was that he knew electronics and had done some work interfacing Reticon solid-state detector arrays to computers. I quickly gave him a post-doc position, and we had someone who could help us make a phase-shifting interference microscope system that would actually work. It turned out that Keith was fantastic.

11.3 Founding WYKO

In December 1982, we received a $60,000 check from IBM, the down payment for our first sale. I rushed off to the bank to cash the check when I learned we had a problem. I had told Bharat that we had formed a company, WYKO Optical, Inc., but we had never actually formed the company. The check was made out to WYKO Optical, Inc., and we could not cash the check.

We formally started WYKO on Dec. 27, 1982, so we could cash the check. The founders were Chris Koliopoulos, who by then had completed his PhD and was an assistant professor at the Optical Sciences Center, Keith Prettyjohns, my post-doc, Steve Lange, an optical researcher who worked on my projects at the university, and me. The original goal was that Steve would leave the university, run WYKO, and make us all rich, and the rest of us would stay at the university.

We rented a small office off campus, and our WYKO goals were to have fun and make money. Unfortunately, neither was happening. We were not having fun, and money was not flowing in through the door. The problem was that we could not make the IBM system work. We were able to make simpler systems for other customers, so we had some income, but the system using the two-dimensional detector array that we sold to IBM would not work well enough for us to deliver it to IBM.

Every month, I would send a letter to the IBM purchasing person telling him that we were unable to ship that month, but we would ship the next month. The next month, I would change the date on the letter and send it again. IBM was extremely nice; they gave us more time and did not ask us to return the deposit.

Finally, in September 1984, I knew that things had to change. WYKO could not continue this way. We made several changes, one of which was that I stopped doing research and went to 20% time at the university, going to WYKO full time, or at least 80 hours per week. I thought this change would be for two to five years, but it continued for 13 years. John Hayes, who had just finished his PhD working for me, also joined WYKO at that time, and he was excellent at designing real products.

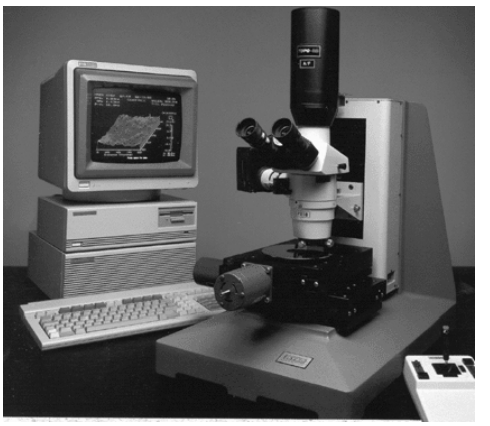

Figure 11.2 TOPO-3D phase-shifting interference microscope.

11.4 Growth Time

WYKO changed rapidly. We were able to deliver the system to IBM and develop an extremely successful phase-shifting-interference microscope, TOPO-3D, shown in Figure 11.2. I found that by putting my full effort into WYKO I was

able to get others to put their full effort in as well. People will work extremely hard for you as long as you work as hard as you ask them to work.

By then we had moved to a larger second location. We shared this second location with a dentist and a podiatrist. Since our name was WYKO Optical, Inc., we had a lot of people stopping in to buy eyeglasses. We decided to change the name of the company to WYKO Corporation.

Sales and profits were excellent, so we developed more products and moved to our third location shown in Figure 11.3, a photo taken by a visitor from Kodak. I thought the rainbow in the photo was fantastic, and I felt we had found the pot of gold at the end of the rainbow. This location was across the street from the university, so I could easily walk to the university to teach a class, and students could easily work for us. University students make great employees. They are smart and they work hard, and they do not demand high wages. It gives you a great opportunity to learn more about the students, and you can easily hire the best after they graduate.

Figure 11.3 The third WYKO location.

During this time we had a big surprise. We started selling a phase-shifting Fizeau interferometer for the testing of optical components and optical systems, and one day, without any warning, we received a letter telling us we were being sued for patent infringement. There was no advance warning that if we did not stop selling we would be sued, but we were simply sued for infringing three patents.

Rather quickly, two of the three patents were removed from the lawsuit, but the suit over the third patent lasted for 10 years. We had been careless. We had known about the patent under question long before we introduced our product. While we thought interferometry experts were well aware of everything in the

patent long before the patent application was filed, we discussed the patent with an expert patent attorney before we introduced our product. He told us what we had to do to avoid problems with the patent, and we followed the attorney's advice, but the smart thing would have been to construct things completely different from the patent, which we could easily have done.

While the patent lawsuit was a terrible experience at the time, in hindsight it helped us, and me especially. It made me realize that a patent does not have to be a Nobel Prize-winning idea. Patents about rather ordinary things can be very important. We began filing our own patents, and by the time we got ready to sell the company, we had some 45 patents that made the company much more valuable. Also, because of the patent lawsuit, I stayed at the company for several more years than I had initially planned to. During this time, I had a lot of fun and the value of the company increased tremendously.

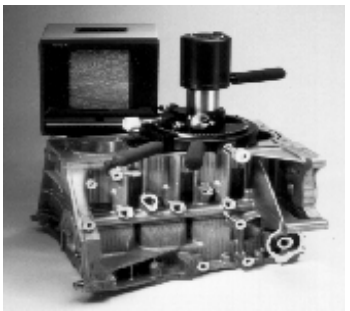

Figure 11.4 Phase-shifting interference microscope for measuring the inside of an engine bore.

Figure 11.5 Solder bump measurement system.

As the business grew well, we purchased a 110,000 sq. ft. building that had previously been occupied by IBM. We also hired several previous IBM employees, including Esther Davenport, who had an MBA from Northwestern University and added much business expertise. We added a former IBM executive, Carmon Rosato, to our board of directors, and he gave us a lot of valuable advice. We won several awards such as the SPIE Technology Achievement Award, R&D 100 Award, and several Photonics Spectra Awards.

While measuring magnetic media remained our largest market, we added instruments for the automotive and semiconductor industries. (See Figures 11.4 and 11.5). An enjoyable product, but a small financial disaster, was the foot scanner shown in Figure 11.6. The idea was to replace the plaster casts podiatrists use to measure the shape of your feet for making orthotics. Our foot scanner used a phase-shifting technique to rapidly measure a patient's foot, and then this data could be sent over a phone line (the Internet was not yet popular) to a lab that could mill an orthotic. Technically, our foot scanner was fantastic, but we wanted to sell the product for $12,000, and the podiatrists wanted to pay $2500 for it. Thus, we did not sell many of the systems. It was a really fun project and well worth the $1 million or so that we lost on the project. (I might

add that I still have a couple of the foot scanners in my garage, and if any reader is interested in purchasing one, I can give you a real deal.)

11.5 Cashing out

Figure 11.6 Foot scanner.

By the time 1996 came along, I was 53 and knew it was time to sell WYKO. While I was still having fun, I wanted to go back to the university full time before I became too old—and I was tired. I had been working essentially seven days a week since 1984, and I needed a rest. We talked with four companies about buying WYKO, and we finally decided to sell to Veeco. Essentially, every manufacturer of hard-disk drives in the world was using our equipment for evaluating hard disks and recording heads and using Veeco's process equipment for manufacturing the disks and heads, so it seemed like a good match. We worked out a deal where we would trade WYKO stock for Veeco stock in a tax-free swap.

The $60,000 IBM gave us as the down payment on the first system sold was used to fund the WYKO start-up, and we never had to go to outside investors. Thus, we owned the company, and we did not have to split the profits with investors. We were so lucky!

In July 1997, we completed the deal, and I went back to the university. After sleeping and playing with Mathematica for a few months, I once again became a full-time professor and on Jan. 1, 1999, director of the Optical Sciences Center. In July 2005, the Optical Sciences Center became the College of Optical Sciences, and I became its first dean. Once again, I was lucky, and my timing was nearly perfect.

11.6 Biggest Surprises

Involvement with WYKO's start-up and management taught me a lot. My four biggest surprises were:

1. **The difference between research project and product.**
   At the university, we try to get an instrument working well enough that we can take a few measurements and write a paper. If you are selling a product, you must have one that you can ship halfway around the world and take out of a box. An unskilled operator must be able to easily operate it, and the instrument must continue to work well for a long time. This is very difficult. WYKO has caused me to have much less respect for many of the papers I read.

2. **The difference between the cost of parts for a product and the cost to design, sell, produce, and service the product.**
   Sometimes I hear a person say the parts cost only $20,000, therefore selling the product for $35,000 will result in a lot of money. The company would, of course, go bankrupt with such a small markup. I feel the selling price must be high enough that if later the customer has complaints about the instrument, we do not resent fixing the problem.

3. **The amount of money required to run the company.**
   A product has to be conceived and developed. Prototypes have to be made, and a final product has to be constructed and evaluated. The instrument has to be marketed and sold. A product has to be delivered to a customer, and then the manufacturer does not get paid for at least another 30 days. A lot of money has to be spent before any revenue is realized.

4. **The number of personnel problems.**
   While WYKO's turnover rate was much lower than industry norms, and we certainly hired wonderful employees, the personnel problems seem to grow faster than the number of employees. Hiring mistakes are inevitable, and the best policy is to correct hiring mistakes as soon as they are recognized. When personnel problems upraise, they should be solved before they become worse.

11.7 Most Important Factors

The most important factors are to:

- Have a product that people want to buy. When you are thinking about introducing a new product, first ask, "Does it work?" If the answer is yes, then ask, "Does anyone care?"
- Be willing to do whatever it takes to get a job done.
- Be good at hiring people. This is extremely important because it is always the employees that make the company succeed.

I think it is essential that a company leader must have absolute dedication to the company. Timing is extremely important and probably the most important item is good luck.

Starting and growing a company is not for everyone, but for the right people it can be an extremely rewarding experience and I strongly recommend it.