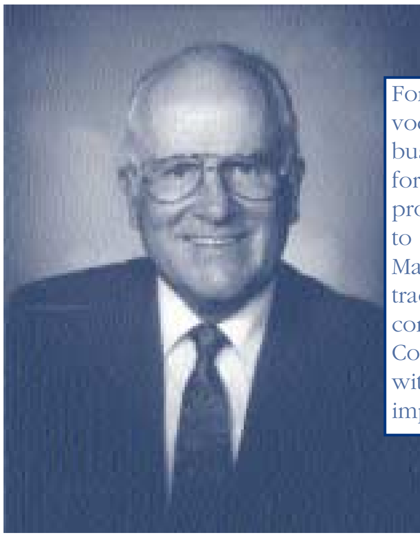
Contemporary Controls Interviews Tom Bullock



For years Tom Bullock has been one of the most vocal and visible figures in the motion control business. Mr. Bullock worked at Giddings & Lewis for 28 years, where he drove many important product development initiatives, and left in 1990 to form his present consulting firm, BullsEye Marketing. He has been featured in virtually every trade magazine in the automation business, and continues to shape the direction of our industry. Contributing Editor Perry Sink Marshall caught up with Tom recently and got his perspective on important issues, past and present.

When did you first realize that you wanted to have a career in the tech world?

I was in high school. I was very good at math and sciences and less than stellar at English, history, etc. I also liked the idea of being an engineer. I am one of 12 children. My dad delivered mail, so financing a college education wasn't in the cards. I enlisted in the Air Force in 1950 just after the Korean War broke out. That four-year enlistment entitled me to the GI Bill. The Air Force put me through an electronics course so I could be a technician repairing gun sights and radars on F-84 and F-86 jet fighters.

I was sent to Germany in 1951 as part of the occupation forces. It was a six-day trip on a troop carrier! I also spent a year in France and was returned home after 38 months (again on a troop carrier) only to find out that I had a far advanced case of tuberculosis with only a few months to live. Fortunately, a new drug, PAS, was being tried and it worked on me. After a 14-month hospital and sanitarium stint, I was off to the University of Wisconsin to pursue my dream of being an engineer.

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Having an advanced case of tuberculosis with only a few months to live—Can you tell a little bit of this story? How did it affect you? How has it shaped your life and your outlook since then?

I was mustering out of the service in July of 1954 when they did a routine physical and X-ray. The X-ray showed two, 1-inch diameter holes in my right lung. They put me in a TB ward with about 25 others and gave me a leaflet to read that said a high number (I think it was 50% or so) do not survive from an advanced case. And I was the only one on the ward who was hacking up blood!

They didn't actually tell me that I had only two months, but I found out later that this is what the doctor who admitted me thought. They gave me a new drug, PAS, and the attending physician, after a month or two, called my progress a miracle. Perhaps it was, as I had returned to my Catholic faith after falling away for several years. I vowed that if I survived this, I would never fall away again and I haven't. My weight increased from 135 to over 160 within six months. After 14 months, mostly at the veteran's hospital in Tupper Lake, NY (near Lake Placid), they released me a bit early so I could attend the University of Wisconsin in September of 1955.

One advantage is that my GI Bill payment was $175 whereas all the other GI's were getting $110 per month. It was because they didn't want me taking a part-time job to make ends meet. The drug treatment contained the disease in a calcium shell much like a bird's egg. The two shells were surgically removed in 1958.

You should also know that I left home at 10 years of age due to my mother's death and a family too large for my dad to handle. I spent most of the next five years on a farm working before and after school and on weekends. This plus the near-death experience has made me thankful for what I have and the long life that I am enjoying.

You know, there is one big advantage to having grown up poor and that is, that you can't believe that every year you seem to have more than you have ever had. I've often thought that being born rich often means that things don't get that much better. Maybe that is why rich people often get into drugs. The station in life to which one is born has less to do with one's happiness than one's attitude, experiences and perseverance.

What is it that caused you to gravitate towards motion control? What was fascinating about it?

After college in 1959, I was offered a job with RCA at their Missile and Surface Radar facility in Moorestown, NJ. They were in the late stages of developing BMEWS (the Ballistic Missile Early Warning System). They assigned me to the servo group to join several dozen servo engineers. BMEWS was a huge radar inside a large white bubble. The first time I stood inside the bubble and looked up to see this massive parabolic antenna scanning the sky, I almost became disoriented and almost lost my balance. I remember thinking that learning to control something this massive with pinpoint accuracy was a major challenge and one that I wanted to pursue.

RCA had a graduate study program that I qualified for. They gave me two days off each week for four semesters which allowed me to get my masters degree in controls and servos.

What do you think are the most important major industry technical developments that have happened in the last 40 years?

I assume you mean the controls industry and that would be since 1964. Before 1964, the vacuum tube was the active element of choice, so we have come a long way since then. Relays and stepper switches from the telephone industry were also in high usage. I was working for Giddings & Lewis (G&L) in 1964 designing solid state circuits to replace all the above. The application was machine tool controls. Solid state seemed like a big step at the time.

In the early 70s, we built a control using a CRT as the display. We were ridiculed for thinking that a TV could survive on a factory floor. In the late 70s, we designed a PLC with motion control using computer chips (I believe it was the Motorola 6800 family). The motion algorithms were in software, and there were subroutines for doing most other tasks. *PLC User* magazine had a panel evaluate several brands of PLC including ours. The panel concluded that computers had no place on the factory floor!

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In the 80s, the personal computer found its way into controls and opened up a whole new world of software. By the 90s, the personal computer industry was 100 times larger than the numerical control industry. Numerical control was able to ride on the coattails of the PC industry. There were graphics packages, statistical software, communications devices, mathematical algorithms, and a host of other software that was available for pennies on the dollar compared to the cost if the numerical control industry had to develop it.

In the 90s, we saw the PC open doors to allow information exchange and control up and down the corporate hierarchy as well as sideways. It also extended outside the company to vendors, customers and service providers. And now, in the last five years, the Internet is blossoming as the major technical development.

Not only is information immediately available, but embedded web servers allow controls to be accessed from any place that has Internet connectivity. With laptop computers and satellite connection, access will soon be from anywhere.

So you ask which was the most important? In their time, they were all important. But, since we tend to have short memories and since technology grows exponentially, we would have to conclude that the most recent is the most important. The Internet is changing the way controls are operated, updated, serviced, advertised, designed, sold and whatever other action verb I have left out.

What do you think about the massive shift to off-shore manufacturing?

That doesn't worry me as much as staying on the forefront of technology. I'll get into that in a minute. Commodities are basically sold on price. And much manufacturing is becoming a commodity, unlike how it was 50 years ago. Therefore it seeks the lowest cost producer. We have been quite effective in automating manufacturing here in the USA so that, despite a large wage difference, it is still more economical to produce it here. Some manufacturing is still labor intensive and can be accomplished more effectively offshore.

The key is to encourage companies to automate, but help train displaced workers for future jobs. Wouldn't it be great if the tens of millions of people around the world who are idle and starving could be gainfully employed? They would earn wages and buy products so that everyone could enjoy a better standard of living. You may see this as a pipe dream, but how can there be any hope at all of this if we don't head in that direction with freer trade and a world trade organization?

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Now back to my initial point. The key to the USA being a world leader is technology. A large number of the significant developments of the last 100 years have come from the USA. We need to ensure that it stays that way. Health care is the fastest growing major segment of our economy. This tells me that we should stay on the forefront with stem cell research, gene splicing, pharmaceuticals, etc. Yet, we are driving much of this research to foreign countries for political reasons. I want to see America remain strong for future generations and my own grandchildren. If we accept offshore manufacturing and concentrate on technology, we will continue our world leadership.

What is your opinion about the massive outsourcing of tech jobs and knowledge workers, i.e. programmers, to countries like India?

The tech and knowledge worker jobs that are going to other countries are not the most creative ones. If we view all jobs as a hierarchy with pure commodity type jobs at the bottom and totally creative and high knowledge jobs at the top, we find that it continually grows upward with time because new tools (like computers) make it possible for those at the top to expand their horizons.

The success of this country can be attributed to our ability to concentrate on the peak of this hierarchy. The jobs at the bottom of the hierarchy are the easiest to outsource. As the hierarchy grows, more and more jobs in the lower part of the hierarchy begin to approach commodity status and become open for outsourcing.

I cringe when I hear politicians say that we need to grow manufacturing jobs; a statistic that has been declining as a percent of the workforce for 50 years. It is a changing world and spending vast sums to buck long-term trends will not keep this country great.

It is possible that within 50 years, we will be outsourcing highly professional people such as doctors. With scanning techniques and global communication, why can't a doctor in India observe and diagnose some illness that I may have?

What worries me is that politics will force us to invest our resources in the bottom half of the hierarchy instead of the top half. I cringe when I hear politicians say that we need to grow manufacturing jobs; a statistic that has been declining as a percent of the workforce for 50 years. It is a changing world and spending vast sums to buck long-term trends will not keep this country great.

What's the difference between college grads of today and the ones you graduated with years ago?

They don't have a slide rule hanging from their belt. Engineers today are much more systems-oriented as opposed to components-oriented. They see the bigger picture much better. In the 60s, it was a major effort to automate a single machine. There were counters, flip-flops, I/O, displays (like 7-line), servos, etc., that all had to be understood and designed. It was a major accomplishment just to get a machine running from punched paper tape or through manual input.

As large scale integration developed, the detailed designs were no longer necessary and the engineers could focus more on tying the factory together. Now machine automation is seen as a commodity. The engineers of today are using computers and connectivity techniques to automate all aspects of a business. They work at a computer terminal instead of in the lab with a soldering iron and a box of components. Is this good? Of course, because we are working on the front edge of technology with the latest tools. That is productivity!

On one hand, vendors in the industrial controls business are fighting commoditization of all their technology—PLCs, motion controllers, HMIs, sensors, etc. etc., so vendors must constantly innovate. But on the other hand, customers resist new technology because it's risky. Where's all this heading?

What a great question! In the product adoption cycle, customers are classified as innovators, early adopters, and late adopters. There are companies who, because of their culture, are innovators and willing to take the risks to be on the forefront of technology with the latest products. The non-innovators view them as the guinea pigs. The rewards can be great, but so can the penalties of failure.

Innovators are selective with their vendors. Does the vendor have a track record for producing successful new products? During the early days of numerical control, the aircraft industry recognized the large savings possible in both productivity and lower scrap, so they took the risk. Giddings & Lewis had a reputation for innovation, so it was not difficult to get customers to risk trying new products. Microsoft enjoys that type of reputation today.

The concept of open controls is a good illustration of risks. It was 10 years ago when we started talking about the concept of open controls. Open control would allow each vendor to do what he does best. One might envision a vendor for his I/O, another for HMI, a third for drives, a fourth for the main controller, several for software, etc. The key would be that these would all 'plug and play.'

The OMAC (Open Modular Architecture Control) organization was formed consisting of some of America's largest companies. Yet, the adoption of open control is progressing at a snail's pace. In discussing this with executives from large companies, they cite the high risk involved. Many have a single preferred vendor with hundreds of employees who are trained and working with that vendor. They are afraid of the finger pointing should a problem occur.

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I am still betting on open controls and the Internet. As the Internet makes it possible to work on controls in customer sites from vendor locations, open controls become more feasible. The office environment has gone from one where you selected a single vendor (IBM, DEC, or Wang) 25 years ago to one where there is a different vendor for each component. But, each office either has his computer guru to solve the interface problems or they have a local expert on call. This will happen in the plant environment with system integrators serving the role of the guru, and the integrators will use the Internet to get the answers they do not already have.

All the components you mentioned will continue to migrate to commodities. The challenge for the engineers will be to continue to integrate the enterprise and to include vendors, customers and services in that integration. This is where the challenges are and this is where the smart guys will gravitate.

Tell me your Giddings & Lewis (G&L) story. How did it start and end and what happened in the middle? How did G&L shape the industry and what commonplace things were G&L innovations?

I had 28 years with G&L from 1962 to 1990. We decided to come back to Wisconsin from my tenure at RCA in New Jersey, so I answered an ad in aW isconsin paper that my father-in-law had been monitoring for me. I was hired as an electrical engineer in the R&D department. They wanted someone to design solid state circuitry.

As you may know, numerical control was invented by John Parsons in the 1940s. His firm made helicopter blades which he figured out how to define using an IBM mainframe computer. The result was a stack of IBM cards. He thought it would be great to take those cards and feed them into a device that would mill the part. After a few false starts, he gave the project to MIT and a successful demonstration was given in 1948. A first, commercially available product was finally made in 1955 by Concord Controls, a company that G&L owned. It was full of vacuum tubes and was so unreliable that they used it to generate magnetic tapes that were then 'played' on the actual machine to cut the part.

When I came to G&L in 1962, they were worrying about the unreliability of the tubes, relays, and steppers. Another engineer and I started designing transistorized machine control components.

In 1965, I was part of a three-man team that built a contouring control around a seven-decade adder/subtractor/multiplier/divider/square-rooter. It was programmed with diodes on matrix boards. One might argue that this was the first Computer Numerical Control (CNC), but one might also argue that our math unit with diode matrices does not qualify as a computer.

In 1973, the responsibility for Electrical R&D was put in my hands as we were embarking on the design of a software controller with an in-house designed CPU programmed in assembly language. We called it the CNC800. Later in the 70s, we designed a computer-based PLC with built-in motion control. It was called a PiC for Programmable Industrial Computer.

In 1980, I was made a vice president and given the sales and marketing responsibility for the PiC and outside sales of CNCs. In 1987, the full profit and loss responsibility for the PiC product and group was placed on my shoulders. I retired 3 1/2 years later. I would not have taken early retirement if my boss, Bill Fife, the president of G&L, and I got along better.

The G&L engineering department maintained its cutting edge leadership throughout the 80s with its innovations in the flexible manufacturing systems (FMS) arena. They designed a system using an IBM host computer directing the activities of a multi-machine line and utilizing a material handling system to transport parts throughout the system.

What was your first big career failure and how did it influence future decisions?

My first major technical failure was in trying to design a DC servo drive. It was the late 60s and G&L was spending a lot of money buying servo drives. I agreed to take on the task as I had several patents under my belt and was feeling my oats a bit. Most drives used SCRs at the time, but I decided to be innovative and see if a Triac design would be better.

After several months of breadboarding and testing, I couldn't get any decent performance out of the motor, and I really didn't know why. I remember making few changes to the design and then throwing the main circuit breaker to restore power. If you have ever seen one of those waterfall fireworks on the Fourth of July, you'll know exactly what I experienced. By the time I got the power disconnected, my circuitry was fused together and dripping hot metal on the floor. I marched straight into the engineering manager's office and announced my retirement from the DC drive design business.

This experience had a profound effect on many future decisions. You see, I had no mentor and no one to consult with since no one at G&L had any experience with drive designs. When I later got into management, I was careful about going too far afield in the R&D that we undertook and the applications that we did. I remember one time we had a chance to design a special machine involving imagery for the medical profession. We decided to pass despite the challenge that the R&D engineers saw. Whenever I think back on that, I am thankful that we didn't dilute our focus. We knew little about imagery and even less about the FDA and the myriad of codes, rules and regulations. Experience is a great teacher!

What do you think is the 'next big thing' in motion control?

I think embedded web servers will be big, but there is something I have been hoping for, but no one seems to be doing much about. Let's call it MAAM for Machine Axis Analysis Module. Most drives have embedded computers in them, position feedback, and current (torque) feedback. It seems that these tools can be used to make drives a lot smarter in helping to keep the machine running properly.

For instance, there are three elements to the total torque that a motor provides an axis. They are the torque for acceleration, the torque to overcome friction, and the torque to do whatever work that machine axis must perform (such as pushing a drill through a metal block). By using learning techniques, and mapping the axis for irregularities, the drive should be able to tell how much of each is being expended at any time.

If I have a constant horsepower application, the drive can take that component of torque, multiply it by the speed and tell me how much horsepower I am delivering to the load at any time, so I can adjust feeds to keep it constant. Also, with time, it can show me how my friction component has changed so I can foresee a bearing starting to deteriorate or an axis starting to bind at a particular point. There has been some work done on modeling a machine so that it can be run as productively and accurately as possible. The drive can be the caretaker of this model and even modify it as it sees things change. Self-tuning uses some of this information, but it is only scratching the possibilities. My partner, George Younkin, has done some good work on modeling, and his results show a lot of promise. If there is some drive company looking for a way to spend its R&D budget, give this some consideration.

We all know that history repeats itself... so based on your 40 years of experience, what cautions would you offer to a 20- or 30-something engineer?

How about 45 years since I graduated in 1959? If you want to be successful, my advice would be to make yourself valuable to the organization. This is done by keeping up-to-date and accepting challenges. By making yourself valuable, even if you were to be fired for reasons beyond your control, there will be many other opportunities. This may be trite, but you should still ask yourself if your last 5 years have been 5 years of experience or one year of experience five times.

My caution would be to ensure that you enjoy what you are doing. It is much easier to change direction early in life than late.

If you could change something about our industry, what would it be?

I would hope that we could react faster to technology (as with open controls), but in general not much. We are taught in school to be critical, but isn't it equally important to find the good in what is there?

We have a good industry. We deal a lot with engineers who tend to be pretty honest and forthright. It is not uncommon to see engineers spending 50- or 60-hour weeks because they like what they are doing. We do a good job staying on top of technology and maintaining world leadership in this area. As the old adage goes, 'if it ain't broke, don't fix it.'

If you had asked me what I would change in this world, it would be to stop educating people to hate. For instance, 15 of the 19 9/11 hijackers were from Saudi Arabia, and we have now found out that they were taught hate in school. The textbooks (which have been changed in the last year or so) taught children to hate infidels. And their religion taught them that killing infidels would get them to heaven. And the decadent USA with its tolerance of nudity, sex, etc., was the worst of the infidels.

Peddling hate in this country is big business, especially for the political parties. For example, what Republican will donate to the party if they are not convinced that liberal Democrats would free all known killers if any of their rights had been violated? I have no idea what to do about hate, but it is certainly something I would change if I could.

Tom, thanks for your insight. Readers can visit Tom's company website at **www.bullseyenet.com**.