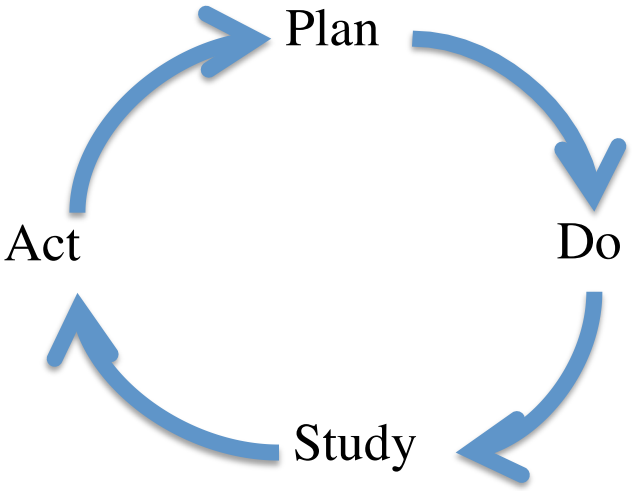
Wobbly Light: Improving quality improvement

While at the University of Oregon my colleagues and I were engaged in several research studies concerning the social [1] and economic [2] effects of employing people with developmental disabilities. Our economic research method included studies of individual and collective productivity and wage earnings. When we paired this research with our social network studies we were studying social capital as it related to the reversal of Oregon's eugenic practices. Each day we would collect data, study productivity trends and plan the next day's training and support activities. We realized that this approach was in line with continuous quality improvement [3]. I became a member of the local Association for Quality Improvement and met Lou, a Manufacturing Director for Wobbly Light. I shared recent research we had done of social support networks and my development of social action research, which I referred to then as action science. Lou invited me to his company to present to his manufacturing team. At that meeting, I invited them to invite me to engage in a social action research study. This is a case study of a company I'll call Wobbly Light.

I met Paula at 5:45am. She was a team member on the manufacturing line and the lines safety lead. She fitted me with a blue antistatic uniform and bracelet and made a short presentation on safety. We joined the team at 6am for 15 minutes of stretching exercises. In my first half hour, I was already feeling the care for the safety and wellbeing of others extended to me by the team. After calisthenics, the team's quality lead, Sheri, took me for a tour of the line. The built hand held bar code readers – they kind of devices used by retail stores to scan bar codes on the products we buy. The line consisted of stations for each step of the assembly process. At each step, Sheri would introduce me to the assemblers and they would briefly describe their task to me. As we walked down the line I watched the hand held scanner coming together. Everything was very smooth and efficient until we reached one of the last stations in the line. There, Phuy was gluing a laser motor onto an shaft and then putting the sub-assembly in am oven to cure the adhesive. Phuy and Sheri were engaged in an animated conversation. It was a polite conversation and intensely focused on the sub-assemblies that had been "baked" by the oven. Afterwards, Sheri told me that many of the assemblies failed a simple test after baking. When put in a fixture and pointed at a white card with lines on it, the laser light "wobbled" or jumped all over the lines on the card instead of resting between them like it should have. This was not the first time the sub-assemblies failed. In fact, it had been happening so often lately that the assemblers were getting used to working late and on weekends just to make enough products to meet customer orders.

I asked Sheri if we might fix the problem. *"Not until we file a production change order that is approved by Lou,* (the Manufacturing Director)." Off we went to see Lou to file our change order. *"That's engineering's job. But, why not? As long as you don't take any time away from the manufacturing team I'll sign it."*

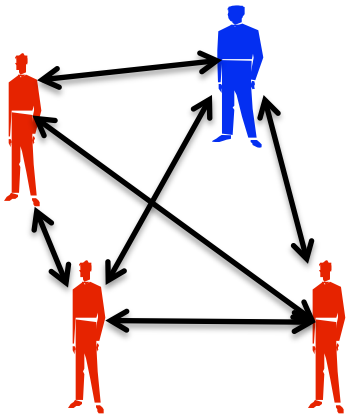
Dr WE Deming was a statistician and innovator in quality processes. He created the famous **Plan->Do->Study->Act** [4] that he envisioned as a continuous cycle. The notion



behind the cycle was that a team would create a plan to improve manufacturing, implement the plan, study the results and then take action on the data they collected. If there were still defects the team would return to the planning phase of the cycle, if not, they would collect data periodically to see of the process of manufacturing was still yielding the desired results. I had taken an interest in Deming's work and thought that continuous quality improvement start in the study phase of the cycle. This brings the culture to us, the network of conversations aimed at continuously improving quality. And, if we begin by asking about significant accomplishments we begin with positive conversations.

Deming was a systems thinker. He saw organizations a system, or, *"network of interdependent components that work together to try to accomplish the aim of the system. A system must have an aim. The aim is a value judgment."* [5]. A few years before Paula gave me her safety training at Wobbly, my colleagues and I had been studying social networks. Because we were interested in understanding social care for people considered to be with developmental disabilities, we had been mapping social support networks [1, 6]. Learning about laser motor wobble, I was interested in using social network mapping to study the *study* phase of Deming's continuous quality improvement cycle.

I began my asking Sheri if she could tell me who was studying laser motor wobble on the manufacturing line. *"I'm not sure. But, I know that no one here on the line is. Check with our Tech."* Wobbly had several manufacturing lines, each one dedicated to a different product. Each line was assigned a Technician who sat with product engineers and was "on call" to support quality leads like Sheri. Walking into the administration in my blue antistatic jump suit, it felt like I was being watched. I gave the technician the same social network mapping form I had used in our studies of social support networks. It simply asked, *"With whom do you study laser motor wobble?"*. Under the question was space for answering by writing down the name and role of each person that came to mind. Once complete, I would send a form to everyone who was listed. I'd do this until there were no new names listed. Here is the social network map for those studying laser motor wobble in October 1994.

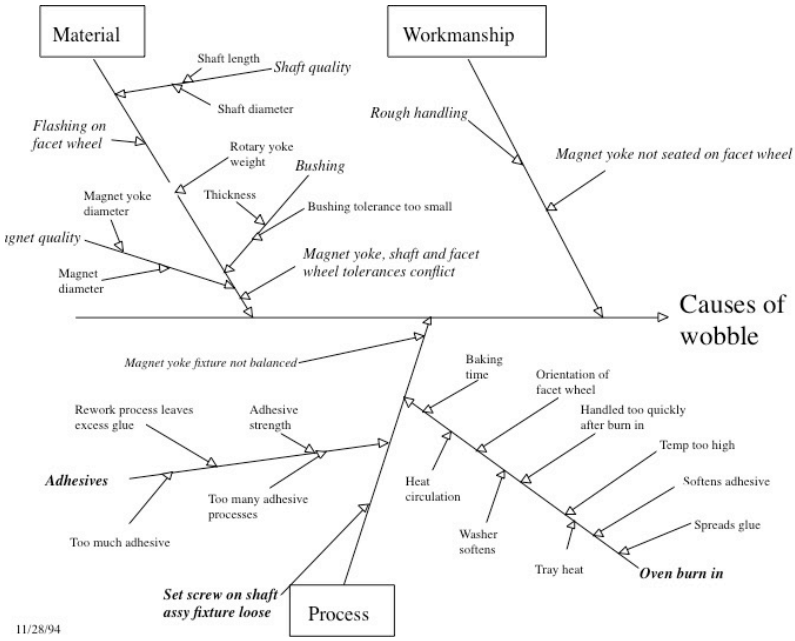


The social network of those studying wobble was really interesting. The color code represented different roles. The technician is blue and he was connected to three engineers shaded in red. The network was collaborative with everyone listing everyone else as those studying laser motor wobble. Collaboration is shown in the two-way lines showing reciprocity. Social cohesion can be measured by *incoming centrality* or how many arrows point to each person. In this case, everyone had the same centrality

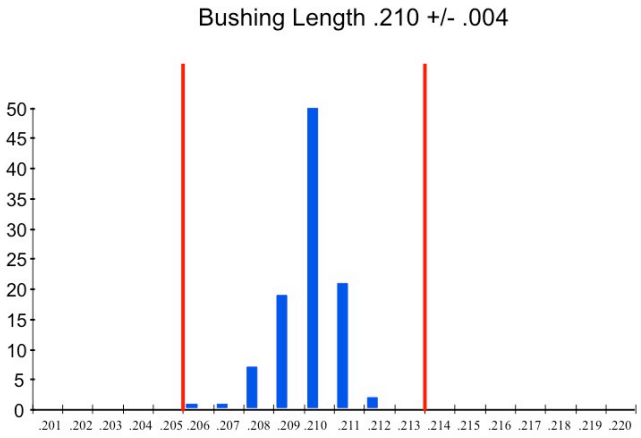
measure- 3. For me, perhaps the most interesting feature of the network map was what it didn't show. Sheri, Paula, Phuy were not included, nor, were any of there manufacturing associates.

I was using social network mapping as a new quality improvement tool to *study* quality improvement. But, how should we *act* on this data? Sometimes I admit to feeling mischievous. I showed the social network map to Sheri. "*Hey Sheri, why don't we study laser wobble?"* There was a glint in her eyes, *"Ok, but we have to go back to Lou."* So we did. We showed him the data, but this time Lou wasn't so quick to respond. "*This involves engineering so I'm going to have to take the change order to our staff meeting. No promises."* Without giving us any details, Lou came back a few days later with the OK. We could go ahead and study laser motor wobble. But, before we did Lou told us that we had to measure exactly how much time the we spent studying wobble and calculate the labor costs due to the time spent studying and not assembling product.

The assembly team and I met and decided to brainstorm wobble solutions during the last 10 minutes of each of our afternoon breaks. We also decided to use a wall behind the wobble testing station to post data we would collect during our studies. Sheri and I knew some of the basic quality tools and processes and decided to draw a chart where we asked the team to list all of the possible problems that could result in wobble. We posted the fishbone chart in the break room.



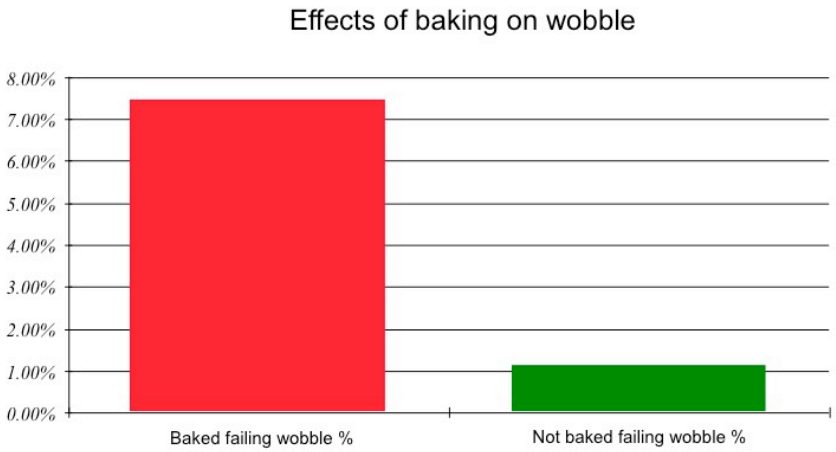
This was our map to solving wobble, and it eventually became our "flag" of pride. Word was spreading through Wobbly Light that we were taking on a chronic quality problem. Perhaps there was a friendly bet at the staff meeting Lou attended between he and engineering. If there was, we didn't care. We used our first afternoon break to create the fishbone chart. During the second break, we consulted the chart and choose our first study. "*Maybe it's the length of the motor bushings? Dennis, can you go into the warehouse to measure the length of the bushings we have in stock?"* This was a good idea for the only reason that by now we knew I shouldn't assemble a thing! In the warehouse, I found the bushings, but before I could unpack them out on a table, a warehouse worker stopped me, *"Not until engineering says you can"* Soon, a senior engineer came back with the warehouse supervisor. As if he was surprised that we were really going to do this he asked me about my intentions. When I told him, he loaned me a pair of calipers to measure bushing length.



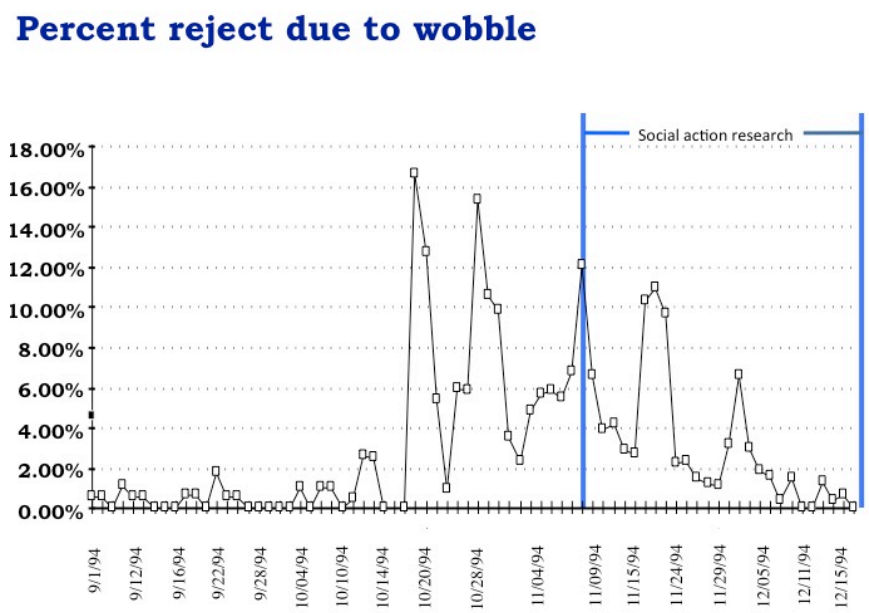
I used a histogram to study the bushing length. The specification required the length be .210 with a tolerance of .004. The bushing length data fell between the two red lines (.206 and .214) meeting specification.

We looked at the histogram during our afternoon break and went back to our fishbone analysis. We were fishing for a cause. Quiet Phuy spoke up. *"I think it's the oven."* Our next study would be on the oven baking process. This time we were going to change the process significantly. We wanted to process a hundred motors or so and bake half of them in the oven while letting the other half to cure at room temperature. Back we went to Lou and back Lou went to the staff meeting. Permission came back soon enough and we ran Phuy's study. He was onto something. The motors that went through the oven had a higher failure rate than those that cured at room temperature.

Phuy had hit the home run. He probably suspected the baking all the time, but, like the social network map showed, only technicians and engineers studied wobble. Sometimes even though you would like to make the product better you cant. You're not seen as a legitimate source of improvement ideas so why bother? Anyway, it was easier to come to assemble the electronics as a way of meditating and zone out. But, this time Phuy had data behind him and the team. All of our data was publically posted so anyone in the plant could see.



We asked for another change order this time pulling the oven out of the process and setting up a station for drying the small motor assemblies at room temperature. The laser motor error rate didn't fall to zero (although it did at times) so there was still work to be done. But, there was a significant improvement when compared to the history of laser motor wobble. We graphed failure rate due to laser motor wobble. I added the blue lines to show the period of social action research.



The graph showed the laser motor wobble doing pretty until October 1994. That's when the trouble started with the error rate jumping from between 1-2% to over 16%. The day I was given a tour of the line the reject rate due to wobble was just over 12%. Now Phouy's intervention had brought it back below 2%.

We were still curious. How was the quality of the new process compared to the old one? To answer this question we used statistical process control (spc). To be under statistical process control data must lie between the upper control limit (ucl) and the lower control limit (lcl). During those first ten days of September the defects due to laser motor wobble were not under statistical process control.

We repeated the statistical process control analysis for the time frame that covered the social action research. This time we saw the process control data coming down below the upper control limit. It kept dropping until it had fallen under the lower control limit.

The new procedures for curing the laser motor seemed to be working well. The social action research had ended and saying goodbye to the assemblers I could tell they were still curious about the measures we used. Sheri, being a quality lead was well versed on production quality improvement tools so she knew what to do.

I was still curious too. I returned to the plant after the first of the year to a story. Results had come in from a lab test done in the Silicon Valley. Failed motors were sent to a lab to be tested. The report that came back indicated that the adhesive used to glue the motor to the shaft never really hardened as it should had.

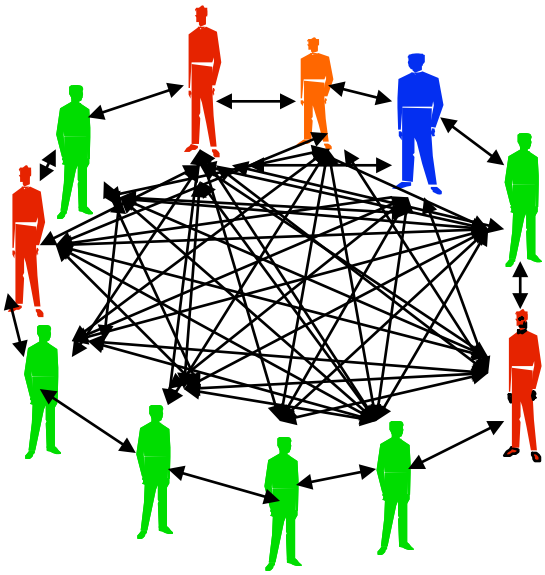
I also learned that the Director of Engineering had put the oven back into the process for his own experimentation. No luck. In fact the statistical process control chart for the period I had been away should only one data point when the process was out of control. It was the day the oven was used again. But, the end of the story caught me by surprise. The Engineering Department took all of our data down from the walls. It appeared that the freedom for manufacturing employees to improve the quality of the product they built was short lived.

We still owed the company a cost analysis of the laser motor wobble study. We factored in the labor time cost for training, team meetings and collecting data. Then we looked at monthly cost savings. There were positive cost savings from decreasing laser motor wobble. I calculate a simple Return on Human Investment (ROHI). It was 17.42:1. For every $1 Wobbly Light invested in studying laser motor wobble they saved $17.42. Simply by giving the manufacturers freedom and a little support the company saved over 17 times what it invested. There was something more. The solution would continue to generate monthly savings that would accrue with time.

Every month the product was built using the new curing process the company saved money, not much compared to other production costs but still savings.

I collected a last piece of data at the end of the social action research. It was another social network survey of those *studying* laser motor wobble. We had error rate data, spc data and cost savings data all helping us to study the laser motor failure problem. But had the companies culture changed?

Culture arises in a dynamic network of conversations. The network of conversations involving the study of laser motor wobble could be studied using social network mapping. I am so glad to have collected the data before I left.



The same folks that had been studying laser motor wobble, the engineers (red) and technician (blue). A month later, the social network had expanded to include six manufacturers (green) and me (orange).

During the social action research study, the *study network* of Deming's continuous quality improvement cycle had expanded and the network had conserved its original structure with everyone seeing everyone else in the network as a legitimate other in the study of laser motor wobble. The quality culture had changed too and it hadn't cost a dime. In fact, the cultural change was saving money.

There was one more "Wobbly" surprise. The Chief Financial Officer at Wobbly Light was enrolled in the University of Oregon's Masters of Business Administration and taking a class on action research. He asked me if I wouldn't mind if he studied the social action research study of laser motor wobble. He proposed studying the social action research study of the quality improvement study of wobble. All though I was working at the University, at the time I wasn't aware of the class he was in. Nonetheless, no harm no foul. A short few months later he shared his paper with me and its results.

He used qualitative and quantitative methods in his action research. He presented his findings in his paper. They included:

1. The project was seen as beneficial to the assemblers.
2. The assemblers acted to improve quality and not to please me.
3. There were mixed feelings as to whether or not the new practices would continue to be used with most responses being neutral.
4. Most assemblers experience was positive and they saw the purpose of the social action research to teach new techniques to the team so they could solve problems.
5. What the assemblers liked best was that the social action research enabled them, to interact and actually work as a team to solve a problem.
6. What the assemblers liked the least was the little time we had to study laser motor wobble and a need to expose the social action research to engineers.

The short paper on the social action research of laser motor wobble included a section of the financial measures I used.

"A final comment addresses Dennis' return on human investment. The fact that he includes a monetary analysis on return on investment is to be applauded. This type of pay back is rare in research and yet is usually the most important factor when determining the effectiveness of continuous improvement. However, the analysis seemed to lack the depth and impact of Dennis' other techniques. The actual monetary feedback reveals $262 spent and $585 saved, resulting on human investment of $2.23. If the motor team actually reduced failure rates from 7% to 1% on motors, intuitively the savings would be truly significant, particularly if calculated over a one year period. The actual savings seem to be substantially understated and therefore the monetary value of the project is understated." [7].

There is much that there will be said about social capital. Generally, I'm against any economic model that treats humans as financial resources. From what I've seen, social capital talks about the importance of reciprocity in social networks. I think that is right, contemporary thinking about social capital as a collaborative social network corresponds to these and other social action research findings. By giving manufacturing associates the freedom to study wobble, Lou's team became more productive.

Productivity is health and group productivity is social health. Social health is constituted in relational behaviors such as mutual respect, understanding, trusting and love. The culture of health is collaboration. Relational behaviors ebb and flow with time. Healthy

relational behaviors such as mutual respect, openness, honesty, data based decision making, love and social support expands productivity. Conversely, hate, disrespect, intolerance and lying diminish productivity. Freedom, having the autonomy to accomplish ones work expands social productivity. Social control, monitoring and commanding others relational behaviors, diminishes social productivity.

The social relation that improves productivity has to do with the structure of the network. In the wobble study I mapped two networks whose structure is an example of social cohesion. Every one is connected to everyone else in reciprocal relationships. Love [1] is the relation that flows through this network and optimizes total value creation. It can feel magical as we achieve our accomplishments without resistance. This contrasts with hierarchical and bureaucratic management practices that create networks of networks of social control behaviors. On another layer, social control networks create greed, competition, sabotage and lies. Love infinitely expands health and productivity that in turn expands economic capital. Love expands networks and social control contracts networks. Social control does not serve the whole. It serves self, fueled by greed, mistrust and control while ignoring the cries of others.

1. Sandow, D. and D. Olson, eds. *Integration at work: Multiple methodologies in research*. 1991, University of Oregon: Eugene, OR. 94.
2. Rhodes, L. and D. Sandow, *NEC America Plant: Employees with disabilities value added analysis*, 1990, Specialized Training Program.
3. Mank, D.M., D. Sandow, and L.E. Rhodes, *Quality Assurance in Supported Employment: New approaches to improvement.* JVR, 1991. **14**(1).
4. Shewhart, W.A., *Statistical method from the viewpoint of quality control*, ed. W. Deming, Edwards. 1939, Washington, DC: The Graduate School, Department of Agriculture. 155.
5. Deming, W.E., *The New Economics*. 1993, Cambridge, MA: Massachusetts Institute of Technology. 240.
6. Yan, X., et al., *Evaluating support networks: The effects of employment in one person's life*, 1993, Specialized Training Program: University of Oregon.
7. Eckerdt, A., *Action Research: Emphasis on Human Investment in the Private Sector*, 1995, EDPM 607, University of Oregon.
8. Maturana, H. and P. Bunnell. *Biosphere, Homosphere and Robosphere*. 1998.

[1] "Love is the domain of those relational behaviours through which another (a person, being, or thing) arises as a legitimate other in coexistence with oneself." 8. Maturana, H. and P. Bunnell. *Biosphere, Homosphere and Robosphere*. 1998.