TMG News

The Manufacturing Game®
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How Does The Manufacturing Game Help to Create a Culture Change in an Organization?

The best way to answer this question is through a socio-technical network of people — people who operate, maintain, improve, and innovate ways to use equipment in the production of a product that has value realized by a customer. Let's explore what makes a manufacturing organization. Over the last 100 years, the nature of work that people do in manufacturing organizations has shifted from manual work (moving something that has mass and occupies space to another space) to the mental work of setting dials and pushing buttons that activate machines to perform the manual work. For example, men shoveling coal into a firebox and iron ore in a crucible to create steel is now done by a machine dumping coal and iron ore in a hopper and a conveyor belt feeding the coal to the furnace and iron ore to the crucible. The work of the men and women is to operate the machines by pushing buttons or joy sticks or setting dials that control the movement of the machines. The machines also need to be maintained and improved over time if the organization is to remain competitive. Therefore, the machines make up the technical part of the network and the people are the social part of the network.

In our benchmarking work in the 1990's, we were able to model the technical part of the network as a set of functions that produced the product. In the process of producing the product, defects are created in the equipment in five different ways: by how we operate the equipment, repair the equipment, purchase spare parts for the equipment repair, design the equipment, and manage failure events. These defects eventually cause certain functions to fail in our equipment which then determines how much product we can produce and therefore how much value we can create in our socio-technical system. The transactions that the organization engages in with customers to realize the value of the products can also affect the availability of resources to deal with removing and eliminating the defects. Therefore, these transactions have an impact on the rate of defect generation as well and can be considered another source of defect generation.

So in this context of the socio-technical network, how is the knowledge to perform all of these tasks conveyed to the employees? When a new employee is hired or a contractor is engaged to perform work, they come with a certain amount of explicit and tacit knowledge of how to do the work. However, the people with

Eliminating Small Defects Makes a Big Difference

Prudhoe Bay, Alaska has a unique set of distinct challenges, safety, and health risks that must be mitigated every day. Maintaining numerous tanks, vessels and miles of pipeline in extraordinary conditions are faced daily by the workers of CH2MHILL. They are achieving successful results by implementing cross functional action teams who eliminate the small defects. Cody Carlson and Eric Visser, Continuous Improvement Specialists for CH2MHILL, with the support of Adrian McCaa and Shawn Croghan, Campaign Maintenance Managers for BP, have been the leaders in introducing "Solutions Without Boundaries" to the workforce on the North Slope.

The "Solutions Without Boundaries" Program combines employee input with CH2MHILL's expertise in Continuous Improvement. Since April 2009 through September 2010, the O&M Service team generated a total of 890 "Solutions Without Boundaries" ideas for BP's Greater Prudhoe Bay operations, split nearly evenly between efficiency and safety. Fully implemented, these ideas will save approximately $7.2 million.

BPXA President John Minge praised the "Solutions Without Boundaries" Program and noted CH2MHILL's significant competitive advantage in Continuous Improvement. The Program boosts CH2MHILL's position as a Continuous Improvement leader not only on the North Slope, but in the oil and gas industry.

A vital part of this work is

more experience with the particular equipment have more knowledge than the new person may have. This tacit knowledge was created over the history of the facilities, and the people who were not there when a particular piece of implicit knowledge was learned need a means for learning the significance of certain actions. They can learn this by trial and error, which gives them direct experience of the emotions that are felt when certain actions are taken. This method, however, tends to be rather expensive and could be

dangerous, so various means are used to convey the emotions without trial and error in the real world. Some of this can be done with simulated situations where the emotions can be experienced without the full consequences being generated on the machinery. This can be created by an experienced person letting a novice make a mistake and correcting the mistake once the novice experiences the emotions but before any damage is done to the equipment. The best way to pass on the tacit knowledge, however, is through story telling about events that had high emotional content in the past. This is best done in a situation where an opportunity exists to improve the operation, maintenance, or design of a piece of equipment. Whenever a piece of equipment fails and needs to be fixed, an opportunity to improve that piece of equipment exists. If that failure is examined from the perspective of the five different sources of defects, many times there is a root cause that can be found for that failure. If action is taken during this repair to eliminate that source of the defects that created this failure, then a future failure can be delayed or eliminated altogether. Research on brain activities has shown that there is a strong emotional experience when a person accomplishes a meaningful task. This emotional experience becomes part of that person's tacit knowledge because it integrates a large amount of information that exists in that person's brain at the time of the success. This experience lives on because of the memory of this experience.

So how is this type of experience passed on to others? When we interact with other people face to face, an interesting thing happens. In our brains are cells that are known as mirror cells. The function of these cells is to mirror the emotions of the people we are interacting with. This is done primarily by visual observation of the other person's face, but also there are mirror cells

that pay attention to audio signals, and other input from people, like the tension in their muscles. When the emotional experience of one person, addressing an equipment problem, is mirrored by other people there can be a direct exchange of experience with these people in regard to that particular equipment. This then becomes tacit knowledge for the people who mirrored the experience of one person. Secondary tacit knowledge may be very unconscious and can cause people to have an intuition about a particular piece of equipment that they cannot explain how they know it. This is true tacit knowledge.

So back to our original question—How does The Manufacturing Game help to create a culture change in an organization? We engage people from different functions in the game that simulates the three main functions of manufacturing; operations, maintenance, and business services. We have people play a role in the game that is not what they normally do in their jobs. This puts them in a position where they can't use their tacit knowledge and have to be conscious of their actions. On the other side of the table, someone else is playing the role that the participant normally plays in his job. This creates sympathy with the other person who is fighting the battles that they normally fight. This creates an urge to help that person based on your tacit knowledge. However, to give that help, you have to articulate your tacit knowledge at least enough to get through the game. The person across the table is doing the same thing so the sympathy is mutual, and together you master the game creating an emotional charge. This joint experience with the other people at your table creates an emotional bond that enhances trust in each other.

At completion, the people in the workshop are reorganized into cross–functional teams who have
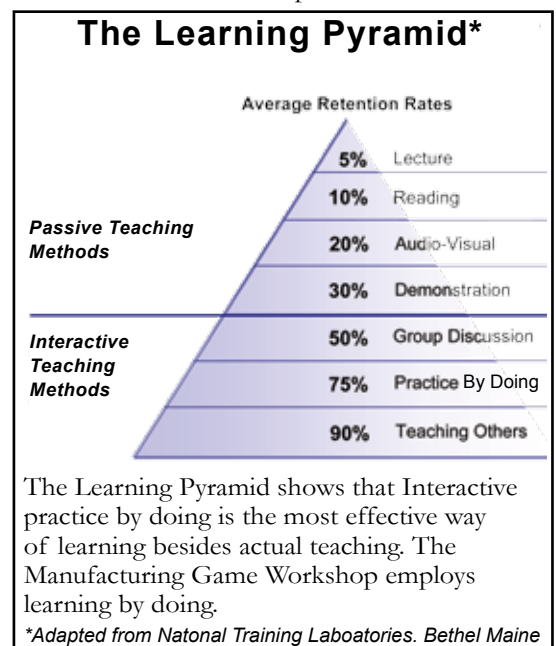
joint responsibility to operate and maintain a piece of equipment that has business performance deficiencies. With the new experience of mastering the game and the feelings of trust, the team examines what they collectively know about the problem. The choice of equipment is left to the team, and they are encouraged to choose something to work on that they have a passion for. The size and impact of the problem is disregarded in order to work on things that have emotional significance to the members of the team. This emotional atmosphere enhances the probability that tacit knowledge is passed on within the team. This bonding when the team successfully solves the problem becomes a new avenue for accomplishing work that may not have existed before the workshop. The action teams created in a workshop begin a new habit of forming a cross-functional team whenever people want to make a performance improvement. If the management system in the organization recognizes and supports these teams, self organizing teams begin to form when other problems come up. For this process of self generating teams to continue, there has to emerge a spirit of continuous improvement that is passed on to people through emotional experiences of improvement. This process is much like lighting a pile of charcoal briquettes; the game provides a spark and some lighter fluid to the participants. The teams provide the opportunity for small groups of 4 to 7 people, who work close enough together, to experience the mirroring of each others emotions. This radiation among the team members reinforces the emotions, and people feel more comfortable opening up their minds to learning from each other. When people in the workshop see the results that other teams are getting, it reinforces their hope that the organization as a whole will continue

to work this way and make it a better place to work. This optimism spreads to other people when the team members return to their regular work with a more hopeful presence, which is then mirrored by the other people they work with every day.

Sustainability can be looked at in the same way as we looked at lighting the fire in the pile of charcoal briquettes. Everyone who has not been involved in the workshop and action teams tends to absorb some of the emotion from those who participated. They don't necessarily reflect their hope for improvement until they attend the workshop. If the rate of people going to the workshop is too slow, the fire in those who have been dies out before it can be reinforced by new people coming back from a workshop. Because it works this way, we find that it is important to get 80% of the people in an organization through the workshops in the first year to create enough fire to make a culture change. To accomplish this rate of change, we find that there needs to be a process to lead this transformation. The organization of this leadership forum, which we call a Continuous Improvement Forum, is very simple. It is a place where each successful team can come to tell their story of success. This is the reinforcement they need to solidify their bonds. They also need a place to report on the obstacles they encountered along the way. If these reports are in the form of "the facts wrapped in the emotions" of the change, other people will mirror the value as well as the facts of their success. The reporting of the negative emotions they experienced along the way, are signs of the defects that exist in the work management process. These defects can be the subject of other action teams that include managers who can take actions to remove the management generated defects. From a
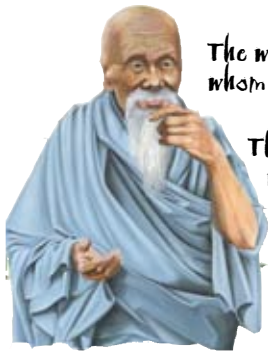
factual and rational point of view, the functioning of the equipment would not require that the workshops be run that fast or for the forum to exist to fan the fire. However, from a tacit knowledge point of view, if you let the spirit die, you have to start all over again.

A simple way of determining if the organization is progressing fast enough to create a culture change is to monitor the number of work orders that are being executed. The equipment keeps a great record of how it is being treated and reports back in the form of work orders. Technically, the manhours of work orders is the more correct way to measure this, but this gets somewhat distorted by the fact that everyone has to be accounted for in the work management system so it is better to measure the overtime and the number of work orders to determine if the equipment is getting better or not. Of course, the value of this new culture is measured in terms of profits and return on investment. The simplest method for creating a leading indicator measurement of progress, is the number of improvement teams divided by the number of work orders completed. We have found that a rate of 0.5% to 2% is enough to initiate the culture change. Eventually, all work orders will contain improvements.

The Learning Pyramid*

Average Retention Rates

5%	Lecture
10%	Reading
20%	Audio-Visual
30%	Demonstration
50%	Group Discussion
75%	Practice By Doing
90%	Teaching Others

Passive Teaching Methods

Interactive Teaching Methods

The Learning Pyramid shows that Interactive practice by doing is the most effective way of learning besides actual teaching. The Manufacturing Game Workshop employs learning by doing.

*Adapted from Natonal Training Laboatories. Bethel Maine

The wicked leader is he whom the people despise.

The good leader is he whom the people revere.

The great leader is he of whom the people say, 'We did it ourselves.'
—Lao Tzu

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replacing insulation end caps on the pipeline after inspections. The end caps typically come from scrap metal sheets measuring from ten feet to six inches. Originally Richard Derkevorkian, (Insulation Lead, Fabrication) would have to find a piece of metal in the scrap metal bin that was close to the size needed and shear the metal into the appropriate size then cut it on the circle cutter while as many as 4 to 10 people were waiting on the work crews for up to 10 end caps. Often there was a considerable amount of metal and manhour time wasted. Then he would have to calculate the insulation size to go along with the metal end cap. His defect elimination plan was to make his work more efficient and less stressful.

Richard designed a divided rack for the metal pieces and by using the practice of load leveling (using downtime to find the best layout for the scrap metal) increased the efficiency by almost 5 times). The rack was placed directly above the circle cutter to reduce time getting the metal. Each bin was marked with the size of the metal and labeled by pipe size and insulation thickness being used. Previously there were a lot of calculations involving circumference that had to be made for each end cap. Now Richard has a chart with metal size, insulation size and the correct settings on the circle cutting tool for each size so anyone who is trained on the circle cutter can come in and cut the precise end cap needed eliminating human error. Prefabricated end caps are now produced during down time and have eliminated 25% of the waste for a savings of $12,900 to date.

Another team addressed extension cords and hoses that are frequently used amongst the workers. So they don't present a tripping hazard they are secured to handrails or pipes with zip ties or duct tape. The zip ties are sharp and their removal presented another safety hazard. The zip ties and the duct tape needed to be cut off with a razor knife or snips, potentially cutting the hoses, cords or the employee. All of these consumable products had to get thrown out each day filling approximately 350 trash bags per year.

Aaron Goodwin and Sean-Michael Watson headed up the improvement team that removed the hazard of sharp objects and cuts and the cost of buying zip ties, duct tape and trash bags. They replaced all the consumables with reusable Velcro straps—no sharp zip ties, no trash and no need to use razor knives or snips for a savings of $25,655 per year.

These types of small defect elimination ideas add up to considerable savings, improved safety conditions, and a more efficient and productive work environment for the employees of Prudhoe Bay.