Executive Summary

Students at the Manufacturing Technology Academy were trained in late October to use the Plan, Do, Study, Act (PDSA) process to solve problems. The students went through a two-day seminar and then were sent to local companies to utilize their newly learned skills. One such team of students was sent to RJG.

When the team arrived at the company, they were taken a tour of the sensor production department. They then began to work on the first stage of the PDSA cycle, Plan. To begin, they needed to define the problem, so they took all their observations from the tour and placed them on several tools. The team then studied the various tools in order to come up with areas where there were possibly problems. The team determined that the problem most likely existed in the process itself, or the amount of flow in the process. The team then proceeded to state their goal. They decided a good place to start would be the problem statement provided by RJG. This stated that the desired state was incoming sensors to be populating the "ready to use bins" in a timely manner.

Next, the team began to study the situation. To begin, they created a flowchart of what was actually occurring in the check-in process. This allowed the team to see each step of the process and enabled them to focus on specific parts. The team noticed much of the time was spent on the exercising of the pressure sensors. A spider diagram was created that showed the amount of time spent on each type of sensor. The team also noticed that RJG did not have a set process to follow and that it varied from worker to worker. With this information, the team decided that it would also be in the company's best interest to have a simplified and improved flow.

Then, the team brainstormed a list of potential causes. It was decided that the lack of a set flow and the tinning process needed on one type of pressure sensor were major causes. After further questioning, it was discovered that the company providing the sensors could perform the tinning process for no additional cost. The team then created several tools to test and confirm their theory about the lack of flow being a major cause of lost time.

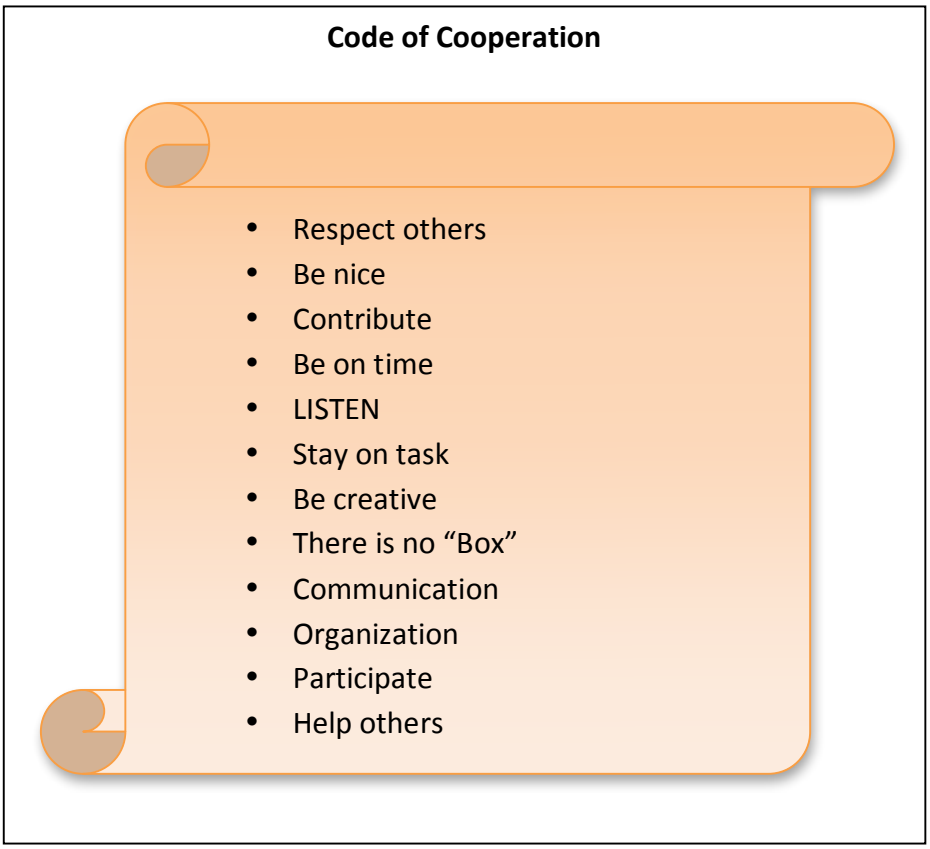
The team then moved on to the second stage of PDSA, Do. This was the final part of their work at RJG. Through the use of several tools comparing possible solutions and a significant amount of brainstorming sessions, the team decided the best solution to the current problem was to create a flowchart that would set an order of operations. They also recommend that a timer be placed on the exerciser to reduce idle time. The team organized the steps to be in the most efficient order. This flow chart is located in the Appendix.

Table of Contents

Introduction:

The team attended a two-day Teams Training seminar hosted at the Manufacturing Technology Academy (MTA). During the seminar, the team learned about the Plan, Do, Study, Act (PDSA) problem solving process. See the "Probletunity Overview" in the Appendix for details about this process. The team learned through example and after completion of the seminar the team was sent to RJG to assist with the solving of perceived problems. The time spent at RJG furthered the learning process started at Teams Training.

To begin with, the team needed a set of rules to follow so that there was an even playing field and everyone's ideas would be heard. To do this, the team used the *Code of Cooperation*, which was created during the teams training. This tool is used when a team or large group is in need of focusing and reducing destructive behavior. This tool is created at the beginning so the team members would have guidelines to follow.



The *Code of Cooperation* shown above explains what the team thought was expected from everyone on the team. This tool was used throughout the process at RJG.

Purpose:

The team was sent to RJG to find solutions for the bottleneck that was occurring in the Sensor Production Department. The provided goal statement listed on the "Quality Teams Employer Sponsor Worksheet", located in the appendix, gave the team a place to start the process. It

stated that the bins for pressure sensors weren't being filled when needed. This resulted in the exercise rig becoming a bottleneck. This is what RJG wanted them to rectify. The team had a purpose, and the problem-solving process could begin.

Plan: Define the Problem

The first round of data gathering began when the team was given a tour. After the tour and gaining information about the company, the group created several tools to sort and organize the information. The first was a *Parking Lot.* The *Parking Lot* is a place where group participants can put notes suggesting positive comments, needs for improvements, questions, or insights to be reviewed at a later time. It is made by drawing four boxes and labeling each section with one of four symbols. The "+" sign represents items that seem to be doing well. The "Δ" represents the things that the company can improve upon. The "?" is for questions for the company. The "I" is for ideas to improve the company that could be used later on in the process.

Parking Lot of RJG

+

- Only cut wires if they might have late orders
- Batch=9
- Shipping on time

Δ

- Testing for the 414s takes too long

?

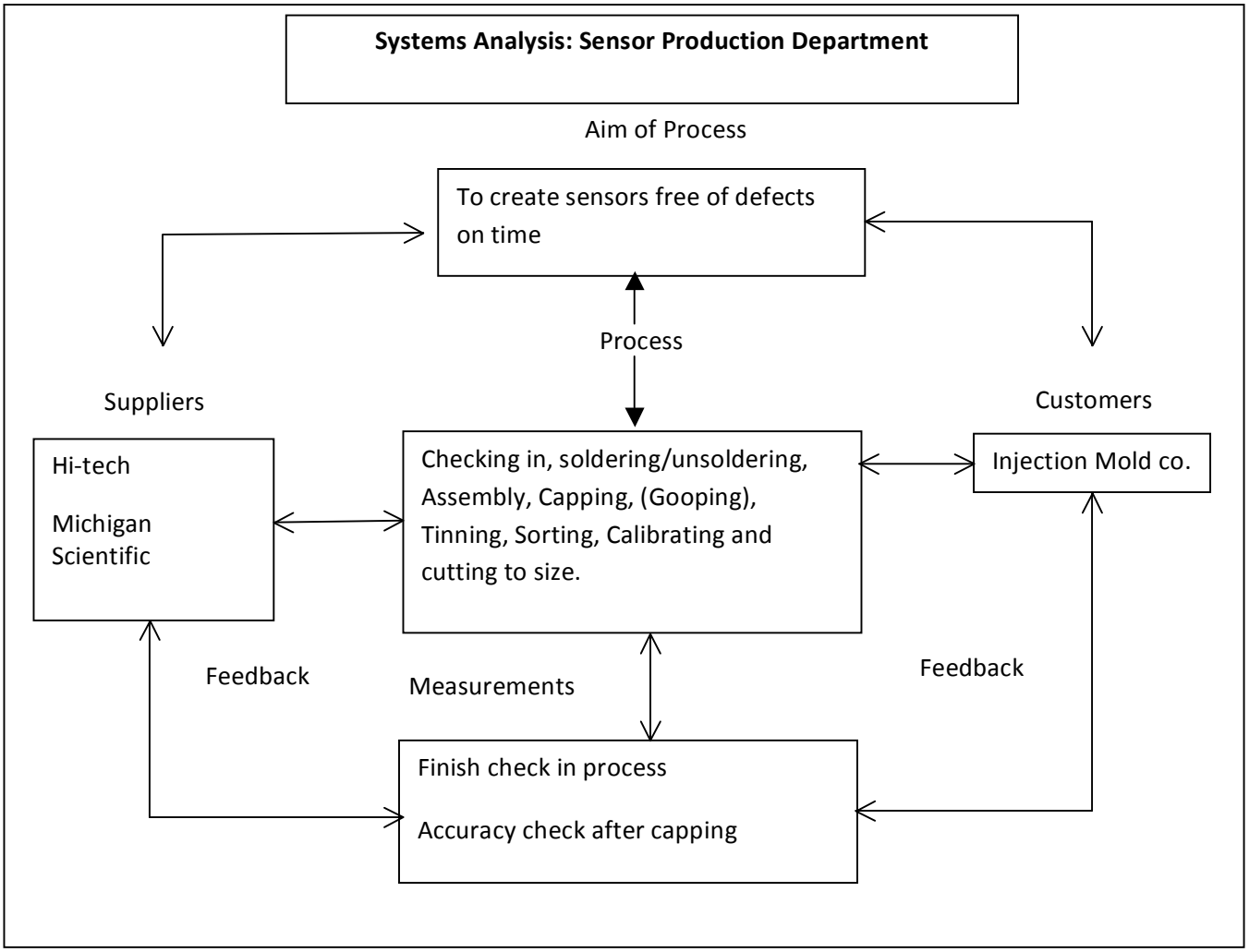
- What is the training for the check-in?
- Why can't the supplier sort the sensors?
- Set up time
- How much is the cost for the tinning for the 414s?
- What kind of quality
- Can quality control be moved?

I

- Take length data
- Pull system for ordering
- Organize
- Improve flow of raw
- The customer is the next person in the process.

The *Parking Lot* tool allowed the team to stay organized. It also allowed them to see their ideas for improvements and the good and the bad things that were going on in the manufacturing process. This tool helped the group to identify and solve questions and was constantly updated throughout the process

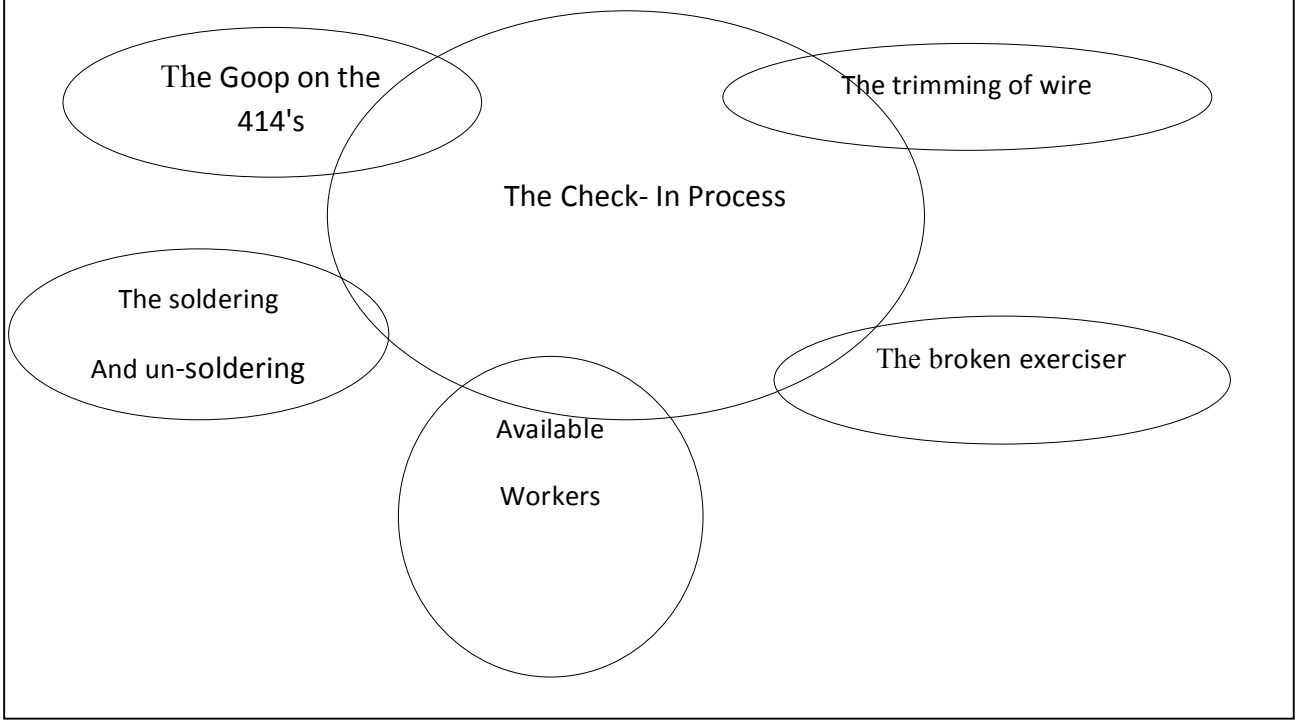
Next a *System Analysis of the Sensor Department* was created. This tool is used to classify information and different processes that are happening in the sensor department. It was created to give an understanding of how the sensor department is set up.



This *System Analysis of the Sensor Department* shows how different parts of the system affect everything that is involved in the final production of a sensor. This tool showed every process that went into the creation of the final product and took the team in the direction of investigating problems involved in each process in the production department. It also showed how the check-in process affects the department as a whole.

After touring the department and observing the Check- In process, many things stood out. In order to relate the things that stood out to the Check- In process, this *Bubble Chart* was created. A *Bubble Chart* is used to show the general interrelationships between outside forces and the system. This chart reveals how outside forces affect one another. It is generally used when the "big picture" needs to be shown. Overall, this tool gave a good pictorial view of the Check- In process.

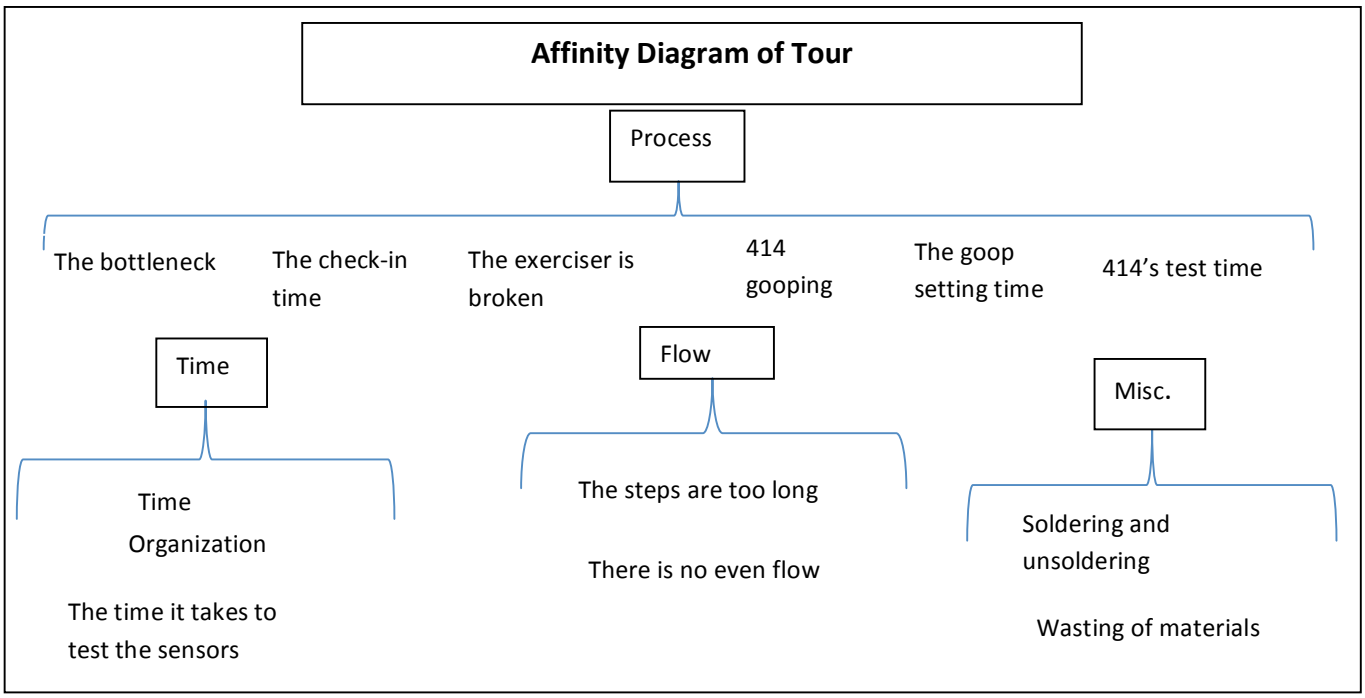
Bubble Chart for the Check- In Process



The *Bubble Chart* helped the team discover potential problems in the process. It shows the relationship of the different important aspects to the main process as a whole. Overall, it allowed the team to narrow down the search for the solution onto five major topics.

Next the team used an *Affinity Diagram.* This tool is used to identify the different places where the cause of the problem could be occurring. This tool is made by brainstorming what the possible causes of the problem are. After coming up with a few ideas, they are then placed on a sheet of paper and categorized. For example, two ideas that were thought of were, "the steps are too long" and "there is no even flow". Both of these ideas relate to the flow of the manufacturing process, so they were put under the "flow" category.

See Affinity Diagram on the next page



This *Affinity Diagram of the Tour* showed different potential causes of the main problem. Being able to see all of the possible causes allowed the team to pursue each cause and determine whether they were actually possibilities or not.

Plan: State your Goal

Once the team had used enough tools to sort through the first round of data gathered on the initial tour and identified the main problem, they used the *Initial Problem Statement* to articulate it. The *Initial Problem Statement* is a word for word copy of the problem originally stated by the company given in the "Quality Teams Employee Sponsor Worksheet", which is found in the appendix. Having an *Initial Problem Statement* allows a team to stay focused on the given problem and work towards a common goal. Included is the current perceived problem, the impact of the problem, and the desired outcome after fixing the problem

Initial Problem Statement for RJG

Current:

Raw gauges are shelved after being received at the door. They are not available in the "ready to use" inventory bins in a timely manner, causing stock out conditions.

Impact:

Exercise rig is a bottleneck in the build process of a finished sensor.

Desired:

Raw incoming sensor gauges populate the "ready to use bins" efficiently while still stabilizing the raw offset of the gauge to insure the repeatability of the finished sensor.

The team used the *Initial Problem Statement* to focus in for the next step of the problem solving process. It gave the team both a beginning condition (current) and an end condition (desired) to observe and allowed them to ask questions and gather more information and data.

During the process so far, the team encountered a few terms that they were unfamiliar with. The *Operational Definitions* tool is simply a list of industry related words that may not be understood by the average person. Having a list of operational definitions eliminates any confusion or misunderstanding due to the definition of words; moreover, it allows the team to convey ideas more easily to each other.

Operational Definitions

1. Viscosity- the measurement of the thickness of a liquid.
2. Soldering- the connection of two things by the addition of a hot, soft material.
3. "Goop"- Dielectric touch gel/ two part silicon.

The *Operational Definitions* helped the team communicate in a clearer and correct way. The team updated this list as they went along and made sure that everybody understood the terms that the team needed to know.

After the team identified the initial problem and clarified the related terms, they used the *Imagineering* tool to form a potential image of the solution. The *Imagineering* tool is used to decide what the ideal state or condition of a process is. This gives a clear goal to work towards and allows a team to clearly define its direction. Imagineering consists of a statement question of what the ideal condition would be and then has the users work backwards to decide how to achieve those conditions.

Imagineering

What would be the perfect check-in process?

- The "ready to use" bins are always full
- Process is done in a timely manner
- No defects
- Continuous flow of sensors to bin
- Continuous availability of desired length of sensors

The team used the Imagineering tool to identify what the perfect check-in process would be. It narrowed down the scope of choices when trying to look for solutions on how to solve the initial problem.

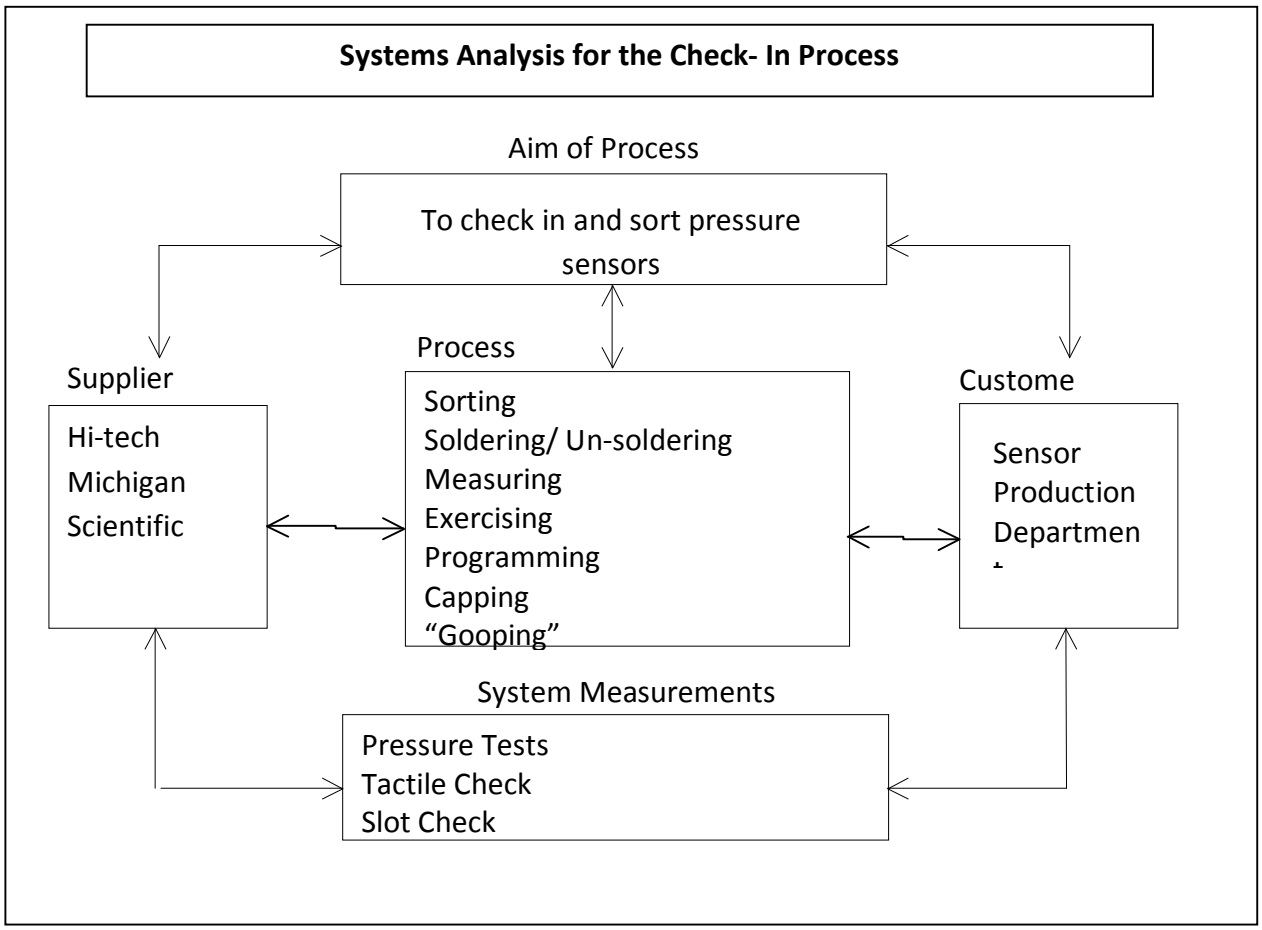
Plan: Study the Current Situation

After the initial information from the tour was sorted and understood, the next step is to go further into the current situation and study it more thoroughly. A flow chart is a good tool for this. The Team asked if a flowchart currently existed for the sensor department. They were given the "Lynx Sensor Build and Test Flow Chart". However the supervisor indicated that it was not accurate any more. A verbal description of the process was then given. However, the team decided to make their own. To look at the actual process being done, an *Initial Flowchart* was constructed. The *Initial Flowchart* is a flowchart made after observing the exact process in the sensor department. The *Initial Flowchart* gives a visual representation of what is going on in the process and allows the team to search the process for bottlenecks and constraints. It also provides an easy means of reorganization and recreation of a revised process.

For chart see Flow Chart of Check-in Process in the Appendix.

The reason an *Initial Flowchart* was made was to fully understand how the Check-In process worked and how to improve it. The Flowchart that was provided to the team, allowed them to study and show areas for improvement.

Although the team already created one *System Analysis of the Sensor Department*, the team decided to create another system analysis that only focuses on the Check- In process. The *Systems Analysis for the Check- In Process* is on the next page.



It shows the connection between the overall aims, the customers, the suppliers, and the measurements associated with the Check-In process. This, along with the flow chart, gives a greater understanding of the aspects of the Check-In process.

After creating the *Systems Analysis for the Check- In Process*, the team needed to organize all of the data that they collected. To plainly state all of the initial conditions, a list was constructed. The *Bullet Point List of Initial Conditions* was used to give a central location to all the data collected.

Bullet Point List of Initial Conditions

- They buy 100 414's at a time (twenty of each length)
- 412's, 413's, and 445's all are on automatic refill
- No credit for waste wire, just a discount on wire bought
- 414's have to be "gooped" and tinned
- Six month shelf time on the "Goop"
- 414- 125 lbs. on 400 cycles

The creation of this allowed the team to keep track of crucial information. They used it throughout the process and much of the information placed on it was later put into other tools and used to further the process.

After looking at the bullet above, the team had further information about the sensors that had not been captured yet. Therefore, a *Lotus Diagram* was created to organize all the data about the variety of sensors in order to see if anything became appearant. A *Lotus Diagram* is an analytical organizational tool for breaking broad topics into components, which can the be prioritized for implementation. It is used when there is a need to organize and prioritize large sums of information.

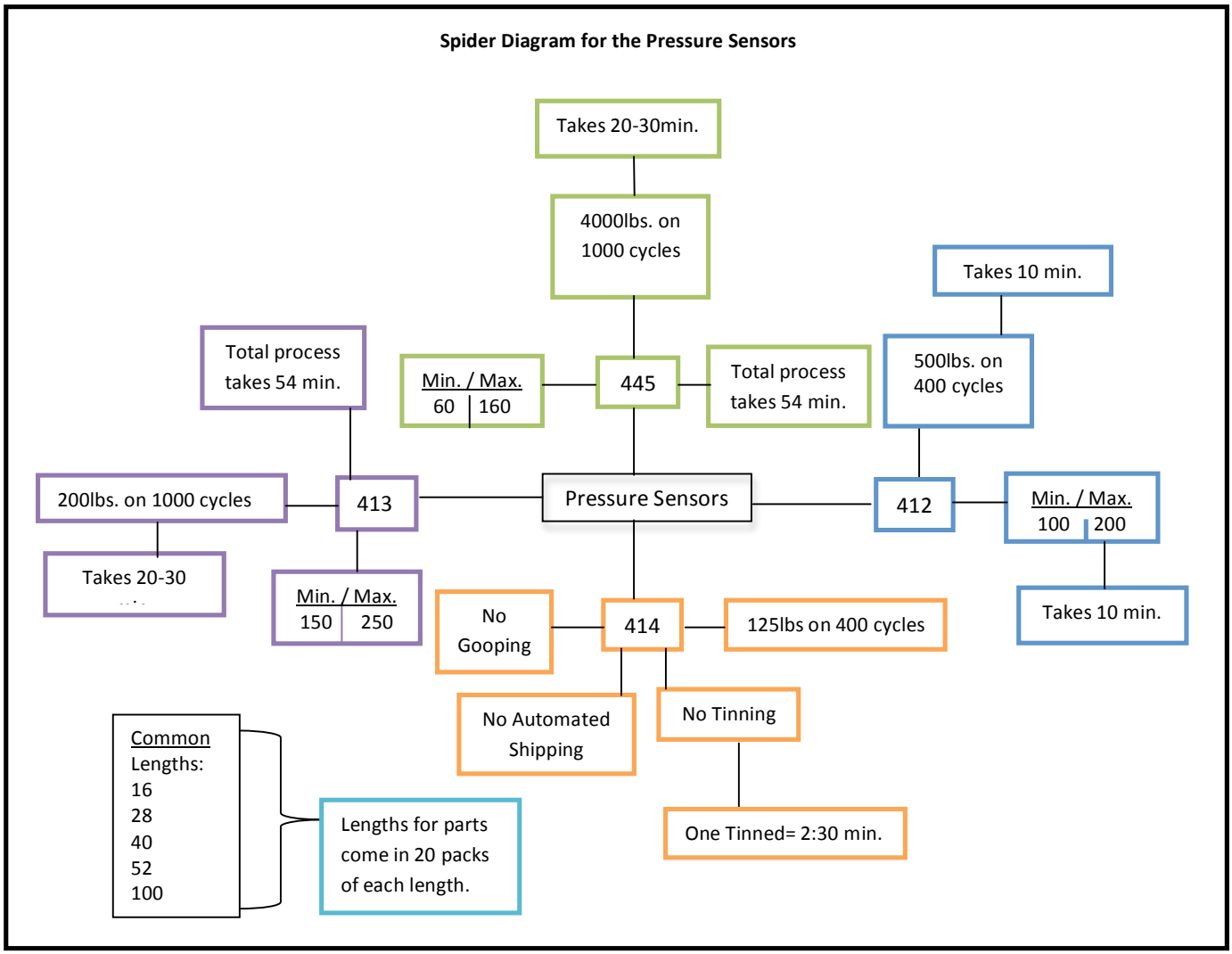
The Lotus Diagram for the Check-In Process

				"Gooping"	Tinning	6 scrap 414 and 412's last year	Cutting	Trimming
				414's	Capping		Scrap	No payment for scrap
					Extra Process Time			Discount on wire bought
	414's- 100 bought at a time	20 of each size		414's	Scrap	445- 4000 lbs on 1000 cycles	1 space is out of order	9 spaces to calibrate
	Supply	Don't come on a regular schedule	Supply	The Check-In Process	Exercising	414- 125 lbs on 400 cycles	Exercising	Different PSI
	412, 413, and 445's automatic	Sizes-16, 28, 40, 52, 100 and 124 inch	Shipping	Quality	Sorting	413- 2000 lbs on 1000 cycles	412- 500 lbs on 400 cycles	Programs
		Usually ship in two days		Sorting- by feel	During exercise process			By size
	Shipping	Under 10 - 1 week		Quality	Tactile		Sorting	By length
		Over 10- 2 weeks		Slot check	After capping			By type

The overall process is in the center, which is the Check-In process. Off of that are each of the subcategories that make up the Check-In process. The subcategories then became the main topic and the surrounding boxes became the details about the subcategories. It allowed the team to sort through the large amount of data about the Check-In process.

The next tool used was *the Spider Diagram*. This tool is used to compile thoughts and information that can be organized into a readable form. This tool is built by first stating the project or main idea, which will be the main focus point. From there, main categories branch out from the central concept. Patterns may appear from their content. This is an ongoing process until all the information is gathered.

Spider Diagram for the Pressure Sensors



In the *Spider Diagram for The Pressure Sensors* above, the pressure sensors is the main topic to branch off. Then the four different kinds of pressure sensors and their contents were listed. While creating this, tool the team noticed that the 414 sensor was the only one that wasn't automatically shipped, the wire wasn't tinned, and it needed "goop" on it. This lead to more questions on why the other sensors had those features and the 414 did not.

Plan: Restate the Problem

Once the team thought they had enough information to relook at the main problem, they created the *Revised Problem Statement*. The *Revised Problem Statement* is the next step of the *Initial Problem Statement*. It is done to ensure that the original problem statement is accurate. It can also be clarified and additional information can be added. Sometimes the two are very different from each other.

Revised Problem Statement for RJG

Current:

Bins are not being filled

Impact:

Creating stock out conditions

Having to cut wires

Desired:

Bins are full

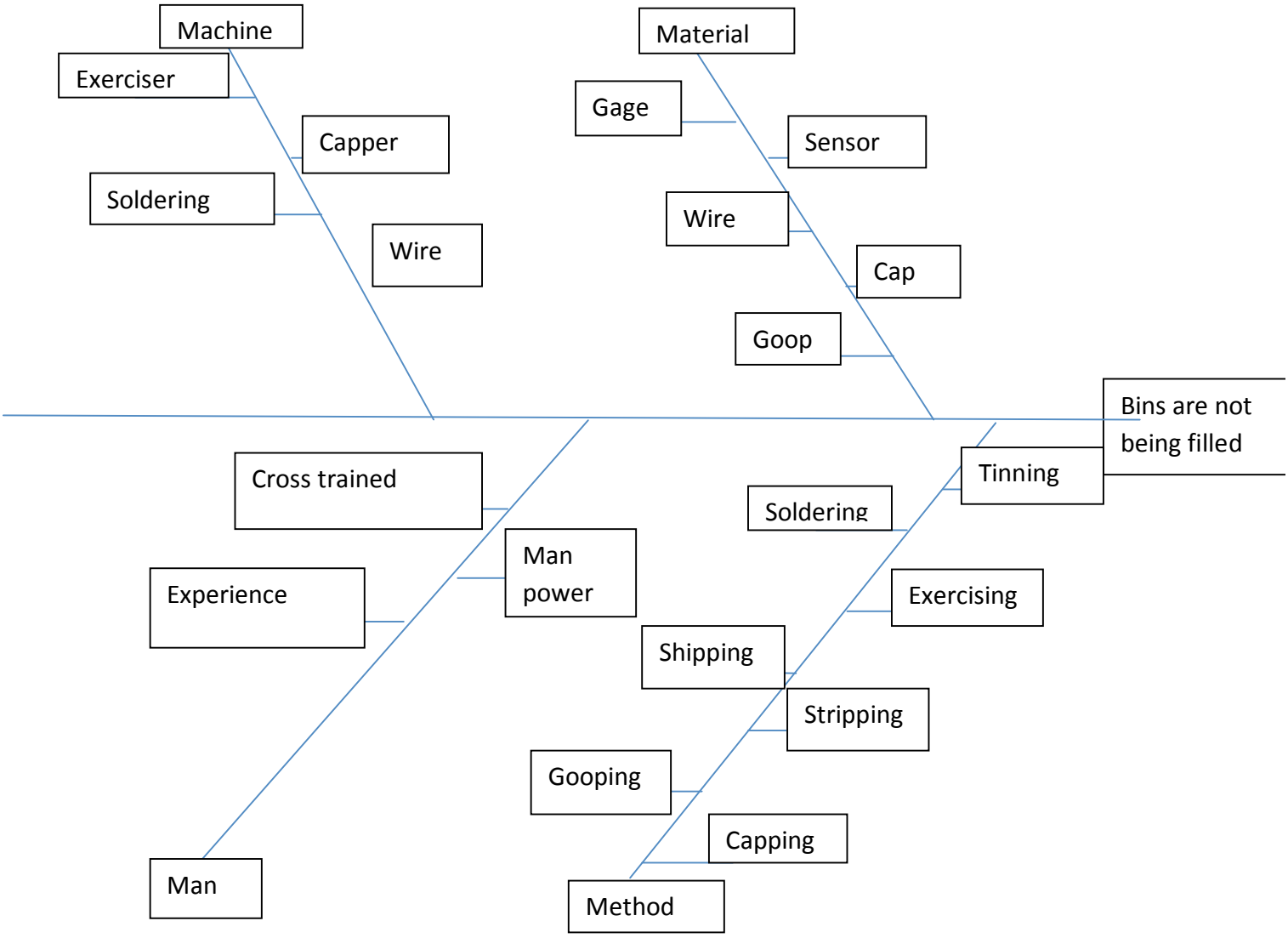
Flow simplified

The team decided that a simplified flow was desired, as well as the bins being full. The *Revised Problem Statement* gave them an accurate current state and an updated desired state, which gave them a goal. After creating the *Revised Problem Statement*, the group began to look at some of the causes of the new statement, which a different desired state, but the same problem.

Plan: Analyze the Causes

When a team is trying to figure out the potential causes to a problem, a *Fishbone Diagram* can be used to look at different areas where the problem could be occurring. This is done by boxing the main problem and then adding the "back bone" and "ribs" of the fish. A box is then placed at the end of each bone. There will be an area in each where it is possible that the cause to the problem could be occurring.

Fishbone Diagram of the Sensor Department



This tool identified the possible areas where the cause of the problem could be occurring. Each variable was sectioned into one of four categories: Man, Method, Material, or Machine. This way if the causes of the problem are occurring in one of the variables/areas, they knew where they have to go and what questions they will have to ask. For example, if the group thought that cause of the problem was occurring in the sensors, they would have to contact the supplier and ask why their product was not working properly.

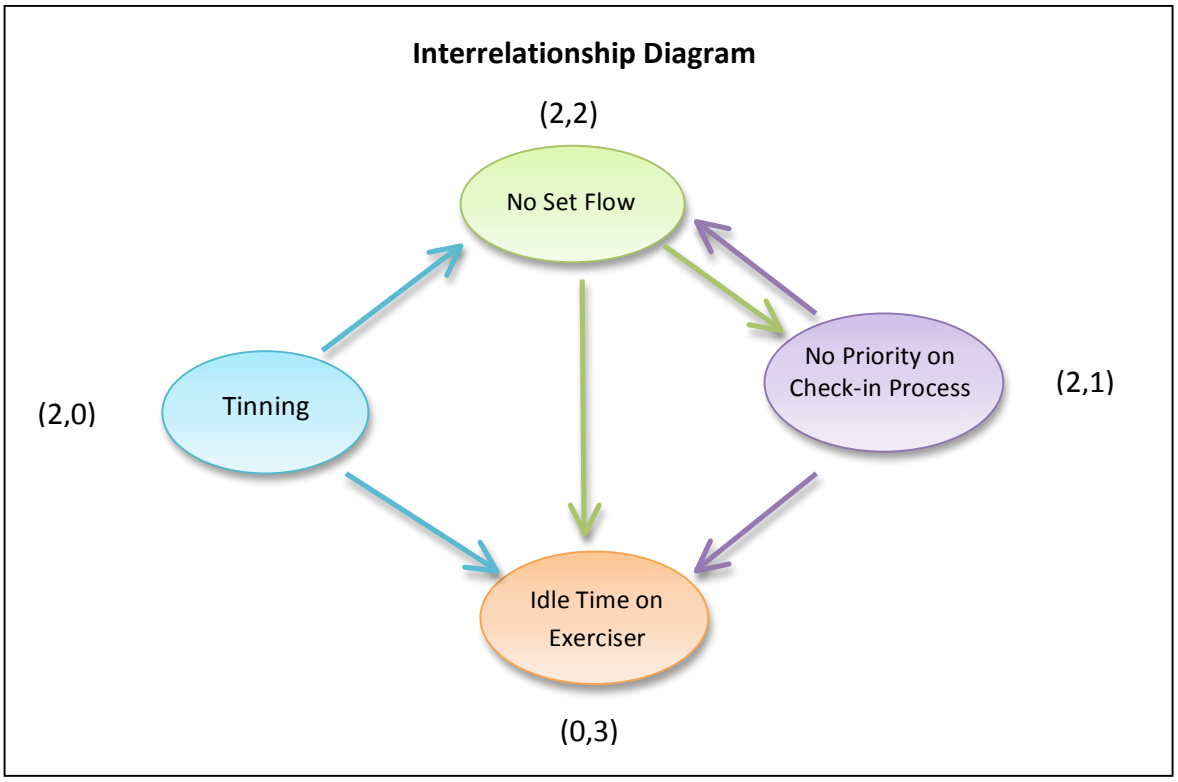
After gathering all this information the team needed to clarify a list of some causes. They did this by making a *List of Potential Causes for Bins Being Bare*. This is where brainstorming begins. A team first makes sticky notes of potential causes on their own. From there, they group the sticky notes and make major categories, which in turn change to some potential causes. All these ideas created during the brainstorming came from information found using other tools. This tool helps a team narrow their focus on the real cause.

List of Potential Causes for Bins Being Bare

- No set flow
- Idle time on the Exerciser
- Tinning process
- No priority on the check-in process
- Shipping

When building these potential causes above, the first thing listed was the old, unorganized flow chart that was provided. Idle time is because the employees had multiple jobs to fill; therefore, there was no priority on the exerciser or even the check-in process. They concluded that the tinning process was a possible cause because it took a maximum of four hours to complete 100 un-tinned wires. Lastly, the team put shipping as a potential cause because one of the wires, the 414's, was not on the automatic system for shipping. Later, the team determined that shipping wasn't a big priority and removed it.

Next, the causes listed above needed to be analyzed to see if any of them related to each other. The *Interrelationship Diagram* is a good tool to use for this. This tool helps take the potential causes and narrow them down to the main root cause. This is done by taking the potential causes and putting them in a circular formation. By starting with the top one and going clockwise, a question is asked, does this affect this? If it does affect, draw an arrow. If it doesn't, go to the next. When determining the root cause, the one that affected the most or the one that has the most arrows coming off of it is the potential root cause.



This tool showed not just one root cause, but two potential root causes. One of them was having no set flow in the pressure sensor department. The other root cause was having no priority for the check-in process. The reason why there were two was because having no set flow caused employees to have no priority and no priority caused the flow to be unorganized; therefore the team needed to focus on only those two. Even though tinning was not a root cause, the team still had to ask questions about the process in order to find out further information about it.

After finishing the *Interrelationship Diagram*, the team used *The Five Why* tool to double check the root cause. If there is more than two root causes, this tool can also help with determining which cause is more important. By first stating the "why?" for the root cause, it follows with an answer. From there it follows with the "why?" for the answer. After doing this for a couple of times, and it doesn't have to be five times, the end result should either end with something similar to the problem statement or a new potential problem.

Five Why's for the Root Causes in the Check-in Process

The Five Why's for Priority on Check-in Process

1. Why is there no priority on the check-in process?
   - Because they have multiple jobs.
2. Why do they have multiple jobs?
   - Because they need to meet demand.

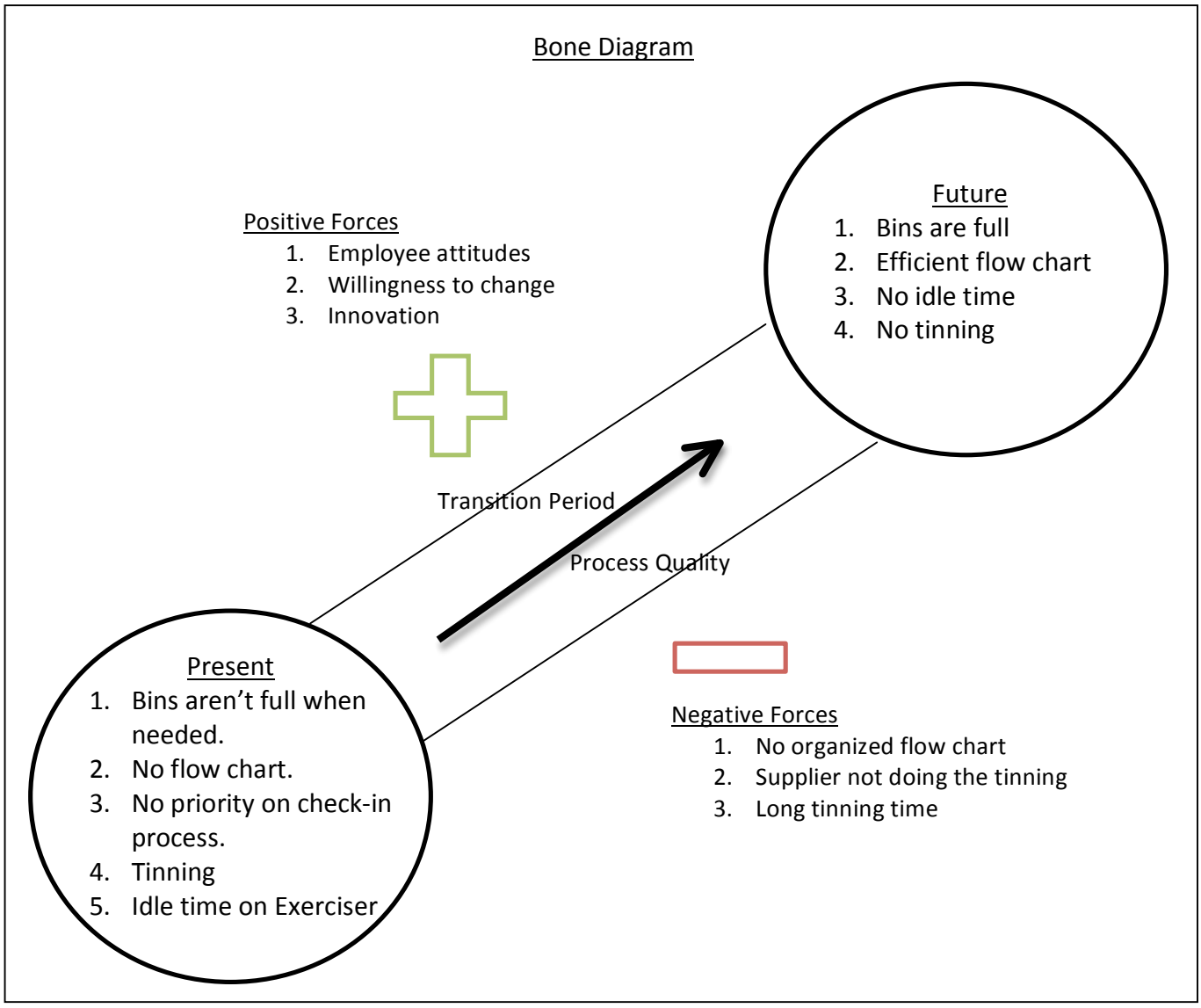
The Five Why's for Set Flow

1. Why is there no set flow?
   - Because there is no current flow chart.
2. Why is there no flow chart?
   - Because they haven't had the time.
3. Why haven't they had the time?
   - Because they need to meet demand.

However, using this tool for the team was different. They had two root causes, so they had to do a "why?" tool for each root cause. Starting with the basic "why?", the team found that the result on having no set flow and no priority both affect the meets with demand of the company. In addition, by having the results the same, this proved that the two root causes were equally contributing to the problem and it indicated that they could be interconnected.

Do: Select and Develop a Theory

After the team determined the root cause they began to develop a theory using a *Bone Diagram*. This tool is a reflection and planning tool that can help a team understand the big picture of change. In a *Bone Diagram*, a list of the present organization is stated first, which clarifies the current problem. Then a list of the future organization is drawn. This helps clarify the goal of the organization. Next, identify the positive forces that will create growth and the negative forces that will prevent growth.



This bone diagram helped the team see the overall process of getting from the present state to the future state. During this process, they found that the tinning on the 414 wire could be done for free by Michigan Scientific. This would eliminate labor time on the 414. Although the team

discovered the tinning problem, questions popped up in other areas. They wondered if there was a way to cut the idle time on the exerciser.

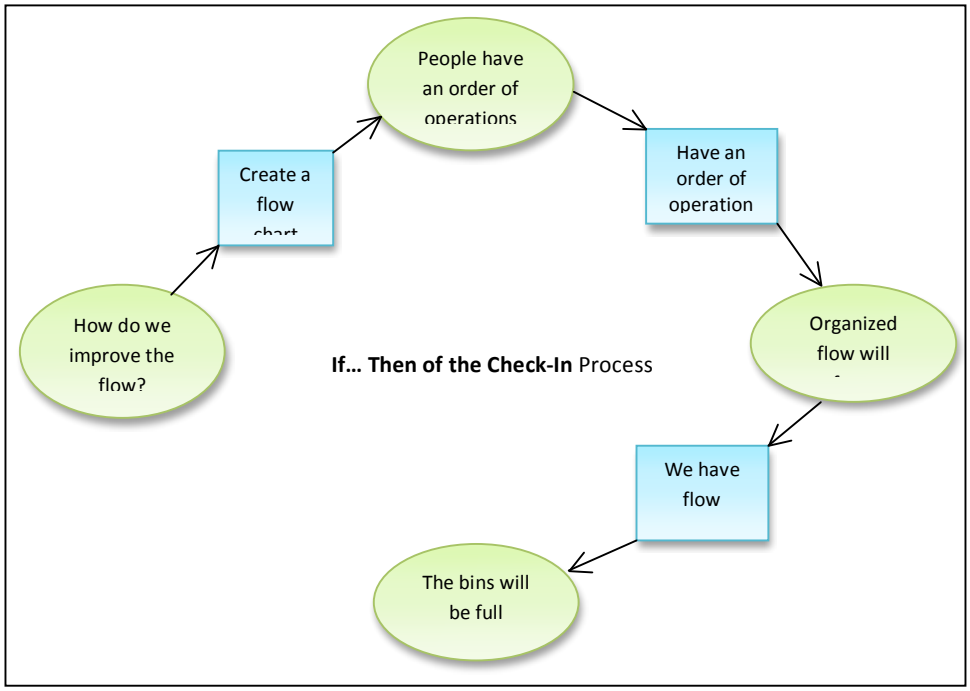
After using the bone diagram the team used the *Improvements: Brainstorming tool*. This tool can be used by a team to start thinking of ideas and solutions to certain problems. This tool is used to put a team's solutions on paper and how they positively affect the company.

Improvements: Brainstorming

1. Michigan Scientific put tinning on wires for no charge.
   - The tinning took a minimum of 4 hours for a batch of 100 sensors
   - Held up employees from other jobs
2. Make an updated Flow Chart.
   - To solidify the correct order of operations
   - Organize the employees
   - If needed, assign a work rotation to the check-in process
3. Set an alarm on the exerciser.
   - Decrease idle time
   - Would alert employees when the exerciser is done so it does not sit idle.

The chart above shows the potential solutions to ensure the sensor flow stays at the right speed so bins are full. This tool brought up the fact that the team needed to make a new flow chart of the sensor department. This led the team to suspect that they needed to create a flow chart arranged in the optimal manner for organized flow.

Knowing what had to be done, the team created an *If… Then Statement of the Check-in Process* in order to confirm their theory. An If…Then statement is created when the team thinks they have the answer to the problem and see if that is what the real answer could be. This tool is also used to find answers in a hypothesis of what could help the company fix some of the problems.



The *If… Then of the Check In* chart above shows what would happen if the *Suggested Flow Chart* was created. The tool confirmed their theory. After receiving this conformation the team created an updated flowchart that specified instructions upon how to work in the sensor department.

See the Appendix for the *Suggested Flowchart.* This tool is a flowchart that is used to makes steps to a process so one can follow these steps from start to finish and complete the task. This tool is used to organize employees upon what needs to be done and how this can be accomplished. This is created when a team sees that a group of people are unorganized.

The Flowchart shows how to complete the steps of sending a sensor the next department. This was the final tool in the process, and was included to help the company's problem. This led the team to finishing the project and giving the final recommendations.

Conclusion:

After a three day process of working through the PDSA cycle the team determined a flow chart would be of great use to the sensor production department. It should improve the flow in the sensor production process. The team also suggests that a timer be put on the exerciser to alert employees when the cycles are finished. This should reduce idle time on this particular machine and increase the flow. The team hopes that the solutions provided will be of use to RGJ in the next steps in the PDSA process.

Works Cited

Tool Time for Education: Choosing and Implementing Quality Improvement Tools. Molt, MT: Langford International, 2008. Print.

Appendix

Probletunity Overview

Quality Teams Employer Sponsor Worksheet

Lynx Sensor Build and Test Flow Chart

RJG Hitec Inventory

Flow Chart of Check-In Process

Suggested Flow Chart for the Check-In Process