Creating Good Jobs in Automotive Manufacturing

by

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Abstract

A stable workforce is critical to successful manufacturing operations. A stable workforce results in repeatability of jobs, which in turn leads to higher quality vehicles and decreased down-time on the assembly line. It also results in lower turnover costs and allows management to focus on performance improvement instead of putting out fires that arise throughout the workday. This research explores the current employment strategy of a major automotive manufacturer, and identifies key drivers that lead to the 11.8% annualized turnover rate they are experiencing, with some employee segments as high as 38%. Specifically, we dive into the dynamics of the Trim & Chassis Department, which has the highest employee turnover in the manufacturing plant, in order to identify how effectively Nissan is meeting employee needs, and where they can adapt in order to improve. The goal of this research is to identify the key drivers of turnover, quantify effects of turnover in an automotive manufacturing setting and to provide recommendations for how to reduce turnover.

Through a combination of data analysis, employee interviews, and Gemba walks, we find that workload, employee empowerment, and career development play a prominent role in this high-volume manufacturing environment. Employee turnover is 57% more costly than previous models predicted when accounting for indirect costs of employee turnover. I also find that using System Dynamics modeling can be an effective tool to model these interconnected variables in order to better understand the reinforcing feedback loops at hand, and how to address them in order to make positive change. Additionally, this research makes recommendations on how to use the Good Jobs Strategy framework to reduce employee turnover and improve performance. Specifically, we look at increased staffing levels, investments in people, and cultural wins, combined with a financial calculator for management to use in order to quantify their investments.

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Opportunity Statement and Overview

1.1 Opportunity Statement

In an increasingly competitive labor market in the surrounding areas of Nashville, Tennessee, Nissan's Smyrna Assembly Plant (NNA-S) has struggled to attract and maintain skilled labor talent. In late 2019 and early 2020, the local unemployment rate of Rutherford County, Tennessee was at a near all-time low of 2%, leading to significant turnover levels within their technician workforce, and levels as high as 38% annual turnover in some employee segments. This employee turnover within the technician population is problematic because NNA-S suffers from both the associated direct and indirect costs, making the entire plant less competitive under the global Nissan manufacturing umbrella.

NNA-S has historically tracked turnover rates as an annual percentage, as well as a 90-day turnover rate to quantify the number of employees who leave the company soon after joining. Additionally, they have historically tracked the estimated cost of technician turnover as simply the overtime coverage required to fill a position. Current accounting practice at Nissan uses only overtime coverage costs to quantify turnover, and the estimate is that each technician who leaves the company costs above $15,000 to replace. This is clearly a significant amount, and is only part of the total, true cost of turnover. As we will see, the cost of turnover encompasses much more than overtime coverage mentioned above; newer employees have higher defect rates, cause the assembly line to stop more frequently, and salaried Human Resources (HR) personnel must spend more time hiring, onboarding, and training employees to replace them, meaning that this $15,000 value is much higher in reality. Thus, we must first understand the true cost of turnover and the drivers of turnover, before moving to put in measures to reduce it. In a cost cutting industry such as the automotive industry, reducing turnover is vital, and if successful, will maintain Nissan-Smyrna's success as a leading manufacturer under the Renault-Nissan-Mitsubishi Alliance.

Nissan Motor Company, like other companies that compete in the automotive industry, relies on employees at all levels to expertly perform their jobs, from finance and accounting, to manufacturing, in order to produce high quality vehicles and deliver them to customers all over the world. However, although each employee's job is required in order to produce these complex vehicles, the heart and soul of Nissan lies with their frontline technicians who work tirelessly on the assembly lines, adding tangible value in each step of the manufacturing process as vehicles are built one step at a time through the system. At the Nissan Smyrna vehicle assembly plant (NNA-S), a stable workforce with strong attendance and skills contribute to higher quality vehicles and decreased down-time. It also results in lower turnover costs, and allows management teams to focus on performance improvement instead of putting out "fires" that arise throughout the workday.

The objective of this research is to analyze the current employment strategy of NNA-S, and identify how the turnover rate can be reduced. The scope of this research will encompass NNA-S' current labor structure, including contract workforce, within the Trim and Chassis department. This department will be used to understand where NNA-S should adapt to meet employee needs and how doing so will better position them to compete within the Nissan manufacturing portfolio.

1.2 Thesis Overview

This research was conducted in collaboration with employees from NNA-S and faculty from the Massachusetts Institute of Technology from February – August 2020. This thesis is organized as follows:

Chapter 1 offers motivation for the project and an overview of the thesis.

Chapter 2 provides a background of the automotive manufacturing industry, the history and current state of NNA-S and the types of frontline employees that work there, and a literature review that discusses key concepts and ideas that were applied during the duration of this study.

Chapter 3 describes the methodology and approach that was taken throughout this research, and outlines key initial findings.

Chapter 4 provides a deeper dive into the "Good Jobs Strategy" and how it can be applied in high-volume manufacturing environments in order to drive value to investors, customers, and employees.

Chapter 2

Background

2.1 The Automotive Industry

2.1.1 Industry Overview

The automotive industry is one of the largest industries in the world, with a global market value of $978B in 2019 according to a recent industry profile, but it has also been stagnant in terms of growth (with a slight decline) between 2015 and 2019, with a CAGR of -0.4%("MarketLine Industry Profile," 2020). The year 2020 also brought a significant downturn due to the onset of the COVID-19 pandemic—many manufacturing plants were forced to shut down due to concerns of spreading the virus, which halted production, and car dealerships were forced to close their doors as well which halted sales. Some manufacturers were forced to furlough employees and drastically cut costs in order to stay afloat.

Competitively speaking, the industry is comprised of a few major players to include both foreign and domestic manufacturers. The major manufacturers, or OEMs, include Ford, General Motors (GM), and Chrysler (U.S. based), as well as foreign companies such as Toyota, Honda, Nissan, Hyundai, and Volkswagen. Specifically, Toyota, Volkswagen, Hyundai Kia Automotive, and General Motors own almost 40% of the market, and the other manufacturers make up the remaining 60% ("MarketLine Industry Profile," 2020). The competition between these players is fierce—they compete on price, and differentiated product offerings in order to gain market share and sell vehicles to customers.

Profitability within the industry is largely driven by differentiation of products (the ability to charge higher prices for luxury vehicles, or additional features) as well as cost-cutting. Automotive manufacturers have to pay for labor, materials, and services, and source raw materials and other parts from additional suppliers further down the supply chain. Additionally, brand image is critical within the industry, and takes time to establish. This, coupled with the high fixed costs associated with manufacturing vehicles, makes this industry difficult to enter for new players—an enormous amount of capital is required in order to do so.

2.1.2 The Rise of Automation

There are varying opinions on how the future of automation will affect the labor force—some believe that the introduction of high-tech automation will lead to increased demand for highly skilled workers, thus leaving low-skilled employees without jobs and others believe that the introduction of this technology may just simply widen the skill gap between the two workforces, even if the number of jobs stays the same. Broadly, we know that automation and the use of robotics has increased within the United States—the number of robots per thousand workers has increased from 0.49 to 1.79 between 1995 and 2017 and in 2014, the automotive industry alone accounted for 54% of the total stock of robots within the U.S. (*The Rise of Automation*, n.d.). One recent study by MIT researchers has shown that automation has negatively affected both employee wages and the number of jobs—they concluded that for every robot per 1,000 workers added in the U.S., wages decline by 0.42% and the employment-to-population ratio (measure of employment) goes down by 0.2%, which means to-date, automation has led to the loss of 400,000 jobs across industries (Acemoglu & Restrepo, n.d.).

The automotive industry is no stranger to automation and is sitting at the forefront of robot adoption. Some of the first automation was introduced onto assembly lines as early as 1913 with the introduction of the assembly line by Ford. Since then, robots have become more complex, and more common throughout automotive plants, being used to pick up large parts, or to paint the outside of vehicles to ensure smooth application. Now, the automotive industry leads all others in robot adoption, with 38% of existing robots falling into this category (Acemoglu & Restrepo, n.d.). The use of automation certainly results in quantifiable efficiencies, and improved quality when used and implemented correctly, but the question will always remain: what about the employees?

2.2 Nissan Smyrna Assembly Plant (NNA-S)

Nissan is a part of the Renault-Nissan-Mitsubishi Alliance and has manufacturing plants located all over the world. Within the United States, Nissan has four plants located in three locations: Smyrna, TN, Canton, MS, and Dechard, TN. Each plant is responsible for delivering high quality vehicles (Smyrna and Canton) or powertrains (Dechard) to their customers all over the world.

2.2.1 History and Operations

NNA-S is located in Smyrna, Tennessee and has been manufacturing vehicles since 1983—it was the first automotive manufacturer in the state. Over the last 40 years, NNA-S has consistently produced various models of Nissan vehicles, and has remained an important strategic asset to the company. Currently, NNA-S is capable of producing 640,000 vehicles annually, the highest capacity in North America. The plant employs over 7,000 people in the six million square-foot facility and has also remained a non-union plant to this day. In addition to their regular Nissan employees, Nissan also utilizes a contract workforce within the manufacturing plant, Yates Services, whose employees work both on the assembly line and within the kitting and picking areas of material handling.

NNA-S is divided into two distinct manufacturing systems: Line 1 and Line 2, each consisting of its own flow of vehicles from start to finish. The lines are separated by model, with Line 1 producing Sport Utility Vehicles (SUVs), to include the Nissan Rogue, Nissan Pathfinder, and Infinity QX60 and Line 2 producing primarily cars, such as the Nissan Altima, Nissan Maxima, and Nissan LEAF[1]. Each vehicle undergoes the same process from raw material introduction to final assembly and inspection, and the manufacturing process is broken down into four distinct departments or shops after raw materials are received: Stamping, Body, Paint, and Trim & Chassis. After final assembly,

[1] Specific model production is based on the time this research was conducted. NNA-S began production of the Nissan Murano in late 2020 and the Nissan Rogue was shifted to System 2.

vehicles are thoroughly inspected prior to shipping to the customer. The complete vehicle manufacturing process can be seen in Figure 1.

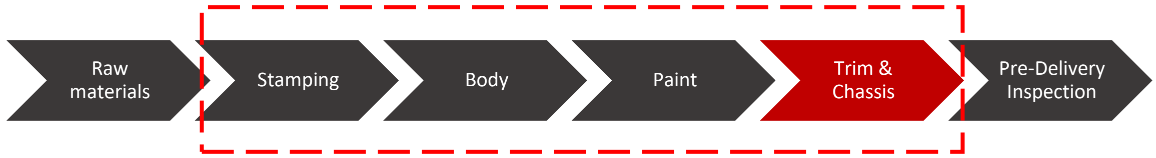

Figure 1: The vehicle production process at NNA-S by department

NNA-S operates on a three-shift rotation, five days per week, and each shift is broken down in Appendix A to include break times. Zone Supervisors are expected to arrive at the facility 30 minutes prior to shift start, and technicians must arrive in time to participate in warmup exercises as well as receive information from the Zone Supervisor prior to production.

On the assembly line, NNA-S operates with a system similar to the Toyota Production System and it is referred to internally as the Alliance Production Way (APW). Andon cords are placed along each assembly line so that technicians can pull these cords if there is any type of issue such as quality defect, incorrect part, etc.—these calls are referred to as "help calls." Once the andon cord is pulled, either the "off-line technician" or "line leader" will respond to the help call, and attempt to fix the defect if there is a quality issue, or assist the technician with whatever they need assistance with. After this, they will log it in the defect tracking system. This defect tracking system can be accessed by all members on the plant floor, and is used for both assigning responsibility of the defect, and ensuring it is fixed before the vehicle is delivered to the customer. If a defect is found at the Pre-Delivery Inspection (PDI) point following the final line assembly, the vehicle is taken off of the line, and to a repair area to be fixed. This process is much more expensive, especially if it involves rebuilding certain areas of the vehicle.

It is important to note that there are a couple of metrics that will be discussed throughout this research when discussing the effects of employee turnover: quality and downtime. Quality is measured at NNA-S mainly by Defects per Hundred Units (DPHU) and downtime is measured as a unit of time depending on the length.

2.2.2 Trim and Chassis Department

As seen in Section 2.2.1, the Trim and Chassis (T&C) department within both systems (car and SUV) begins when a freshly painted body enters the assembly line from the paint shop. T&C is the area of the plant where the unit actually begins to look like a vehicle, and the entire T&C department encompasses five individual assembly areas: Trim Line 1, Trim Line 2, Trim Line 3, Chassis Line, Ring Line, and Final Line. Additionally, there are three feeder lines including Engine Dress Line, Door Line, and IRS Line.

- <u>Trim Line 1</u>: The vehicle enters T&C at this point. All doors are removed to avoid scratching, and parts such as wiring harnesses, air bags, and sunroofs are installed.
- <u>Trim Line 2</u>: Additional wire harnesses, rear hatch, headliner, seatbelts, quarter-glass, gas and brake pedals, and the cockpit module are installed.
- <u>Trim Line 3</u>: Roof racks, windshield, and spoilers are installed onto the vehicle.
- <u>Chassis Line</u>: Engine components finished to body along with vehicle exhaust, front and rear fascias, and wheels and tires are installed.
- <u>Ring Line</u>: Parts of suspension and engine are installed into the vehicle.
- <u>Final Line</u>: All fluid tanks are filled or topped off, seats installed, and final checks made prior to sending the completed unit/vehicle to Pre-Delivery Inspection (PDI).

Figure 2: T&C breakdown by individual assembly lines

T&C is known within the plant to be physically demanding. Each technician easily installs hundreds of parts over their eight-hour shift, some which require awkward positions, or repetitive motions that can make certain muscles sore, especially for technicians with less experience than others. Since the manufacturing environment is a vertical structure as mentioned above, most new technicians are sent to this department, on the afternoon or night shift (off-shifts), since more tenured technicians at the company have “done their time” and transferred to a less physically-intensive department such as paint or stamping.

Figure 3: A technician on Trim Line 2 installs a wiring harness into the floorboard of a vehicle

2.2.3 Summary of Employee Types

Below is a brief summary of the different employee types at NNA-S. As mentioned in Section 2.2.1, Nissan partners with a contract workforce, Yates Services, in order to fill manpower needs.

- Yates Classic: Contract employees who work in the kitting and picking areas of the plant. These employees sort various parts, fill kit carts that are delivered to the main assembly line, and inspect incoming parts for damage. They are the lowest wage employees.
- Yates Associate: Contract employees who work on the main assembly line. Primary responsibilities include installation of parts and checking for defects. These employees earn a small premium above their Yates Classic colleagues due to the additional strain of working on the assembly line.
- Nissan Pathways: Employees who have worked as Yates Associates, and who have met minimum requirements to be hired as Nissan-paid employees. These employees earn a wage premium over their Yates counterparts and have access to additional benefits such as the lease car program, 401k program, and different healthcare plans.
- Nissan Legacy: Older generation employees who were Nissan employees prior to the establishment of the Pathways program. They have access to benefits they were granted when they joined the company that are no longer available, such as a paid pension.

2.2.4 Organizational Structure

Manufacturing organizations are typically structured vertically, and NNA-S is no different. This structure's positive aspects include that it "encourages efficiency, promotes collaboration, and provides opportunities for further development or professional expertise and a path for growth within the organization" (*Advantages & Disadvantages of Vertical Organizational Design*, n.d.). Specifically, this vertical structure allows Nissan to clearly define responsibilities and distribute work among employees, as well as assign defects and other issues for resolution to the required and responsible party. It also allows technicians to learn their craft, and work their way towards a supervisor position. Nissan's "plant manager" position is held by a Vice President who presides over the entire facility. Additional personnel that comprise the "management" team under the VP include six Directors of production: Stamping/Body, Paint, Supply Chain, Trim & Chassis, Maintenance, and Manufacturing Strategy, ten Senior Managers, and 25 Section Managers.

- Senior Managers: Responsible for all shifts in specific departments within an assigned plant to include Body, Stamping, T&C, etc.
- Section manager: Responsible for their specific department on a designated shift, and individual assembly lines within the larger system as a whole.
- Zone Supervisors: Frontline managers on the plant floor responsible for a "zone" within an assembly line. They typically have 15-30 technicians who report to them.
- Line Leader: The most senior technician within a zone. Have additional preventative maintenance responsibilities and respond to andon cords while the assembly line is running. This role is paid with an hourly wage and Leaders earn a premium over their counterparts.
- Off-Line Technician: Technician who knows each process within the zone and is dedicated to respond to andon cord pulls during the shift and to fix any defects before a vehicle leaves the zone. Additional to the Line Leader.
- Technician: Responsible for installing parts and completing various processes as vehicles pass through. Each "job" is completed within a single "pitch" which is a stretch of the assembly line.

2.2.5 The Hiring Process

All new technicians are hired as Yates employees. Nissan and Yates partner with companies such as Indeed, in order to post job descriptions and accept applications. An example of a technician job posting (specifically for the kit/pick area although mainline postings are similar) can be found in Appendix B. The entire hiring process is broken down as follows:

- Application Intake/Screening: Application received through online posting submission, or in-person submission at Nissan plant. This is a "red flag" check that looks for constant turnover of jobs, etc. There are currently no education or criminal requirements.
- Interview: Within a day or two, candidates interview with Yates Human Resources (HR) personnel who are typically former technicians and supervisors themselves. Interview is a "get to know you" assessment, and goal is to find out why the candidate wants to work at Nissan.[2]
- Background Check/Drug Screen: Within two to three days, candidates who have successfully completed the interview process have a background check and hair follicle drug test. This screening can last up to one week.
- Orientation: The first Monday after drug screening and background check are completed is orientation for the candidate. This half-day session is an introduction to Nissan, safety discussions, and guest speakers.
- Training Area: New technicians start at the training area before going to their assigned zones. For mainline (ML) hires who are going to the assembly line, this is a slow, simulated assembly line station that allows them to build confidence and work on basic skills. For Yates Classic hires heading to the picking and kitting area, they are sent to a different, specific training area.
- Arrive at Zone: Technicians arrive to a zone once they are deemed able to complete basic tasks, and then their zone-specific training begins. Technicians are trained on two jobs/processes to begin with. They are also placed into a "soft landing" program which is a mentorship program designed to check-in on new hires and ensure they feel comfortable during their first 30-days.

[2] Since this study was conducted, a new, behavioral component has been added to the interview stage.

2.3 Literature Review

2.3.1 *The Good Jobs Strategy*

Developed by MIT Professor Zeynep Ton (2014), The Good Jobs Strategy (GJS) is a system that is founded on the premise of investing in employees in order to achieve superior results. She has studied numerous high-performing organizations who have been able to maintain high levels of employee satisfaction and profitability in industries where competitors have failed to do so, most notably, the retail industry. The Good Jobs Strategy focuses on four main operational pillars: Operate with Slack, Focus & Simplify, Cross-Train, and Standardize & Empower.

- <u>Operate with Slack</u>: Staff units with more labor hours than the expected workload, so that they are able to meet customer demand during peak periods. This allows employees to work without making mistakes, and to serve customers how they are expected to. Additionally, this allows managers to focus more on performance improvement and employee development and less on last-minute scheduling.
- <u>Focus & Simplify</u>: Simplify customer offering and employee tasks in order to reduce variability, improve performance, and provide predictable schedules.
- <u>Cross-Train</u>: Train employees to perform a multitude of tasks which allows the workforce to be more versatile. This also improves employee motivation because they are able to learn new skills and help the team in new ways.
- <u>Standardize & Empower</u>: Standardize routine processes while empowering employees to improve them. This gives employees a feeling of creativity, and also increases employee motivation because it shows them that management listens to their voices.

Additionally, Ton emphasizes the significance of companies meeting employees basic, and higher needs, represented in Figure 4--these needs are based on Maslow's research on human psychology as well as Herzberg's theory of motivation. Throughout the analysis within NNA-S, these needs will be referenced, and metrics will be quantified to determine how successful the organization is at meeting these needs of their employees.

Figure 4: Employee Hierarchy of Needs (Ton, 2014)

By investing in employees, putting them first, and making operational decisions that improve employee motivation and productivity, companies who employ the Good Jobs Strategy can create superior value for employees, customers, and investors.

2.3.2 Drivers and Consequences of Turnover

There is a lot of research that dives into key drivers of employee turnover, and these findings cover a broad range of reasons, from job-related drivers to organizational-related drivers. For the purposes of this research, we will look at turnover drivers internal to an organization, and ignore broader labor market conditions, even though these certainly do play a role in employee turnover. Job-related factors can include reasons such as employee stress, job dissatisfaction, or even a sense of loneliness (Ongori). These are second-order consequences however, and typically are a result of the organization's failure to provide employees with the basic and higher needs represented in Figure 4. For example, if an organization does not provide employees with a living wage, this adds a large amount of stress on the individual who has to now juggle financial stressors with those associated with their job. We can also look at the organizational-structure issues which lead to turnover, which also tie back into the employee needs hierarchy. At a high-level, organizations that seem to be in turmoil or unstable, tend to have higher employee turnover. These organizations lack predictable work schedules (basic need), find themselves in a cost-cutting situation which leads them to treat employees quantitatively (feeling of belonging), and even cut employees out of key decision-making processes (meaningfulness).

There are some mixed conclusions on the effects of turnover and their magnitude. Some researchers have noted that turnover can be a positive thing, and that it allows new employees with new thought processes to enter into an organization and drive change due to diversity of thought. Other researchers focus on the negative consequences of turnover, such as reduced performance, lost experience, and high costs associated with hiring. At a management level, or at an organization that is reliant on innovation, it is more likely that turnover would have a lower effect, and may even benefit from the reasons above, but in industries that rely on repetition of known tasks, these consequences can be much more severe. For example, in an analysis of the book store chain, Borders, Ton and Huckman analyzed frontline employees at multiple stores, whose roles were to stock shelves, assist customers, and manage inventory (Ton & Huckman, 2008). They found that on average, employee turnover negatively affected store performance as measured by profit margin and customer service across all stores.

2.3.3 System Dynamics

System Dynamics is a way to visualize and analyze complex systems. These systems may be strictly behavioral, technical, physical, or may even be a combination of all three. Regardless of the type of system, System Dynamics models are a useful tool when attempting to solve complex, real world problems.

2.3.3.1 Feedback Loops and Modeling

There are two types of feedback loops within System Dynamics: positive (self-reinforcing) and negative (self-correcting). Positive loops reinforce whatever is happening in the system; for example, a firm lowering its price to gain market share may result in competing firms also lowering price, causing the original firm to reduce the price further. Although this is a “negative” example, positive loops can also be the cause of extreme growth. Negative loops oppose change—they seek equilibrium and balance. For example, a negative loop might be as the price of a commodity increases, the lower the demand becomes, and as inventory increases, the firm must lower the price to regain competitiveness. It is important to note that the use of the words “positive” and “negative” strictly refer to these types of loops within System Dynamics, and that either type of loop can be good or bad.

The modeling process within System Dynamics is iterative, and Dynamics can be broken down into five steps seen in Figure 5. In order for one of these models to be useful, the problem must be scoped accordingly, and therefore the model must address a specific problem within an organization—in this case, turnover. The next step is developing a dynamic hypothesis as to what may be driving the problem. This is a working theory, and must be revisited within each iteration in order to ensure the model is matching the real-world system. According to Sterman, the next step, formulation, is important because “formulizing a conceptual model often generates important insight even before it is ready to be simulated” (Sterman, 2000). For the purposes of this study, no equations will be used to model the systems, and thus we will ignore step four in this process. Finally, step five is a significant step within the System Dynamics process because it involves approaching the client and working with them to enact policy change to address the problem at hand. The purpose of these policies must be to change dominant feedback loops, in order to fundamentally change the current, real-world system.

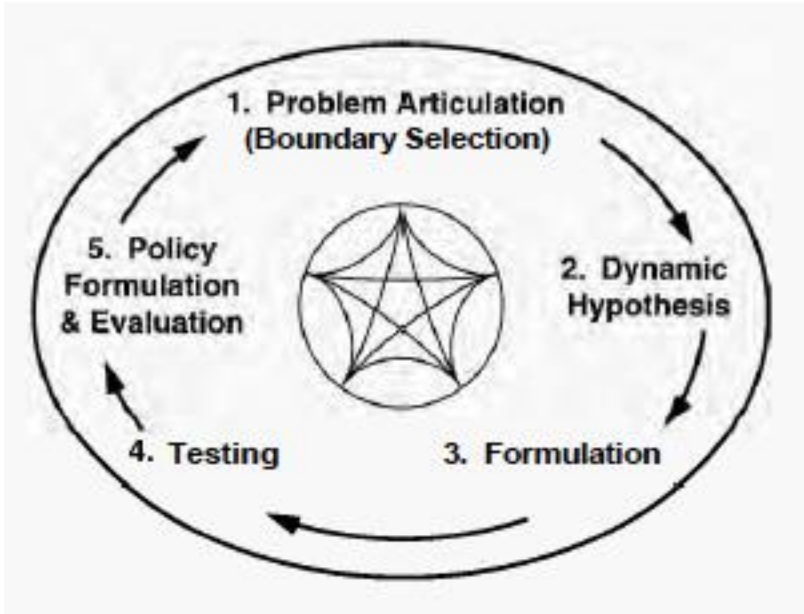

Figure 5: Five main steps of System Dynamics

The way models are represented in System Dynamics are with Causal Loop Diagrams (CLDs). These diagrams consist of variables that are linked with arrows which annotate the relationship between them. Additionally, important feedback loops are noted within the diagrams. The variables are related by “causal links” that are also annotated with a “polarity.” These polarities define how one variable affects the other: for example, a positive polarity means that as you increase one variable, the related variables also increases. A negative polarity would mean that as one variable increases, the related variable would decrease. An example of a CLD can be seen in Figure 6.

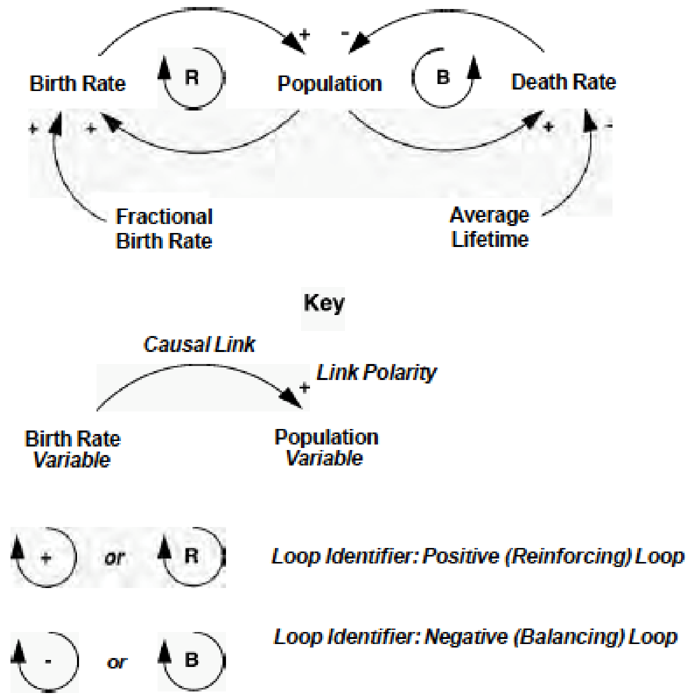

Figure 6: Example of a CLD used to model birth rate and average lifetimes

2.3.4 Field Failures

Many factors are related to product reliability, including complexity, workers' skill level, or even efficiencies of machines. One factor that has not been studied as often, is worker turnover in the manufacturing process. Moon, Loyalka, Bergemann, and Cohen used data from a major consumer technology goods producer and one of its contract manufacturers in China to relate product reliability to factory workforce turnover (Moon et al., 2021). This research was able to track multiple types of defects via warranty claim data, back to the exact week the unit was manufactured, and using the number of worker quits, were able to examine this relationship effectively.

The main hypothesis in this research was that worker turnover did in fact affect product reliability, and that it would manifest through two causal channels. When workers quit, the overall experience level of the staffed assembly line goes down, and since the work of a new hire would be assumed to be lower than one more senior, they would be more likely to make mistakes. Secondly, the actual process of replacing an individual may be “disruptive,” and divert the attention of workers and supervisors.

The results of this research show that, after controlling for multiple outside factors, “worker turnover's post-payday peaks make field failures 7.1% to 7.6% more likely. Even in other weeks, the mean level of worker turnover boosts field failures by an estimated 1.1% to 2.3%, and by 1.6-3.3% for worker turnover's 75th percentile” (Moon et al., 2021)

Chapter 3

Methodology and Initial Findings

3.1 Gemba Walks, Employee Interviews, and Data Collection

For the duration of my research, I was located at the NNA-S facility in Smyrna, Tennessee, and was unable to conduct site visits at other Nissan facilities due to the travel restrictions associated with the ongoing coronavirus pandemic. All of this research was conducted across three shifts, specifically within the Trim and Chassis (T&C) department which accounts for roughly 38% of all technicians in the plant, and has an employee mix that is consistent with the entire plant at large as well. It is important to note that the methodology used throughout this research closely follows the GJS framework outlined in Chapter 2, and that the fundamental pillars of the GJS were examined during each phase of this research.

As mentioned in Chapter 2, NNA-S maintains turnover data within their internal systems, and tracks employee exits surveys in order to tag the reasons why employees leave the company. Figure 7 is a breakdown of the fiscal-year 2019 turnover based on HR-based exit interviews. As we see, the majority of employees who left the company did not provide reasoning for their departure ("no information"), which Nissan refers to "no call, no shows." This is an ongoing issue within the organization, and stifles the attempts to reduce turnover, because issues are unable to be addressed unless they are identified. Additionally, this is the entire FY19 turnover data set, to include all departments. To verify this distribution is representative of the T&C department, the interviews that were conducted with employees addressed reasons for turnover.

Additionally, we see that "shift" is the second reason for turnover according to exit surveys. New technicians, when hired at NNA-S, are always assigned to either the afternoon shift or night shift (both considered "off" shifts) because the shiftwork system at NNA-S, like other OEMs, is based on tenure at the company. Technicians must earn their way to working day shift, and this is typically a process that can take years depending on openings in other shops. For this reason, this research does not address this driver, and instead will focus on job difficulty, work/life balance, personal health/medical, attendance, wage, career, and job fit.

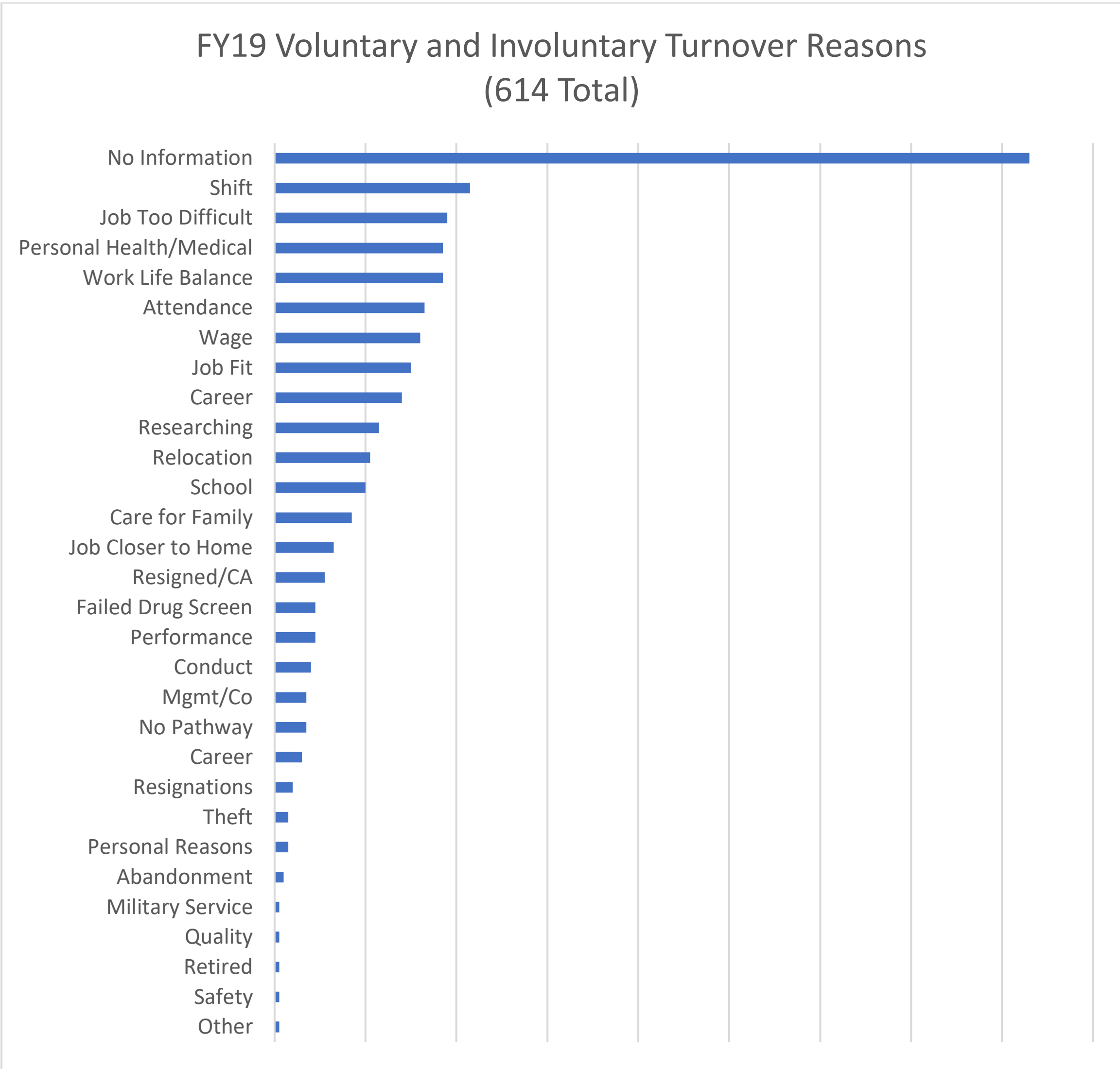

Figure 7: FY19 Turnover reasons for all technicians at NNA-S

3.1.1 Gemba Walks and Employee Shadowing

To learn the general structure of NNA-S and KPIs that are tracked, I spent as much time as possible on the plant floor. I shadowed different Zone Supervisors in order to understand the daily processes that both frontline employees and managers complete as part of their jobs. Zone Supervisors' daily work includes managing technician attendance, following defect tracking protocols, maintaining other KPIs for their respective spaces including downtime, overtime, scrap costs, etc., and working on quality-related "problem solving activities" for high defect items. Technicians sole responsibility once they arrive at the plant is to complete their assigned jobs, with no defects, on the assembly line.

Similar to other manufacturing environments, NNA-S has a dress code and depending on what someone is wearing you can quickly get an idea as to who they are, and their role in the organization. At Nissan, management typically wears a bright red, Nissan golf shirt, although technicians are allowed to wear as well (though not typical). The management at NNA-S is generally looked at positively, but the same sentiments arise within the workforce that are typical of most hierarchical environments, such as an "us versus them" mentality. Since I was issued this exact uniform typical of management personnel, and it is what I wore daily, I realized it could possibly affect how I may be viewed form the technician's, and even the Zone Supervisor's point of view. To build credibility within these two groups and to be able to see genuine interactions between people, I ensured each technician and Zone Supervisor knew the scope of my work, and that I was working on research to make their jobs better and more fulfilling—I was not one of "them" referring to management.

One of the key takeaways from these observations was that the interactions between Zone Supervisors and technicians were overwhelmingly positive. Technicians love to talk about their jobs, and the teamwork mentality of a zone really shines through when a Zone Supervisor walks the line and checks in on each technician during one of the production runs of the day. However, it was clear that this was not achievable given the current status quo and structure of the plant floor. The Zone Supervisor workload very often took them away from tasks such as developing technicians and focusing on their major quality issues within the zone. Most days, Zone Supervisors were busy fighting attendance fires, and finding personnel to fill their required to operate (RTO) manpower for that shift. If they were unable to fill the positions with technicians from other shifts using overtime, the Zone Supervisors themselves were forced to work on the assembly line themselves in order to meet RTO and resume production. Additionally, this means that one of either the “off-line” technician or “line-leader” would be required to work on the assembly line, leaving the other to respond to all help calls by themselves. These shifts were chaotic, and often resulted in reduced quality (higher DPHU) and lower employee morale from both the technicians and the Zone Supervisors themselves. These shifts also meant that the Zone Supervisor was unable to perform their required administrative duties for that day, and had to stay later at the plant in order to complete them. This major insight showed the necessity to quantify this phenomenon, so I developed a Zone Supervisor survey on the topic.

3.1.2 Employee Interviews and Surveys

3.1.2.1 Employee Interviews

Although I was able to learn general Section Manager, Zone Supervisor, and technician sentiments regarding the causes and effects of turnover, during informal conversations in the break areas or on the assembly line, the information was not granular enough to move forward with analyzing. Thus, one-on-one interviews were conducted with five Section Managers, five Zone Supervisors, and 15 technicians across all shifts and zones, in order to dive deeper into the causes of turnover. Each interview lasted approximately thirty minutes, with the goal of examining their personal experiences as well as why they thought people left (most technicians still kept in touch with others who left the company). In addition to these broad topics, the interviews covered specifics such as their employment history, whether they feel connected to the customer, the current turnover trends and reasons for them, and general frustrations about everyday life within the T&C shop. Although I chose a variety of employees to interview in order to obtain a representative sample, I also worked with Nissan leadership to select individuals who they believed would not be overly positive or negative, in order to avoid any potential bias during the interview process.

There are a few major takeaways from these conversations that drove the next steps of the research process: high workload, lack of career development, a lack of voice and empowerment, and poor benefits. These common themes and drivers of turnover tie directly back to the concept of meeting employee needs introduced in Section 2.3.1, specifically the hierarchy of basic and higher needs. The fact that there were common themes in all of the interviews showed that none of the interviewees were providing biased responses, or responses that would not apply to the rest of NNA-S. Now, it is important to note there is a difference between complaining about a shift, and feeling overworked. It is important to also note that there were multiple positive points and experiences brought up by technicians. Many spoke of the team-oriented experience of working on the assembly line, in addition to the connection they felt to the customer. For example, one technician said "I know my job is important, and that I need to do my job well because my family might be driving this car one day."

Although the term "high workload" is broad, we can actually see that this issue prevents Nissan from meeting employee needs in the current state. Ten of twelve technicians noted that due to manpower shortages (from turnover and attendance problems), they had worked the same job every day because there was never enough personnel slack to allow them to train on new processes. For example, since the zone was required to constantly fill manpower gaps, new employees who only knew one job would be forced to only work that job, while overtime technicians worked the other jobs. This directly affects technicians' personal growth, and leaves them feeling unaccomplished, and frustrated at the everyday repetition of performing the same job. This also drives a lack of engagement within the workforce, and can be a source of quality issues when these technicians become complacent.

Technicians further elaborated on this point, but in the context of career trajectory. Technicians explained that they often felt a sense of being "stuck" in their place at Nissan, and that there was no room to move up, or even to another shift due to a backlog of senior personnel. As mentioned above, this is not simply being "promoted" although that is part of the issue, but due to these manpower shortages, employees are not even given the opportunity to obtain new skills, and further their personal skillset which would thus make them more competitive for a follow-on promotion. New hires are always sent to afternoon or night shift, and the time to get onto day shift was sometimes multiple years. This is an example of a failure to meet a basic need, specifically providing a career path for technicians. One technician described this as “short term [Nissan] support[s] my goals, but not the long-term. [There is a] lack of opportunities to elevate yourself and move up in the company.”

The final two themes, lack of engagement and benefits, also tie back to the hierarchy of needs. Even though there is a Kaizen program at NNA-S, technicians still felt as though their ideas were never making it to the management level for review, and thus felt without a voice. This, coupled with a lack of on-on-one time with their Zone Supervisors, led to the lack of engagement feeling, and did not give technicians a feeling of empowerment whatsoever. Without a sense of empowerment, or belonging, technicians are unable to emotionally invest in the organization, and do not build a sense of trust with management. Arguably the most researched and discussed need is compensation, both pay and benefits. 100% of technicians interviewed listed “healthcare” as their most important benefit. This was chosen over hourly wage, 401k, and the employee lease car program[3]. Nissan technicians were disgruntled with their current healthcare plans, claiming that they would receive expensive bills and that the system was difficult to use. Some technicians told me that they wished they were still Yates employees so that they could access the healthcare benefits again. On the other side, the Yates Associates who were interviewed also listed their healthcare plan and the most important benefit, except this response was overwhelmingly positive.

3.1.2.2 Frontline Manager Surveys

As mentioned in Section 3.1.1., from observing the Zone Supervisors on a daily basis, it was clear that there was a large amount of variability within their day-to-day

[3] Nissan’s Employee Lease Program is available to Nissan employees only (not Yates) and gives access to Nissan vehicles for a reduces monthly rate.

workload, mostly attributed to absenteeism and staffing levels. I created an anonymous survey and sent it to all Zone Supervisors within T&C in an attempt to quantify the effect of this variability. Questions included estimated time spent on required administrative items, whether they felt like they have enough time in the day to complete those items, and whether they had enough manpower allocation within their zone in order to meet required targets set by management. Figure 8 summarizes the results of the Question 3: “How much time (in minutes) do you spend on each of the following, per day, on average?” The options Zone Supervisors were allowed to choose from came from the daily Zone Supervisor task list, that was developed by Nissan internally, and includes items such as Alliance Production Way (APW) requirements, addressing quality concerns, managing employee attendance and callouts, updating boards in their spaces which show zone performance, technician interactions, and time spent working on the line themselves.

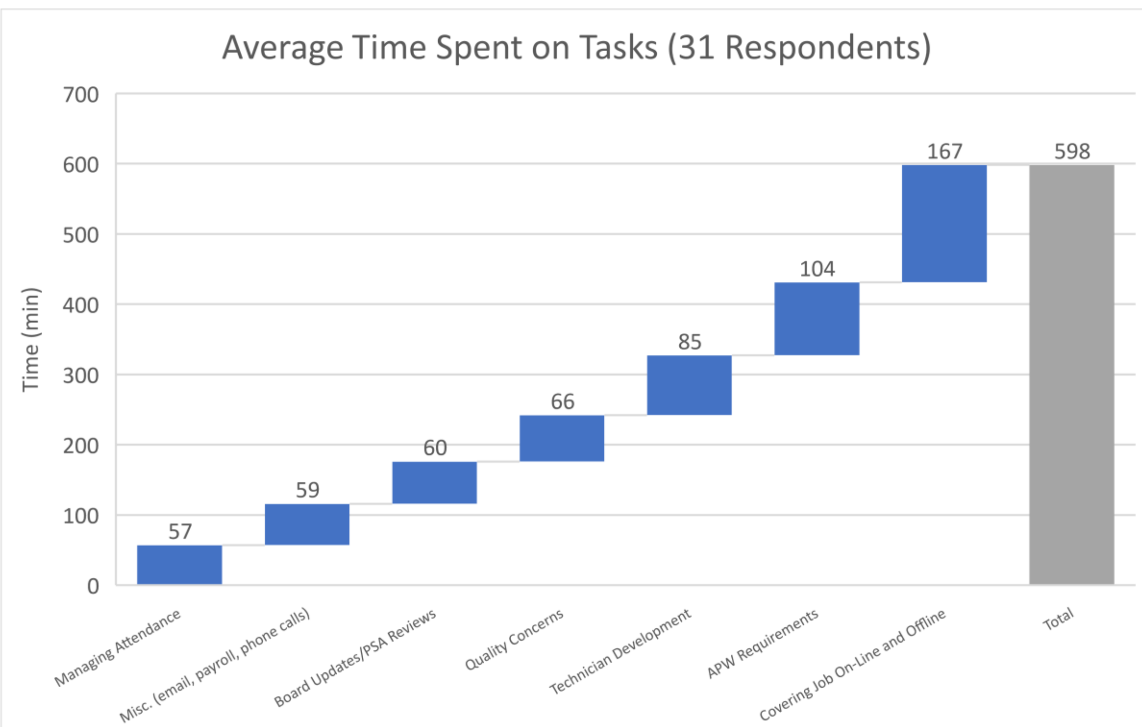

Figure 8: The average amount of time spent (in minutes) on daily tasks according to 31 Zone Supervisors in an anonymous survey

As we see in Figure 8, according to Zone Supervisors, "Covering Job On-Line or Offline" accounts for an average of 167 minutes (almost three hours) per day. Although there may be some bias within these numbers, and typically human beings do not estimate time well, this is a confirmation of the phenomenon that was observed during the Gemba visit, and the beginning of quantifying the true effect. The operational side effects from a system that operates like this can be devastating, as well as the effect this can have on an employee's mental stability and health. For example, "technician development" was estimated to account for an average of 85 minutes (likely a large overstatement due to personal observations and interview responses) during a Zone Supervisor's day. This may seem sufficient, but when we add in the variability of these days (discussed later in this paper) we can see that this might not be enough. Without time for one-on-one discussions or employee development, feelings of abandonment, or lack of empowerment can creep into the minds of technicians, and we have already seen that those feelings existed from the interviews in Section 3.1.2.1. Although the average "total" time committed to these tasks is approximately ten hours per day, the variability makes it difficult for these frontline managers to have predictable schedules, and takes them away from important softer tasks such as developing their technicians.

Though we can see from Figure 8 that Zone Supervisors spending time on the assembly line is an issue, only 22% of these supervisors claim to have enough time to do their jobs well on a daily basis. On top of that, just 16% of Zone Supervisors claim to accomplish all of their required tasks (assigned by management) each day. These missed items could include safety audits, job observations, and one-on-one check-ins with technicians. Not doing these tasks may go unnoticed for a few days, but the effects that this has in the long-term can be part of the reason technicians feel neglected or stressed out on the assembly line. These costs of turnover will be further evaluated later in Chapter 3.

These insights drove further action to analyze these effects, and an Industrial Engineering work study was performed on multiple Zone Supervisors, in order to get a more accurate assessment of their day-to-day processes (Section 3.1.3.3).

3.1.3 Data Collection

To understand drivers and costs of turnover, I used existing data within Nissan's systems and conducted Industrial Engineering time studies in order to quantify them.

3.1.3.1 Living Wage Analysis

Pay and benefits are "basic needs" for employees. Workers all over the world need adequate pay in order to live comfortably. At the same time, companies cannot expect employees to perform their jobs well if they are stressed about finances, or focused on making ends meet due to low pay or inadequate benefits. In order to dive deeper into the pay and benefits of mainline technicians, we can conduct a living wage analysis, which provides insight into how many of these employees earn a true, living wage. M.I.T has a "Living Wage Calculator" that estimates the cost of living based on a specific area and zip code within the United States. This living wage model is different from the federal poverty threshold typically used to determine economic policy in that it accounts for expenses such as childcare, healthcare, transportation, and other basic necessities such as clothing and also varies based on geographic location. Additionally, this model is only a "step up" from the poverty level—it accounts for the most basic needs by a family, and "does not account for what many consider the basic necessities enjoyed by many Americans.[4]"

Figure 9 shows the 2019 Nissan wage data for all Nissan technicians[5] compared to living wage for three households: 1- sole earner, 2- two earner, four-person family, and 3- single working parent with one child. The annual wages in this analysis include all paid "straight time" hours in addition to "overtime" hours, so this distribution does depend on how many overtime hours technicians signed up for during this fiscal year.[6]

[4] All assumptions behind MIT's Living Wage Calculator can be found at https://livingwage.mit.edu/resources/Living-Wage-Users-Guide-Technical-Documentation-2020.pdf
[5] Yates Services was unable to provide contract workforce wage data for this research. Living wage analysis was completed for Nissan workforce only.
[6] Actual wage amounts have been removed for confidentiality purposes.

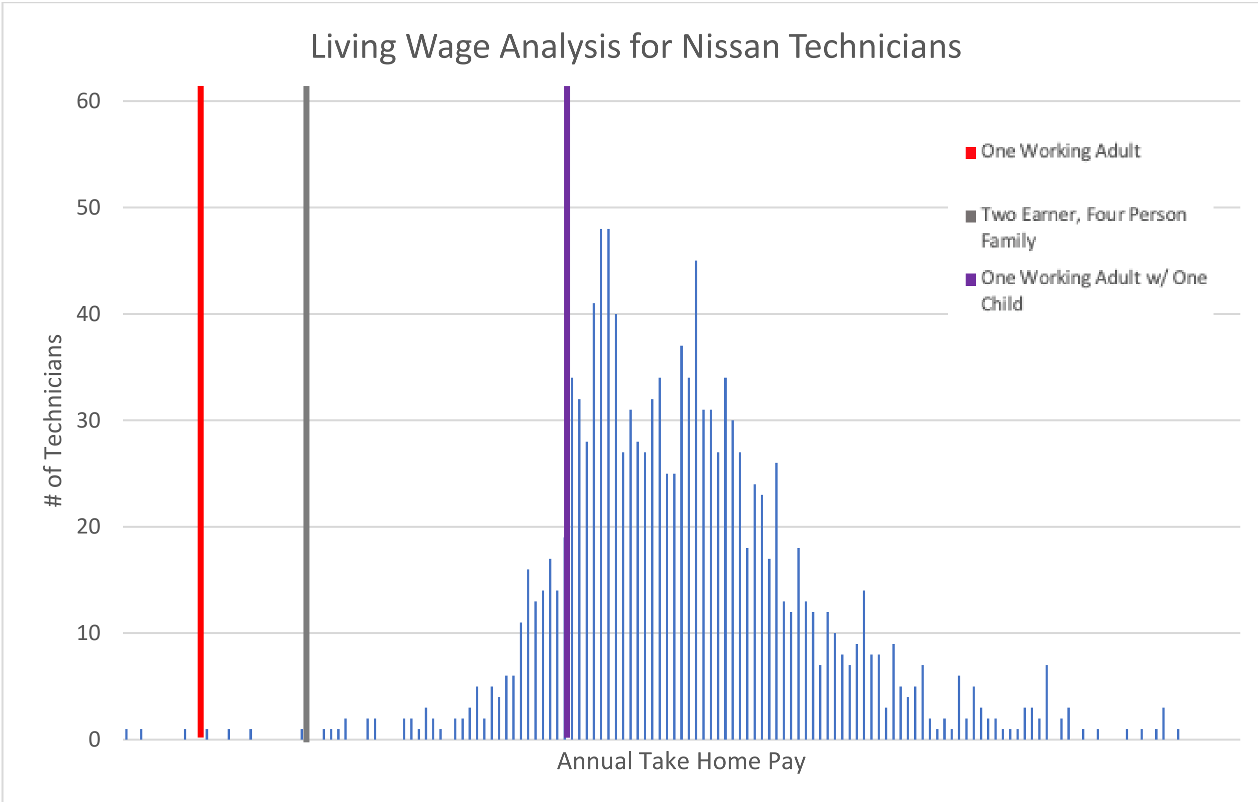

Figure 9: 2019 Wage distribution among Nissan technicians

We see that almost all technicians at NNA-S make above the living wage for two-earner four-person family and 86.4% make above the living wage for a single parent with one child. Coupled with the insights from the interviews that no technician listed "wage" as their most important benefit, or a top reason for leaving, low pay is likely not the most important driver to focus on—unless a significant number of Nissan technicians are from single parent households. To obtain more accurate percentages, more details regarding employee families would need to be collected.

Table 1: Percentage of NNA-S technicians who earn a living wage

Living Wage Hurdle	% of Technicians Earning This Wage
One Working Adult	99.1%
Two Earner, Four Person Family	98.9%
One Working Adult w/ One Child	86.4%

3.1.3.2 Bell-to-Bell Study of Frontline Managers

Earlier in Chapter 3, we saw that there was a pattern of frontline managers constantly putting out fires instead of focusing on improvement of operations or developing their employees. This fire-fighting is typically a symptom of not operating with slack, as Ton writes in the GJS, and as we have hinted to already, the effects can be significant. In order to finally quantify this effect on a more granular level, an Industrial Engineering (IE) workload/bell-to-bell study was performed on three different Zone Supervisors within T&C--one from each shift. The bell-to-bell study tracked how much time a Zone Supervisor spent on their required APW tasks, as well as if they spent time on the assembly line or acting as the off-line technician.

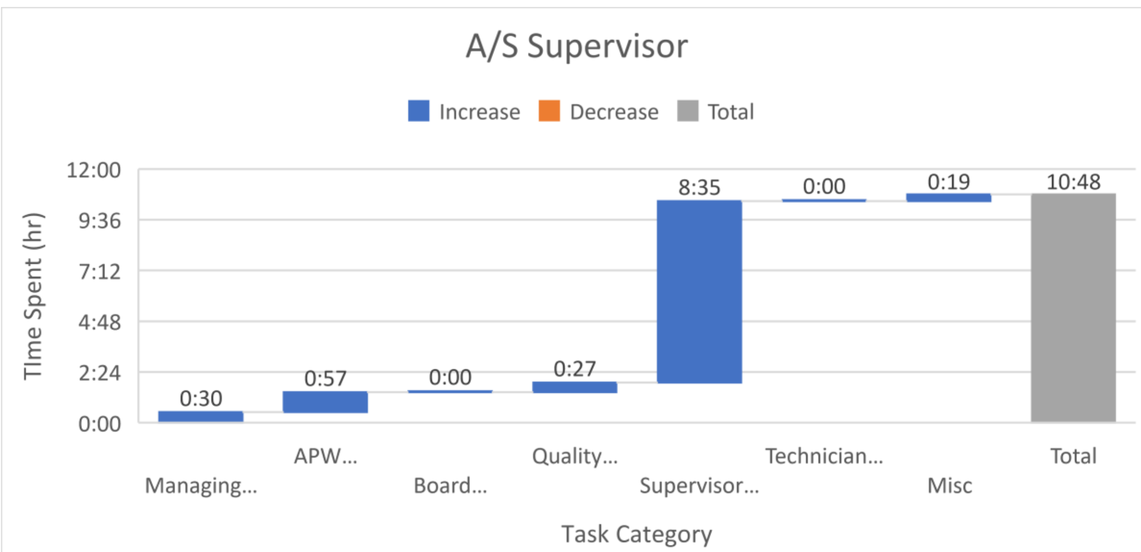

Figure 10: Bell-to-bell study on an afternoon shift Zone Supervisor

Figure 10 shows the results of the bell-to-bell study completed with an afternoon-shift Zone Supervisor. Due to absenteeism and a lack of manpower within zone, this Zone Supervisor was forced to spend the entire shift either on line working jobs, or as the "off-line" role responding to help calls within the zone. This means that during this shift, this Zone Supervisor was unable to complete any of the required tasks expected by management, unable to check-in with technicians or conduct a one-on-one, and unable to manage ongoing quality issues. At the same time, since the Zone Supervisor was acting as the “off-line” while trying to complete a safety audit that was due that day, their attention was not fully committed to either task, meaning defects could have gotten out of the zone, and the safety audit could have missed a key item. The full results of the bell-to-bell studies and the APW requirements can be found in Appendices C and D.

3.2 Modeling the Manpower System

The turnover problem at NNA-S is complex, with multiple drivers causing technicians to leave the organization. There are also multiple indirect and direct costs of the turnover which makes NNA-S less competitive as a manufacturing plant. In order to simplify the problem, we can use System Dynamics modeling, which will help identify key relationships that are keeping NNA-S in this vicious cycle. This modeling will not only identify relationships, but will show that some of these key drivers are reinforcing, and only feeding the turnover problem further. Figure 11 is a casual loop diagram (CLD) representing the manpower system at Nissan, specifically as it relates to turnover and its effects.

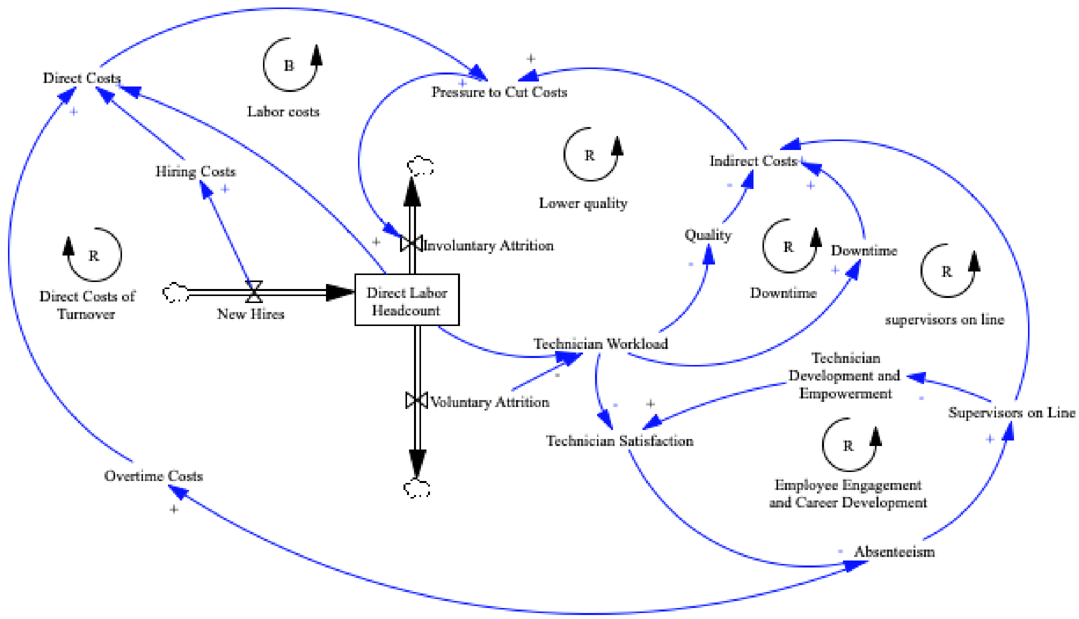

Figure 11: System Dynamics CLD representing NNA-S manpower system and the associated negative reinforcing loops

3.2.1 Drivers of Employee Turnover

As seen in Figure 11, there are multiple, reinforcing loops that drive employee turnover at NNA-S, in addition to themes we previously covered in Chapter 3, specifically in Section 3.1.2. These are driven by key variables such as a lack of career development, high workload, and a lack of employee empowerment.

3.2.1.1 Workload

We will start by diving deeper into the "Technician Workload" variable which drives indirect costs. By nature, the automotive industry is a cost-cutting industry, and OEMs compete against each other on the cost side of the balance sheet (within same vehicle segments). This creates an inherent pressure to cut costs across the business, and specifically at the plant level. This cost cutting mentality as a company almost always results in cost cutting within the manufacturing business unit. The easiest way for management to “cut” costs within manufacturing, is to reduce the direct labor headcount, which means removing personnel from the assembly line, and combining jobs and processes on the assembly line to make up for it. Though this might be a quick win in terms of reducing the direct labor budget, this increases the workload for each individual technician on the assembly line, because now they have to complete more tasks within their takt time. With more to do in the same amount of time (assuming no line speed changes), technicians are more likely to make mistakes, which can then lead to more defects, or even the line to stop if the mistake is severe enough. These mistakes also cost money, both in repair costs and downtime costs (lost units), and further puts pressure on the manufacturing plant to cut costs even more, which has historically led to reducing headcount once again. These reinforcing loops are some of the major drivers of turnover at NNA-S.

3.2.1.2 Employee Empowerment and Career Development

If you walk around NNA-S, you will see hundreds of certificates hanging on cubicles representing career milestones and how many years an employee has worked at the company. NNA-S is a giant family, and used to be the premier place to work in Tennessee--some current NNA-S employees are even third-generation employees at the plant. As we covered in Section 3.1.2.1, current technicians do not feel the same way. One technician noted that “it feels like they’ve turned this into a short-term job versus a career” when asked about whether they viewed Nissan as a career. Outside of the difficulty in simply moving to a day-shift, there are very few opportunities to either promote to Zone Supervisor (the first salaried position) even though Nissan maintained a very high internal promotion rate.

This feeling of being stagnant, along with a lack of personal development from their supervisor (possibly not being allowed to learn new, interesting jobs on the line), drives a reduction in employee satisfaction. When employees are not satisfied, they either call out (absenteeism) or quit (turnover). By calling out, Zone Supervisors either have to pay additional overtime, or work on the lines themselves, and when they work on the line, they are unable to develop their current technicians. Even when they use overtime to fill gaps, this still means that they are unable to train technicians on new jobs or processes, which also drives employee satisfaction down, reinforcing the positive loop we see above.

When Zone Supervisors are forced to work on the line themselves, we also note that they do not have time to devote to administrative tasks such as the Kaizen program, which means the employee suggestions may get delayed in the administrative trail, or forgotten altogether, leading to the technicians feeling without a voice, and that management does not care about their concerns. Additionally, with multiple process changes and line speed changes driven by management, technicians find themselves in a reactive state adapting to change, vice proactively seeking improvements of their jobs. Also, although the work of automotive manufacturing is highly standardized (including Nissan), a lot of the improvements are driven through problem solving activities (PSAs), which are focused efforts to improve either a quality concern or downtime concern. These PSAs are great opportunities for employees to develop creative solutions and bring up their ideas, but they are only at the Zone Supervisor level—technicians do not participate, and are therefore are limited to the Kaizen program, that sometimes does not get adequate follow through.

3.3 Direct and Indirect Costs of Employee Turnover

3.3.1 Direct Costs

Direct costs of turnover include the cost of the technician leaving, finding their replacement, and transitioning to the new replacement. These costs include the salary paid to HR personnel, whose time is now needed to be spent finding new technicians, the costs paid to online job postings (NNA-S partners with Indeed), associated drug tests, and the overtime needed to pay current technicians to cover the lost productivity on the assembly line, and the hourly wage for the replacement technician once they have been officially hired. NNA-S also bears these costs if a technician does not make it to employment, or fails the drug screen or background check. NNA-S has identified that each lost technician costs over $15,000 to replace, but as mentioned previously, only accounts for the overtime required to fill the gap which leads to an inaccurate cost of direct turnover.

3.3.2 Indirect Costs

Indirect costs of turnover are much more difficult to quantify, and include the costs associated with lost production and reduced performance. In our case at NNA-S, the major indirect costs associated with turnover are reduced quality (increased DPHU) and increased downtime. Additionally, whenever a Zone Supervisor is working on the assembly line, there is a premium being paid since they are a salaried worker compared to the hourly worker who should be completing that job.

The cost of quality is extremely complex and difficult to quantify precisely. Different repairs cost widely different amounts, and also take different timelines to complete, making this a difficult effect to fully quantify. However, as we saw in Chapter 2, in a previous study linking worker turnover to product reliability, failures could be anywhere between 1-7.6% more likely when worker turnover increases by 1%. This is a good proxy for estimation, but further work is recommended in order to identify the true cost of quality within automotive manufacturing. Additionally, if we simply look at DPHU levels between shifts, we can see that quality levels vary between day shift, afternoon shift, and night shift. Day shift, which is the most experienced, has the best quality, and afternoon and night shifts (where all new hires are placed) have worse quality. Although correlation does not mean causation, and there could be other factors, this is a starting point and important note when analyzing the effect of employee tenure on quality.

The other indirect cost that can be analyzed is downtime. Downtime from turnover can happen in two major ways: the technician has less experience and thus has to pull the andon card or stop the line more often than an experienced technician, or the line has to be stopped while training a new technician before they are certified. NNA-S uses an estimate that for every minute of downtime, the indirect cost is approximately $1,000. In order to tie this to turnover, downtime data was collected for all of T&C with the goal of quantifying the downtime resulting from training a newly hired technician.

The entire data set was filtered down to only andon pulls that resulted in the line stopping for “Training less than 2 jobs,” which is a signal for new hire training (all new hires are certified on two jobs to begin with).

The results of this analysis showed that this downtime was a significant indirect cost, and that the line was in fact stopping extremely often due to training new technicians (since technicians were leaving so frequently). In total, during FY19, the estimated cost of downtime due to training new technicians exceeded $2.5MM.

Chapter 4

Applying the Good Jobs Strategy to Manufacturing

4.1 Staffing

4.1.1 Manpower Allocation

We have covered the drivers of employee turnover, and both the direct and indirect effects it has on the business unit. One of these key drivers, technician workload, is mainly caused by management-level decisions to reduce direct labor headcount in order to make budget and we saw how this was part of the reinforcing feedback loop in the manpower system. Additionally, with multiple line speed changes and rebalances, technicians are having more processes added to their jobs, and zones are becoming much "thinner" with fewer technicians assigned to each one after these changes. This causes the job to become much more complex, and adds variability to a job that is normally highly standardized. Currently, zones operate with 20-30 personnel: most are designated as normal "technicians," which means they are matched up with certain processes on the line. In addition to this number (often considered the bare minimum to run, or RTO), each zone is assigned one "leader" and two "absentee" heads, which would mean that each zone is technically staffed above RTO. Although one's first instinct might be that this means NNA-S is operating with slack, we see through absenteeism data, that zones are rarely operating at RTO, and often have to pay overtime just to have the minimum required personnel on the line. We have also already noted that this has cascading effects such as constraining technicians to a single job for months, which directly affects higher employee needs such as "meaningfulness" and "personal growth" since they are stagnant and it also handcuffs these zones into the overtime payments mentioned above.

In order to improve this and add flexibility within the manpower system, it is recommended to strategically operate with slack. Before doing this, it is critical to identify what activities are adding variability within the system, in order to streamline these processes and make them more manageable. Absenteeism must also be addressed and is described in more detail in Section 4.2.2. Once these are studied, NNA-S can strategically add more direct labor personnel to various assembly lines throughout the plant. This should not be a blanket policy, but should be approached in a way that zones will be covered on their worst absenteeism days (usually Mondays or Fridays). Adding labor hours will allow Nissan to improve their cross-training of employees, which is a useful tool that can be implemented more broadly within the zones in order to address the "workload" driver.

Additionally, NNA-S can add more "off-line" or "leader" roles and leadership opportunities within each zone, which would have three major benefits. This would more similarly mimic the Toyota Production System (TPS), which assigns an "offline" technician to four to five assembly line workers. First, doing so would reduce the number of pitches that these "off-line" technicians would be responsible for, thus reducing the response time when an andon cord is pulled by an on-line technician and would theoretically improve the overall efficiency of the zone. Secondly, this would also provide more promotion and career opportunities for technicians, who, if motivated, could learn each job in their zone, and apply to become one of the permanent "offline" technicians and earn the pay increase and resume bullet for when they apply to become a line leader. Not only does this address the basic employee need of having a career path, but a zone with technicians who know more jobs is more versatile, and can better adapt to high absenteeism days. Finally, by adding additional heads to the line, the Zone Supervisor workload would theoretically decrease, and they would not be forced to work on the line themselves. Thus, they would be able to focus on their actual job descriptions, including fixing quality and downtime issues affecting their zone and developing their technicians, addressing their concerns and giving them a sense of "belonging," another higher need of employees.

4.1.2 Hiring and Onboarding

"Job fit" is often a reason cited for technicians leaving NNA-S. The work is hard, and demanding, but incoming employees know this when they sign up—it is covered in the interview process. Although new technicians are placed in “soft landing” and a training area in order for them to get their feet wet before working on the line, there still seems to be a gap. One psychologist, John Wanous, originally proposed that companies should give applicants a realistic preview of what the job is like. Other companies such as Marriot have found ways to do this electronically, with games such as “My Marriot Hotel” which allows people to play the game who might not understand what the job entails, then if they score well, they are directed to the website to apply (Cappelli, 2019). NNA-S does have a facility across the street from their manufacturing plant, the Tennessee College of Applied Technology (TCAT), at which they have historically held training sessions for new employees. Currently, they are building and designing a new onboarding program, during which new hires will drill bolts, hand start screws, and perform other skills required to work on the assembly line—essentially a hands-on version of the Marriot idea. This program will then assign that employee a score, and based on how well they perform on various tasks, management could use that data to assign them to the best shop to start their careers. This will allow Nissan to ensure new employees have required skills and physical abilities before placing them on the assembly line or even into “soft landing.” Although this is a great start, there is much more potential within this program. Once TCAT starts collecting data and scores from new hires, the system could save those scores and associate them with the employee’s employee ID number. Then, based on where that new technician was sent, and if they left the company or not, a data point could be saved that is associated with that score. With enough data, a Machine Learning program could be used to assign employees to different shops based on their technical skills rating earned in this program.

Simply put, by hiring the right people and improving onboarding in order to set new hires up for success, not only can NNA-S improve turnover, but can also provide the higher need of giving career paths to employees, and giving them a job that allows them to find meaningfulness in their work.

4.2 Invest in People

4.2.1 Compensation and Benefits

The most common, historical answer to the turnover problem at NNA-S has been to introduce small wage increases across all employee segments. Although wage increases are a beneficial way to improve employee morale in the short term, they have not historically helped the turnover rate at NNA-S. By looking at the data presented in Section 3.1.3.2 and Table 1, we see that most technicians are making a living wage, and "wage" was only the sixth most common turnover reason found in the exit surveys (Figure 7). Now, this does not mean that a wage increase of the right amount would not help turnover. Wage is still an important lever that can be effectively used to improve performance. For example, NNA-S could implement a new wage system, that ties additional bonuses to those technicians who achieve proficiency in all jobs within their zone, essentially, they are more "valuable" and can be used in more positions to help the zone.

Additionally, if wage is not the lever management wants to pull, there are other ways to increase the amount of money in technicians' wallets. In this case, we already saw that healthcare was the top ranked benefit by technicians, and instead of implementing a $.50 wage increase, NNA-S management could investigate new ways to improve healthcare benefits. We've covered that the healthcare plans between Nissan and Yates are different, specifically Nissan offers a high deductible plan, whereas Yates offers a more standard, co-pay driven plan. If we look at this strictly from a financial perspective, the Nissan plan is superior and gets more money into the pockets of technicians, and saves them money over time, yet 100% of technicians preferred the Yates plan. Interviews brought up that Nissan healthcare has been "difficult" to use, and they were unfamiliar with the benefit in general. This lack of information regarding a core benefit is driving these beliefs. Moving forward, Nissan can introduce a training program, or add more opportunities to explain to technicians what their benefits are.

In order to quantify these changes, a simple model can be applied that accounts for the indirect and direct costs of turnover. A shell of the model can be found in

Appendix E and includes multiple assumptions for management to decide on. By inputting current plant data, such as number of employees, current turnover rate, direct costs of turnover (OT/training), and indirect costs (supervisors on line premium, reduced quality and increased downtime) management can understand the current cost of turnover. Then, using assumptions based on turnover improvement (these could be company targets) and the reduced associated costs, they can see the total cost savings associated with reduced turnover and benchmark them against proposals to invest in people, such as increased wages, or investment in better benefits. This model could also be built so that the input is an investment in people, and how much turnover would need to be improved to pay off those costs. This model can also be used to look at adding hours (Section 4.1.1) in addition to wage and benefits.

4.2.2 Increasing Expectations

When investing in people, whether it is a wage increase or an improved benefit plan, management can couple it with higher expectations from employees in order to generate the most value after the implementation. For example, recently Quest Diagnostics, a clinical lab company, introduced a combination of higher wages, clear career paths, and stricter attendance policy in their call centers which resulted in absenteesim decreasing from 12.4% to 4.2% and turnover decreasing from 29% to 25% (Ton & Reavis, 2017). The current attendance policy at NNA-S allows unexcused occurrences to accumulate before corrective action is taken. If a technician is late to work by less than four hours, it is considered one half of an "occurrence." Anything above four hours, all the way to three consecutive days is considered just one single occurrence, and if the call-outs are spread out, each day would be its own occurrence. Each occurrence results in the next step of disciplinary action, from counseling, to verbal warning, to written warning, final warning, and ultimately termination. This policy means that technicians can somewhat abuse the attendance policy in order to talk multiple days off, which can affect the assembly line due to the high absenteeism. If this policy were to be made stricter in order to encourage better attendance, it could be reinforced if coupled with a wage increase, and could help the costs related to absenteeism. Another way to incentivize while increasing expectations is to tie financial compensation directly to attendance. For example, while this research was being conducted, a new bonus structure was unveiled. It incentivizes good attendance, but is based on an annual attendance metric, which still means there could be room to abuse. For example, if a technician knows that he or she will not reach the target, they will be more inclined to call out anyway. NNA-S could reconsider making this a monthly or quarterly incentive to keep technicians engaged year-round.

4.2.3 Changing the Automation Narrative

When we look at the job of a technician, it is simply installing parts and drilling bolts for eight hours each and every day. There is no doubt that this is mind numbing, and can be seen as frustrating by someone who wants to solve problems or be involved in problem solving activities. This is where the intersection of automation and human workers has potential outside of quality savings or manpower savings from adding new machines. There has been a lot of research about the intersection of automation and human beings when it comes to manufacturing. Will human beings be entirely replaced by machines within the automotive manufacturing industry? Tesla has already experimented with this, and has experienced quality concerns while doing so. However, it still holds true that the types of jobs found in automobile manufacturing are typically ones that are repetitive, and do not utilize heavy critical thinking skills and are thus primary targets for robot introduction (Fiorelli et al., n.d.). Changing the automation narrative from "machines taking human jobs" to "machines improving human jobs" is critical, and can have positive effects such as improving employee engagement.

Specifically, when making the decision to invest in automation, companies typically conduct a business decision making process that analyzes CAPEX and possibly a discounted cash flow (DCF) of the savings that might be realized from the implementation. It is possible to promote good jobs while investing in automation, but management needs to identify the correct uses and the correct pieces of equipment. Management can easily look at the turnover related to a specific line or job when looking to replace a worker with a robot, and these turnover savings can be used in a DCF analysis. However, when deciding on a robot, management can get creative with what model or supplier they choose. At NNA-S, most robots are supplied by FANUC, and require a computer programmer to set up and code appropriately. In this case, the technician who used to have this job, must be placed elsewhere on the assembly line, or let-go (NNA-S does not let go of Nissan employees due to automation). However, with the advancement of automation technology, we have seen new, collaborative robots (co-bots) that are much easier to use. These robots can be programmed simply by moving the machine to a desired location, and pressing a button to "save" the location and movement. This process could easily be completed by a technician, and could provide a much more fulfilling job, thus improving employee morale and satisfaction.

Figure 12: A new co-bot lifts a rear glass part from a pick cart

4.3 Culture Wins

Although qualitative and "soft" by nature, there are some quick culture wins that management can implement in order to improve morale in the workplace and reduce turnover. First, we can look at job design, which is at the forefront of employee satisfaction. Hackman and Oldham identified that the following characteristics must be in place in order to achieve employee satisfaction (*Heroes of Employee Engagement*, 2018):

- <u>Skills Variety</u>: do tasks vary, and are they challenging? Or are they monotonous and too easy?
- <u>Task Identity</u>: do tasks have a defined beginning, middle and end? Without this, it's hard to achieve the satisfaction of an attained goal.
- <u>Task Significance</u>: does the employee feel that their role has meaning?
- <u>Task Autonomy</u>: can individuals have a say in how they carry out their work?
- <u>Job Feedback</u>: are employees receiving feedback on their performance?

We have briefly touched on a few of these, but ultimately, it is important for NNA-S, and other companies, to keep these in mind. Skills variety ties back to cross training which ties back to the higher need to personal development, Task significance directly relates to the employee higher need of "meaningfulness." Task autonomy and job feedback both relate to employee empowerment, and giving employees a sense of respect when it comes to their ideas.

If we continue to look back to the hierarchy of needs presented in Figure 4, we can introduce more solutions that specifically target those needs. For example, in order to meet the higher need of "belonging" and instill a sense of pride and team-oriented culture, NNA-S could reintroduce some previous events within the plant. For example, NNA-S used to provide ping-pong tables for tournaments in between production runs and there used to be basketball pick-up games before and after shift-starts. NNA-S employees who have been with the company for years have not forgotten these days, and often reminisce about them being the "good old days." Bringing back these team-based activities could improve comradery within the plant, and add a sense of belongingness to their employees. Although each zone and shift have quality and downtime targets they work towards as a team, NNA-S could implement other metrics to incentivize behavior, such as an absenteeism or turnover goal within the zone. Additionally, by adding more positive visual aids that show plant performance could also instill a sense of teamwork within new technicians' minds while satisfying the higher need of recognition as well. Continuing with the higher need of "recognition," we can look at the rewards and incentives given for high performance. The current process for recognizing good work at NNA-S is the "best catch awards." These awards are given to the sole individual who "caught" the biggest quality issue for a given month. They are given a certificate signed by the director, a meal voucher, and a parking spot closest to the plant entrance they utilize. Though this is a positive action by management, it does not seem to resonate with technicians. Management could investigate improving the timeline of these awards, the actual rewards, or possibly reward more technicians for good work, not just the "best catch."

Right now, there is no easy "fix" for such a complicated problem. Bottom-up improvement is difficult to achieve when an organization is busy fighting fires. Once NNA-S is able to stabilize the workforce, and lower turnover and absenteeism to more manageable levels, they will be in a much better position to recreate this "bottom-up" improvement culture, and implement their technicians' ideas for the plant.

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Appendices

Appendix A: NNA-S Shift Schedule

SUV Late Start 3-Shift Schedule
N1/D1/A1

Night Shift		Day Shift		Afternoon Shift	
N1		D1		A1	
9.6 Hrs		8.1 Hrs		7.6	
Shift Start		Shift Start		Shift Start	
9:00 PM - 9:06 PM	Shift Start Meeting	7:00 AM - 7:06 AM	Shift Start Meeting / Stretching	3:30 PM - 3:36 PM	Shift Start Meeting / Stretching
1st Run (9:06 PM - 11:40 PM)		1st Run (7:06 AM - 9:40 AM)		1st Run (3:36 PM - 5:50 PM)	
11:40 PM - 11:53 PM	Break	9:40 AM - 9:53 AM	Break	5:50 PM - 6:03 PM	Break
2nd Run (11:53 PM - 2:00 AM)		2nd Run (9:53 AM - 12:00 PM)		2nd Run (6:03 PM - 8:00 PM)	
2:00 AM - 2:30 AM	Lunch	12:00 PM - 12:30 PM	Lunch	8:00 PM - 8:30 PM	Lunch
3rd Run (2:30 AM - 4:50 AM)		3rd Run (12:30 PM - 2:40 PM)		3rd Run (8:30 PM - 10:40 PM)	
4:50 AM - 5:00 AM	Break	2:40 PM - 2:50 PM	Break	10:30 PM - 10:40 PM	Break
4th Run (5:00 AM - 7:06 AM)		4th Run (2:50 PM - 3:36 PM)		4th Run (10:40 PM - 11:36 PM)	
7:06:00 AM	End of Shift	3:36:00 PM	End of Shift	11:36:00 PM	End of Shift

SUV Late Start 3-Shift Schedule
N2 thru A4

Night Shift		Day Shift		Afternoon Shift	
N2 - N4		D2 - D4		A1 - A4	
7.6 Hrs		7.6 Hrs		7.6	
Shift Start		Shift Start		Shift Start	
11:30 PM - 11:36 PM	Shift Start Meeting / Stretching	7:30 AM - 7:36 AM	Shift Start Meeting / Stretching	3:30 PM - 3:36 PM	Shift Start Meeting / Stretching
1st Run (11:30 PM - 1:30 AM)		1st Run (7:36 AM - 9:40 AM)		1st Run (3:36 PM - 5:50 PM)	
1:30 AM - 1:43 AM	Break	9:40 AM - 9:53 AM	Break	5:50 PM - 6:03 PM	Break
2nd Run (1:43 AM - 3:30 AM)		2nd Run (9:53 AM - 12:00 PM)		2nd Run (6:03 PM - 8:00 PM)	
3:30 AM - 4:00 AM	Lunch	12:00 PM - 12:30 PM	Lunch	8:00 PM - 8:30 PM	Lunch
3rd Run (4:00 AM - 6:00 AM)		3rd Run (12:30 PM - 2:40 PM)		3rd Run (8:30 PM - 10:40 PM)	
6:00 AM - 6:10 AM	Break	2:40 PM - 2:50 PM	Break	10:30 PM - 10:40 PM	Break
4th Run (6:10 AM - 7:36 AM)		4th Run (2:50 PM - 3:36 PM)		4th Run (10:40 PM - 11:36 PM)	
7:36:00 AM	End of Shift	3:36:00 PM	End of Shift	11:36:00 PM	End of Shift

SUV Late Start 3-Shift Schedule
D5/A5

Night Shift		Day Shift		Afternoon Shift	
N5 (Same as N2 - N4)		D5		A5	
7.6 Hrs		9.1 Hrs		9.6 Hrs	
Shift Start		Shift Start		Shift Start	
11:30 PM - 11:36 PM	Shift Start Meeting / Stretching	7:30 AM - 7:36 AM	Shift Start Meeting / Stretching	5:00 PM - 5:06 PM	Shift Start Meeting / Stretching
1st Run (11:30 PM - 1:30 AM)		1st Run (7:36 AM - 9:40 AM)		1st Run (5:06 PM - 7:20 PM)	
1:30 AM - 1:43 AM	Break	9:40 AM - 9:53 AM	Break	7:20 PM - 7:33 PM	Break
2nd Run (1:43 AM - 3:30 AM)		2nd Run (9:53 AM - 12:00 PM)		2nd Run (7:53 PM - 9:50 PM)	
3:30 AM - 4:00 AM	Lunch	12:00 PM - 12:30 PM	Lunch	9:50 PM - 10:20 PM	Lunch
3rd Run (4:00 AM - 6:00 AM)		3rd Run (12:30 PM - 2:40 PM)		3rd Run (10:20 PM - 12:50 AM)	
6:00 AM - 6:10 AM	Break	2:40 PM - 2:50 PM	Break	12:50 AM - 1:00 AM	Break
4th Run (6:10 AM - 7:36 AM)		4th Run (2:50 - 5:06)		4th Run (1:00 AM - 3:06 AM)	
7:36:00 AM	End of Shift	5:06:00 PM	End of Shift	3:06:00 AM	End of Shift

Appendix B: Indeed Job Posting Example

READY. SET. *GO* Career!

Are you ready to be in the driver's seat of your career? Do you enjoy a fast-paced work environment? Most importantly, are you looking to be part of a team that knows its most valuable resource is its people?

If this sounds like you, then let's get ready to start your career. Come and grow with Nissan!

NO EXPERIENCE NECESSARY – We will train you.

Job Description:

- Your job will be to support the Nissan automotive production line in the building of quality vehicles.
- Responsibilities include:
  - Identifying, checking, sub-assembling, and "kitting" (sorting into containers) parts to be delivered to the production line for final vehicle assembly
  - Receive, count, and stock parts quickly and accurately
  - Inspect parts to ensure quality standards
- Job includes plenty of active movement, being on your feet for entire shifts, and working at a rapid pace in order to keep the production line running on time. Our customers need their vehicles!

What's In It For Me? (Pay and Perks)

- $15.25/hour starting (Afternoon and Night Shifts), with lots of upward potential as your experience increases.
- Start off with 2 weeks paid time off during summer + up to 13 additional paid holidays
- Competitive benefits package including Medical and 401k
- Access to fun company-sponsored events for you and your family

Our Commitments to You:

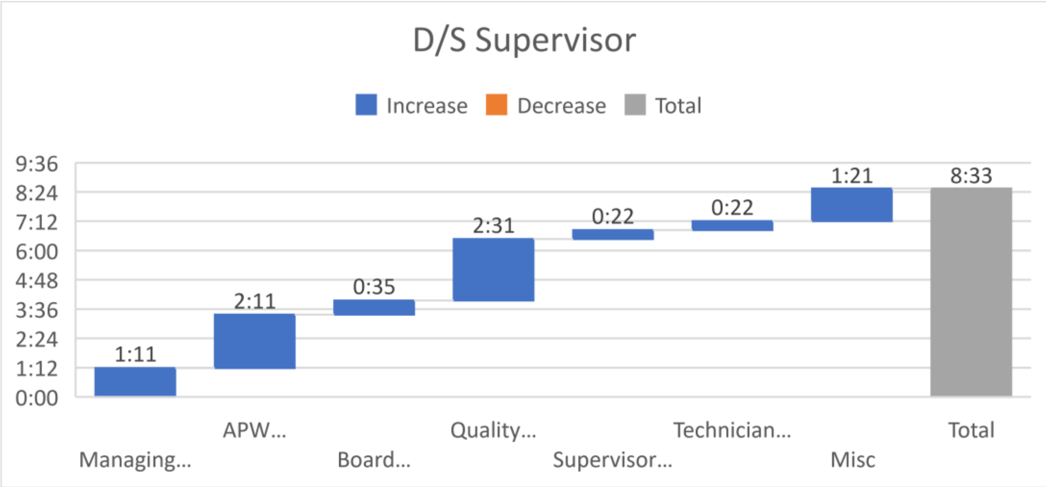
- Safety first: we are continually improving safety procedures to help ensure that you are safe at work.
- Your Development: We want you to be successful and grow your career within the Nissan family. We will train you to be great at your job, and we will provide opportunities for you to learn new skills.

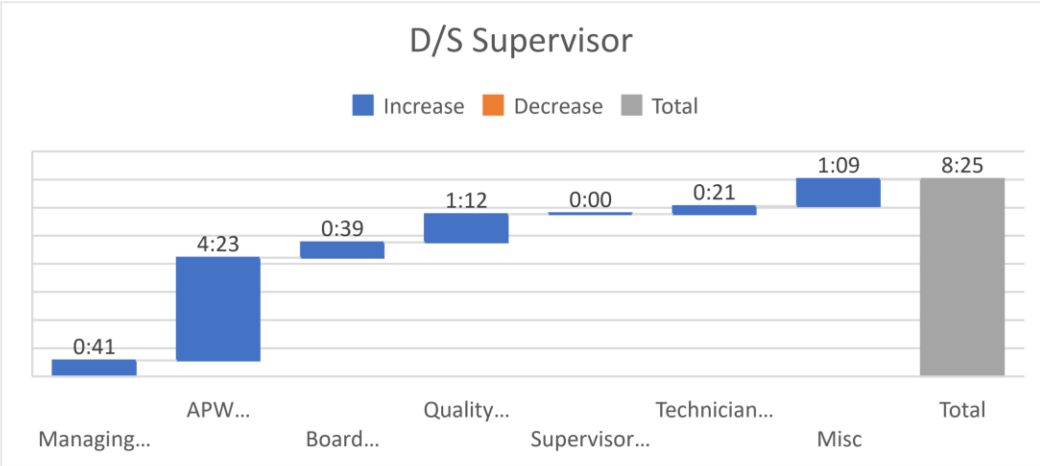
About Nissan and Yates: Our people are what drive the business forward. Nissan Smyrna plant has been producing quality vehicles for over 35 years, and is the highest-producing Vehicle plant in North America, thanks to our amazing, dedicated team. You will find a culture where employees' sense of achievement is as high as the number of their vehicles driven in the community. Nissan has partnered with Yates for over 16 years in sourcing quality team members, and we have converted over 2,700 Yates hires to Nissan. We hire you to grow you.

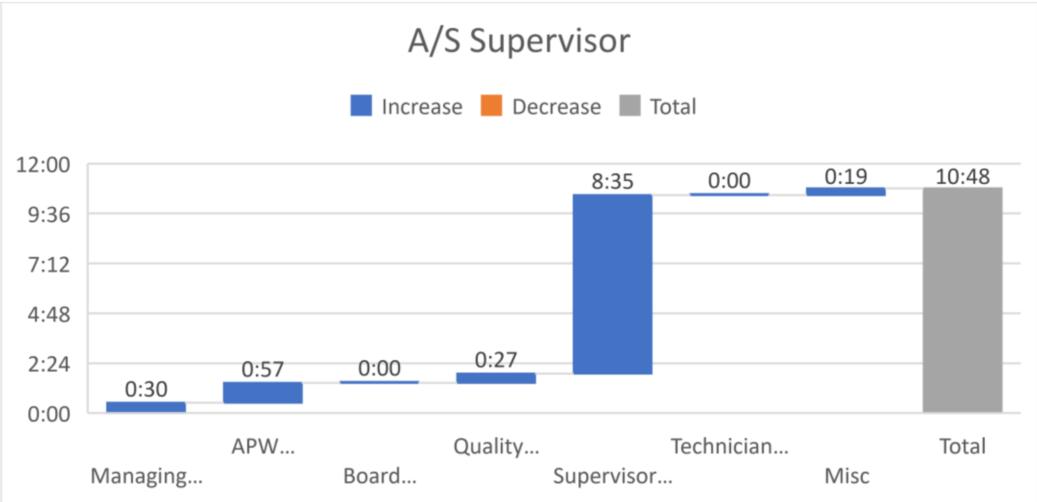
Do you meet the following criteria? If so, scroll down get started on your new career at Nissan today!

- 18 years or older
- Understand that TEAMWORK makes the DREAM WORK
- Safety conscious
- Available to work either Afternoon or Night shift, including occasional week-ends.
- Speak, read and write English
- Successfully complete chemical screen and background checks
- Able to lift up to 25 lbs
- Able to stand for long periods of time
- Hard working with the ability to stay focused, pay attention to detail

Appendix C: Full Bell-to-Bell Analysis







Appendix D: Shell of financial model that can be used to calculate tradeoffs from investment in people (hours, wages).

Pre-Action Assumptions		Effects Assumptions		Estimated Results	
Number of ML Employees	3152			Number of ML Employees	3151.84
Annualized Turnover Rate	11%	How much employee turnover could we reduce?	-2.00%	Annualized Turnover Rate	9%
Number of Lost Employees	347			Number of Lost Employees	284
Total Attrition Cost/Tech	$ 6,144.00			Total Attrition Cost/Tech	$ 6,144.00
Training Cost/Tech	$ 15,360.00			Training Cost/Tech	$ 15,360.00
Training Downtime (hrs)	2504	If we reduced turnover by above %, what DT reduction can we expect?	-1.00%	Training Downtime (hrs)	2478.96
Downtime Cost/hr	$ 1,000.00			Downtime Cost/hr	$ 1,000.00
Supervisor Hours On-Line	10000	If we reduced turnover by above %, what Supervisor Hours reduction can we expect?	-1.00%	Supervisor Hours On-Line	9900
Supervisor Labor Rate ($/hr)	$ 60.00			Supervisor Labor Rate ($/hr)	$ 60.00
DPHU/Quality Cost	$ 750,000.00	If we reduced turnover by above %, what quality improvement can we expect?	-0.08%	DPHU/Quality Cost	$ 749,407.50
Totals				**Totals**	
Coverage/Training	$ 7,455,488.41			Coverage/Training	$ 6,099,945.06
Downtime	$ 2,504,000.00			Downtime	$ 2,478,960.00
Supervisor Premium	$ 600,000.00			Supervisor Premium	$ 594,000.00
Quality	$ 750,000.00			Quality	$ 749,407.50
Total Cost of Turnover	$ 11,309,488.41			Total Cost of Turnover	$ 9,922,312.56
		What percentage of savings do we want to allocate to wage increases?	50%		
		What percentage of savings do we want to allocate to hours increases?	50%		
		What percentage of savings do we want to allocate to benefit changes?	0%		
		Total Cost Savings to Invest in People	$ 1,387,175.85		
		Wage increase allocation	$ 693,587.92		
		Hours increase allocation	$ 693,587.92		
		Healthcare/benefits allocation	$ -		
		Convert all Associates to PW <3 yrs LOS	$ 3,260,625.00		
		Increase Associate Progression $1/hr	$ 2,532,971.00		
		Increase PW Progression $.050/hr	$ 2,333,760.00		