Sustainable Manufacturing

Using "Green Stream Mapping" techniques to optimize Sustainable Manufacturing

A Fabrinet Case Study
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Abstract

Today, businesses worldwide are placing more and more focus on the environmental impacts of their products and operations. Manufacturers in particular are expected to actively promote clean and sustainable production methods and processes. In many cases manufacturers are mandated to drive such efforts by legal requirements or international standards.

This paper describes a substantial initiative undertaken by Fabrinet, a large contract manufacturer located in Asia, to introduce sustainable manufacturing through greener operations leveraging LEAN manufacturing principles. By adding a green focus to LEAN manufacturing principles already in place, and by involving all staff in Green Living Workshops and Global Awareness training, Fabrinet achieved major cost savings and waste reductions with a substantial and positive impact on the environment. The same approach can be used by any company to make positive environmental impacts and realize substantial savings.

Multiple projects and activities – from the very simple to the more complex – must combine to form a truly green organization. With the right training and awareness, everyone can contribute to the success of sustainable manufacturing. Fabrinet created a Green Stream Mapping Methodology, leveraged from LEAN manufacturing's Value Stream Mapping, to systematically identify green projects that could lead to reductions in cost and a healthier environment. The paper describes Fabrinet's use of Green Stream Mapping and other activities to frame projects which resulted in significant reductions in paper usage, energy consumption, water usage and solid waste generation, with associated cost savings.

Fabrinet Overview

Fabrinet is a global engineering and manufacturing services provider specializing in manufacturing simple to complex optical and electromechanical components and bulk optics. We serve the data communications, telecommunications and medical industries. Fabrinet employs over 5000 people worldwide with over 1 million square feet of manufacturing space located in Thailand, China and the United States. As a specialist in high-mix, low volume manufacturing, Fabrinet strongly advocates and ardent practitioners of Lean Manufacturing.

Regulations and Standards vs. Opportunities

Most manufacturing organizations are held to some degree of environmental compliance by the laws of the countries in which they operate. Most governments drive basic environmental protection in industry. In Thailand, for example, Fabrinet as a manufacturer is required to follow the 1992 Enhancement and Conservation of National Environmental Quality Act, The Factory Act of 1992, and the Industrial Estate Authority of Thailand regulations. Basic environmental controls such as these exist in almost in every developed and developing nation.

Like many companies, Fabrinet chose to augment their legal compliance with certifications to international environmental standards. The most well known is the ISO 14000 series, which ensures that certified companies comply with local laws and regulation and have implemented effective environmental policies and practices.

In addition to controls over the activities of manufacturers, there are also international environmental standards and regulations applied to the products Fabrinet makes. WEEE / RoHS, for example, implemented across all product lines at Fabrinet, is an international standard for the environmental safety of electronic products.

Many companies stop at these compliance-focused environmental efforts. While effective and relatively thorough in minimizing harmful impacts to the environment, there are other opportunities to further drive sustainability in company operations. By using the manufacturing improvement techniques that they already knew, Fabrinet implemented process changes and organizations that helped the environment while also saving significant costs.

Getting Started with Sustainable Manufacturing

Beginning to build a Sustainable Manufacturing Organization requires a definition of "Sustainable," an understanding of the challenges, and a clear guideline on an approach to implementing the organization.

The Definition: Fabrinet defined "Sustainable Processes" as those that:

- Are non-polluting
- Conserve energy
- Conserve natural resources
- Are safer for people, environment and the planet
- Increase company profits and cut costs
- Foster team work amongst all employees
- Provide a competitive advantage

The Challenges: Fabrinet needed a clear understand the challenges it would face in implementing Sustainable Manufacturing. The challenges identified were:

- Corporations limit efforts to mandatory regulatory compliance
- Lack of awareness of all the non-regulatory opportunities
- Lack of top down buy-in on the subject
- Lack of SM training programs in the company
- Little motivation within the companies to pursue sustainability
- Lack of tools to identify Sustainable Manufacturing projects
- Sustainable Manufacturing not widely taught in colleges
- People often associate extra cost with Sustainable Manufacturing
- Faces similar challenges in implementation as Lean Manufacturing

The Approach: Once the objective was defined and the challenges were identified, Fabrinet was able to form an effective approach to implementing sustainable manufacturing. The approach included:

- Top-down awareness and sponsorship.
- A corporate steering committee to promote Manufacturing Sustainability.
- Leveraging Lean Manufacturing principles.
- Using Green Stream Mapping to identify all sustainable 6 Sigma and Kaizen projects.
- Assigning task teams to develop and execute green projects.
- Holding regular classes for all employees to improve their understanding.
- Tracking the progress of each project from start to end.
- Rewarding the teams for their work at the end of the project.
- Holding an annual competition for the best Sustainable Manufacturing projects.

Establishing the Sustainable Manufacturing Organization

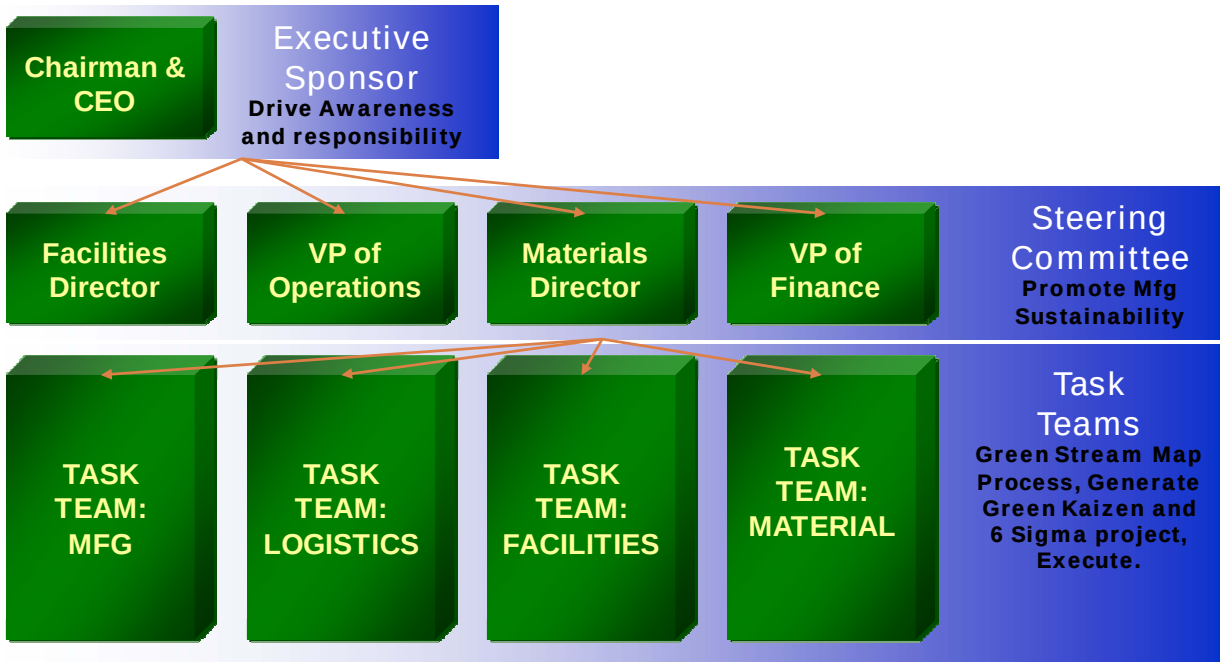

Figure 1: Fabrinet's Sustainable Manufacturing Organization

At Fabrinet, the Chairman and CEO kick-started the effort as the Executive Sponsor, reinforcing the importance of the initiative:

- Formally announced to the company the directive to become a conscientious, "green" manufacturer.
- Appointed an Executive Steering Committee made up of Directors and VP's from various departments.
- Chaired committee meetings.
- Sponsored a Green Awards system to motivate the organization.

When the Executive Sponsor nominated his Steering Committee, that team defined the key areas for improving sustainability in manufacturing:

- Employee awareness
- Efficiency
- Paper usage / Unnecessary printing
- Recycling
- Energy Saving

The committee set up task teams to focus on improvements in key areas: Manufacturing, Logistics, Supply Chain and Facilities. They organized education and training and monitored projects. The Steering Committee also defined an effective methodology for realizing sustainable manufacturing goals based on their widely used practice of Value Stream Mapping.

Education and Training

The Steering Committee designed an education and training program for all employees at Fabrinet. The program was a three-tiered approach that focused on different aspects of sustainability.

Global Awareness training: In these seminars, employees were updated on current global environmental conditions. The courses emphasized the importance of natural resources and showed how human activity and habits affect the big picture of the environment. One session focused on the importance of trees in maintaining the global environment and the impacts of paper usage on consumption of trees.

The impact of reducing paper usage:

- 1 ton of paper = 400 reams = 200,000 sheets
- 1 ream (500 sheets) uses 6% of a tree
- 1 tree makes 16.67 reams of copy paper or 8,333 sheets
- Production of 1 ton of copy paper produces 19,075 gallons of waste water
- In 2004 the United States used 8 million tons of office paper ;That's the equivalent of 192 million trees
- 4281 acres of rainforest are lost every hour worldwide
- Production of 1 ton of copy paper produces 5,690 lb. of greenhouse gases (the equivalent of 6 months of car exhaust)
- Global paper products consumption has tripled over the past three decades and is expected to grow by half again before 2010.
- Production of 1 ton of copy paper uses 11,134 kWh (same amount of energy used by an avg household in 10 months)
- Making one single sheet of copy paper can use over 13oz. of water– more than a typical soda can.
- One ton of paper requires the use of 98 tons of various resources
- Production of 1 ton of copy paper produces 2,278 lb of solid waste

Figure 2: Awareness training material on paper usage and trees.

Green Living Workshops: With the theme "Fabrinet Going Green," staff was engaged in workshops where they were taught different ways to conserve and protect the environment in their everyday lives.

One workshop, for example, provided training on how to produce an environmentally friendly, bio-organic fertilizer and dishwashing detergent from common household garbage.

Green Manufacturing: These training sessions were very instrumental in creating a sustainable manufacturing organization within Fabrinet. Here, staff was trained in Fabrinet's key sustainable methodology called Green Stream Mapping.

The Key Methodology: Green Stream Mapping

As a basis for forming an effective methodology to drive sustainability in the organization, Fabrinet looked to leverage its existing skill in other manufacturing optimization techniques. Fabrinet is a recognized leader in Lean Manufacturing. As a matter of best practice, the company uses Value Stream Mapping to increase efficiency and cut costs in all simple to complex business process, not just on production lines.

Value Stream Mapping (VSM) identifies waste and inefficiencies in processes. The Steering Committee leveraged the company's successes and skill with Value Stream Mapping to develop what they called the Green Stream Mapping (GSM) method.

Green Stream Mapping is an extension of Lean Manufacturing concepts. While Value Stream Mapping identifies waste and inefficiencies in processes, Green Stream Mapping helps identify opportunities to improve sustainability in manufacturing and business processes. The methodology and execution are the same.

In Value Stream Mapping, organizations typically map an entire process in a detailed flowchart, and then evaluate each step of the process in terms of cycle time, efficiency, and waste. In Green Stream Mapping, the process map is the same, but instead each process step is evaluated in terms of Inputs and Outputs that have an environmental impact.

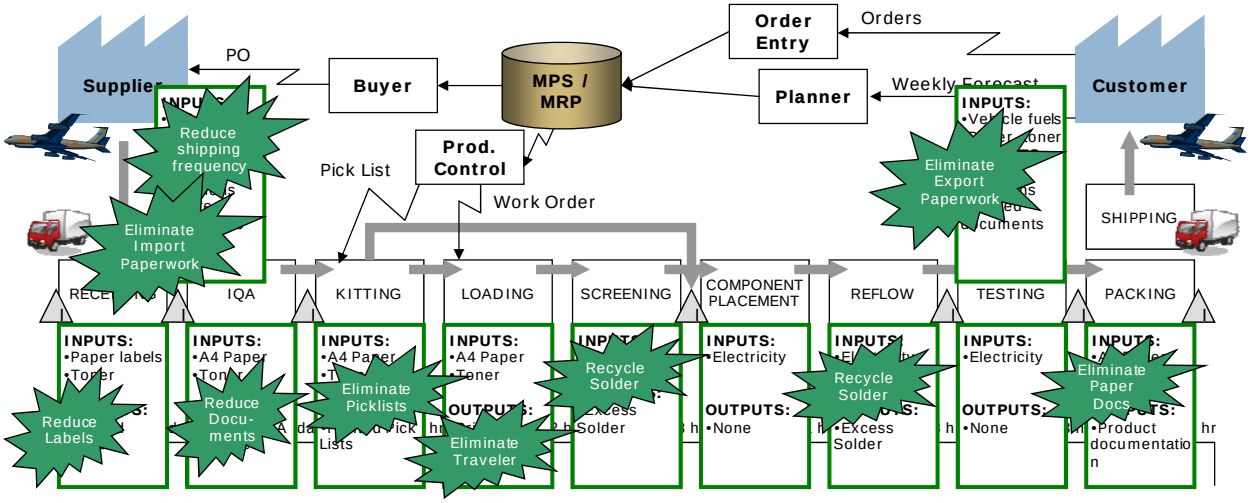

Figure 3: An example of a Green Stream Map showing process step inputs, outputs and Kaizen bursts.

Green Stream Mapping, like Value Stream Mapping, can drive improvements in any business process or phase of the product lifecycle. Fabrinet applies these techniques to various processes including:

- Design,
- Manufacturing,
- Packaging / Shipping,
- Logistics,
- Administration,
- Planning,
- Supply Chain,
- Maintenance,
- Human Resources.

The following table shows the similarities between Value Stream Mapping and Green Stream Mapping.

Characteristic	VSM	GSM
Visualization Tool	☑	☑
Makes it easier to understand the process	☑	☑
Helps to streamline the process	☑	☑
Maps the process from start to end	☑	☑
Helps to identify steps for improvements	☑	☑
Helps to understand the current state	☑	☑
Helps to develop the future state	☑	☑
Its applicable in all phases of the product cycle	☑	☑
Conserve energy	☑	☑
Conserve Natural resources	☑	☑
Safe for people, environment and the planet	☑	☑
Better for team work amongst all employee	☑	☑
Helps to improve profitability	☑	☑
Provide Competitive advantage	☑	☑

Figure 4: The similarities between VSM and GSM.

An example of Green Stream Mapping applied to a Logistics business process is illustrated below. In this example, the Logistics Task Team mapped the export process and generated Kaizen projects that eliminated paper usage and reduced the need for manual data entry. Not only is this an environmentally friendly project, but it also resulted in hard cost savings in paper and printing materials for the company.

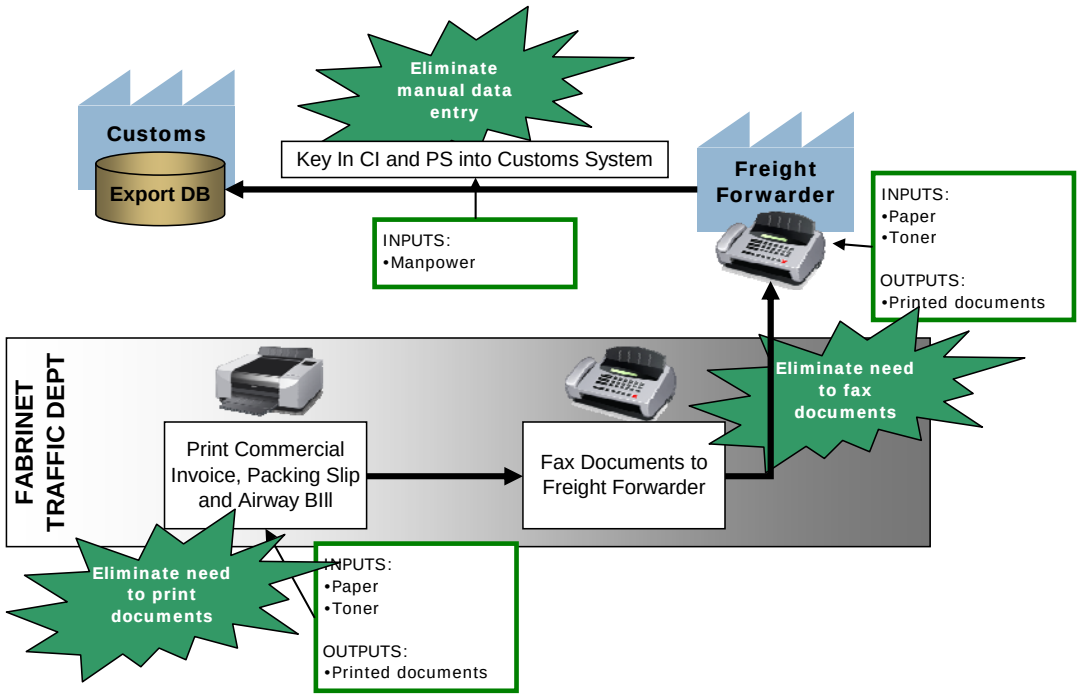

Figure 5: Green Stream Map of the export logistics process.

This particular project saved approximately 40 reams of A4 paper per year. As taught in the company's global awareness training, employees knew that one tree makes approximately 16 reams of paper. So, they calculated that this project saved at least two trees.

The Green Projects

Throughout the organization, the overall Sustainable Manufacturing efforts generated many "green" projects. Some examples are:

- **Tree Planting Outings**: A green living project where staff planted trees in various locations in the province.
- **Environmental Protection**: Company volunteers constructed an environmental breakwater in Trad province to preserve shoreline ecology.
- **Freight Consolidation**: A Green Stream Mapping project that directly reduced carbon emissions, saved paper and lowered costs.
- **N2 Generation**: A Green Stream Mapping project that directly reduced carbon emissions through a reduction in some transportation.
- **Paperless Purchasing**: A company wide effort to eliminate all printing of procurement documents; saved thousands of reams of paper per year.
- **Paperless Warehouse**: A major Six Sigma project generated from Green Stream Mapping where all paper-based warehouse process were replaced with hand-held electronic devices.

- **Water Recycling**: Green Stream Mapping water handling processes lead to a project to build a highly efficient waste water treatment and recycling system; recycled water is used throughout the facilities for flushing and gardening.
- **Office Temperature Controls**: Preset temperatures and timing of office climate controls lowered power consumption and reduced overtime.
- **Low-Loss Ballasts**: Installing efficient lighting throughout the factory reduced power and saved costs on replacements.
- **And many more**.

The Green Results

After completing many of the projects, the teams got together and calculated the overall results of the Sustainable Manufacturing efforts.

Green activities aimed at reducing paper usage resulted in proportionately lower consumption of paper compared to the growth of the business:

- Based on pre-green paper usage rates, Fabrinet saved an estimated 3,469,200 sheets of paper in FY2008.
- The paper usage reduction equates to 6938 reams, or 17 tons of paper.
- This reduction saved 416 trees.
- We saved 192,761 KWh of electricity required to produce that paper.
- 357,933 gallons of water were saved from paper production.
- 330,400 gallons of waste water were eliminated.
- 39 tons of solid waste were eliminated.
- 49 tons of CO2 were eliminated.

Similarly, green activities aimed at reducing electricity consumption resulted in proportionately lower consumption of electricity compared to the growth of the business.

- Compared to pre-green electrical consumption rates, we saved an estimated $567,000 in electricity costs.
- The amount of electricity saved was approximately 6,600,000 kWH
- The reduction in electricity consumption at Fabrinet reduced 4356 tons of CO2 emissions in FY2008 from power generation.

Fabrinet as a Sustainable Manufacturing Organization

Fabrinet has built an effective sustainable manufacturing company resulting in a green-oriented organization with reduced impact on the environment. By involving all staff in Green Living, Global Awareness, and Green Stream Mapping, Fabrinet was able to make a major impact to the environment. Many green projects and activities – from the very simple to the more complex – combined to form a truly green organization. With the right training and awareness, everyone contributed to the success of sustainable manufacturing.

Special Thanks

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