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Washington Lean and Green Program Report on Project Results and Lessons, 2010-14

Executive Summary

The Washington Lean and Green Program is a unique technical assistance partnership between the Washington State Department of Ecology (Ecology) and Impact Washington¹ that aims to help businesses become more financially and environmentally sustainable. Ecology, Impact Washington, and other technical assistance providers such as Washington State University (WSU) Extension Energy combine lean manufacturing, environmental, and energy technical assistance to improve operational and environmental results for Washington facilities. This report summarizes results and lessons from the Washington Lean and Green Program over a five-year period from 2010 to 2014. Ecology received funding from the U.S. Environmental Protection Agency (EPA) for this period to continue the Lean and Green Program after an initial three successful pilot projects. With this grant funding the past five years, the partners sought to refine and scale up their lean and green service model so they could reach more facilities and generate even more lean and environmental results.

Projects and Results

Ecology, Impact Washington, and other partners helped nine businesses with lean and green projects from 2010 to 2014, as well as many other businesses through independent efforts. These in-depth, implementation-focused projects used lean methods such as weeklong “kaizen” process improvement events to address environmental, energy, and operational issues for small and medium-sized manufacturers. The partners also contacted many more businesses through marketing and outreach efforts. Key results (or anticipated results) from the lean and green projects included:

- **Accra-Fab, Inc.** saves \$179,000 per year and reduced chemical use by 50% through process improvements to its ion exchange system.
- **Cosmo Specialty Fibers** has started evaluating waste stream diversion to produce several possible secondary products that could increase revenues as well as reduce environmental wastes. Given the preliminary nature of the work completed under this grant and uncertainty surrounding implementation, the company is not yet able to estimate savings.
- **Decagon Devices** is now lead-free and avoids the use of 105 pounds lead annually; the company also increased stenciling quality from 35 to 95 percent of products accepted.
- **Dolco Packaging Co.** achieved cost, energy, and waste savings through an improved recycling program, community collection program, and energy improvements.
- **Kärcher** is achieving a 95 percent drop in line stoppages and a 10% reduction in natural gas consumption through line balancing and standardization.

¹ Impact Washington is part of the National Institute of Standards and Technology Manufacturing Extension Partnership (NIST MEP) network. It was formerly known as Washington Manufacturing Services.

- **Heath Tecna, Inc.** is saving \$125,000 per year through lower water use, less hazardous waste generation, and reductions in scrap and defects.
- **National Industrial Concepts Global Manufacturing Solutions (NIC)**, has started improvements that are expected to save over \$36,000 annually, while reducing energy consumption by 19,000 therms, water use by over 680,000 gallons, and chemical use by 140 gallons per year.
- **SunOpta Healthy Fruit Snacks** reduced landfillable wastes by 64 tons/year and energy costs by \$84,000 per year through improvements in cold storage, lighting, and insulation, for a total annual savings of about \$98,000.
- **Western Chemical** evaluated three different technologies to begin recovering as much as 70% of ethanol for reuse. Due to the high capital expense of the recovery technologies, the company is also exploring distillation of the spent ethanol for use offsite as a fuel, which, if feasible, could save the company \$38,000 per year in avoided disposal costs.

Lessons Learned

This five-year period was a continued learning period for the public-private partnership. The partners faced challenges marketing a paid service to prospective clients in a depressed economy, while also adapted to lower levels of public funding available per project compared to the pilot phase. (Facilities paid a portion of Impact Washington's fees for lean services, with the federal grant and state matching funds covering the remainder.) Some key lessons learned from these experiences include:

1. "Lean and green" is a valuable service that produces substantial, on-the-ground results for businesses, including long-term operational efficiencies, environmental improvements, and positive financial returns. Lean and green uses the business efficiency tools of Lean manufacturing and extends them to achieve environmental and energy benefits.
2. Marketing the lean and green service proved to be very difficult, particularly during a depressed economy.
3. Much of the success with marketing depended on maintaining good relationships among the partners.
4. Allocating grant funds based on the environmental benefit helped Ecology to target funding towards its priorities, but created a marketing challenge for Impact Washington.
5. Project difficulties, when they occurred, centered on communications, clarity of roles, and procedures, rather than conflicts related to the substance of the lean and green improvements.
6. Lean and green is effective, in large part, because it leverages the power of teams to drive change through structured waste-identification and process-improvement activities.
7. Lean and green projects combine rigorous, data-driven analysis of environmental and operational improvement opportunities with in-depth implementation assistance through weeklong process-improvement events known as kaizen events.
8. Given their greater experience with lean and green, the partners were flexible in how they applied and adapted lean methods to address lean and environmental opportunities in projects.

Recommendations

Recommendations for other organizations considering similar lean and green initiatives include:

- Help build and maintain regular connections between partners to facilitate marketing and project success.
- Develop standard operating procedures and clear roles and responsibilities for projects among partners to help make the partnership operate smoothly, recognizing that partner organizations have different organizational cultures and needs.
- Marketing and sales messages should be fine-tuned to address key business needs for facilities and alleviate potential concerns about working with environmental agencies
- Public funding is useful as an incentive for facilities to conduct lean and green projects with lean manufacturing and environmental technical assistance providers, although there will still be marketing challenges in a depressed economy.
- To increase impacts and ensure durable results, support implementation and follow-up from events with additional technical assistance and incentives for undertaking capital improvements.

This report also contains specific, tactical tips for marketing and implementing lean and green projects based on the experiences of Ecology, Impact Washington, and their partners on these projects.

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I. Introduction

Washington Lean and Green Program Service Approach

In the Washington Lean and Green Program, several public and not-for-profit technical assistance agencies collaborate to help manufacturing and industrial businesses improve their productivity while reducing environmental wastes and costs. Using lean manufacturing methods with an increased focus on environmental wastes, the program helps facilities to become both more competitive and more sustainable. Originally used to describe Toyota’s production system, “lean” is a production philosophy and set of methods that seek to improve process speed, product quality, and customer responsiveness by eliminating non-value-added activity or waste. Common benefits of lean projects include lead-time reduction, increased productivity, reduced work in progress, and quality improvements. Lean and green projects focus on reducing environmental and energy wastes while also meeting other lean goals.

Each of the Lean and Green Program partners brings an important service to businesses (see Figure 1).

- **Washington State Department of Ecology (Ecology) Technical Resources for Engineering Efficiency (TREE) Program** provides environmental assistance and engineering resources to businesses at no additional cost.
- **Pacific Northwest Pollution Prevention Resource Center (PPRC)** and the consulting firm **Lean Environment Inc.** also provided environmental and engineering assistance as subcontractors.
- **Impact Washington**, a not-for-profit organization, provides lean manufacturing services, such as facilitating weeklong process improvement events, on a fee-for-service basis, among other business productivity, sustainability, and innovation services.
- **Washington State University (WSU) Extension Energy Program** conducts energy assessments for manufacturing plants, among other services.

Figure 1: The Washington Lean and Green Program Service Delivery Model



The Lean and Green Program focuses on small and medium-sized manufacturing and industrial businesses in Washington State that seek to reduce their environmental wastes, such as toxic chemicals. The lean and green approach is built around a few key beliefs:

- The lean process improvement framework and methods are useful for making significant reductions in energy use and environmental impacts.
- Combining lean and green technical assistance produces better results than if Ecology and Impact Washington operated independently (that is, the sum is greater than its parts).
- Lean and green technical assistance for implementation (e.g., kaizen events) offers greater likelihood of success than efforts that only focus on assessments of opportunities.

Several of these themes are touched on in the lessons learned section below.

Program Funding and Support Structure

The Washington Lean and Green Program began with three pilot projects in which Ecology and Impact Washington combined lean and environmental technical assistance to help manufacturing facilities generate impressive operational and environmental savings.² Following the pilot phase, Ecology received a State Innovation Grant award from the U.S. Environmental Protection Agency (EPA) to continue to provide lean and green assistance with Impact Washington for the period of 2010-2014. Using the State Innovation Grant and matching state funds, Ecology paid for a portion of Impact Washington's lean facilitation fees and some subcontractor engineering support for lean and green projects, while the participating facilities paid for the remainder. The manufacturing facilities did not have to pay for the environmental and energy services provided by Ecology, WSU Extension Energy, and PPRC. Grant funds also supported cross-training and marketing efforts of the partners, as well as documentation of project experiences, results, and lessons.

There were a few key differences between the support structure during the pilot phase and during this State Innovation Grant supported period.

- First, there was less public money available to support each project. This meant that more facilities could be assisted, but facilities would pay a larger share of the cost for lean services.
- Second, the scope of project activities varied considerably between projects. While each of the pilot projects included a value stream mapping exercise and three kaizen events, the projects in this phase tended to be more focused and involve varying amounts of lean and green activities.
- Third, Ecology allocated grant funds for lean and green projects more explicitly based on the potential for environmental waste reduction, with a particular goal of reducing toxic chemicals use and hazardous wastes.

² For more information about the pilot phase of the Lean and Green Program, see Washington State Department of Ecology, "Washington Lean and Environment Project Final Report," Revised 2008, Publication 07-04-033, <https://fortress.wa.gov/ecy/publications/publications/0704033.pdf>.

- Fourth, Ecology aligned the Lean and Green Program with its TREE Program. Instead of developing competing programs, Ecology has positioned lean and green as one of the services that its long-standing industrial technical assistance program, TREE, can provide to facilities.
- Fifth, Ecology and Impact Washington brought in additional partners to build the lean and green service. WSU Extension Energy conducted energy assessments for the projects with Dolco Packaging and Kärcher. The consulting firm Lean Environment, Inc. provided environmental technical assistance for the Accra-Fab, Western Chemical, and Cosmo Specialty Fibers projects. PPRC also continued to supplement Ecology's TREE team, providing research and on-site environmental assistance and documentation on several of the projects.

These changes, among others, were designed to improve the Lean and Green Program and work towards establishing a long-term model for the program.

Report Organization

The remainder of this report describes the activities during the grant period and offers key lessons and recommendations that may be drawn from them, as follows.

- The next section provides a summary of project activities and accomplishments, including highlights of results from each of the facility projects.
- Section III describes lessons learned from the lean and green projects and related partnership activities.
- Finally, Section IV outlines recommendations for other technical assistance providers that offer or may be considering offering similar lean and green services.

II. Project Activities and Results

Partnership Activities During the Grant Period

This phase of Lean and Green Program kicked off with reviews of the earlier pilot projects to identify improvement opportunities moving forward, marketing of lean and green services in Washington, and a cross-training meeting with partners to build shared expertise and partnerships.

Marketing for Lean and Green Projects

Marketing for new projects began after the first three pilot projects. Ecology and Impact Washington sought to leverage the success of those initial projects to attract new clients to initiate lean and green projects. Initial efforts included:

- Direct outreach to potential candidate facilities in Washington state
- Statewide, live videoconference in four locations (September 2010), to share the successes of the first projects with manufacturers across the state, and encourage them to participate in future projects
- Publishing and dissemination of the case studies for the first projects, in hardcopy and online

With the transition to funding from the State Innovation Grant for 2010–14 projects, Ecology established criteria for how it would allocate funds to lean and green projects with Impact Washington, with the cost share determined largely based on the anticipated environmental results from the projects. Ecology and Impact Washington worked together to develop a two-page flyer with frequently asked questions for distributing to potential clients. Ecology and Impact Washington also reached out to WSU Extension Energy to include the organization formally as one of the partners in the program and the flyer.

Program coordinators at Ecology and Impact Washington had monthly calls to coordinate on project opportunities and discuss any issues. The partners exchanged lists of facility contacts and used those as starting points for discussions about which facilities to approach for marketing lean and green services. Typically, Impact Washington led the initial outreach to facilities, but both Impact Washington and Ecology attended site visits to follow up with leads and further scope potential lean and green projects.

Following the successful conclusion of several projects, Impact Washington developed three videos of the lean and green work: one focused on an overview of the lean and green services, another highlighted the Accra-Fab project, and a final one was developed for the SunOpta project, but this has not been approved for release by the facility. In 2014, Impact Washington invested in a new marketing strategy (not funded by the EPA grant), which included using a third party to set up appointments and then staff time to sell services directly. This helped bring in projects at the end of the grant period.

Cross Training and Resolution of Issues

Early on in the State Innovation Grant period, the program partners recognized that there would be value from bringing a broad group of staff from all the partners together to learn from each other,

strategize on marketing efforts, and discuss coordination issues. The cross-training occurred in September 2010, with Impact Washington, Department of Ecology (Ecology), WSU Extension Energy, PPRC, and Ross Strategic, with each partner presenting aspects about their expertise so others could better understand the strengths and knowledge each partner brings to a project, along with shared skills. This occurred after several new lean and green projects had been initiated. In follow-up meetings after the cross training, the partners worked on materials to establish clear expectations, roles, responsibilities, and processes for how they would interact with each other on projects, as a way to prevent future coordination and communication issues on projects.

2010–14 Lean and Green Projects

The marketing efforts resulted in lean and green projects occurring at these nine facilities during this grant period:

- Accra-Fab, Inc, Liberty Lake, Washington
- Cosmo Specialty Fibers, Cosmopolis, Washington
- Decagon Devices, Pullman, Washington
- Dolco Packaging Co, Wenatchee, Washington
- Heath Tecna, Bellingham, Washington
- Kärcher, Camas, Washington
- National Industrial Concepts Global Manufacturing Solutions (NIC), Woodinville, Washington
- SunOpta Healthy Fruit Snacks, Omak, Washington
- Western Chemical, Ferndale, Washington

As of September 2014, six facility projects had been completed, and three projects—Cosmo Specialty Fibers, NIC, and Western Chemical—were in progress. The environmental goals, lean and green activities, and service providers involved in each project varied considerably (see Table 1), but all of the projects achieved (or are anticipated to achieve) operational and environmental savings for the facilities. Each project is described in this section, followed by tables that summarize the project drivers, problems addressed, and solutions (Table 2) and the estimated results of the projects (Table 3).

Table 1. Lean and Green Project Components Overview

	Business Products/ Services	Target Reductions	Lean & Green Activities	Service Providers	Grant Funding
Accra-Fab (Liberty Lake, WA)	Custom metal fabrication, assembly, and design services	Wastewater	Kaizen event, targeted process improvements	Ecology, IW, Lean Environment	Yes
Cosmo Specialty Fibers (Cosmopolis, WA)	Dissolving wood pulp used as feedstock for a variety of products	Wastewater, solid waste	Engineering and lean analysis	Ecology, IW, Lean Environment	Yes
Decagon Devices (Pullman, WA)	Electronic sensors for food, environmental research, and agriculture	Lead solder	VSM, kaizen events, occupational training on lead free soldering	IW, outside training	Yes, for training

	Business Products/ Services	Target Reductions	Lean & Green Activities	Service Providers	Grant Funding
Dolco Packaging (Wenatchee, WA)	Expanded polystyrene products, including egg cartons and food packaging	Solid waste, energy	VSM, kaizen event, and energy assessment	Ecology, IW, WSU	Yes
Heath Tecna (Bellingham, WA)	Composite interior parts for airplanes, such as closets and overhead bins	Hazardous waste, energy, water, defects/scrap	Environmental opportunity assessment and 3 kaizen events	Ecology, IW	Yes
Kärcher (Camas, WA)	Industrial, household, and commercial washers	Chemical usage, defects, energy	Kaizen event	Ecology, IW	No, Ecology staff time only
NIC (Woodinville, WA)	Custom and turnkey sheet metal and mechanical products	Energy, water, chemical usage, labor	VSM, kaizen event	Ecology, IW	Yes
SunOpta (Omak, WA)	Organic and natural fruit bars and fruit snacks	Energy, solid waste	VSM, 2 kaizen events, and energy assessment	Ecology, IW, WSU	Yes
Western Chemical (Ferndale, WA)	Fish culture products, biosecurity supplies, and spawning agents	Hazardous waste	Engineering and lean analysis	Ecology, IW, Lean Environment	Yes

The following are abbreviated in the table: IW = Impact Washington; PPRC = Pollution Prevention Resource Center; VSM = value stream mapping; WSU = Washington State University Extension Energy.

Accra-Fab, Inc, Liberty Lake, Washington

Accra-Fab provides high quality precision custom metal fabrication and assembly for companies throughout the world, and offer design services for metal products and parts. In 2009, Accra-Fab management determined the facility was spending too much staff time and money handling wastewater from the metal treatment lines.

Wastewater was identified as a priority, and Accra-Fab used assistance from Ecology and Impact Washington to resolve this issue. Through a kaizen

event, Impact Washington and Accra-Fab evaluated the conversion coating process, looking for inefficiencies and ways to reduce wastewater generation. Along with improvement in standardized procedures, layout, and system measurement, Ecology was able to support a consultant from Lean Environment, Inc. who helped the facility to redesign and refurbish the ion exchange system.

With minimal capital investment, the efforts of this public-private partnership increased production capacity, saved the company **\$179,000 annually** in avoided wastewater management and treatment costs, and **reduced chemical use by 50%**.



Future State: New Ion Exchange System at Accra-Fab

Accra-Fab, Inc. received a national award for “Best Multimedia Video” as a 2013 “Pollution Prevention MVP” (MVP2). The video is titled Accra-Fab – Lean & Green Manufacturing and is found here: <http://vimeo.com/43681916>.

Cosmo Specialty Fibers, Cosmopolis, Washington

Cosmo Specialty Fibers, Inc. (CSF) is a wood product company producing dissolving pulp in Cosmo polis, Washington. It is completing acetate pulp qualification to expand into that pulp market as well.



CSF is evaluating waste stream diversion to produce several possible secondary products. This could significantly increase revenue and decrease wastewater discharges, benefiting both the top line and the environment. Impact Washington and subcontractor Lean Environment, Inc worked with the company to provide high-level engineering and lean review of secondary product options for this lean and green project.

The independent review corroborated the company’s approach. It also provided a framework and specific engineering steps to take next. Given the preliminary nature of the secondary products evaluation, no estimates of potential savings are currently available. Possible revenue increase and environmental waste reduction range from very small to very large depending on what is implemented.

Decagon Devices, Pullman, Washington

Decagon Devices manufactures electronic sensors for the food, environmental research, and agriculture industries. A leader in its field, the company had long used traditional lead-based soldering for manufacturing circuit boards. With stringent international anti-lead standards for electronics, along with motivation to improve employee health and reduce hazardous waste, Decagon worked with Impact Washington to achieve both.



Decagon Devices

Through the EPA grant, Ecology was able to help cover in-house training and certification for Decagon production staff to begin the transition to meet the stringent international standards for lead-free products, and continue supplying international markets. Decagon also used Impact Washington expertise in lean and green efforts, to improve productivity and product quality.

Decagon successfully **eliminated all lead use at the facility, avoiding 105 pounds of lead consumption each year**, along with avoiding resulting lead-bearing waste disposal and management. The lean and green efforts also greatly **increased stenciling quality**, from 35 percent to 95 percent accepted, offering significant cost savings.

Dolco Packaging Co, Wenatchee, Washington

The Wenatchee Dolco Packaging facility produces different expanded polystyrene (EPS) products, such as egg cartons and fast food packaging. The manufacturing process delivers virgin pellet and/or post-industrial regrind feedstock from silos to extruders, then extrudes the blown foam sheets, cures the sheet material, then forms the products.



Dolco Packaging Products

One of the key reasons for Dolco's interest in a lean and green project was the parent company's view that lean manufacturing could improve its bottom line. Impact Washington and Ecology partnered with Dolco to conduct three, week-long events at the site, including a lean training and value stream mapping effort, a facility energy assessment by WSU Extension Energy, and a kaizen event around solid waste reduction. The focus of the kaizen event was on solid waste management, reduction of scrap, especially regrind and rework rates, and initiation of a community drop-off collection and recycling program.

Although Dolco did not report quantitative results from the project, it did achieve several lean and operational process improvements. The team's efforts resulted in a vastly **improved internal recycling** and paper collection system, allowed for more rigorous data collection on scrap generation, to help with decision-making for continuous improvement over time, and a **consumer recycling collection program** for post-consumer EPS egg cartons. This program, initiated in Wenatchee, has now rolled out to Dolco's four sister plants across the U.S.

The energy efforts resulted in a comprehensive energy review with suggestions for managing compressed air systems, and optimizing the thermal oxidizing system for butane recovery and neutralization. The facility also learned how to better use its own infrared camera for energy assessment and improvement opportunities, including operation of motors and pumps. This offers the benefit of more proactive preventive maintenance and lowers potential energy losses from overheating.

Heath Tecna, Inc., Bellingham, Washington

Heath Tecna, Inc. manufactures composite interior parts for airplanes, such as closets and overhead bins. Heath Tecna has a lean culture, conducting at least one lean event each week at the facility. Numerous staff are trained and experienced in facilitating internal lean events. This allowed Heath Tecna staff to take a very active role in helping manage four week-long lean and green events along with Impact



Heath Tecna Kaizen Event Team - Week 2

Washington. Ecology staff lead or assisted the pollution prevention assessment and implementation aspects of the events.

The lean and green efforts focused on hazardous wastes, core sheet scrap, water consumption, and defect scrap. The company achieved a **savings of \$125,000 annually** because it added environmental waste reduction to its lean manufacturing efforts.

After implementation of the future state for each of the focus areas, Heath Tecna cut **dangerous waste by 18,000 pounds** and use of toxic materials by 400 pounds per year. Reduction in core sheet scrap, through more efficient material utilization, is saving the facility \$35,000 annually, with the added benefit of decreased production time. The facility is also **saving 10,000 gallons of water per day**, mostly from water flow metering that showed the water pressure was much higher than the necessary operating specs for the vacuum pumps.



Scrap Reduction Efforts at Press #4

Heath Tecna: "This program has proven financially and ecologically successful and I am proud of the work we have collectively achieved." Angela Davis, Manufacturing Engineering Manager.

Kärcher, Camas, Washington

Kärcher, in Camas, Washington, makes industrial, commercial, and household pressure washers. Primary processes include steel fabrication, painting and powder coating, washer assembly, and label production. Kärcher was initially interested in reducing the natural gas consumption of its paint line, but through a lean and green project, found significant labor and natural gas savings waste by reducing work stoppages on its metal paint line.

The paint line commonly suffered line stoppages, which caused other problems, such as over curing of parts stuck in the oven, flash rust forming on parts just out of the washer, and uncured powder coat losing its charge and ability to adhere to the substrate. This increased defects and caused rework. Kärcher was spending time and money on tasks that did not add value to its products.



Paint Booth at Kärcher

Impact Washington and Ecology technical assistance staff teamed helped the Kärcher staff by supporting a one-week kaizen event, involving lean training and use of various tools, such as Seven Ways, 5S, standard work, process diagrams, and others, to identify what the future state process would look like. The team carefully assessed the process steps that added value to the product and those that did not. The team was able to balance the production lines and standardize several processes, achieving a **95 percent drop in line stoppages and reduction in annual natural gas use by 10 percent.**

National Industrial Concepts Global Manufacturing Solutions (NIC), Woodinville, Washington

NIC is a tier-one manufacturer that delivers custom and turnkey sheet metal and mechanical products to the medical, heavy truck, industrial and consumer sectors. The nature of custom fabrication and production for multiple customers poses some challenges for NIC. The company is continuously looking to improve production and environmental efficiency.

Impact Washington led NIC staff through lean training and an intensive Value Stream Mapping event, in which Ecology, Impact Washington, and NIC staff comprehensively evaluated the current chemical and paint processing steps. The team assessed chemical bath operations, painting application, oven operation, work flow, and work instructions.

In a future state kaizen event, in September 2014, the team reconvened to identify working solutions to improve production throughout the chemical treatment line. The teams focused on instituting visual and process controls to standardize bath times for different work pieces. Instructions and standard work will be enhanced and simplified for different and custom work pieces. Bath titration processes were evaluated, and countercurrent



In-depth Value Stream Map of a Metal Part at NIC

rinsing and bleed & feed systems were designed to further minimize staff time, chemicals, and water usage. An infrared camera audit showed

inconsistent heating in the drying oven, which can be improved with better airflow. Lastly, the quality conformance system will be used to track sources of defects for future prevention efforts.

The company has estimated a savings of about **\$36,000 annually from the process changes**, and these improvements would **reduce energy consumption by 19,000 therms, water by over 680,000 gallons of water, and hazardous chemical usage by 140 gallons per year.**

SunOpta Healthy Fruit Snacks, Omak, Washington

SunOpta Healthy Fruit Snacks processes and produces organic and natural fruit bars and fruit snacks. In 2010, the facility set goals to improve efficiencies and cut waste in its operations. From March through June, a series of four lean and green events were conducted in partnership with Impact Washington, Ecology, and WSU Extension Energy.

First, Impact Washington led SunOpta staff through lean training and value stream mapping of its process. Following the VSM, three additional events occurred, focusing on solid waste, wastewater, and energy. Lean manufacturing techniques, energy assessment, and source reduction tools were used to identify and implement improvement opportunities. Ecology specialists assisted with the waste issues and were able to find a recycler for pallets, saving **\$10,000** per year. With additional recycling and elimination of paper towels, which were replaced with air dryers, SunOpta **reduced solid waste** to landfill by **64 tons per year.**



Energy Assessment Walkthrough at SunOpta

For the final event, WSU Extension Energy visited the site for an in-depth energy assessment, which uncovered numerous energy efficiency improvements. One of the larger findings was that SunOpta could save **\$84,000** annually on energy through more efficient use of cold storage space, lighting upgrades, pipe and facility insulation, and other energy improvements.

The total project savings for SunOpta were **\$97,900 per year.** SunOpta's success can be attributed to corporate leadership setting sustainability goals, the employees who took ownership of improvement efforts, and the public/private partnerships forged.

Western Chemical, Ferndale, Washington

Western Chemical Inc. operates its corporate offices, quality control laboratories, and U.S. Food and Drug Administration (FDA) inspected manufacturing plant in Ferndale, Washington. For over 35 years, it has worked in developing and marketing FDA and EPA approved fish culture products, biosecurity supplies, and spawning agents.

Impact Washington approached the company during a final marketing effort for lean and green projects, and discovered its interest in reducing ethanol waste, generated during production of one of the

company's fish sedation products. This process generates a significant volume of ethanol waste, which is designated as Dangerous Waste in Washington State. The purchase and disposal of denatured ethanol represents a significant cost to the company.

A team of Western Chemical staff, Impact Washington, Ecology, and subcontractor Lean Environment, Inc. worked together starting in summer 2014 to evaluate ethanol waste generation and three recovery technologies for spent ethanol. Challenges arose in this effort due to the composition of the waste product and the high purity (99.9%) of recovered ethanol needed to reuse it onsite. The team designed and bench scale tested a recovery system that produces ethanol of sufficient purity. The next step is to pilot scale the process to address current operational and cost uncertainties. These two pieces of information will allow the company to make a final decision on implementation. In addition, the team investigated direct sale of the high BTU waste as an offsite fuel.



Waste Ethanol Treatment System

If a reactor technology is viable, Western Chemical **could avoid \$44,000 to purchase 60,000 pounds of ethanol and \$38,000 in disposal costs each year.** If beneficial reuse and end market is secured instead, the **avoided disposal costs could be \$38,000 each year.** Capital expenses and return on investment are to be determined based on pilot scale and company decisions about scaling up production.

Summary of Project Solutions and Results

The following tables summarize the solutions and results that the Lean and Green Program partners worked with manufacturing facilities to achieve. Table 2 describes the drivers for why facilities participated in the projects, the causes of problems the partners addressed, and the solutions the teams identified and implemented. Table 3 summarizes the environmental, productivity, and cost savings from the six completed projects and the anticipated potential savings from the three projects that were ongoing as of September 2014. (Some facilities did not quantify all the savings from the projects.)

Table 2. Overview of the Lean and Green Project Drivers, Causes of Problems, and Solutions

	Project Drivers	Causes of Problems	Solutions
<i>Completed Projects</i>			
Accra-Fab	<ul style="list-style-type: none"> Reduce high cost to haul wastewater to third party treatment Ensure that wastewater system adequately treats wastewater 	<ul style="list-style-type: none"> Wastes were added to wastewater system that it wasn't designed to treat Lack of clear, written instructions and staff training on wastewater treatment system Physical system awkward to access and operate 	<ul style="list-style-type: none"> Improved and developed standard operating procedures (SOP) for the ion exchange wastewater treatment system Redesigned and refurbished the ion exchange system, including reconfiguring tanks, to improve performance and allow easier, safer access to treatment units
Decagon Devices	<ul style="list-style-type: none"> Retain existing customers and expand European markets when new stringent no/low lead solder requirements started 	<ul style="list-style-type: none"> Needed staff training to make process changes to remove lead solder 	<ul style="list-style-type: none"> Provided training for staff on lead-free soldering techniques, allowing the company to completely eliminate the use of lead
Dolco Packaging	<ul style="list-style-type: none"> Achieve green & energy improvements Improve the bottom line Demonstrate good environmental stewardship 	<ul style="list-style-type: none"> Costs of scrap and other environmental wastes were hidden in overhead or other categories, not visible to management, and not communicated to staff No quantification or tracking of environmental costs Excess energy use and lack of awareness about causes 	<ul style="list-style-type: none"> Determined costs of reprocessing scrap and ways to cut scrap rate Addressed environmental and energy wastes with staff to increase awareness. Sorted and properly disposed of obsolete electronics through a take-back program Reduced internal and customer paper use Started regional network to establish consumer recycling for styrofoam egg cartons Used infrared camera to survey motors for preventative maintenance

	Project Drivers	Causes of Problems	Solutions
Heath Tecna	<ul style="list-style-type: none"> Expand lean events to include environmental improvement Reduce chemical use, improve waste separation and comingling procedures, and reduce water use 	<ul style="list-style-type: none"> Rapid business expansion and difficulty manufacturing many different products for different companies Defects Over use of two hazardous chemicals Lack of information on best segregation of waste streams Lack of awareness of water pressure for vacuum pumps 	<ul style="list-style-type: none"> Evaluated defects and implemented system corrections Changed testing procedure for mixing adhesives Changed which wastes to comingling and which to separate for disposal Reduced water pressure to certain process units Installed low-flow toilets
Kärcher	<ul style="list-style-type: none"> Improve productivity and throughput Eliminate painted part defects 	<ul style="list-style-type: none"> Paint line stoppages Unbalanced production lines 	<ul style="list-style-type: none"> Established procedures and criteria for who can stop the line and when Balanced work in production line Organized work areas Evaluated defects and implemented system corrections Improved layout to decrease product distance traveled Completed compressed air survey and repair leaks
SunOpta	<ul style="list-style-type: none"> Increase process productivity Accelerate energy and material use reduction Reduce high levels of solid waste 	<ul style="list-style-type: none"> Food processing is intrinsically energy and water intensive, and generates wastewater Low cost of water meant that there was little incentive to reduce its use Lack of awareness of local recycling and solid waste recovery options 	<ul style="list-style-type: none"> Implemented best practices to separate solid and liquid wastestreams Assisted with the solid-waste issues and found recycling outlets for pallets and several plastic streams Replaced paper towels with air dryers Identified energy savings opportunities, and reduced warehousing, improved insulation, and upgraded lighting
<i>In-Process Projects (as of September 2014)</i>			
Cosmo Specialty Fibers	<ul style="list-style-type: none"> Increase revenues through additional secondary products Reduce solid waste volume Address sources of high biochemical oxygen demand (BOD) levels in wastewater 	<ul style="list-style-type: none"> Lack of financial certainty and knowledge about process viability of markets for certain recyclable or reusable waste streams 	<ul style="list-style-type: none"> Completed engineering analysis of secondary products and identified engineering next steps Process improvements are ongoing based on the engineering analysis*

	Project Drivers	Causes of Problems	Solutions
NIC	<ul style="list-style-type: none"> • Address process bottlenecks to expand production • Reduce energy, water, and chemical use per unit production 	<ul style="list-style-type: none"> • Chemical and paint lines are located in separate area from rest of plant • Minimal cross-organizational knowledge about bath chemistry • Difficulty manufacturing many different products for different companies • Full cost of chemical processing is unknown • Inefficient air flow in curing oven 	<ul style="list-style-type: none"> • Involved staff from different company departments in Lean events • Eliminated unnecessary chemical processing steps via standardization for product families. Use visual controls for clear work instruction • Optimizing bath chemistry and testing for bath concentrations* • Improving countercurrent rinsing* • Improving convection in curing oven*
Western Chemical	<ul style="list-style-type: none"> • Reduce high waste disposal costs for spent ethanol 	<ul style="list-style-type: none"> • Process chemistry makes ethanol wastes difficult to treat or recover 	<ul style="list-style-type: none"> • Evaluating possibility of onsite distillation and beneficial reuse for spent ethanol* • Evaluating business case for installing an ethanol recovery system*

*Activities that were in progress or still under evaluation as of September 30, 2014.

Table 3. Annual Cost, Time, and Environmental Savings from Lean and Green Projects

	Raw Material and Solid Waste	Hazardous Substances and Waste	Water	Wastewater	Energy	Labor/Productivity	Reported Annual Cost Savings
<i>Savings from Completed Projects</i>							
Accra-Fab		Chemical use reduction of 50%	73,000 gallons	73,000 gallons		Increased production capacity	\$179,000
Decagon Devices	50%+ improvement in quality/reduced defects	105 pounds of lead feedstock, plus avoided generation of lead-bearing waste				Inventory turns in repair down from 120 to 10 days	Not quantified
Dolco Packaging*	Community recycling collection; useable feedstock	One-time removal of 4,000 pounds of obsolete electronics					Not quantified
Heath Tecna	\$35,000 worth of core material, plus anticipated 10% reduction in defects	Chemical use reduction, 18,000 pounds hazardous waste eliminated	10,000 gallons	10,000 gallons		Reduced work in process (WIP) by 1 day	\$125,000
Kärcher		47 gallons of wash chemicals	20,000 gallons	20,000 gallons	10% reduction in natural gas	95% reduction in line stoppages	\$2,200 (electricity only; other savings not quantified)
SunOpta	64 tons solid waste, saved 320 rolls of paper towels				190,000 kWh	Safer and more ergonomic work setting	\$97,900
<i>Anticipated Savings from In-Process Projects (as of September 2014)</i>							
Cosmo Specialty Fibers**	Environmental waste reductions and revenue impacts not yet quantified						
NIC		140 gallons	680,000+ gallons	680,000+ gallons	19,000 therms	>110 hours	>\$36,000
Western Chemical		60,000 pounds (or 10,000 gallons)					\$38,000 to \$82,000 (Depending on solution)

*Dolco Packaging did not report quantitative results from the lean and green project activities.

**Cosmo Specialty Fiber was not able to estimate savings given the preliminary nature of the work completed and uncertainty surrounding implementation. Possible revenue increases and environmental benefits range from very small to very large.

III. Lessons Learned

Even though the Lean and Green Program partners had already tested the basic approach of combining lean and green services in the initial three pilot projects, the projects and related activities over the last five years continued to be an opportunity for learning and refinement of the program. This section summarizes key findings and lessons learned from the nine projects from 2010 to 2014, based on interviews conducted by Ross Strategic and PPRC with Ecology, Impact Washington, and facility staff.

1. **“Lean and green” is a valuable service that produces substantial, on-the-ground results for businesses, including long-term operational efficiencies, environmental improvements, and positive financial returns.** Lean and green projects combine the efficiency and productivity improvements of lean manufacturing with environmental expertise that helps facilities to save money, improve quality, and reduce toxic chemicals, energy use, and water use. Ecology staff have found their engagement in lean kaizen process improvement teams to be a powerful vehicle for environmental change and building relationships with facilities, while

Value of Lean + Green

Additional savings above and beyond labor and “traditional” lean savings can typically be found by looking at environmental wastes along with lean wastes. For example, Heath Tecna found an additional \$17K of savings by metering its two largest water uses, decreasing water pressure to those uses, and calculating the savings in water and wastewater bills.

Impact Washington staff have noted that involving Ecology staff in projects helps them provide additional value for clients. Along with delivering long-term results for facilities, the partners equip businesses with tools and methodologies to continue to improve their performance. As a testament to the value of the lean and green service, some Impact Washington staff have contacted Ecology staff to ask for technical advice on situations that Impact Washington clients had outside of the grant-supported projects. Facilities interviewed, including Accra-Fab, Heath Tecna, and Kärcher, say they would recommend the lean and green service to other clients. Results from projects in this phase (see Table 3) typically included significant operational gains for facilities, such as reduced costs, defects, and line stoppages, as well as environmental savings depending on the focus area, such as reduced chemical use, energy use, and wastewater discharges.

2. **Marketing the lean and green service proved to be very difficult, particularly during a depressed economy.** Especially in the first part of the grant period, Ecology and Impact Washington approached numerous businesses to find potential clients for lean and green projects, but was not able to secure many project commitments, despite having a public subsidy and past successes from the initial pilot projects. Several factors contributed to the marketing challenges:
 - Companies do not necessarily distinguish between the regulatory and technical assistance programs at Ecology, and can be reluctant to work with Ecology because of the regulatory stigma. To help with this challenge, Ecology provided Impact Washington with a copy of a

letter that designated certain Ecology staff as Technical Assistance Officers and explained their roles. Impact Washington distributed this to facilities if they had questions.

- Although there was a public subsidy provided by the federal grant, facilities needed to pay a portion of the fees for Impact Washington's lean facilitation services, as well as dedicate considerable amount of staff time towards the lean improvement activities (e.g., teams of three to ten for up to four weeks of improvement projects). During tough economic times, it is hard to make that type of financial and staff investment, even if it promises greater returns long term.
- Ecology staff implementing the Lean and Green Program are engineers, and do not have extensive experience and training on marketing and sales. Impact Washington project managers have more overall marketing experience, but less experience specifically marketing environmental and energy services. Most, but not all, of the lean and green projects over the last five years began with conversations initiated by Impact Washington.
- Ecology and Impact Washington were searching for a very specific type of client for projects. They were looking for clients that:
 - Had management/leadership commitment to the project
 - Were interested in environmental as well as lean/operational improvements
 - Had significant environmental wastes, particularly toxics
 - Were the size that Impact Washington serves (small/medium manufacturer), but also large enough to have significant environmental and/or energy impacts
 - Would allow Ecology and/or other environmental service providers on site
 - Would provide the financial and staff commitment
 - Were willing to share their story/results

- 3. Much of the success with marketing depended on maintaining good relationships among the partners.** The marketing efforts for lean and green projects tended to build from the existing relationships that Impact Washington and Ecology had with facilities. Impact Washington most often led the initial outreach to facilities to market projects, although once a prospect was identified, both Impact Washington and Ecology would typically participate in an on-site visit and discussion with the company. The more familiar Impact Washington and Ecology staff were with each other's services and capabilities, the better able the partners would be able to describe what each partner could bring as part of the lean and green service package. The cross-training meetings and discussions at the beginning of this grant period, as well as regular calls between the lean and green program coordinators, were helpful for bridging the gap between the two organizations. When the Lean and Green Program and Ecology staff connections were not on the forefront of Impact Washington project managers' minds, however, they were less likely to market those projects to clients. This may help explain why there was less project activity for much of the grant period.

Tips for Lean and Green Marketing and Sales

- ✓ Establish clear criteria for projects and get all partners on the same page before launching efforts to recruit potential new facilities for projects.
- ✓ Leverage existing relationships and contacts with facilities to let them know about the lean and green services.
- ✓ Initial site visits, involving both the lean and environmental assistance partners, are critical to understanding the facility's goals and issues.
- ✓ Asking the right questions about environmental or other “pain” for facilities is critical. Phrases such as “improved product quality,” “less product variability” may resonate with a company more than messages around decreasing environmental wastes.
- ✓ Typically, the largest to smallest cost savings for environmental improvements is as follows:
 - Labor, including rework, slowed, or stopped production
 - Infrastructure investment (e.g., avoided facility expansion or avoided investment in new treatment equipment)
 - Raw materials, including product materials and chemicals
 - Energy use
 - Chemical and hazardous materials waste disposal
 - Water use and wastewater disposal costs
- ✓ The time between approaching prospective clients and signing a contract with facilities for projects can be significant.
- ✓ Proactively address potential facility concerns about regulatory agencies coming on site at facilities with materials and messages that communicate the distinction between technical assistance and regulatory staff, or by providing environmental assistance through a third party.

4. **Allocating grant funds based on the environmental benefit helped Ecology to target funding towards its priorities, but created a marketing challenge for Impact Washington.** To better align resource investments with its objectives, Ecology funded projects differently depending on the target areas of the project. Ecology program managers initially identified a specific funding percentage for projects, but over time, Ecology became more flexible with its funding allocations. Ecology provided the most funding towards projects that reduced toxic chemical wastes or use. While this flexibility was beneficial for Ecology, the lack of consistency in project funding was one of the major complaints expressed by Impact Washington project managers. For Impact Washington, it made it more difficult to market the projects to prospective clients without knowing there would be a standard subsidy provided by the grant funds. In some cases, it was not clear to Impact Washington or the facility, as to what met Ecology's criteria for funding (e.g., a paint booth did not have much hazardous emissions since it was a powder coating process). To mitigate these concerns about differential funding for projects, Ecology and Impact Washington potentially could have:

- Established and more clearly communicated the criteria and process for funding projects at the beginning of the grant cycle.
- Provided additional cross training about how Ecology and Impact Washington staff should identify potential clients based on the key lean or environmental issues (“pain” areas) they might be facing.

- 5. Project difficulties, when they occurred, centered on communications, clarity of roles, and procedures, rather than conflicts related to the substance of the lean and green improvements.** In the pilot projects, one of the major lessons related to the challenges of having two organizations with different organizational cultures, service models, and styles work together. (For example, Impact Washington service providers are in the field with clients most of the time, so are not used to the same level of email communications as are Ecology staff.) In these projects, there continued to be some of this same friction between Impact Washington and Ecology, especially initially and as staff at both organizations worked with unfamiliar people. WSU Extension Energy conducted energy assessments in two of the six projects (only one facility shared the report); these services tended to be implemented separately from the other lean and green activities at the facilities, such as value stream mapping and kaizen events.

After a few hurdles, particularly in projects with Dolco and SunOpta, Impact Washington and Ecology worked to address the coordination issues by developing procedures and expectations for how they would interact and coordinate on projects. They focused on these issue areas:

- Establish clear lines of communication among Impact Washington, Ecology, other service providers, and the facility.
- Provide clear expectations for each partner's role in project activities, including who is leading the project and what days and times service providers were expected to attend.
- Conduct advance planning and preparation before lean events, particularly pre-work such as data collection before kaizen events.

It is difficult to say how the communication and process challenges affected the overall project results (e.g., an Ecology recycling expert did not attend an event because he did not have enough advance notice about when it was occurring), but addressing the challenges certainly could have improved the quality of the project experience for the facilities and service providers. Some of the 2014 projects also had some communication challenges, which indicates a need to reinforce project procedures and ground rules among the partners regularly.

- 6. Lean and green is effective, in large part, because it leverages the power of teams to drive change through structured waste-identification and process-improvement activities.** Regardless of whether the driver for a lean and green event is operational or environmental objectives (e.g., productivity or expensive environmental wastes), the combination of lean and green is very powerful for identifying and acting on improvement opportunities. The people and the process of lean and green can matter more than the tools themselves in this context. Ecology and PPRC's role in the projects was to be an active team participant in the lean events, raising environmental issues and asking questions of staff to help identify the root causes of wastes. Without Ecology's presence, the same environmental issues likely would not have been addressed or been dealt with as thoroughly. The culture of lean and process improvement can be quite powerful. At Heath Tecna,

lean event teams wear red vests, designating their importance to the company. Ecology staff wearing the red vests were more able to get answers to questions they had during events.

- 7. Lean and green projects combine rigorous, data-driven analysis of environmental and operational improvement opportunities with in-depth implementation assistance through weeklong process-improvement events known as kaizen events.** The partners provided assistance to facilities to help them quantify the costs, production impacts (defects, time, excess work-in-process, etc.), natural resource use, and environmental wastes associated with current operations, identified the root causes of problems, and then worked with facilities to prioritize, plan, and implement process and technology changes to address the problems.

 - Outside assistance from Ecology, its subcontractors PPRC and Lean Environment, Inc., and WSU Extension Energy was particularly valuable to help quantify environmental and energy wastes and associated costs, as facilities often had less experience with documenting these impacts. The quantification and analysis of environmental wastes and costs helps to uncover improvement opportunities, inform implementation priorities, and demonstrate results.
 - All the lean projects included in-depth technical assistance to facilities to not only help identify potential solutions but also to implement solutions that could provide lasting financial, operational, and environmental benefits. Most projects did this through kaizen events, which are weeklong periods when the partners worked in teams with facility staff to implement process changes, document the results, and institute systems and tools to ensure improvements can be sustained and continue in the future.
- 8. Given their greater experience with lean and green, the partners were flexible in how they applied and adapted lean methods to address lean and environmental opportunities in projects.** The partners adjusted to the culture and needs of the organizations they were working with, as well as the specific target opportunities for the projects. For all projects, an initial site visit was an important way for Ecology and Impact Washington to help set the scope for the project. The types of approaches included some or all of the following:

 - **Value stream mapping or facility-wide opportunity assessment:** Many of the projects began with an assessment of the improvement opportunities at a facility through the lean value stream mapping method or other means. The partners also often incorporated “Lean 101” training as part of the initial on-site activities. In the Heath Tecna project, the partners decided that a facility-wide environmental opportunity assessment would be more appropriate than a value stream map, since many of the environmental issues the facility was interested in examining cut across value streams and processes. In other projects, the partners did value stream mapping together to prioritize implementation projects, noting the potential green opportunities along with the lean opportunities. While for others, the specific target processes had already been chosen, so Ecology did not feel a need to collaborate on the value stream mapping.

- Although focusing Ecology participation on kaizen events and not attending the value stream mapping event has the advantage of limiting staff time required, this approach also has its disadvantages. Facility employees may not view and accept Ecology staff as full members of the team when their participation is sporadic, and Ecology staff may miss opportunities to help the project team with idea generation.
- **Kaizen events:** Lean and green kaizen events are the main vehicle the partners have used for process improvements. They are particularly useful for engaging teams of facility staff and Ecology/environmental staff in looking at ways to reconfigure and improve a process from a holistic, systems perspective. Many lean tools can be applied or adapted to address environmental impacts through or outside kaizen events, including the seven ways brainstorming method, 5S (or 6S) workplace organization method, standard work, root cause analysis, process mapping, Failure Mode Effects Analysis (FMEA), and many others.
- **Small group focused projects:** For some specialized projects, such as an energy assessment or in-depth analysis of a support process such as wastewater treatment, smaller teams may make more sense than full kaizen team engagements. Ecology has successfully worked in pairs or small groups with facility staff both within and outside lean events to do specialized analysis and support work on projects. To get the broader cultural benefits of changes, these projects should be connected to the team-based process improvement activities.

Collectively, the lean and green projects supported in this grant period provide examples of a successful collaboration between unique technical assistance organizations. They illustrate the value of combining lean and green strategies, but also the challenges for this type of service provider partnership. The next section discusses recommendations for other service providers.

IV. Recommendations

As discussed in the Lessons Learned section, all participants – whether facilities or service providers – find value in the lean and green projects. Nevertheless, there are challenges to making lean and green technical assistance programs successful. Below are some recommendations for other technical assistance providers considering lean and green partnerships. Textboxes in this section and in Section III also identify numerous, specific tactical recommendations and tips on marketing, implementing projects, and building effective partnerships.

- **Help build and maintain regular connections between partners to facilitate marketing and project success.** When relationships between service providers are stronger, they are more likely to call on one another to assist with projects. For the Washington Lean and Green Program, these connections include not only interactions between program coordinators but also opportunities for regional staff at Ecology and Impact Washington to meet and interact. In addition, it may be useful to fully integrate WSU Extension Energy as a partner in marketing and delivering lean and green services to Washington businesses.
- **Develop standard operating procedures and clear roles and responsibilities for projects among partners to help make the partnership operate smoothly, recognizing that partner organizations have different organizational cultures and needs.** In particular, it is important to clarify which organization is “leading” the project, make sure improvement priorities are clear to all parties, and reinforce ground rules when projects begin. There was some confusion with the Washington Lean and Green Program as Ecology changed its priorities to focus specifically on toxic metal reductions. For the Washington Lean and Green Program, the partners should ensure that the existing procedures meet WSU Extension Energy’s needs and expectations, or whether changes are needed to accommodate WSU Extension Energy’s participation in projects.

Tips for Effective Assistance Provider and Facility Relationships

- ✓ Clear roles, responsibilities, and processes for communications and “baton passing” between the MEP project manager, the MEP facilitator, environmental assistance provider staff, and the facility are critical to the success of projects.
- ✓ Establish points of contact within each organization and clear communication channels between parties for each project.
- ✓ Conduct cross-training events or provide other forums for technical assistance providers to interact, better understand each other’s business models and services, and develop relationships with one another. These relationships can improve marketing success as well as help individuals work together more effectively on projects.
- ✓ When environmental assistance providers participate fully in lean and green activities at facilities instead of dropping in and out of events, they are generally more accepted by facility staff and thus able to contribute more effectively to process-improvement efforts.

- **Marketing and sales messages should be fine-tuned to address key business needs for facilities and alleviate potential concerns about working with environmental agencies.** The Washington lean and green partners may wish to develop a marketing strategy to systematically enhance marketing and sales efforts, as well as to address common barriers to facility participation, including lack of awareness, perceptions of Ecology as a regulatory agency, and financial hurdles to investing in improvement efforts. Productivity and operational issues are better selling points for most facilities than environmental wastes. It can be useful, therefore, to connect the environmental wastes to other areas of “pain” for facilities, such as production delays or costs. It also is helpful to proactively address concerns facilities may have about environmental agencies by clearly designating technical assistance staff as separate from staff with regulatory compliance responsibilities or by offering services through another entity (e.g., a non-profit organization). One effective marketing strategy Impact Washington tried was to have a third party call a facility to set up a face-to-face appointment with Impact Washington, then an Impact Washington representative would visit the facility to talk about challenges it was having, and based on that site visit, Impact Washington would engage Ecology on a project. Incentives, recognition, and sector-based outreach are other ways that lean and green assistance providers can enhance marketing efforts.
- **Public funding is useful as an incentive for facilities to conduct lean and green projects with lean manufacturing and environmental technical assistance providers, although there will still be marketing challenges in a depressed economy.** Grant funding has provided an incentive for lean and green projects in Washington since 2006, but was not sufficient to overcome difficult marketing challenges in the last five years. Although developing and implementing an overall marketing strategy in Washington could diminish the need for public subsidies over time, it likely will be important to continue providing an incentive to businesses to participate in lean and green projects by reducing their costs for technical assistance (e.g., for lean manufacturing facilitation), at least for the foreseeable future. Businesses are often reluctant to invest staff time and resources in process improvement activities, including stopping or taking staff off production lines during lean events, even with the potential of a good return on investment. Reducing costs for lean manufacturing assistance can alleviate these concerns and encourage businesses to address environmental wastes and costs (which may be “hidden” in overhead costs) along with operational improvements. Public funding also encourages assistance providers from different organizations to work together. Over the long term, success for public-private partnerships such as the Washington Lean and Green Program will rely on the partners recognizing each other’s value and being able to tap each other’s assets to assist facilities, whether or not there is a subsidy available for lean and green projects.
- **Support implementation and follow-up from events with additional technical assistance and incentives for undertaking capital improvements.** Support for follow-up activities after lean and green activities, such as periodically checking in with facilities on progress on action items, helps to ensure durable results, especially at facilities that may have less active internal champions.

Without this support for implementation, there is a risk of fallback. Although there was not much focus on tracking implementation status after lean and green project activities for the last five years, there were some examples that indicated that additional follow up could have been useful. One way to do this would be to explicitly include implementation check-ins as part of the expectations for Ecology or other staff on projects, in addition to the one-year follow-up survey sent by NIST MEP. To support the next level of improvements at facilities, it may be useful for lean and green programs to offer financial support, such as subsidies, loans, or utility bill rebates, for facilities to undertake capital improvements identified through lean and green projects that could deliver greater operational and environmental results. This type of financial incentive is especially useful in cases where the payback period for environmental or energy improvements exceeds the 12-18 month horizon most businesses are willing to consider.

Tactical Recommendations and Tips for Implementing Lean and Green Projects

- ✓ Data collection during the lean and green process allows new improvement opportunities to be discovered and addressed. Assistance providers may go into a facility focused on one issue, but learn that other issues have greater cost savings or environmental benefits.
 - At Dolco Packaging, scrap was initially viewed as acceptable since it was recycled back into the process. However, after considering the production costs of rework, the facility realized how much it could save by preventing, not just recycling, the wastes.
- ✓ Empowering employees is critical to the success of lean and green initiatives, as with lean initiatives. For assistance providers, this means that it is important to not simply focus on hardware solutions to problems, but also support in-house solutions to process problems.
- ✓ One of the most effective strategies for environmental assistance providers to engage with lean teams is to ask questions related to environmental wastes. This can help employees recognize the sources of environmental wastes and help them identify potential solutions.
- ✓ Approaches for bringing environmental wastes to a facility's attention in a lean process include:
 - Collect environmental waste data as part of a lean event (e.g., identify scrap amounts or costs on process maps).
 - Use lean methods to improve processes with known environmental issues, through team-based kaizen events or through specialized in-depth projects.
 - Assemble facility-wide environmental and energy data from utility bills, waste generation data, and raw material costs to identify large sources of environmental wastes and costs. Review these wastes and savings opportunities with facility staff as part of a value-stream mapping process, lean and green assessment, or a "treasure hunt" to identify improvements.
- ✓ The "Seven Ways" tool of brainstorming at least seven solutions to a problem can be very effective for identifying solutions to environmental challenges.
- ✓ Estimated savings are not the same as actual, realized savings from lean and green projects. It is important to get pre- and post-measurements to confirm savings, as well as follow up with facilities after events to ensure that process improvements are sustained.
- ✓ Many companies will invest in more efficient equipment if it delivers a payback of a year or less. Equipment rebates (e.g., from electric utilities) can be a very helpful for moving implementation forward, along with using grants to buy down payback periods from 2-3 to 1 year.

These summary recommendations highlight key areas of attention for technical assistance providers involved in lean and green efforts, based on areas that have been challenging or important lessons for Ecology, Impact Washington, and other participants. Overall, despite the continued opportunity for learning and improvement, Ecology, Impact Washington, and their partners have developed and delivered a lean and green service that draws from the strengths of each partner agency to deliver demonstrable results for an array of manufacturing businesses in the state.

This report was prepared by Jennifer Tice of Ross Strategic and Michelle Gaither of the Pacific Northwest Pollution Prevention Resource Center, under contract to the Washington State Department of Ecology, September 2014.