UNIVERSITY OF OREGON, DEPARTMENT OF PLANNING, PUBLIC POLICY, AND MANAGEMENT

SUSTAINABILITY AT WILLOW LAKE

A CASE STUDY IN SERVICE-LEARNING AND THE SUCCESSFUL IMPLEMENTATION OF INDUSTRIAL SYMBIOSIS

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ABSTRACT

Industrial ecology explores how industrial systems can function more like natural ecosystems. Industrial symbiosis is a subfield of industrial ecology and aims to develop mutually beneficial scenarios for the economy and the environment. The purpose of this study is to explain how industrial symbiosis networks can be created and implemented successfully.

This study provides a narrative to describe how Willow Lake Water Pollution Control Facility, once a facility only for the management of wastewater, is now a multi-purpose asset for a range of organizations with waste disposal needs. Central to the Willow Lake narrative is a service-learning partnership between City of Salem and University of Oregon. The narrative was developed with eight interviews and supporting documents.

The study concludes with recommendations for universities, cities, and state governments. Recommendations include: State governments should provide funding for cities interested in service-learning partnerships; economic development departments should use an inventorying process; economic development departments that use an inventorying process should assess their ability to function as third party facilitators; Sustainable City Year Program (SCYP) and other universities engaged in service-learning programs should suggest industrial symbiosis projects to partner cities; and industrial symbiosis partners should stay current with changing economic values of materials exchanged in their network.

Table of Contents

CHAPTER ONE: INTRODUCTION……..4

CHAPTER TWO: CONCEPTUAL FRAMEWORK…….6

CHAPTER THREE: METHODS……12

CHAPTER FOUR: WILLOW LAKE CASE STUDY…….17

CHAPTER FIVE: FINDINGS…….28

CHAPTER SIX: RECOMMENDATIONS…….33

BIBLIOGRAPHY…….37

Chapter One: Introduction

Governments can play a key role in transitioning towards more sustainable economies (Young 2013). Facilitating the development of industrial symbiosis is one way that governments can fulfill this role. Industrial symbiosis aims to mimic the efficiency of natural ecosystems by reducing industrial waste streams with the physical exchange of materials among organizations. Successful industrial symbiosis networks can generate economic and environmental benefits for the organizations involved by reducing carbon footprints and creating a market for materials previously considered waste.

Potential for industrial symbiosis networks is often overlooked because organizations lack the knowledge, experience, contacts, or trust needed to develop partnerships. This was the situation in Salem Oregon where Willow Lake Water Pollution Control Facility (Willow Lake) functioned well below capacity. For a variety of reasons the City had not thought much about the economic and environmental benefits of industrial symbiosis partnerships between Willow Lake and local organizations.

The City of Salem partnered with University of Oregon to develop a successful industrial symbiosis project in 2010. The project was part of the Sustainable Cities Year Program (SCYP), a major partnership that involved connecting over 25 classes across 10 disciplines to a range of sustainability-related projects. Projects covered a range of sustainability-related topics tasked to city staff to work on by City Council, but for which there lacked staff capacity in time, thinking, or political space. Sustainable Cities Initiative (SCI) is coordinated through SCYP. SCI is a UO program that promotes education, service, public outreach, and research oriented around the design and development of sustainable cities.

SCYP's service-learning format is critical to the success of the Willow Lake industrial symbiosis project. Service-learning is a process that integrates meaningful community service with instruction and reflection. The process demands reciprocity between academic and community partners in order to create a transformational experience for the people and institutions involved. SCYP's service-learning format helped Willow Lake shift to an income-generating facility while reducing the carbon footprint of various local organizations.

SCYP's service-learning model aided in the development of a generative planning process in Salem that is not commonly used by formal institutions. Generative planning is an informal planning process most commonly used by populations lacking access to formal institutions or channels of power. The process uses small, idiosyncratic, context-sensitive design versus more formal planning processes that rely on power and large-scale changes (Uzzell 1990). Willow Lake and City Council used aspects of a generative planning to expand Willow Lake's role beyond

wastewater treatment.

UO ideas inspired City of Salem to inventory local businesses for potential industrial symbiosis partnerships. The City identified current practices, successes, challenges, and future plans of local organizations that expressed interest in an industrial symbiosis network. The inventorying process identified a potential partnership between Willow Lake and Sequential Pacific Biodiesel (SeQuential) company. Based on the City's findings, students then developed a report assessing the economic and environmental benefits of a partnership between Willow Lake and SeQuential. Willow Lake ultimately adopted the report's recommendations, partnering with SeQuential and other organizations with waste disposal needs. Willow Lake, once a facility only for the management of wastewater, is now a multi-purpose asset that serves a number of partners with waste disposal needs. Willow Lake's new partnerships generated one million in revenue in 2012 (Green Gains 2013).

The purpose of this report is to identify what factors allowed Willow Lake to transcend its role only managing wastewater to become a lucrative, multi-purpose facility. Recommendations include: State governments should provide funding for cities interested in service-learning partnerships; economic development departments should use an inventorying process; economic development departments that use an inventorying process should assess their ability to function as third party facilitators; SCYP and other universities engaged in service-learning programs should suggest industrial symbiosis projects to partner cities; and industrial symbiosis partners should stay current to changing economic values of materials exchanged in their network.

Chapter Two: Conceptual Framework

The conceptual framework expands on ideas introduced in Chapter One. The purpose of the conceptual framework is to help explain how Willow Lake transcended its role only managing wastewater to become a multi-purpose facility. The conceptual framework helps explain the social processes involved as well as the actions of organizations. These concepts include: Industrial symbiosis, third party facilitation, generative planning, and service-learning. Third party facilitation is a concept that is closely related to industrial symbiosis. Generative planning and service-learning are concepts not commonly associated with industrial symbiosis, but useful for explaining how industrial symbiosis networks can be created successfully.

The conceptual framework was developed with a literature review that explores academic journal articles relevant to the Willow Lake case study. Findings and recommendations will explicitly link ideas from the conceptual framework to the Willow Lake case study.

Table 1 lists each idea from the conceptual framework, some of the concept's defining characteristics, and how the concepts link together to explain the Willow Lake narrative. Industrial symbiosis and third party facilitation are related concepts as third party facilitation is a tool used to establish industrial symbiosis networks. Generative planning and service-learning have little in common, but both are tools to facilitate social processes.

Table 1: Conceptual Framework Summary

Concept	Description	Relationship
Industrial Symbiosis	Mimics the efficiencies of natural systems	Networks can be developed with third party facilitation
Third Party Facilitation	Bridges professionals across organizations	A tool for developing industrial symbiosis networks
Generative Planning	Process relies on information versus power Creates small, context-sensitive changes that may generate major system changes	Can facilitate processes that help create industrial symbiosis networks
Service-Learning	A transformative learning process Integrates community service with instruction and reflection	Inspired generative planning during SCYP process

Industrial Symbiosis

Industrial symbiosis provides a sustainability framework for Willow Lake's innovations and explores how industrial systems can function more like natural ecosystems. Industrial systems traditionally function in a linear process where raw materials are consumed and products, by-products, and wastes are produced. In contrast, natural ecosystems do not produce waste. Natural ecosystems are cyclical because outputs of a given system serve as inputs for another. Industrial symbiosis seeks to mimic the efficiency of natural systems, in terms of waste elimination, to those of industrial systems (Chertow 2000).

The term "symbiosis" refers to biological relationships in nature where unrelated and traditionally separate species exchange materials, energy, or information in mutually beneficial ways. In nature and business, symbiotic relationships strive for greater benefits than could be achieved by acting alone. Industrial symbiosis aims to develop mutually beneficial scenarios for the economy and the environment by searching for ways partners across different industries or economic sectors can leverage one another for mutual benefits (Chertow 2000).

Third Party Facilitation

Developing industrial symbiosis networks requires bridging professionals across organizations. This can be difficult due to the varying outlooks, processes and social structures used by different decision-makers and organizations. The actions of decision-makers and organizations are influenced by factors including networks of information, friendship, trust relationships, and the companies they are associated with. Heuristics are also used to make day-to-day decisions when the amount of data needed to make fully informed decisions would be overwhelming. The actions of organizations, in turn, are determined by legal, regulatory, and political factors. Cultural norms and politics of power also play a significant role in the actions of organizations (Boons and Howard-Grenville 2009).

Collaboration is the process of diverse autonomous stakeholders working together to build consensus and produce effective results. Four general approaches typically used to achieve collaboration include: An information exchange that increases understanding among participants; an informal agreement used to address a specific set of identified issues; the development of a plan, contract, or other type of agreement; and the result of an ongoing interaction amongst partners. Collaborations that take the form of ongoing interactions are usually due to a need for a continued exchange of information or the changing nature of a given social system (Margerum 2011).

Cities that seek to use a collaborative process need more than an understanding of how collaborative approaches work if they are to be used effectively. It is not always clear how and when cities should use a collaborative process, or which collaboration approach will yield the best results in any given set of circumstances (Bingham,

Nabatchi, and O'Leary). Third party facilitation is a form of collaboration cities can use to help individuals and organizations overcome limiting factors in order to develop new social networks. Third party facilitation helps individuals and organizations function in ways that might not otherwise be considered due to the context of their typical processes and social structure (Boons and Howard-Grenville 2009).

Boons and Howard-Grenville describe third party facilitation as follows:

> In terms of industrial symbiosis, the broker engages individual firms interested in such collaborations but who otherwise lack some combination of experience, knowledge, or contacts with other interested firms. By making introductions, the brokering organization may "stand in" as an alternative to pre-existing social ties and thus speed the development of a trusting relationship between previously unknown firms.

Third party facilitation is important because decision-makers and organizations often lack the experience, knowledge, contacts, or trust required to build industrial symbiosis networks. Third party facilitators can help build trust amongst participants, share ideas across disciplines, and help develop more cooperative behavior. They also assist with the proprietary concerns of businesses and help connect groups with different cognitive outlooks (Boons and Howard-Grenville 2009).

Local authorities can play an important role in facilitating social networks since they are in a unique position to facilitate environmental, economic, and social performance at the regional level. Local authorities can act as intermediaries and help build networks by facilitating informal meetings that open new channels of communication. Local authorities can serve as knowledge brokers by connecting organizations in the community that can benefit from networking. This networking may serve to provide relevant knowledge, information, or ideas enabling one company to learn from another. Knowledge brokers can also serve as third party facilitators that connect partners to create industrial symbiosis networks (von Malmborg 2004).

Generative Planning

Civil servants including planners and policy makers are responsible for addressing complex social problems. These problems are difficult to define, and rarely are they purely technical or purely political in nature. Professionals tasked with identifying solutions to complex social problems operate with a limited availability of time and resources. The rational model is a policy analysis method used to create solutions for complex problems as professionals are limited by real-world constraints The rational model aims to define the problem, evaluate policy alternatives, and select and implement the preferred policy (Patton and Sawicki 1986).

The rational model employed by planners and policy makers is known as a formal planning process that relies on power and creates new systems to achieve goals. Formal planning is usually employed on a large scale, treats actions as final, and filters out feedback (Uzzell 1990). Unfortunately, policy solutions used to address complex social problems cannot be measured objectively. Solutions inevitably create beneficiaries that support the policy and losers who are disadvantaged by it (Patton and Sawicki 1986). Populations that are disadvantaged by formal planning often seek alternatives processes to create change.

Populations that lack political power or are disadvantaged by public policy often work to facilitate change using informal planning methods. Generative planning is an informal planning method used to empower populations that lack access to more formal institutions or channels of power. Generative planning accommodates to existing systems and aims to develop small, harmonious innovations that may generate major system changes. The process relies primarily on information and is implemented incrementally, allowing for idiosyncratic, context-sensitive design. Generative planning actions incorporate feedback and are treated as experimental. (Uzzell 1990).

The nature of formal and generative planning contrast, but the two processes can compliment each other. Generative planning can inspire ideas and policy that might not be considered using a formal planning process. Planners and policy makers that practice formal planning can adopt ideas and policies developed by generative planning processes (Uzzell 1990). Findings from the Willow Lake case study demonstrate how ideas from a generative planning process can be adopted and implemented by formal planning processes.

Service-Learning

Willow Lake's generative planning process can be attributed to SCYP's service-learning model. Service-learning aims to develop meaningful relationships between communities and academic institutions. These relationships are based on communities needing to address local challenges and academic institutions needing to provide critical learning experiences for students and faculty. Service-learning moves away from universities simply providing aid to their community to a process linking service with learning. Service-learning integrates meaningful community service with instruction and reflection. The process demands reciprocity between academic and community partners (Angotti 2011).

According to Bringle and Hatcher (2001), the five critical elements of service-learning include:

- Encompassing teaching and learning
- Leading to additional forms of civic involvement that can improve other scholarly activities
- Involving faculty and students in educationally meaningful service activities addressing community issues

- Valuing community agency professionals as co-educators
- Ongoing dialogue among all partners to ensure successful implementation

Transformation is key to service learning. Transformative education aims to change students, educational professionals, and community participants while contributing to the transformation of the built environment, institutions, policies, and social practices that shape communities. Community service efforts often fall short when they do not aim for personal, social, and political transformation (Angotti 2011).

Service-learning provides students with knowledge and skills that cannot be acquired in the classroom. Students participate in the planning process by working in student teams, with city representatives, and with project clients from the community. The process allows students to see challenges from the perspectives of various players in the community. Attitude development, values clarification, and greater awareness of problems in society are ways that students say they have been transformed by service-learning (Checkoway 1996).

Service-learning benefits educational professionals by allowing faculty to explore linkages to the rest of their scholarly work (Holand and Gelmon 1998). The process can also provide faculty with new experiences to help broaden their perspectives. Educational professionals often have narrow academic backgrounds and benefit from engaging in real-world projects that require interaction with professionals from other disciplines. Service-learning helps faculty more easily overcome disciplinary barriers, better relate academic theory to real-world practice, and better apply teaching skills to meet student needs (Checkoway 1996).

Service-learning projects can offer a range of benefits for local communities. Service-learning has been used to assess and formulate public policy, support community development initiatives, increase voter turnout rates, and inspire various forms of political advocacy (Checkoway 1996).

Service-learning is facilitated by campus-community partnerships. Campus-community partnerships are a series of interpersonal relationships between (a) campus administrators, faculty, staff and students, and (b) community leaders, agency personnel, and members of communities (Holand and Gelmon 1998).

Campus-community partnerships can be viewed in terms of interpersonal relationships with the following characteristic:

- Mutually agreed-upon goals
- Success defined and outcomes measured in both institutional and community terms
- Control of the agenda vested primarily in community hands
- Clear identification of community resources and strengths for effectively using and enhancing community capacities
- Education components have clear consequences for the community and the institution

- Ongoing commitment to evaluation that involves all partners (Holand and Gelmon 1998)

Conclusion

Industrial symbiosis, third party facilitation, generative planning, and service-learning are concepts used to explain the narrative of events leading to Willow Lake's transformation to a multi-purpose facility. The concepts outlined in this chapter describe the social procession and actions used by organizations associated Willow Lake's innovations. Industrial symbiosis and third party facilitation are related concepts as third party facilitation is a tool used for establishing industrial symbiosis networks. Generative planning and service-learning have little in common, but both are tools to facilitate social processes.

CHAPTER THREE: METHODS

Interviews and supporting documents are the two methods used to collect data for this report. I developed a case study of Willow Lake to answer the following question: What factors allowed Willow Lake to transcend its role only managing wastewater to become a multi-purpose facility? The case study relies on qualitative and qualitative data. Data was derived from semi-structured interviews and supporting documents provided by interviewees and the SCYP program manager.

DATA COLLECTION

The data collection process included semi-structured interviews and document analysis. Semi-structured interviews were assessed to develop a cohesive narrative of events and identify major takeaways for interviewees. Semi-structured interviews allowed interviewees to guide conversations and expose issues not previously considered.

Document analysis provided information regarding 1) Sustainability efforts in Salem before SCYP, 2) the Salem SCYP process, 3) successes following the Salem SCYP partnership, and 4) operations at Willow Lake. Interviewees and the SCYP Co-Director provided all documents.

INTERVIEW PROCEDURE

I conducted eight interviews for data collection. Three interviews were conducted in person and five were conducted over the phone. Interviewees include employees from Salem Urban Development Department (SUDD), Willow Lake, SeQuential, and Professors Jennifer Howard-Grenville and Marc Schlossberg at the University of Oregon. Interviewees were selected for their involvement with the Willow Lake SCYP project. Interviews lasted 30 to 90 minutes and responses were digitally transcribed. Interviews consisted of open-ended questions including:

- What was your role in developing Willow Lake's industrial symbiosis network?
- Who were other major players involved in developing this network?
- How does Willow Lake's industrial symbiosis network operate?
- What role did SCYP play in these developments?

Data collection began with a visit to Willow Lake and an interview with the wastewater division manager. He was selected as an interviewee for his role facilitating Willow Lake developments following Salem SCYP. This initial interview provided a broad narrative of Willow Lake events and identified key informants at SUDD.

Two SUDD project managers were interviewed at SUDD's offices in downtown Salem. SUDD employees explained their personal roles in the Salem SCYP process and described the Willow Lake narrative from their own perspectives. Important information regarding SUDD's role in facilitating SCYP and SUDD's inventorying process events was discovered. The interview also identified additional key informants at Willow Lake and SeQuential.

SeQuential's general manager was interviewed for his role as SeQuential's liaison for Willow Lake and Salem SCYP. He described how SeQuential became involved in Salem SCYP, the benefits of the Willow Lake partnership, and subsequent developments at SeQuential resulting from Salem SCYP. Quantitative data was also provided concerning SeQuential cost savings as a result of Salem SCYP and volumes of materials transported to Willow Lake. Data concerning the newfound value of SeQuential's effluent material was also provided.

Professor Jennifer Howard-Grenville was interviewed for her role in the Salem SCYP partnership. Professor Howard-Grenville taught an industrial ecology course focused on developing sustainable innovations at Willow Lake. All SCYP student involvement at Willow Lake was facilitated through her class projects. Professor Howard-Grenville described her role in Salem SCYP, explained the role of her students, and provided her own opinions about why SCYP is a successful service-learning model.

Willow Lake's Wastewater Division Manager appointed the BIOGRO Program Coordinator to answer additional questions I might have during my course of research. I contacted the BIOGRO Program Coordinator to better understand operations at Willow Lake and obtain qualitative data. Qualitative data includes a list of Willow Lake's accepted partners, a chart of methane capture and use, anaerobic digester capacity and average use, tipping fees, fee resolutions passed at Salem City Council, and a list of income-generating partnerships at Willow Lake.

Professor Marc Schlossberg was interviewed for his role as SCYP Co-Director. Professor Schlossberg described the SCYP process including how partners are selected, the responsibilities of SCYP partners, and his opinions about why SCYP is a successful service-learning model. Professor Schlossberg highlighted the importance of student attention for initiating policy change.

SUDD employees identified Willow Lake's Wastewater Operations and Control Systems Manager as their liaison during SCYP. She was interviewed to better understand her role in Salem SCYP and to provide any insights she might have about the process. A general explanation of Willow Lake's energy use was also provided during this interview.

All interviewees conducted follow-up interviews via email due to the semi-structured interview process. All interviews produced answers that required greater clarification or follow-up questions.

DOCUMENTS

UO, Willow Lake, and SUDD provided documents for analysis. Documents provided quantitative data and qualitative details for an improved understanding of Willow Lake's developments. Table 2 provides a list of analyzed documents with their source and authors. Each document is explained in greater detail below.

Table 2: Documents Summary

Document	Source	Author
Environmental Action Plan charter	SUDD	Salem City Council
2010 Environmental Action Plan	SUDD	Salem City Council
SCI industrial symbiosis scope of work letter	SUDD	UO
SCI industrial symbiosis scope of work memorandum	SUDD, UO, Salem City Council	SUDD, UO
Notes from By-Product Reuse open house	SUDD	SUDD
"Class Act" internet article	SUDD	Financial Times
"Green Gains"	SUDD	UO Lundquist College of Business
Methane Production and Waste graph	Willow Lake	Willow Lake
SCYP thesis study	Professor Schlossberg	Ashley Webster
Industrial symbiosis examples	Professor Howard-Grenville	Professor Howard-Grenville
SCI Industrial Ecology report	SCYP	UO Students

Salem City Council developed the Environmental Action Plan (EAP) charter in 2008. The charter addresses sustainability efforts related to energy, drinking water, stormwater quality, waste, transportation, sustainable buildings, sustainable business, landscape, and toxics. SUDD employees provided the EAP as context of Salem's sustainability goals and initiatives prior to the SCYP partnership.

Salem's 2010 EAP assesses the progress, successes, and challenges associated with implementing the EAP charter following the first 18 months of its publication. The report provided further background of Salem's sustainability goals and initiatives prior to the SCYP partnership. The 2010 EAP also provided information describing the committee responsible for composing the annual EAP.

The SCI Industrial Symbiosis Scope of Work letter documents the beginning of Professor Howard-Grenville's formal role in Salem SCYP. The letter is written by SCI project management and requests Professor Howard-Grenville's assistance in formulating the scope of work for SCYP's industrial ecology projects. The scope of work letter allowed me to develop a timeline of events and provided an understanding of Professor Howard-Grenville's role in the development of industrial ecology efforts at Willow Lake.

The SCI Scope of Work Memorandum formally establishes details for Salem SCYP industrial symbiosis projects. The purpose of project, desired outcomes/project objectives, expected deliverables, responsibilities of partners, external stakeholders, timeline of events, and project budget are detailed. The memorandum helps describe the Salem SCYP partnership, expectations, and the foundations for later developments. The memorandum also helps develop a timeline of events.

The Industrial By-Product Reuse Synergies open house meeting notes were recorded at an event sponsored by SUDD. The event was used to inventory the existing efforts, challenges, opportunities, and next steps of local organizations with an interest in industrial ecology. The meeting notes document the beginning of Willow Lake's participation in the Salem SCYP industrial symbiosis project. Willow Lake, Oregon Cherry Growers, and NORPAC Foods attended, among others.

Two articles documenting Willow Lake's environmental and financial successes provided a better understanding of Salem SCYP achievements. Class Act, published online by Financial Times, describes the SCYP process, offers a narrative of SCYP's impact in various communities, and contains interviews by SCYP Co-Directors, Willow Lake employees, and the Economic Develop Analyst for Springfield, Oregon. Class Act was published in September 2012 and cites revenue generated as a result of the Willow Lake SCYP project at $400,000.

Green Gains, published by the UO Lundquist College of Business in March 2013, provides a brief synopsis of the Willow Lake industrial symbiosis project. The article includes interview quotes from Professor Jennifer Howard-Grenville, Willow Lake employees, and SUDD employees. The article highlights the participation of UO MBA students and Professor Howard-Grenville's class on industrial ecology. A list of Willow Lake's industrial symbiosis partners is included. The article cites revenue generated as a result of the Willow Lake SCYP project at around $1 million.

Methane Production and Waste Graph illustrates Willow Lake's methane production and use by month for 2012. The graph shows what proportion of methane went to the facility's cogenerator, waste burner, and boilers.

Assisting an Urban Sustainability Transition: Exploring the Partnership Between the Sustainable City Year Program at the University of Oregon and the City of Salem, Oregon is a Masters thesis by Simon Fraser University student Ashley Webster. Ashley Webster's thesis explores the Salem SCYP partnership and the benefits of service-learning. The thesis provides SCYP background data and highlights elements that make SCYP a successful service-learning model. The thesis provides information about the SCYP replication workshop and the sentiments of professionals that have been involved in the SCYP process. It also includes data on SCYP costs and SCYP processes.

Professor Howard-Grenville developed an informal memorandum providing examples of industrial symbiosis. The memorandum was provided to SUDD employees for a better understand of how industrial symbiosis works and what

SCYP projects might look like. Local examples provided include Kettle Chips in Salem, Oregon and a cogenerator near Hermiston, Oregon. Additional examples were provided from the UK's National Industrial Symbiosis Programme.

The Sustainable Cities Initiative Report for Industrial Ecology presents work and recommendations developed by students in Professor Howard-Grenville's industrial ecology class. The report includes two case studies and five projects, three of which were conducted at Willow Lake. Information for my report pertains to one specific Willow Lake project assessing the feasibility of a symbiotic relationship between Willow Lake and SeQuential. Students concluded that a Willow Lake and SeQuential partnership would be prove economically beneficial to both parties. Further, SeQuential would reduce its carbon footprint by reducing transport distances and disposing of effluent more efficiently.

Chapter Four: Willow Lake Case Study

The Willow Lake case study provides a narrative of events to describe how Willow Lake transcended its role only managing wastewater to become a multi-purpose facility. The narrative is divided into three parts: Pre-SCYP Developments, SCYP Process, and Post-SCYP Developments. Pre-SCYP Developments offers a description of the five major players prior to their involvement in the Salem SCYP process. SCYP Process describes events during SCYP and the important interactions between major players. Post-SCYP Developments describes significant activities since Salem SCYP concluded and future plans for each major player.

A timeline of events supplements the narrative by highlighting critical events from before, during, and after Salem SCYP. Two industrial symbiosis maps provide visual representation of Willow Lake's industrial symbiosis network before and after Salem SCYP.

Pre-SCYP Developments

Willow Lake

Willow Lake Water Pollution Control Facility (Willow Lake) provides wastewater treatment for the communities of Salem, Keizer, Turner, and other unincorporated areas of Marion County. The facility serves approximately 229,000 people. Treated wastewater is piped to the Willamette River. City of Salem's Public Works Department operates the facility (SCI 2010).

Willow Lake was constructed in 1963. It is the City of Salem's most expensive asset valued at roughly $500 million. The newest addition to the facility was completed in 2009 at a cost of over $100 million. Willow Lake was built with state of the art designs now considered industry standard. A cogenerator produces approximately one-third of Willow Lake's energy needs with the remainder purchased from PGE (Willow Lake 2013).

Willow Lake was designed to accommodate a thriving agricultural community. Anaerobic digesters were built to treat wastewater solids. Anaerobic digestion is an oxygen-free process where microorganisms break down biodegradable material into nutrient-rich biosolids (sludge) and methane gas. A thriving canning industry created high volumes of wastewater solids, and a second anaerobic digester complex was built in response. Seven anaerobic digesters were built total. Anaerobic digester operations dropped well below capacity following the decline of the local canning industry (Willow Lake 2013).

Industrial ecology principles are reflected in Willow Lake's design. The facility's cogenerator and anaerobic digesters were designed to operate in unison. Methane captured from the anaerobic digestion process powers the cogenerator. Hot water

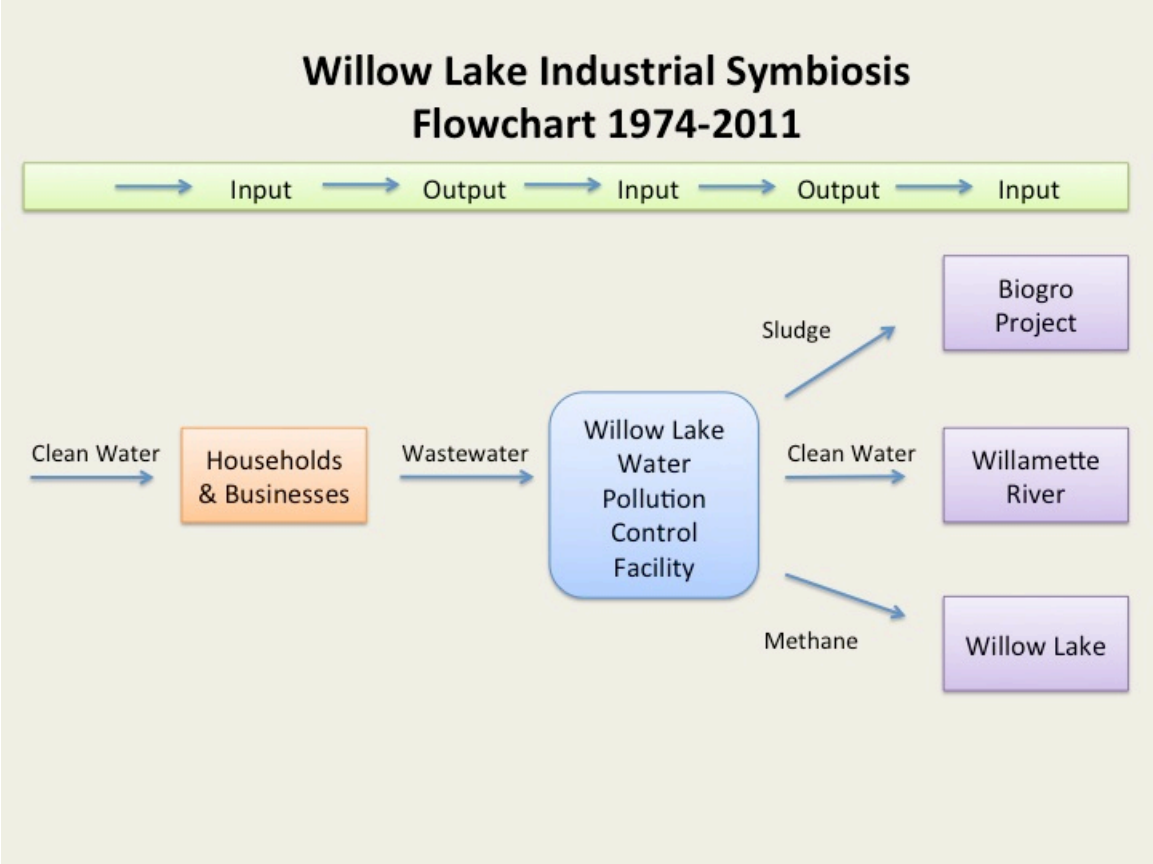
produced by the cogenerator is fed into the anaerobic digesters to sustain temperatures around 98.6 degrees (Willow Lake 2013).

Willow Lake's industrial symbiosis network began in 1974 with the Biogro Project. The Biogro Project was developed to deliver sludge to local farmers. The sludge, provided free of charge, is used by farmers as a fertilizer. The Biogro Project expanded Willow Lake's industrial symbiosis practices to include partners in the community (Willow Lake 2013).

Tough economic times beginning in 2008 led Willow Lake to consider ways to expand the use of its facilities. Willow Lake was only expected to meet permit regulations and process municipal wastewater prior to the economic downturn. When financial strain on the City resulted in Willow Lake's inability to procure a bond for a new cogenerator, Willow Lake began considering how the facility might generate income. Willow Lake acknowledged their facilities were functioning under capacity and that an opportunity existed to accept waste from new partners to generate revenue (Willow Lake 2013).

Diagram 1 is a flowchart to provide visual representation of Willow Lake's industrial symbiosis network prior to Salem SCYP. Clean water used by households and businesses generates wastewater sent to Willow Lake. The Willow Lake wastewater treatment process results in clean water and wastewater solids. Clean water is discharged to the Willamette River, and wastewater solids are processed by anaerobic digesters. Sludge and methane are generated in the anaerobic digestion process. The Willow Lake Biogro Project distributes sludge to local farmers who use the material as fertilizer. The Willow Lake cogenerator uses methane to produce energy.

Diagram 1: Pre-SCYP Industrial Symbiosis Network



SeQuential

SeQuential Pacific Biodiesel LLC (SeQuential) opened the first commercial biodiesel production facility in Oregon in 2005. The SeQuential community-based model uses locally collected waste cooking oil and Oregon-grown canola to produce biodiesel. SeQuential prides itself on supporting both the environment and the economy by using a sustainable approach that benefits local farmers and the greening of communities (Pacific Biodiesel 2013)

Wastewater Grease Trap (WWGT) is Sequential's process effluent derived from waste cooking oil and canola. SeQuential had not processed WWGT with anaerobic digesters prior to Salem SCYP. Instead the material was shipped to Portland, dehydrated, and spread on land with significant environmental and financial costs (SCI 2010). SeQuential had previously sought out local partners for WWGT disposal, but was unable to find any (SeQuential 2013).

City of Salem: Salem City Council

Salem affirmed its commitment to sustainability with the adoption of the Environmental Action Plan (EAP) charter. The charter addresses sustainability efforts related to energy, drinking water, stormwater quality, waste, transportation, sustainable buildings, sustainable business, landscape, and toxics. The charter seeks, "To be an agent of change" in three ways: Targeting behavior change for employees and citizens, operational change at the institutional level, and policy change seeking to eliminate obstacles and promote opportunities for advancing sustainability goals. The charter also includes three long-term goals: To increase efficiency of City resources, increase sustainability awareness, and to measure outcomes of sustainability efforts (Salem City Council 2008). A 23-member team comprised of professionals from various city departments annually publishes an Environmental Action Plan as mandated by the 2008 charter (Salem City Council 2010).

City of Salem: Salem Urban Development Department

Salem Urban Development Department (SUDD) provides a range of services and programs to strengthen the local economy. The Department's many responsibilities include serving as the liaison to community organizations, businesses, City Council, and Agency Board appointed advisory groups (City of Salem 2013). SUDD represents a business community with a broad range of attitudes concerning sustainability initiatives. On one end of the spectrum are businesses that have taken a leading role in the community for the development of sustainable business. On the other end of the spectrum are businesses that perceive sustainability initiatives unfavorably. The very word sustainability carries a negative stigma for some in Salem's business community. SUDD tends to message the efficiencies and cost savings associated with sustainability, rather than using the term sustainability, for the purpose of being understood by a broad range of Salem business interests. (SUDD 2013).

University of Oregon: Sustainable City Year Program

The Sustainable City Year Program (SCYP) is a UO partnership that lasts one academic school year with a city in Oregon. Students and faculty across various disciplines collaborate with city staff to develop and implement a variety of sustainability and livability projects. Students gain real-world experience and offer innovative approaches to community problems. SCYP collaborates with communities prepared to transition to a more sustainable and livable future (SCI 2010).

SCYP projects are developed with a matchmaking process. Cities provide a list of issues they would like addressed and SCYP identifies professors on campus with similar interests. Occasionally professors submit project ideas to the city. An iterative process between the university and partner city leads to agreement on project specifics. Classes are then designed to include 10-week student projects (Webster).

SCYP has received notoriety for its service-learning model and achievements. According to New York Times, "The Sustainable Cities Initiative is perhaps the most comprehensive effort by a U.S. university to infuse sustainability into its curricula and community outreach." SCYP held a replication workshop in April of 2012 attended by 22 universities across the US and Canada. Faculty and staff from the cities of Gresham, Springfield, and Salem referred to students as, "Idea machines", helping to "unstick" projects, educating staff and citizens about sustainability, and providing political cover to explore a wide range of ideas" (Webster 2013).

SCYP expenses are paid by the partner city. Fixed annual costs for SCYP are approximately $200,000. SCYP final costs can be significantly higher depending on the number of projects and reports developed. The SCYP price tag assures the program is well organized and run professionally. It also assures that partner cities use all resources at their disposal to facilitate productive and beneficial outcomes (Schlossberg 2013). According to SCYP Co-Director Marc Schlossberg, "For the city side, we absolutely insist they pay so they have skin in the game."

Trust is critical to the SCYP process. SCYP requires cities to invest hundreds of thousands of dollars without a clear concept of end results. Cities take a leap of faith that the ideas and projects developed by university students will be worth the financial investment. SCYP continually holds meetings with prospective partners across Oregon in order to build trust. Cities join SCYP when a high enough level of trust is established and the municipality is prepared to invest significant time and resources in sustainability initiatives (Schlossberg 2013).

University of Oregon: Professor Howard-Grenville

Professor Howard-Grenville is an associate professor of management in the Lundquist College of Business at UO. Professor Howard-Grenville received a Masters degree from Oxford University as a Rhodes Scholar and then a doctoral from MIT in Technology, Management, and Policy. Her work has been published in an array of journals and she is the author of three books including *The Social Embeddedness of Industrial Ecology*. Her areas of expertise include business and the natural environment, and processes of organizational change. (Howard-Grenville 2013).

SCYP Process

The Salem SCYP partnership began in February 2010 (Webster). Salem's participation in SCYP reflected the City's sincere commitment to sustainability and an investment in student ideas. The partnership was an opportunity for Salem to develop projects related to Council goals and other City initiatives and priorities – including those reflected in their EAP charter. 18 total projects were developed on a broad range of topics, all of which were related to Council goals. SUDD served as the City's liaison during the partnership (SUDD 2013).

Professor Howard-Grenville's involvement in SCYP began in March 2010 after she learned about the program from a student. Professor Howard-Grenville realized

SCYP was an opportunity for students to learn about industrial symbiosis by addressing real-world challenges. Professor Howard-Grenville contacted SCYP faculty and discovered that the Salem SCYP partnership had recently begun. Professor Howard-Grenville attended an SCYP meeting in Salem soon thereafter and pitched ideas for an industrial symbiosis project (Howard-Grenville 2013).

Professor Howard-Grenville provided SUDD with an informal memorandum describing examples of industrial symbiosis projects. SUDD immediately recognized the potential benefits and strongly supported project development. Professor Howard-Grenville, SUDD, and SCYP staff began working on project details in April 2010. Project names were important to assure that projects made sense and were relevant to the business community. SUDD officially called the project Industrial By Product Re-Use (SUDD 2013).

SUDD's initial vision for an industrial symbiosis project contrasted with later developments. SUDD first envisioned creating an inventory of local businesses that might later facilitate an economic process. An awareness of the material flows of local businesses could eventually help lower costs and increase efficiency by developing new partnerships. SUDD was familiar with few local businesses and sought to identify local efforts, challenges, and opportunities for industrial symbiosis networks (SUDD 2013).

Agriculture and food processing has long been a large component of Salem's economy. With this strength came experience with waste re-use, including land spreading, re-use of water, and other sustainable treatments. SUDD initiated dialogues with local businesses to better understand what waste re-use efforts were already underway. Beginning with the agricultural community, SUDD looked to gauge organizations that might have an interest in industrial symbiosis partnerships. SUDD staff contacted the Oregon Department of Agriculture and local fruit growers. Several businesses in the agricultural community were already engaged in waste re-use and a few expressed their disinterest in working with the City on this project. Reasons for disinterest included insufficient resources in staff and time (SUDD 2013).

Assessing sustainability leaders in the community, SUDD soon identified SeQuential who expressed interest in formalizing a relationship. SeQuential still had an interest in identifying a local, more efficient way to dispose of WWGT. SUDD wanted to see what they could do to support SeQuential's efforts and keep them invested in the local community (SUDD 2013).

SUDD set up an open house for local businesses to discuss industrial symbiosis opportunities in June 2010. Individuals representing Willow Lake, Oregon Cherry Growers, and NORPAC Foods attended, among others. Open house attendees identified existing efforts, challenges, opportunities, and next steps for industrial symbiosis efforts within their own organizations. The open house helped SUDD solidify Willow Lake opportunities with SeQuential's WWGT (SUDD 2013).

SUDD's inventorying of community businesses helped develop the scope of work for SCYP industrial symbiosis projects. Scope of work for five industrial symbiosis projects were finalized in September 2010, three specific to Willow Lake. A Willow Lake project was created for assessing the feasibility of a Willow Lake and SeQuential partnership, and $8,401 from the Salem general fund was provided (SUDD 2013).

Students began work on SCYP Salem projects in October 2010. Willow Lake, which previous functioned quietly under the radar, began receiving a significant amount of attention from UO and SUDD. Students that worked with the Willow Lake and SeQuential feasibility report accomplished three tasks. First, students explored the results of four case studies from other wastewater facilities that process food and grease wastes. Second, students assessed SeQuential's greenhouse gas emissions resulting from their current WWGT disposal practices and how they might be abated with a Willow Lake partnership. Third, students assessed potential savings and reduced costs from a Willow Lake partnership. Students determined a Willow Lake and SeQuential partnership would be financially and economically beneficial. The industrial symbiosis project was completed in 10 weeks and a final report was presented to SUDD, Willow Lake and SeQuential in December 2010 (SCI 2010).

Post-SCYP Developments

Willow Lake

Willow Lake hired a new Wastewater Division Manager in September 2011, and one of his first tasks was reviewing the student SCYP report for valuable ideas. Upon review, the Willow Lake and SeQuential report was not only supported for its findings, but was also interpreted as an opportunity to reshape Willow Lake's role in the community (Willow Lake 2013).

Some City Council members initially expressed concern about Willow Lake expanding its services beyond wastewater management. The SCYP Industrial Ecology report findings played a significant role in persuading apprehensive City Council members. Willow Lake employees have since referred to the SCYP Industrial Ecology report as "The Golden Ticket" (Willow Lake 2013).

Passage of fee resolutions formalized Willow Lake's role as a multi-purpose facility. City Council passed seven fee resolutions between January 2012 and March 2013 for specific products to be priced and transported to Willow Lake. Tipping fees at Willow Lake were $0.05 per gallon of solids and $0.03 per gallon of liquids in 2012 (Willow Lake) Willow Lake generated approximately one million in tipping fees in 2012 (Green Gains 2013).

Table 3 provides a list of Willow Lake fee resolutions and the date each was passed.

Table 3: Fee Resolutions Summary

Date	Fee Resolution
1.23.12	New Solids Waste Collection Rates & Charges
2.13.12	Hauled Waste Disposal Sewer/Rate for leachate
4.9.12	IGA with City of Silverton to accept sludge
6.11.12	Fee for treatment of hauled waste from SeQuential
8.13.12	Fee for treatment of leachate from Riverbend
12.3.12	IGA with City of Wilsonville to accept sludge
3.11.13	IGA with City of Aurora to accept sludge

Table 4 provides a list of Willow Lake's income generating partnerships. Type of material and volume of material by partner is also provided. City of Silverton's partnership has since concluded because their anaerobic digester is back online.

Table 4: Willow Lake Partnerships

Institution	Material	2012 Gallons
Coffin Butte Landfill	Leachate	5,402,822
City of Silverton	Sludge	2,873,200
SeQuential Biodiesel	WWGT	126,500
Riverbend Landfill	Leachate	3,800,184
City of Wilsonville	Sludge	349,300
City of Aurora	Sludge	0

Willow Lake's anaerobic digesters run well below capacity at 28%. Anaerobic digester capacity is an average of 0.23 pounds volatile solids/day/cubic feet of digester volume and annual averaged organic loading was .064 volatile solids/day/cubic feet of digester volume in 2012 (Willow Lake 2013).

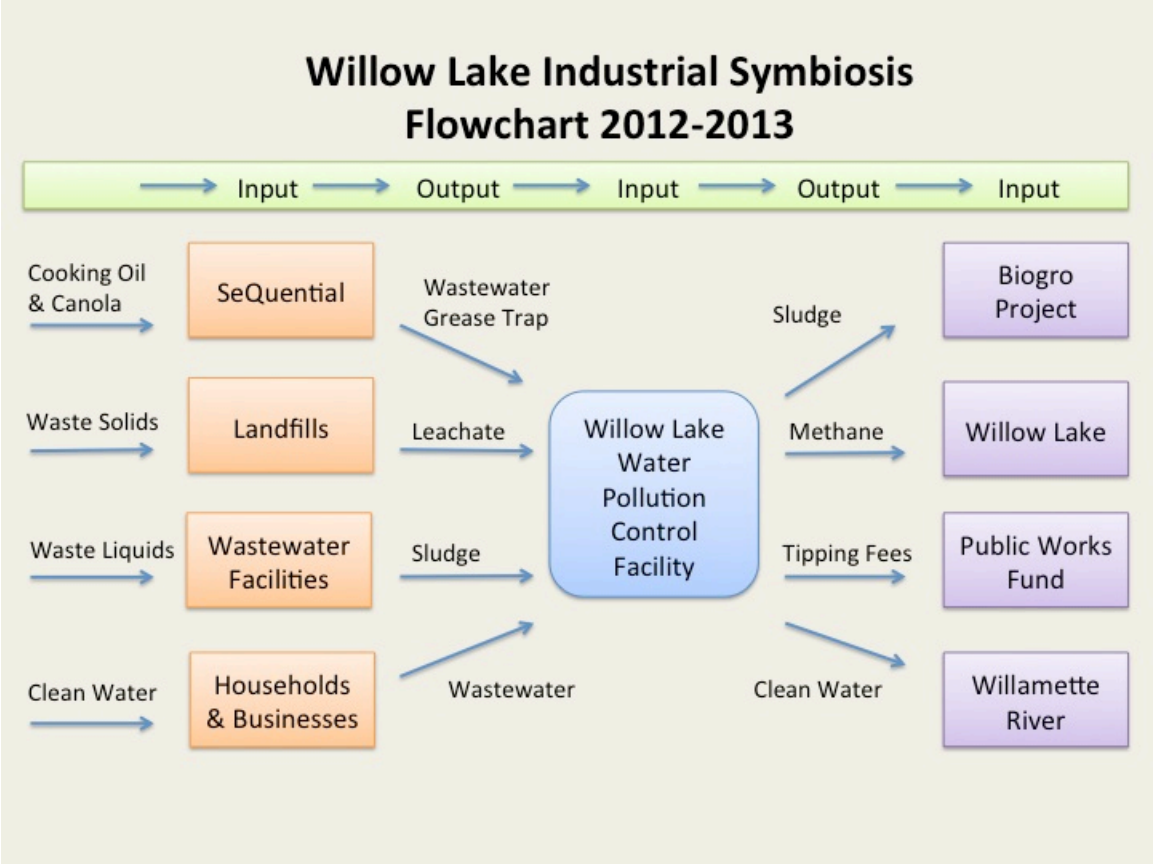
Willow Lake is now actively developing partnerships with organizations around the region because it realizes that the nature of waste management is shifting, and that private companies will corner the market if they fail to proactively capture potential waste streams. Willow Lake employees now talk about seeking new partnerships in terms of "mining for resources." New waste streams are referred to as "conveyer belts of BTU's" for greater methane production. Willow Lake does not want to be pigeonholed as a facility used strictly for wastewater management (Willow Lake 2013).

Willow Lake is assessing infrastructure renovations for greater methane capture. A technical evaluation is scheduled for completion by June 2013. Increased methane capture would reduce Willow Lake's dependency on PGE for electricity. Willow Lake has also entertained the possibility of harnessing methane to power a fleet of City vehicles. The potential of methane production from additional waste streams, coupled with infrastructure renovations, could make the vision feasible. Willow Lake produced 4,133,129 standard cubic feet of methane in 2012. 56% of methane used was by cogenerators, 11% by boilers, and 33% by waste burners (Willow Lake 2012).

Diagram 2 is a flowchart to provide visual representation of Willow Lake's industrial symbiosis network following Salem SCYP. All aspects of Willow Lake's industrial symbiosis process prior to Salem SCYP are still operational. Clean water used by households and businesses generates wastewater sent to Willow Lake. The Willow Lake wastewater treatment process generates clean water, sludge, and methane. Clean water is discharged to the Willamette River, sludge is used as fertilizer, and methane is used to generate energy.

Willow Lake's industrial symbiosis network following Salem SCYP includes the material flows of SeQuential, landfills, and wastewater facilities. SeQuential uses cooking oil and canola to generate biodiesel. WWGT resulting from SeQuential's biodiesel process is sent to Willow Lake and landfills accept waste products from a wide range of industrial processes. Waste solids in landfills produce leachate that is sent to Willow Lake. Wastewater facilities process wastewater and other liquids that are sent to various other wastewater facilities. Sludge generated by wastewater facilities is sent to Willow Lake. In addition to sludge, methane, and clean water, Willow Lake's outputs now include money generated from tipping fees.

Diagram 2: Post-SCYP Industrial Symbiosis Network



Salem Urban Development Department

SUDD had never conducted an inventorying process prior to their efforts in preparation for the Willow Lake industrial symbiosis project. SUDD has realized the value of the process and continues to inventory local businesses as a part of their economic development strategies. SUDD's 2013-2014 proposed budget includes funding dedicated to an inventorying process for economic development that focuses on business recruitment and retention. Meetings will be held with major Salem businesses and a Business Retention Roundtable will be established (SUDD 2013).

Sequential

SeQuential continues to grow due to ever increasing demand. Its production facility is now located in Salem and currently produces 5 million gallons annually (Pacific Biodiesel 2013).

Sequential has experienced an evolutionary progression in its disposal of WWGT. WWGT is no longer considered a waste product. The material has gained market value as the use of anaerobic digesters has increased in popularity. More private industries using anaerobic digesters are now actively seeking inputs for methane production. The majority of anaerobic digesters used by SeQuential accept WWGT free because it is valuable input for methane production.

Willow Lake is the only WWGT disposal site where SeQuential pays a tipping fee. Regardless of the tipping fee, the Willow Lake partnership saves SeQuential between $5-10,000 monthly in comparison to previous disposal practices. SeQuential still disposes the same volume of WWGT at Willow Lake, but it now amounts to less than ten percent of SeQuential's total WWGT.

Roughly a dozen anaerobic digesters throughout the region accept SeQuential's remaining WWGT for free. One of SeQuential's partners now pays SeQuential for their WWGT. SeQuential hopes Willow Lake will soon acknowledge the value of WWGT and begin paying SeQuential for the material. What was once considered a waste product now has market value (SeQuential 2013).

Table five is a timeline highlighting critical events associated with Willow Lake's industrial symbiosis project.

Table 5: Events Timeline

Date	Event
1963	Willow Lake is designed and built to include methane capture and anaerobic digestion
1974	Biogro program is established to provide anaerobic digester sludge to farmers
2008	Economic downturn spurs Willow Lake to consider new ways to use its underutilized facilities
2008	Salem City Council develops Environmental Action Plan charter
Feb-2010	Salem wins SCY contract for 2010-2011
Mar-2010	Professor Howard-Grenville proposes a SCYP industrial symbiosis project
Mar-Apr-2010	Several meetings with City staff to discuss SCYP project ideas and project scopes
Apr-2010	Scope of work for SCYP industrial symbiosis project is initiated
Apr-Jul-2010	SUDD begins inventorying local businesses for potential Willow Lake partnerships
Jun-2010	Urban Development Department identifies SeQuential and Willow Lake as potential partners
Jun-2010	Urban Development Departments holds industrial symbiosis open house
Sep-2010	Scope of work for industrial symbiosis projects is completed
Oct-2010	SCYP industrial symbiosis project begins
Dec-2010	Students present SCYP findings to SeQuential, SUDD, and Willow Lake
May-2011	Salem SCYP concludes
Jun-2011	SUDD staff present SCYP recommendations to City Council
Sep-2011	Willow Lake staff begin reviewing industrial symbiosis recommendations
Jan-2012	City council passes first of seven fee resolutions allowing Willow Lake to begin accepting new waste streams
Feb-2012	Willow Lake begins accepting leachate from landfills
May-2012	Willow Lake begins accepting biosolids from wastewater treatment facilities
August-2012	Willow Lake begins accepting WWGT from SeQuential
2013	Willow Lake continues building partnerships and identifying new waste streams

Conclusion

The Willow Lake narrative can be explained in simple terms. All five major players were committed to sustainability initiatives prior to their participation with Salem SCYP. Salem SCYP was a natural progression for a city that had already established a sustainability framework. Professor Howard-Grenville first suggested industrial symbiosis for Salem SCYP projects and SUDD moved quickly to identify potential partnerships. Using SUDD's groundwork, students developed an industrial symbiosis feasibility report. The feasibility report helped Willow Lake successfully push for new fee resolutions at Salem City Council.

Chapter Five: Findings

The findings chapter draws upon ideas from the conceptual framework and data from the case study narrative to develop key takeaways. Four key takeaways are listed up front and then each is explored in greater detail. Two takeaways are linked to the conceptual framework and two are observations echoed by various interviewees and supported by the case study narrative.

Key Takeaways

Four key takeaways from the Willow Lake case study are listed below:

- The SCYP service-learning model inspired a generative planning processes for Willow Lake and City Council
- SUDD acted as a third-party facilitator for Willow Lake's industrial symbiosis network
- The SCYP Willow Lake project benefited from excellent timing
- Student attention helped initiate City Council policy changes for Willow Lake.

SCYP and Generative Planning

SCYP's service-learning model inspired a generative planning process in Salem. At Willow Lake and Salem City Council, a bottom-up model was infused into formal institutions. While not commonly used by formal institutions, generative planning processes can facilitate the implementation of non-traditional ideas. Generative planning includes primary reliance on information instead of power, developing small innovations that accommodate existing systems, incremental plan implementation, allowing for idiosyncratic, context-sensitive design, treating actions as experimental, and incorporating feedback (Uzzell 1990). The following paragraphs explain how Willow Lake and Salem City Council incorporated generative planning elements.

City of Salem's commitment to investing in new ideas initiated their generative planning process. This commitment was reflected financially as the City of Salem invested $329,000 with confidence that UO would produce valuable ideas (Webster). The financial investment also ensured that the City made every effort to provide resources to support and facilitate SCYP work (Schlossberg 2013). Salem perceived SCYP input to be apolitical which helped challenge City Council to examine current Willow Lake practices in the face of a viable alternative (Willow Lake 2013).

The Salem SCYP process supported small innovations for realizing Willow Lake's latent potential. The SCI Industrial Symbiosis scope of work was designed for completion in a ten-week period. The report was not overly ambitious, but aimed to compliment work already carried out by the City. SCYP recommendations for the

Willow Lake project focused on increasing the use of anaerobic digesters currently functioning under capacity.

Willow Lake's industrial symbiosis network has expanded incrementally. Salem City Council is responsible for passing fee resolutions before every new partnership at Willow Lake comes online. Willow Lake has developed six new partnerships in the 14 months since accepting new waste streams. Each additional partnership can be seen as a discrete project. Gradual changes at Willow Lake, taken cumulatively, have made a big impact. (Willow Lake 2013).

The Salem SCYP process supported idiosyncratic, context-sensitive design to capitalize on the facility's unique circumstances. Industrial symbiosis was a means for Willow Lake to generate income when faced with economic constraints. Salem City Council supported a break from business as usual by passing fee resolutions and allowing Willow Lake to expand its role beyond wastewater management. Willow Lake's expanded role is not unprecedented for a wastewater management facility, but it did push Willow Lake into new territory.

Investment in experimental actions was key to Salem SCYP success. SCYP is an experimental program, and Salem had the courage to participate. The City invested a large sum without knowing exactly what the returns on student work would be. Willow Lake embraced experimental actions by pressing forward with ideas presented in the SCYP Industrial Symbiosis report. SeQuential was also open to experimenting with new waste management solutions.

Incorporating feedback was also important in Salem's generative process. Salem City Council passed fee resolutions after incorporating feedback provided by Willow Lake. Willow Lake incorporated SCYP feedback and developed a partnership with SeQuential.

Table 6 lists the elements of a generative planning process and how Salem City Council and Willow Lake implemented them.

Table 6: Generative Planning Process

Generative Planning Process	Salem City Council	Willow Lake
Primary reliance on information instead of power	Investment of money and resources for SCYP ideas	Promoting policy change with SCYP report
Developing small innovations that accommodate existing systems	Scope of SCYP projects sized to be completed in 10 weeks	New partnerships that compliment anaerobic digester capacity
Incremental plan implementation	Tipping fee resolutions passed as partnerships come online	Steady addition of industrial symbiosis partnerships
Allowing for idiosyncratic, context-sensitive design	Passing fee resolutions	Envisioning Willow Lake as a regional asset
Treating actions as experimental	Willingness to invest in service-learning partnership	Desire to be creative and capture new waste streams
Incorporating feedback	Passing fee resolutions	SeQuential partnership and the transition to a multi-purpose facility

Formal planners are often deterred from generative planning by factors both professional and institutional. Factors include a perceived inability to control outcomes, inability to control the planning process, lack of institutional support, and lack of funding (Uzzell 1990). SCYP's generative planning process created a temporary, safe space for the City to explore new ideas without undermining more formal planning processes. Student ideas and report findings were outside the City's control. The City's responsibility was to select projects and to decide which ideas to ultimately support or ignore. The process was also endorsed and funded by the City. Endorsement and funding are two factors that commonly hinder generative planning. Developments at Willow Lake can be described as a generative planning process in which formal planners were not hindered by common deterrents.

The Salem SCYP generative planning process reflects the transformative nature of successful service-learning programs. Students, professors and the City of Salem all benefited from a campus-community partnership. The institutions, policies, and social practices shaping the community of Salem have also evolved. As a result of the generative planning, Willow Lake is now a multi-purpose facility, City Council supports Willow Lake's expanded role, and SUDD has adopted an inventorying process for greater economic development.

Third Party Facilitation

SUDD served as a third party facilitator in the Willow Lake industrial symbiosis project. Third party facilitation is a tool used to bridge professionals across organizations, and to forge partnerships using knowledge, experience, and contacts that may not be available to other organizations. Lacking these resources, organizations that could otherwise benefit from partnerships may not identify the opportunity. Third party facilitators also help address difficulties associated with the varying outlooks, processes and social structures used by different decision-makers and organizations (Boon and Howard-Grenville 2009)

SUDD served as a third party facilitator by identifying a potential partnership between Willow Lake and SeQuential. SUDD's inventorying process identified Willow Lake and SeQuential as local organizations with an interest in industrial symbiosis. Willow Lake was identified as a facility functioning under capacity. SeQuential was identified as a local organization with waste disposal needs. SUDD's knowledge of local organizations placed SUDD in the unique position of being able to connect Willow Lake and SeQuential.

SUDD's involvement as a third party facilitator at Willow Lake is critical. Willow Lake's social structure and processes did not previously include partner organizations or any form of recruitment strategy to develop partnerships. Willow Lake's role was limited to wastewater treatment, making partner recruitment a task falling outside their scope of practice. SeQuential's social structure did not include a network with any means of alerting SeQuential to Willow Lake's shifting practices. SeQuential wanted to find a local partner for WWGT disposal, but would not have otherwise been aware that Willow Lake was interested in a partnership without

SUDD's knowledge and involvement. Limitations inherent to the social structures and processes at Willow Lake and SeQuential were overcome by SUDD's role as a third party facilitator.

In the United States, it is rare for governments to serve the role of third party facilitators for industrial symbiosis networks (Howard-Grenville 2013). Successes at Willow Lake suggest economic development departments in local governments can be instrumental in creating industrial symbiosis networks. Third party facilitation requires the knowledge, experience, and contacts that can be obtained using an inventorying process. Developing an inventorying process can be simple, low-cost, and generate income for local organizations.

Timing

The Willow Lake industrial symbiosis project had the benefit of excellent timing. Salem City Council, UO, SeQuential, SUDD, and Willow Lake were all in an excellent position to take part in the process. The following paragraphs explain how each organization was prepared to participate.

Salem City Council had recently developed the Environmental Action Plan (EAP) and a goal of most sustainable capitol city (Salem City Council). SCYP was a way of creating policy congruent with the City's recent developments (SUDD 2013).

An industrial symbiosis project may not have been possible during Salem SCYP had Professor Howard-Grenville learned of the program after the initial project development phase. An industrial symbiosis project likely would not have occurred at all without the professor's participation. Professor Howard-Grenville was responsible for pitching the idea for a SCYP industrial symbiosis project, and happened to hear about SCYP soon after the Salem partnership was formalized. Professor Howard-Grenville's expertise helped steer project development and facilitate implementation.

Timing of the Willow Lake partnership would not have made financial sense for SeQuential had it not set the precedent for their current waste management practices. Prior to the Willow Lake partnership, SeQuential shipped WWGT to Portland at significant cost (SCI). Today, SeQuential delivers WWGT to anaerobic digesters where it is accepted free or paid for. The Willow Lake partnership helped SeQuential turn WWGT into a financial asset (SeQuential 2013).

The City's involvement in SCYP had great financial timing. The SCYP industrial symbiosis project was funded with $8,401 from the City's General Fund. The allocation of General Fund resources to support SCYP was limited at the outset of the City's engagement with UO. Finances from the general fund may not have been available had the project been pitched even a few weeks later, or if other projects had been successfully pursued prior (SUDD 2013).

The presence of forward-thinking players at all of the involved organizations played a significant role in successes enjoyed by Willow Lake's industrial symbiosis

network. Their collective efforts helped shift the thinking about Willow Lake from a wastewater facility to a multi-purpose, regional resource. The initiative of progressive change agents is responsible for making the SCYP vision a reality.

Student Attention

The role of students in the Willow Lake narrative is critical. While students did not discover anything profound, they developed a report drawing attention to latent potential in the community. Willow Lake had acknowledged the potential for industrial symbiosis partnerships in 2008, but students helped unstick the situation. Student attention inspired City Council to adopt a more sustainable vision for Willow Lake. A similar report could have been produced without student involvement, but the changes made at City Council likely would not have occurred. The student report was viewed as apolitical, challenging City Council to examine current practices at Willow Lake and the opportunities presented by a viable alternative.

Conclusion

Four major takeaways from the Willow Lake industrial symbiosis project help explain why it was successful. Two takeaways can be explained using the conceptual framework. These takeaways are that the SCYP service-learning model inspires a generative planning process within formal institutions and that SUDD acted as a third-party facilitator for Willow Lake's industrial symbiosis network. Two additional takeaways were observations echoed by various interviewees and supported by the case study narrative. These takeaways are that the SCYP Willow Lake project benefited from excellent timing and that student attention helped initiate City Council policy changes for Willow Lake.

Chapter Six: Recommendations

Willow Lake has shifted from a facility servicing only municipal wastewater to a multi-purpose facility assisting various organizations with waste management needs. Changes at Willow Lake are the result of Salem SCYP and an industrial symbiosis report produced by students. A partnership between Willow Lake and SeQuential set a precedent for both organizations and helped create a framework for later developments. Students were critical in drawing attention to potential sustainability innovations and helping initiate City Council policy changes for Willow Lake. A new vision is now in place for Willow Lake's role in the community.

The recommendations chapter combines conceptual framework, findings, and subjective opinion to develop recommendations for universities, cities, and states. Five recommendations are listed up front and then each is explained in greater detail.

Recommendations

Five recommendations include:

- State governments should provide funding for cities interested in service-learning partnerships
- Economic development departments should use an inventorying process
- Economic development departments that use an inventorying process should assess their ability to function as third party facilitators
- SCYP should suggest industrial symbiosis projects to future partner cities
- Industrial symbiosis partners should stay current to changing economic values of materials exchanged in their networks

State Governments

State governments should make funding available for cities that want to participate in SCYP and other service-learning partnerships with local universities. State funding would signal to communities that states are serious about endorsing the benefits of service-learning. Successful service-learning endeavors like Willow Lake's industrial symbiosis project can help stimulate local economies, increase sustainability efforts, and educate students and the community. Projects should last one academic school year.

I suggest state governments develop an application process that allows cities to demonstrate their commitment to sustainability initiatives. State governments would then select one to five cities to fund annually. I suggest states begin by providing up to $1000,000 per partner, or the equivalent to half the baseline costs associated with SCYP.

Additional funding may be key for motivating some cities to participate in service-learning partnerships, but it is imperative that cities are equally invested in the process. Cities should be required to match any funds that come from state governments. All funding should be paid to the city's partner university. Service-learning partnerships will generate new ideas, produce student work, add greater credibility to the city's efforts, and increases the trust of local businesses investing time and resources into the process.

Economic Development Departments

Economic development departments should use inventorying as a tool. Inventorying businesses and other organizations is a low-cost process that can identify economic development opportunities in the community. The process is simple, inexpensive, and has the potential to forge income-generating partnerships.

The inventorying process requires economic development departments to increase their familiarity with local organizations. When used for industrial symbiosis purposes, the inventorying process includes identifying the existing industrial symbiosis efforts, challenges, opportunities, and next steps of local organizations. When economic development departments are familiar with the processes, needs, and ambitions of local organizations, they can better identify economic development opportunities in the community. The inventorying process can be conducted with phone calls, open houses, or any other format that initiates useful dialogue.

SUDD had never used an inventorying process prior to their activities associated with the SCYP industrial symbiosis project. SUDD's work identified the potential for a partnership between Willow Lake and SeQuential. The inventorying process has now been adopted as one of SUDD's strategies to better facilitate economic development. SUDD's 2013-2014 budget includes dollars for an inventorying process to explore how SUDD can better support local businesses and recruit new ones (SUDD 2013).

Economic development departments that use an inventorying process should assess their ability to function as third party facilitators. Third party facilitation aims to bridge professionals across organizations. The contrasting outlooks, processes, and social structures of different organization often make it difficult for industrial symbiosis partnerships to occur on their own. The inventorying process produces knowledge concerning the material flows of local organizations, and creates an expanded network of contacts. Economic development departments can use this information to identify potential industrial symbiosis partnerships.

Economic development departments can begin the inventorying process by assessing assets and facilities controlled by the city government. This is a good place to start because cities are often responsible for wastewater facilities and other large-scale assets processing large volumes of materials. Cities are also a good place to start because one city department is inventorying another, increasing the likelihood of cooperation. The process can then be expanded to power plants and

other local businesses that likely processing high volumes of materials. Organizations that identify as sustainability leaders should also be involved in the inventorying process early on. The key is identifying organizations that are willing to share information regarding their own processes, and open to building industrial symbiosis partnerships.

SCYP

SCYP should suggest industrial symbiosis projects to future partner cities. Industrial symbiosis projects are extremely conducive to the SCYP format and provide benefits for UO and SCYP's partner cities. The Willow Lake project proves that industrial symbiosis projects can be successfully conducted for less than $10,000 and generate enormous revenues in return. More UO Professors should become familiar with industrial symbiosis so projects are not necessarily contingent on Professor Howard-Grenville's participation.

In addition to industrial symbiosis projects, SCYP can help set the groundwork for future projects by assisting communities with the inventorying process. Identifying local organizations interested in pursuing industrial symbiosis is a critical first step for developing networks. In Salem, the inventorying process that preceded the Willow Lake industrial symbiosis project was completed by SUDD. SCYP can facilitate similar inventorying processes for partner cities that may otherwise lack the time or staff needed to carry out the process.

Industrial Symbiosis Partners

All organizations involved with industrial symbiosis should stay current to changing economic values of materials exchanged in their networks. Industrial symbiosis strives to mimic natural ecosystems where the outputs of a given system are used as inputs for another system. Successful industrial symbiosis projects find means of transforming waste materials into useful inputs. A material may gain market value once it is identified as a useful input, shifting the dynamics of exchange between partners. Industrial symbiosis networks can break down when a material gains market value and is no longer considered a waste product because other organizations may seek to purchase it.

SeQuential's WWGT is no longer considered a waste product. Roughly a dozen anaerobic digesters now accept SeQuential's WWGT free of charge and one of SeQuential's partners pays SeQuential for their WWGT. The fact SeQuential still pays Willow Lake for the disposal of WWGT is counterintuitive. SeQuential may eventually terminate their Willow Lake partnership if Willow Lake continues charging for WWGT disposal.

Conclusion

The study suggests SCYP played a critical role in assisting Willow Lake to transcend its limited role managing wastewater to become a multi-purpose facility. SCYP's service-learning model inspires a generative planning process that emphasizes information over power. The generative process creates a temporary, safe space for cities to explore new ideas without undermining more formal planning processes. I recommend states provide aid to cities in order to promote service-learning partnerships in more communities.

Economic development departments can play the pivotal role of third party facilitator to help establish industrial symbiosis networks. Economic development departments are in the unique position of being able to inventory local businesses for opportunities like industrial symbiosis. I recommend economic development departments take advantage of the inventorying process because it is simple, inexpensive, and can help identify new ways for local organizations to generate income.

The Salem partnership was SCYP's first industrial symbiosis project, but it should not be the last. SCYP now has more knowledge and experience to better facilitate future industrial symbiosis projects. While SCYP project ideas are most often proposed by SCYP's partner cities, this is not always the case. I suggest SCYP suggest industrial symbiosis projects to future partner cities.

Willow Lake's transition to a multi-purpose facility has been a success, but circumstances continue to evolve. The market value of WWGT has shifted since Willow Lake and SeQuential developed their partnership. The Willow Lake and SeQuential partnership helped SeQuential identify anaerobic digesters as an effective means of disposing WWGT. What was once considered a waste product is now valued by facilities with anaerobic digesters throughout the region. I suggest that organizations involved in industrial symbiosis stay current to the changing economic values of materials in their networks. Industrial symbiosis networks identify new uses for materials previously considered waste products. By doing so, industrial symbiosis partners can inadvertently create new markets for the materials in their networks. Industrial symbiosis networks are therefore at risk as a result of their own successes.

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