Developing and Testing Transition Strategies for Urban Sustainability:

Case Studies in Transition Research in Phoenix, Arizona

by

Braden Ryan Kay

A Dissertation Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Approved November 2012 by the
Graduate Supervisory Committee:

Dr. Arnim Wiek, Chair
Dr. Derk Loorbach
Dr. Daniel Schugurensky
Professor Fern Tiger

ARIZONA STATE UNIVERSITY

December 2012

ABSTRACT

Sustainability challenges with severe local to global impacts require fundamental shifts in what industrial societies aspire to, generate, consume, and represent, as well as how they function. Transition governance is a promising framework to support these transformational efforts. A key component of transition governance is the construction of transition strategies, i.e., action schemes for how to transition from the current state to a sustainable one. Despite accomplishments in building theory and methodology for transition governance, the concepts of what transition strategies entail and how they relate to specific interventions are still underdeveloped. This dissertation further develops the concept of transition strategies, and explores how different stakeholder groups and allies can develop and test transition strategies across different scales, in the specific context of urban sustainability challenges. The overarching research question is: How can cities build and implement comprehensive transition strategies across different urban scales, from the city to the organizational level? The dissertation comprises four studies that explore the dynamic between transition strategies and experiments at the city, neighborhood, and organizational levels with empirical examples from Phoenix, Arizona. The first study reviews and compares paradigms of intentional change, namely transition governance, backcasting, intervention research, change management, integrated planning, and adaptive management in order to offer a rich set of converging ideas on

what strategies for intentional change towards sustainability entail. The second study proposes a comprehensive concept of transition strategies and illustrates the concept with the example of sustainability strategies created through a research partnership with the City of Phoenix. The third study explores the role of experiments in transition processes through the lens of the neighborhood-level initiative of *The Valley of the Sunflowers*. The fourth study examines the role organizations can play in initiating urban sustainability transitions using exemplary strategies and experiments implemented at a local high school. The studies combined contribute to the further development of transition theory and sustainable urban development concepts. While this research field is at a nascent stage, the thesis provides a framework and empirical examples for how to build evidence-based transition strategies in support of urban sustainability.

DEDICATION

This dissertation is dedicated to my incredibly supportive family and to my colleague and classmate Arijit Guha. This dissertation is the result of the lifelong friendship and mentorship of my parents, Ken Kay and Karen Christensen. They have taught me to work tirelessly in the support of making things better for the people around me with creativity and humor in mind. Arijit is an extraordinary example of a family friend who embodies that mission. His grit, humor and determination to advocate for an inclusive society are contagious. This dissertation is an important milestone in my career towards taking wisdom from friends and family and using it to make where I live and work a better place.

ACKNOWLEDGMENTS

I am very grateful to my supportive advisor and mentor Dr. Arnim Wiek and the rest of my dedicated doctoral advisory committee: Dr. Derk Loorbach, Dr. Daniel Schugurensky, and Fern Tiger. The support of members of the Sustainability Transition and Intervention Research Lab at the School of Sustainability, including John Harlow, Michael Bernstein, Lauren Keeler, Chris Kuzdas, and Rider Foley, has been critical to my success. Audrey Maxwell and Dawn Durante provided much needed support and guidance. This work would not be possible without the hard work and dedication of the City of Phoenix Planning Department, Roosevelt Row Community Development Corporation, and Phoenix Union Bioscience High School. Phoenix and Arizona State University's School of Sustainability have provided an incredible opportunity for me to grow as both a practitioner and a researcher, and for that I will be forever grateful.

TABLE OF CONTENTS

Page

LIST OF TABLES xii

LIST OF FIGURES xiii

CHAPTER

1 Introduction 1

1. Problem Statement 1

2. Research Objective and Research Questions 5

3. Research Design and Research Methods Applied 6

4. Individual Studies 8

4.1. Chapter 2 8

4.2. Chapter 3 9

4.3. Chapter 4 10

4.4. Chapter 5 11

5. Overall Results 11

2 STRATEGIES FOR INTENTIONAL CHANGE TOWARDS SUSTAINABILITY: A REVIEW OF KEY PARADIGMS 13

1. Introduction 13

2. Sample of Paradigms and Analytical Framework 16

2.1. Fields of Application 17

2.2. Key Elements 17

2.3. Challenges 18

CHAPTER Page

3. Concepts of Strategies for Intentional Change Towards Sustainability 18

3.1. Transition Governance 18

3.1.1. Background 19

3.1.2. Fields of Application 20

3.1.3. Key Elements 20

3.1.4. Challenges 23

3.2. Backcasting 24

3.2.1. Background 24

3.2.2. Fields of Application 25

3.2.3. Key Elements 26

3.2.4. Challenges 27

3.3. Intervention Research 28

3.3.1. Background 28

3.3.2. Fields of Application 28

3.3.3. Key Elements 29

3.3.4. Challenges 30

3.4. Change Management 31

3.4.1. Background 31

3.4.2. Fields of Application 32

3.4.3. Key Elements 32

3.4.4. Challenges 34

CHAPTER Page

3.5 Integrated Planning 35

3.5.1. Background 36

3.5.2. Fields of Application 36

3.5.3. Key Elements 36

3.5.4. Challenges 38

3.6 Adaptive Management 38

3.6.1. Background 38

3.6.2. Fields of Application 39

3.6.3. Key Elements 39

3.6.4. Challenges 41

4. Discussion 41

5. Conclusions 46

3 THE CONCEPT OF TRANSITION STRATEGIES TOWARDS SUSTAINABILITY 49

1. Introduction 49

2. Synthesized Concept of Transition Strategies 58

2.1. Inputs into a Transition Strategy 58

2.2. Key Compoents of Transition Strategies 58

2.2.1. Sequence of Phases 60

2.2.2. Transition Actions 63

2.2.3. Organizational Structure 65

2.2.4. Required Capacities 67

CHAPTER Page

2.2.5. Required Resources 68

2.2.6. Assets..... 69

2.2.7 Barriers..... 71

3. Case Study: Transition Strategy Towards Urban Sustainability in Phoenix 72

3.1. Inputs..... 75

3.1.1. Current State Model..... 76

3.1.2 Sustainability Vision 77

3.1.3. Theory of Change 77

3.2 Strategy Components 78

3.2.1. Sequences of Phases..... 78

3.2.2. Transition Actions..... 80

3.2.3. Organizational Structure 81

3.2.4 Required Capacities..... 82

3.2.5. Required Resources 83

3.2.6. Assets..... 83

3.2.7. Barriers..... 84

4. Discussion..... 87

5. Conclusions..... 90

4 MAKING A TRANSITION BLOOM: TRANSITION EXPERIMENTS AND THEIR ROLE IN URBAN SUSTAINABILITY TRANSITIONS..... 92

CHAPTER Page

1. Introduction 92

2. Case Study: Valley of the Sunflowers (VOS) 92

3. Research Approach 101

3.1 Reconstructing the Evolution of the Transition Experiment 103

3.2. Appraising the Outcomes of the Experiment Against Sustainability Criteria 104

3.3. Analyzing the Role of the Experiment in the Wider Urban Transition Process 107

4. Results 108

4.1. Reconstructed Evolution of the Transition Experiment 108

4.1.1. Outputs and Proximal Outcomes 109

4.1.2. Experiment Actions 110

4.1.3. Barriers 113

4.2 Sustainability Appraisal 116

4.3 Using the Experiment for Broader Transition Strategy Building 120

5. Discussion 123

6. Conclusion 126

CHAPTER Page

5 WHERE DO WE START? INITIATING LOCAL SUSTAINABILITY TRANSITIONS THROUGH URBAN HIGH SCHOOLS 129

1. Introduction 129

2. Transformational Sustainability Education (TSE) 132

3. Context: Phoenix and Bioscience High School 134

3.1. Phoenix, Arizona 134

3.2. Bioscience High School: From Problem-Based Learning to Transformative Sustainability 135

4. Research Design 139

5. Results 140

5.1. Implementation Strategies 140

5.1.1. Transition Arenas 141

5.1.2. Transformative Sustainability Education Process 142

5.2. Accomplishments and Barriers 145

5.2.1. Accomplishments 145

5.2.2. Barriers 155

6. Recommedations 155

6.1. Recommendations for Research 155

6.2. Recommendations for Practice 155

CHAPTER Page

7. Concluding Remarks 158

6 CONCLUSION 160

REFERENCES 168

APPENDIX

A PERMISSION OF COAUTHORS TO PUBLISH WORK IN DISSERTATION 192

B IRB APPROVALS FOR RESEARCH 194

LIST OF TABLES

Table Page

2.1 Concepts of Strategies for Intentional Change towards Sustainability 43

3.1 Key Components of Transition Strategies 72

3.2 Highlights from City of Phoenix Transition Strategies for Governance and Business..... 85

4.1 Logic Model Progression for VOS Transition Components.. 112

4.2 Barriers and Overcoming Activities in VOS Experiment Implementation 115

4.3 Sustainability Appraisal of the Outcomes of VOS 120

LIST OF FIGURES

Figure Page

1.1 Key features of the dissertation 7

3.1 Conceptual model of strategy inputs 55

3.2 Conceptual model of strategy components 60

4.1 Timeline of Valley of the Sunflowers transition experiment 100

4.2 Reconstruction of transition process 109

4.3 Sustainability transition using VOS as a take-off experiment for land use transition in Phoenix 122

Chapter 1

Introduction

1. Problem Statement

Urban areas have become home to the majority of the world population, and urban areas are challenged to redirect their development pathways towards sustainable patterns that secure societies' long-term viability and integrity (Beall & Fox, 2007; Montgomery, 2009; Satterthwaite, 1997). Cities increasingly need to confront challenges of a dependence on non-renewable energy, availability of healthy food, economic inequity, unemployment, and a host of others. Transitions to sustainability will require intervention (targeted actions that solve challenges, while moving society towards a more sustainable state). These complex challenges are accompanied with high uncertainty are not solved with a single intervention, but require collective transition processes that involve bundles of transitions that develop and change of the course of over a 20-year period (Loorbach, 2007).

In practice, there are attempts to overcome sustainability challenges with the interventions in the form of community-based projects to increase sustainability in urban areas (Bulkeley & Betsil, 2005). Organizations that implement such exemplary projects in the United States include Growing Power in Milwaukee (Broadway, 2009) and Sustainable Bronx in New York City (Carter, 2011). These organizations address sustainability issues and motivate citizen action to implement

intentional change. However, these innovative programs may fail to reach their full potential due to a lack of support from and coordination with the cities in which they operate (Korosec & Berman, 2006). In most cases, organizations cannot tackle these challenges alone, which requires coordination with government, businesses, academic institutions, citizens, and other non-profits.

Often, cities fail to connect municipal sustainability strategies with strategies and experiments at the neighborhood and organizational levels (Bulkeley & Betsil, 2005). Currently, few cities promote experimentation with sustainability concepts and practices at the neighborhood level (Hodson & Marvin, 2010). They often fail to fully use the resources of local organizations, such as schools, to help enact sustainability on the ground level (Brown, 2008). Finally, cities and urban organizations attempting to increase sustainability lack evidence-based justification for what interventions should be implemented. This lack of coordination and use of evidence provides an opportunity, in practice and in research, to create more organized and intentional efforts to improve urban sustainability.

Sustainability researchers and practitioners have done significant work on urban sustainability transitions in theory and practice (Loorbach, 2007; Hodson & Marvin, 2010; Wiek, Binder, & Scholz, 2006). The research in this dissertation is based on the literature of transition governance (Loorbach, 2007) and transformational sustainability research (Wiek, 2009; Wiek, Ness, Brand, Schweizer-Ries, & Farioli, 2012) that

provide the theoretical and methodological frameworks for constructing, analyzing, and evaluating sustainability transition strategies. Transformational sustainability research proposes a basic framework that begins with problem analysis and the creation of sustainability visions in order to create strategies that adequately address sustainability challenges while moving towards a sustainable future. This research framework is constructed in order to address the complex and unstructured nature of sustainability challenges that cannot be solved in more traditional modes of science. Challenges such as addressing transitions from non-renewable to renewable energy or from urban sprawl to transit-oriented development require social, technological, economic, political, and cultural shifts that have to be tested, monitored, and retested in real-world settings. In this way, transition governance is a process that requires reflexivity, which means that researchers and practitioners must react to data from their real-world tests and experiments in order to further develop theories and practices (Loorbach, 2007; Wiek, 2009). The reflexivity and adaptation necessary for transition governance also requires social learning and “gain insights from others” in order to “develop a common agenda” (Loorbach, 2007, pp. 70-71). Reflexivity and social learning are key concepts that have developed in transition governance research. These theoretical developments in sustainability science are critical to addressing the sustainability challenges that cities face around the world.

To increase the positive impacts of urban sustainability efforts, researchers need to fill gaps in urban sustainability theory. Many theories of intentional change have been proposed by researchers in a variety of fields including transition governance (Loorbach, 2007) and change management in business (Hayes, 2007). Research has also been done on transition experiments (van den Bosch, 2010), on transitions within sectors and organizations (Rotmans & Loorbach, 2009), and on the sustainable design of urban areas (Conroy & Beatley, 2007). Within the field of urban sustainability research there is emerging work on the role of sustainability analysis, visioning (goal-setting), but there is more work necessary to develop theories and frameworks for how to develop complex strategies to achieve sustainability. Specifically, there is no clear agreement about the necessary components that should be part of a transition strategy (Loorbach, 2007). While the literature makes it clear that organizations need a plan (van den Berg & Braun, 1999), and there is an articulation of transition agendas as a joint-action program, but explicit details regarding the content of the program and how agendas should be constructed are lacking. There is work on how transition agendas are created by groups of stakeholders (within transition arenas), but there is no comprehensive explanation of what the agenda should contain outside of the inputs of a shared problem understanding, collective sustainability visions, and possible projects (Rotmans & Loorbach, 2009; Shove & Walker, 2007). These gaps in the literature suggest a need to define the essential

elements of a transition strategy and to define guidelines for strategy adoption and implementation across different urban levels.

One challenge in coordinating and implementing transition strategies is our limited understanding of the relationship between transition strategies and transition experiments (interventions meant to make progress in the transition) (van den Bosch, 2010). Nor do we have a clear understanding of how transitions strategies should interact with experiments at various scales (i.e., city-level, neighborhood-level, and organizational-level) (Loorbach, 2007; van den Bosch, 2010). Sustainability scientists have the opportunity to develop theories and practices to expose and understand the relationships between experiments and strategies at various scales in order to facilitate significant change.

2. Research Objective and Research Questions

The dissertation addresses the challenge of how a city can build and implement a comprehensive transition strategy across different urban scales (from the city to the organizational level). The research question reads accordingly: How can a city build and implement a comprehensive transition strategy across different urban scales (from the city to the organizational level)?

Each chapter of this dissertation seeks to address specific components of this overarching question:

- What intentional paradigms can inform sustainability strategy building? (Chapter 2)
- What is a robust synthesis concept of transition strategies? (Chapter 3)
- What resources and processes are essential to catalyze neighborhood-level transition experiments? (Chapter 4)
- What resources and processes are essential to enable organizations, including schools, to catalyze local sustainability transitions? (Chapter 5)

Through addressing these questions, the dissertation fills gaps in the current literature regarding the concept of transition strategies and the resources and processes necessary to carry out transition strategies and experiments. The dissertation also provides knowledge necessary to craft strategies and experiments to address challenges in the practice of urban sustainability at the city, neighborhood, and organizational scale.

3. Research Design and Research Methods Applied

The dissertation is structured into four chapters that contribute to answering the research question. The chapters address the theory concerning intentional change, transition strategies, and transition experiments at three scales with the examination of three case studies (see Figure 1.1). Chapter 2 uses paradigms of intentional change to explore a holistic approach to intentional change for sustainability. Chapter 3 defines the specific components of a transition strategy, while Chapter 4

defines transition experiments. Chapter 3 focuses the strategy-building process on the city level, while Chapter 4 details the specifics of implementing a transition experiment on the neighborhood level. Chapter 5 details the efforts of an organization to implement local transition strategies and experiments. The four chapters combine to define intentional change strategies then use empirical examples from Phoenix, Arizona, to illustrate how strategies and experiments can be coordinated at the city, neighborhood, and organization level.

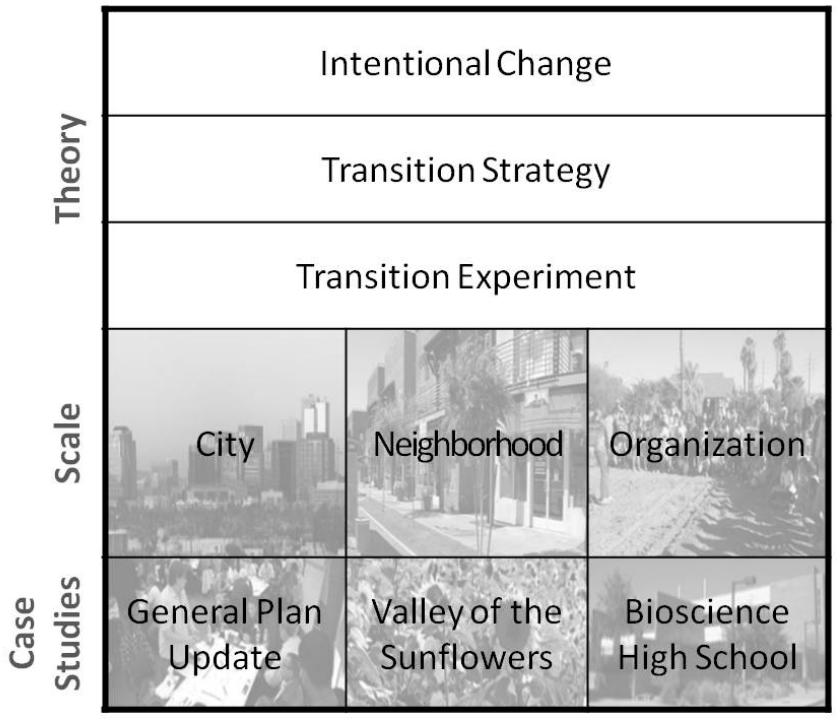


Figure 1.1. Key features of the dissertation.

This dissertation utilizes a variety of research methods to address the research questions and address the practice challenges. Chapter 2 consists of a literature review and document analysis, while Chapters 3, 4,

and 5 are based on strategy-building workshops and interviews. In addition, Chapters 4 and 5 rely on experiment design and implementation to inform theory building and template construction.

All four studies employ participatory research settings (Lang et al., 2012). Participatory workshops and stakeholder-researcher co-created products that were central to the research described in Chapter 3, while the studies in Chapters 4 required participant observation, experiment creation, and implementation with stakeholders, as well as interviews. Participatory research was conducted in partnership with Bioscience High School, The City of Phoenix Planning Department, and Roosevelt Row Community Development Corporation.

4. Individual Studies

4.1. Chapter 2: Strategies for intentional change towards sustainability: A review of key paradigms.

The field of sustainability science is shifting from an analytical and diagnostic practice to a more solution- and transformation-oriented endeavor. An important component of this endeavor is to design and test strategies of intentional change towards sustainability; in short, *change strategies*. Over the last decade, conceptual and practical paradigms have been developed that outline what such change strategies entail. Yet, these paradigms have not been fully developed, have contributed different conceptual facets, and are scattered over multiple strands of literature with limited accessibility by other communities. This chapter reviews six paradigms for intentional

change: transition governance, backcasting, intervention research, change management, integrated planning, and adaptive management. These paradigms provide an evidence-based justification for a comprehensive approach to sustainability transition strategy building that includes five key components: inputs, sequence of phases, change actions, organizational structure, and evaluation. Through this cumulative review, the chapter offers a rich set of converging ideas on what strategies for intentional change towards sustainability entail. The chapter contributes to a solution-oriented sustainability science theory and its application in pursuit of real-world changes.

4.2. Chapter 3: The concept of transition strategies towards sustainability. A key component of transition governance is the construction of transition strategies, i.e., action schemes for how to transition from the current state to a sustainable one. Despite accomplishments in building theory and methodology for transition governance, the specifics of what transition strategies entail have not yet sufficiently been developed. This chapter proposes a comprehensive concept of transition strategies and illustrates the concept with a case study on urban sustainability in Phoenix, Arizona. The concept provides practical guidance to researchers and practitioners engaged in developing transition strategies towards sustainability. This chapter fills the research gaps by explicitly stating the contentions of a transition strategy, while providing practitioners with an empirical example from Phoenix.

4.3. Chapter 4: Making a transition bloom: Transition experiments and their role in urban sustainability transitions.

Transition experiments intend to challenge and shift unsustainable social structures and practices in order to initiate or contribute to a larger transition process towards sustainability. Research has yet to fully spell out the critical components of transition experiments and provide evidence on how such experiments should best be conducted. The study presented in this chapter outlines key activities of a transition experiment and explores its role in a broader transition process towards urban sustainability. The study uses the case of the Valley of the Sunflowers initiative in Phoenix, Arizona, where a community organization, a school, and a corporation partnered to create sunflower-based biofuel on vacant land. The broader objective was to trigger sustainable development in central Phoenix, creating opportunities for community interaction, renewable energy exploration, small local business revenue, and education. Research was conducted through experiment design, participant observation, and interviews of stakeholders involved in the experiment. The results of the study suggest that well-structured experiments, coordinated with city-wide efforts, can overcome inertia and barriers and contribute to larger urban transition processes. The study provides guidance for researchers and practitioners alike engaged in or interested in designing and carrying out transition experiments in pursuit of urban sustainability.

4.4. Chapter 5: Where do we start? Initiating local sustainability transitions through urban high schools.

This chapter examines the possibility that schools can make a contribution to neighborhood-level sustainability transitions through mobilizing teachers, students, and the surrounding community around local projects by implementing sustainability and outcome-oriented, problem-project-based learning (PPBL). The chapter examines curricular efforts at Phoenix Union Bioscience High School, and shares the student-created neighborhood transition strategies and experiments that result of the implementation of a seven-step sustainability strategy building and solution development process for students to use with neighborhood stakeholders. The study builds on the contributions of three distinct but related fields: sustainability education, transformational sustainability research, and PPBL. This chapter provides a rich empirical example of the combination of these three approaches in a local initiative. The study describes in detail the implementation strategies, the main achievements, and the main barriers identified by teachers. Schools and local organizations are not a one-stop solution for creating local urban change, but this chapter outlines and examines one attempt to move toward creating systemic and strategic change in cities using schools and student learning as critical resources.

5. Overall Results

The research conducted in the four studies builds on transition governance literature and incorporates insights from other intentional

change paradigms to strengthen the concept of transition strategies and experiments. The studies contribute specific, applicable knowledge regarding strategy building as a tool for sustainable urban development. The research provides insights into multilevel transition strategy building in an urban context through work in city government, a neighborhood, and at a high school in Phoenix.

Through carrying out and analyzing these efforts in the city of Phoenix, this research provides a roadmap for how a city can improve urban sustainability through comprehensive, evidence-based strategy building that results in coordinated activities in neighborhoods and organizations throughout the city. While results from the three empirical studies do not demonstrate optimal impact, they do illustrate the types of work necessary to coordinate a citywide strategy with local activities. The dissertation aims to illustrate to practitioners and researchers how to avoid the current realities of underdeveloped sustainability strategies and isolated (not coordinated) sustainability activities. The dissertation research improves the implementation of specific urban sustainability transition strategies and experiments, while developing theoretical contributions.

Chapter 2

Strategies for Intentional Change Towards Sustainability: A Review of Key Paradigms

1. Introduction

The field of sustainability science is experiencing a profound shift from a mostly analytical and diagnostic practice to a more solution- and transformation-oriented endeavor (Matson, 2009; Sarewitz et al., 2010; Spangenberg, 2011; Wiek, 2009). Initially conceived with a focus on analyzing and understanding coupled human–environment systems, sustainability science has recently begun to put more emphasis on research that directly contributes to the transformation of such systems under the guiding concept of sustainability and through solution-oriented research (Sarewitz et al., 2010; Wiek, Ness, Brand, Schweizer-Ries, Farioli, 2012).

Several frameworks have been developed that combine research methodologies in pursuit of solution- and transformation-oriented endeavors towards sustainability (Wiek, 2009). Among these frameworks is the transition management or governance framework (Elzen, Geels, & Green, 2004; Kemp, Parto, & Gibson, 2005; Loorbach, 2007, 2010; Loorbach & Rotmans, 2010; Rotmans, Kemp, & Van Asselt, 2001; Rotmans & Loorbach, 2009). Transition governance is characterized in the prevalent literature through *process* features, including participatory, iterative, flexible, reflexive, and coordinated procedures (Loorbach, 2010).

Research as knowledge generation is a critical part of transition governance. The outputs of a structured transition governance process are threefold in its research and planning stage: (a) a *model* of the current state from a complex systems perspective addresses the guiding question "where are we now?"; (b) a *vision* of a sustainable state operationalized through goals and objectives answers the question "where do we want to be in the future?"; and, (c) a change *strategy* that links the model and vision and responds to the question "how do we transition from where we are now to where we want to be in the future?" (Raskin et al., 2002).[1] In addition to these three components and in order to prepare for unintended possibilities, transition governance research would benefit from (d) anticipating alternative future *scenarios* in contrast to the vision that address the question "what if the future does not play out as imagined in the vision" (Wiek, 2009). The implementation of transition strategies and accompanying monitoring, formative evaluation, and learning processes (through tests, experiments, and pilot projects) complete the iterative transition governance cycle (Loorbach, 2010; Wiek, Binder, & Scholz, 2006).

An important consideration for such solution- and transformation-oriented endeavors towards sustainability is to design and test strategies of intentional change towards sustainability—what will later be discussed

[1] It is critical to differentiate among these components in order to conduct genuine research on each component. This is not always coherently done; in particular, visions and strategies are often blurred or confounded in the literature as well as in practical projects.

as *change strategies*. Intentional change, guided by the normative concept of sustainability, is here defined as *a process that initiates and coordinates actions and contributions of all relevant stakeholders to transforming the current state of a system (e.g., a city, a neighborhood, a company) into a sustainable one*; a *sustainable* state or dynamic is here defined as *a state or dynamic that enables economic and social welfare in an equitable manner (worldwide) without compromising the viability and integrity of the supporting social and ecological systems in the long term*. A change strategy (also: complex/systemic intervention, or policy program), guided by the concept of sustainability, is here defined as *a coordinated bundle of prescriptive and evidence-based action items (instructions) that ought to be executed by various stakeholders (with their agreement)*; the action items in concert are considered (based on some evidence) to successfully lead from the current to a sustainable system's state (in other words, realizing the vision); the strategy is being informed and adjusted based on continuous testing, experimentation, and learning.

The importance of change strategies and strategy building within the transition governance and similar transformational frameworks is unanimously recognized. Accordingly, conceptual and practical paradigms have been developed over the last decade that specifically outline what such change strategies entail. Prominent paradigms that deal with the design of strategies, interventions, or policies are: transition governance (Voß, Smith, & Grin, 2009), backcasting (Robinson, 2003), intervention

research (Fraser, Richman, Galins, & Day, 2009), change management (Hayes, 2007), integrated planning (Wiek & Walter, 2009), and adaptive management (Olsson, Folke, & Hughes, 2008). However, these paradigms have not been fully developed, have contributed different conceptual facets, and are scattered over multiple strands of literature with limited accessibility by other communities. Therefore, the objective of this chapter is to cumulatively review and compare these prominent paradigms. Through this cumulative review, the article offers a set of converging ideas on what strategies for intentional change towards sustainability entail.

While the present article outlines the theoretical basis for building strategies for intentional change towards sustainability and suggests what *components* need to be constructed, the methodology of how to fully construct and rigorously test such change strategies, preferably in participatory settings, is beyond the scope of this article and outlined elsewhere (Wiek, 2009). Yet, the present article provides an important stepping stone towards such a methodology. Thereby, it contributes to a solution-oriented sustainability science theory and its application in pursuit of real-world changes.

2. Sample of Paradigms and Analytical Framework

Approaches were selected from different fields that propose what strategies for intentional change towards sustainability involve. The main selection criterion was that the respective approach elaborates to a critical

extent on the specifics of a change strategy and therefore would be suitable to inform a cumulative concept of change strategies. We have selected the following six paradigms and used prominent reference texts for describing each concept:

- Transition governance (a.o., Loorbach, 2010; Rotmans & Loorbach, 2009; Voß et al., 2009)
- Backcasting (a.o., Quist, Thissen, & Vergragt, 2011; Robinson, 2003)
- Intervention research (a.o., Fraser, 2009; Schensul, 2009)
- Change management (a.o., Carnall, 2007; Hayes, 2007)
- Integrated planning (a.o., Wiek & Walter, 2009)
- Adaptive management (a.o., Olsson et al., 2008; Stringer et al., 2006)

As indicated above, these paradigms have contributed different conceptual facets to the concept of change strategies. The intention of this review is not to focus on differences or emphasize weaknesses; instead, we are interested in cumulatively and constructively identifying common elements that can help outline a comprehensive and robust concept of strategies for intentional change towards sustainability. The selected approaches are being analyzed with respect to fields of application, key elements, and challenges.

2.1. Fields of application. Most of the approaches have been developed for specific fields of application, for instance, public health or

business development. We indicate the respective fields of application in order to provide context and allow the respective concept to be traced back to a larger body of literature.

2.2. Key elements. Each paradigm conceptualizes change strategies through a genuine lens and, from a cumulative perspective, puts special emphasis on specific components of change strategies. We use a pragmatic set of elements that defines a change strategy, including *inputs* (ingredients for designing a change strategy), *sequence of change phases*, *change actions*, *organizational structure* of the change strategy (including roles and responsibilities, rules, etc.), as well as *evaluation and modification*. We identify these elements for each of the six approaches in order to highlight what contributions each approach makes to a comprehensive concept of strategies for intentional change towards sustainability.

2.3 Challenges. Together, the six approaches complement each other and allow a cumulative approach to change strategies be outlined. However, each concept faces some challenges that require additional research and insight. We briefly mention these challenges to justify the need for a cumulative perspective on these concepts.

3. Concepts of Strategies for Intentional Change Towards Sustainability

3.1. Transition governance.

3.1.1. Background. Transition governance coordinates actions of different groups of stakeholders, including government, business, and civic organizations, in their joint pursuit to transition from the current state towards sustainable visions (Loorbach, 2007, 2010; Rotmans et al., 2001; Wiek et al., 2006).[2] In its early stages, transition research was predominantly descriptive and often reconstructed past transition processes (e.g., Geels, 2005); more recently, transition governance studies have become explicitly prescriptive and instructional to motivate and support ongoing and future transition processes (Loorbach, 2010; van den Bosch, 2010). Today, the importance of strategy building within the transition governance framework is unanimously acknowledged, and the fact that transition strategies need to be adjusted over the transition cycle (and its phases) is recognized (Chappin & Dijkema, 2010; Voß & Bornemann, 2011; Voß et al., 2009). Key issues such as learning, experiments, niche management, policy design, transition arenas, and the role of transition managers have been conceptualized. While strategy building is explicitly mentioned as policy design in transition governance, transition research scholars often retreat to fairly vague strategies such as enhancing reflexivity, learning, or adaptive capacity (Chappin & Dijkema,

[2] In this article, we use the term transition governance instead of transition management, which has initially been suggested and is still being used as the prevalent label in the literature. Yet, Loorbach (2010) used the term transition governance, too, and stated that "transition management . . . is a governance approach" (p. 163). In our opinion, the term governance puts more emphasize on and better carries the meaning of collective, deliberative, collaborative, and reflexive processes necessary for governing transitions.

2010; Voß & Bornemann, 2011; Voß et al., 2009). Surprisingly, these studies do not offer a great deal of detail on what a transition strategy or policy entails. Despite this lack of detail, the concept of transition governance makes significant contributions to the general concept of change strategies with its focus on transition *phases* and *levels*, strategy inputs, and *organizational structure* (transition arenas).

3.1.2. Fields of application. Transition governance has been developed and applied for over a decade in Europe, most prominently in the Netherlands and the United Kingdom (Loorbach, 2007; Markard, Raven, & Truffer, 2012; Smith, Voß, & Grin, 2010). In the Netherlands, the concept of transition governance has been mainly applied on the regional and national level to land use (Truffer & Coenen, 2012) and infrastructures for energy (Kern & Howlett, 2009), water (van der Brugge, Rotmans, & Loorbach, 2005), and transportation (Cohen, 2010). The concept gained broad reception through the transition town movement in the United Kingdom (UK), which initially focused on small- and medium-sized communities, but has been applied to towns and cities worldwide (Connors & McDonald, 2011; Hopkins, 2008; Mason & Whitehead, 2012).

***3.1.3. Key elements*.** A significant contribution of transition governance to the concept of change strategies is the idea that intentional change is a process with multiple, distinctly different phases, which happen on different levels of the system in transition. This, in return, means that change or transition strategies need to reflect and account for

these different stages and levels of the transition process; it might also be necessary to flexibly adapt transition strategies as the transition process progresses or shifts from one system level to another (Voß et al., 2009). Rotmans et al. (2001) employed engineering and technology development concepts when initially outlining phases and levels of transition processes. Phases of an ideal transition process are predevelopment, take-off, acceleration, and stabilization phase, which happen across and may pass through different levels from micro (niche) through meso (regime) to macro (landscape). Later, this initial concept was further elaborated in different types of transition processes and pathways (Geels & Schot, 2007). There is a clear understanding that agent constellations, tools, and outcomes differ greatly from phase to phase and that strategy development needs to account for these differences in order to successfully steer, manage, and govern intentional change within the distinct phases (Loorbach, 2010). A key conceptual contribution that transition governance makes to the concept of change strategies is that a transition strategy is a complex and evolving sequence of instructions. The concept of transition governance also highlights the role of research (as knowledge generation) in creating and crafting inputs for strategy development through joint problem modeling and sustainability visioning (Rotmans & Loorbach, 2009). The concept suggests that transition agents cannot develop a robust transition strategy (including transition experiments) without a shared understanding of what the problem is

(including how and why it exists) and agreement on what to aim at (including goals and success criteria). The concept of transition governance also extols that change strategies require a fairly clear organizational structure. The transition arena is the organizing frame or institutional setting in which stakeholder groups collaboratively develop and implement transition strategies and practice experiments through which status quo practices—in other words, the current regime level—are being challenged (Van Buuren & Loorbach, 2009; Lawhon, 2012). Lawhon's (2012) study of the transition of electronic waste (e-waste) in South Africa described the promises and challenges of organizing a diverse set of stakeholders, including environmentalists, retailers, government agencies, recyclers, and manufactures, that can negotiate through power structures and self-interest to select a strategy towards a collectively agreed sustainable outcome. There is a strong conviction that for well-governed transitions, transition strategies need to spell out how different stakeholders contribute to the transition process by fulfilling specific roles and responsibilities; these include, for example, groups of forerunners to experiment with novel practices and products, the government to stimulate and incentivize the adoption of new practices and products, non-governmental organizations (NGOs) to facilitate negotiations among different stakeholder groups, research institutes to monitor and advise on transition actions, and so forth (Rotmans & Loorbach, 2009).

***3.1.4. Challenges*.** While transition governance literature states the importance of setting goals and targets for intentional change, there is additional research necessary to improve methods for enhancing the quality and robustness of inputs. Shove and Walker (2007) specifically target the difficulty in creating shared visions using the example of how there can be a collective desire to use more sustainable energy sources in the future, but serious conflicts on whether the use of nuclear energy is an appropriate solution to be included in the vision. The difficulties in achieving visions within transition arenas are well documented, such as in the e-waste example, where the inability of creating a shared vision made large-scale interventions and transformational change more difficult (Lawhon, 2012). Further research to develop collective and coherent sustainability visions is in early stages (Kim & Oki, 2011; Wiek, 2009).

There is also a need to further examine the organizational structures (e.g., roles and responsibilities) that the transition governance literature proposes; for instance, Shove and Walker (2007) discussed whether groups of forerunners should be central to making policy recommendations and sponsoring transition actions or if a boarder deliberation process would be advantageous. Transition governance combined with intervention research (see below) could strengthen the evidence basis for selecting transition actions that effectively and efficiently address sustainability challenges. Transition governance could also be combined with change management (see below) to select actions

that push towards a motivating vision. Combing paradigms and further research to improve the development of robust organizational structures is necessary because studies show that that the selection of participant and transition action can easily be taken over by powerful actors (Lawhon, 2012; Voß & Bornemann, 2011).

3.2. Backcasting.

3.2.1. Background. The backcasting approach proposes a procedure to create a desired set of outcomes (goals) to work backwards from so that appropriate change policies can be designed and explored (Quist et al., 2011). In the 1970s and 1980s, backcasting was used to assess the economic and technical potential of alternative energy systems (Lönnroth, Johansoon, & Steen, 1980; Robinson, 1982, 2003). Backcasting was a direct response to the shortcomings of forecasting methods that attempted to demonstrate the likelihood of possible futures of the energy sector (Robinson, 1982). The move to backcasting represented a shift from prediction to a method that revolved around feasibility and choice (Robinson, 2003). Through selecting a desired future and then examining the possible pathways to that future, backcasting delivers a vision-oriented strategy building method that integrates stakeholder perspectives and preferences (Berkel & Verburg, 2012; Robinson, 2003). The approach has grown from a technical policy analysis tool to a sophisticated method of policy deliberation at various scales (Carlsson-Kanyama, Dreborg, Moll, & Padovan, 2008).

***3.2.2. Fields of application*.** Today, backcasting is a popular method used to develop intentional change strategies in energy, transportation, urban planning, and corporate strategic planning (Phdungsilp, 2011). Notably, backcasting is used in regional and city planning and governance projects (Carlsson-Kanyama et al., 2008; Robinson & Tansey, 2006; Robinson, Burch, Talwar, O'Shea, & Walsh, 2011). In the Georgia Basin Futures project, for example, models were used to backcast from stakeholder visions of regional sustainability and test stakeholders' strategy preferences on how to reach these visions. Phdungsilp (2011) examined how backcasting was used to create an intentional change plan for the city of Gothenburg for the year 2050. Backcasting has also been used in projects on sustainable food, transport, waste, energy, and water systems (Quist & Vergragt, 2006). Svenfelt et al. (2010) described the use of backcasting to decrease energy consumption in Sweden by 50% of 1995 levels by the year 2050. Sweden's energy usage goals were used to work backwards to develop a series of coordinated actions to create the necessary change to achieve the desired goals. Backcasting is also used to develop corporate strategies for intentional change as it informs the Natural Step approach (Holmberg & Robert, 2000; Phdungsilp, 2011). There is also an increasing trend in combining backcasting with participatory techniques to create socially robust visions (Robinson et al., 2011).

***3.2.3. Key elements*.** Backcasting puts the emphasis on value-based visions (normative scenarios), goals, targets, etc. as key input when constructing strategies for intentional change (Quist & Vergragt, 2006; Robinson, 2003). Principles of sustainability ought to inform the vision to ensure that the vision meets the normative expectations of the sustainability concept (Holmberg & Robert, 2000). The literature also highlighted the role of *stakeholders* and coproduction in creating visions that guide the design of transition strategies (Robinson & Tansey, 2006; Talwar, Wiek, & Robinson, 2011). Carlsson-Kanyama et al.'s (2008) study of producing city-specific sustainability visions highlighted the differences that can emerge depending on the type of stakeholders participating and the context in which they are participating. Berkel and Verburg (2012) described how policy makers, experts, and NGOs developed policies for different normative visions they supported. There are also attempts to specify change actions. Quist and Vergragt (2006) elaborated on communication, education, research, product development, regulation, and social measures as actions necessary to transition to a society that relies on novel (lab-created) proteins as a food source. These action plans tend not to have explicit timelines, roles, and responsibilities; however, they are examples of the intent to develop comprehensive strategies for intentional change.

***3.2.4. Challenges*.** While backcasting has its strength in developing visions (normative scenarios) of a desirable future, there is a lack of

conceptualizing the actual strategies for how to get there, including change actions and organizational structure. The backcasting approach tends to be vague when it comes to details on how to select change actions and assign roles and responsibilities to a diverse set of stakeholders (Phdungsilp, 2011; Wangel, 2011). Svenfelt, Engstrom, and Svane (2010) critiqued their own backcasting studies, stating that they did not develop “coordinated measures and specific pathways towards the [desired outcomes]” and that the specification of roles and responsibilities “was not especially thorough” (p. 6). Recent backcasting studies have attempted to overcome this challenge. Wangle (2011) recommended four approaches to incorporating actors and governance mechanisms into the backcasting approach and points to using actor-oriented future study methods that create vision elements with actions that individual actors agree to carry out. Svenfelt et al.’s (2010) study on the Swedish energy transition and Phdungsilp’s (2011) study on Gothenburg’s urban transition are both examples of backcasting studies that attempted to create strategic action plans with assigned stakeholders. The outlined challenges of how actions are selected and stakeholders are assigned hint towards the broader challenge of how stakeholders are held accountable to carry out the actions considered critical for the intentional change. This exemplifies where backcasting would benefit from other approaches, for instance, the change management approach (see below) that focuses on leadership and accountability when creating intentional change strategies.

3.3. Intervention research.

3.3.1. Background. Intervention research is a body of research that is focused on developing evidenced-based programs (interventions) that are intended to mitigate or resolve social problems, including public health challenges and social disparities (Fraser et al., 2009). Interventions are cultural products (events and processes) that "may speed, slow or reduce change towards a desired outcome" (Schensul, 2009, p. 241). Intervention research was initially developed in child psychology as researchers tested remedies for various disorders (Auerbach & Kilmann, 1977). The approach is tied to prevention research where, for instance, interventions were initially developed for work-related injury prevention (Schulte, Goldenhar, & Connally, 1996). The approach became popular in the medical field, including HIV/AIDS and cancer prevention (Fraser et al., 2009). Intervention research has matured in the field of social work sifting from program evaluation to a proactive approach creating evidence-based manuals for intentional change actions and developing training mechanisms to improve their effectiveness (Fraser et al., 2009).

***3.3.2. Fields of application*.** Intervention research is commonly used to develop actions towards disease prevention, such as HIV/AIDS (Choi & Coates, 1994; Wallerstien & Duran, 2010). It is also used in education and community psychology to develop programs to address literacy, school truancy, smoking cessation, and other community challenges (Potvin, Cargo, McComber, Delormier & Macaulay, 2003).

Significant developments in interventions research are seen in the field of obesity prevention (Brennan, Castros, Brownson, Claus, & Orleans, 2011) in targeting and assessing optimal interventions to develop evidence-based policies and programs.

***3.3.3. Key elements*.** Intervention research approaches intentional change through a systematic understanding of a problem that practitioners wish to address (input), the setting of targeted outcomes (input), and the participatory design and testing of interventions (change actions) to achieve these outcomes. For example, Potvin et al. (2003) started with a problem analysis of childhood obesity in an aboriginal community in Canada to develop evidence-based interventions and coordinated in a comprehensive education, exercise, and health program with the goal to enable change in the community so that children can thrive happily and healthily. Thereby, interventions are based on and informed by general theories of change that conceptualize problem structures, intervention points, driving forces, and effectiveness of particular change strategies (Fraser et al., 2009). The concept of evidence-based interventions adds a profound body of insights on the details of change actions and organizational structure to the intentional change literature. Intervention research directs attention away from the inputs and focuses on the details of the change strategy itself, which is usually articulated in so-called *intervention manuals* that explicate actions, roles, and responsibilities (Fraser et al., 2009). For example, White, Keonig and Scahill (2007)

detailed the design of intervention manuals, in which each action is selected using evidence from previous research, tested in randomized trials, and then evaluated as it is implemented. White et al. (2007) demonstrated how a sound intervention program can coordinate a series of actions in order to overcome learning challenges for children with autism. Intervention research pays increasing attention to multilevel, complex interventions based on the insight that intentional change of societal significance requires to design and coordinate a number of interventions that address aspects of the problem at multiple levels, such as the personal, familial, and institutional (Schensul, 2009). Intervention research is also putting emphasis on evidence and thus includes sophisticated evaluation procedures to measure the effectiveness and efficiency of interventions (Fraser et al., 2009; Schensul, 2009). For example, Brennan et al. (2011) developed a multitiered ranking system to rate the quality of evidence that a particular obesity intervention is effective. This system points to how intervention research characterizes change actions in a way that allows decision makers to make informed choices depending on context and resources.

***3.3.4. Challenges*.** While intervention research offers a sophisticated approach to the activities and organizational structure of change strategies, the inputs used for designing and evaluating interventions are somewhat underdeveloped. This pertains to the framing of the problem, which could still benefit from richer and more systemic

analytical approaches. It also pertains to the setting of the goals for the intervention. While interventions are usually linked to specific targets, a broader vision of what the system or community situation would look like with the problem solved through the intervention is usually not considered. Yet, this seems critical if the intention is systemic change (Schensul, 2009). A stronger, vision-oriented characteristic would allow countering the general critique that is brought forth against problem-focused approaches: that they neglect underlying structural problems and fail in utilizing synergies among different solution options (Robinson & Sirard, 2005). There is great promise of merging, for instance, backcasting's focus on desired future states (normative scenarios) with intervention research's strengths in detailed transition action planning.

3.4. Change management.

3.4.1. Background. Change management was first developed and used in business practice and theory in the 1970s (Beckhard & Harris, 1977; Nadler, 1982) and is now used for all types of organizations, governments, and initiatives (Doppelt, 2007; Hayes, 2007). Change management approaches intentional change from the perspective of transitioning a business or department to a desired state. Emphasis has been put on the organizational structure needed for change, usually conceptualized as managers leading staff in changing organizational behaviors and infrastructures (Hayes, 2007). While its early legacy is an analysis of business practices, the field has developed a set of tools from

visioning, agenda creation, and organizational structure that make it a generally applicable intentional change paradigm.

3.4.2. Fields of application. Change management has traditionally been oriented towards business cases, i.e., individual corporations and their managers. Hayes (2007) covered case studies from traditional corporations, such as UK Coal and McDonald's, examining what inputs, change actions, and organizational structures were created to implement change. There is some recent change management literature that uses tools to lead organizations towards sustainability using case studies of companies like Patagonia (clothing) and Interface (carpeting) (Doppelt, 2009). New forms of change management have broader applications that include governments, such as Burlington, Vermont's Legacy Project, and Santa Monica's (CA) Sustainable Communities program (Doppelt, 2009).

3.4.3. Key elements. Sharing some characteristics with transition governance, change management acknowledges the importance of inputs, including the current state and a desirable future state, as well as transitional states (Hayes, 2007; Nadler, 1982). Unlike intervention research that focuses on problems, change management is concerned with the current state of the company (from a somewhat neutral perspective). Obviously, change management is motivated by identified challenges or deficits; yet, there is no explicit or detailed problem framing. The literature emphasizes an inspiring vision that motivates people to change the status quo towards a desirable future as a key input into the

change strategy. Doppelt (2003) referenced the carpet company Interface's sustainability vision as an example. The company's vision "to become a leader in industrial ecology by first becoming a sustainable corporation and eventually a restorative enterprise" is an example of a vision that clearly separates Interface from the status quo definition of being a carpet manufacturer (Doppelt, 2003, p. 152). There is also the recognition that different types of change require different forms of change management. Nadler (1982) differentiated change management into incremental (small-scale changes of the existing business practice) or transformational (radical changes of the existing business practice). Similarly, Gersick (1991) suggested that incremental change management introduces new moves into the game, while transformational change management introduces new rules of the game. Combined with the differentiation between proactive versus reactive change, Gersick (1991) outlined four types of change: tuning (proactive and incremental), adaptation (reactive and incremental), re-creation (reactive and transformational), and reorientation (proactive and transformational). This typology can help frame the change strategy to be developed on a case-by-case basis. For example, Hayes (2007) described how McDonald's made menu changes to address competition and health concerns while sticking to its core business of selling fast food as an example of adaptation. As for sustainability efforts, the sustainability science literature referred to the need for proactive transformational change (Kates et al.,

2001; Tukker, Charter, Vezzoli, Stø, & Andersen, 2008; Wiek et al., 2012). Therefore, the change management tools intended towards reorientation merit further study and experimentation. Change management also makes a major contribution to the intentional change literature through studies on the organizational structure of change management. For instance, the field emphasizes the role of transition managers and details appropriate communication, reporting, and accountability structures (Hayes, 2007).

***3.4.4. Challenges*.** Two areas of improvement are: a more holistic view of who should be involved in the management of change (organizational structure), and systemic and normative analyses of the inputs (current state and vision). Change management does not sufficiently address the management of a complex network of stakeholders. External stakeholders' concerns, such as customers' shift in preference or changes in regulation, are often underrepresented in change management strategies (Hayes, 2007). This results in deficient change management actions that assume a shift in management and employee behavior or infrastructures would be sufficient to produce desired outcomes. Stakeholder mapping in integrated planning (see below) and the involvement of a diverse set of stakeholders in transition governance and backcasting can improve the practice of how change strategies are being developed. The second shortcoming refers to a lack of acknowledging systemic and normative foundations of the inputs. Change management does not systemically explore the current state,

which means change management strategies may not systematically target what is causing the deficits in the current state. Here, change management would benefit from integrated planning (see below). Change management also shows improvement potential in developing broader normative visions that go beyond financial outcomes. Doppelt (2003) and others are moving the field to integrate sustainability goals into change management; adopting concepts from backcasting and transition governance could support this effort.

3.5. Integrated planning.

3.5.1. Background. Cities and regions are challenged in their sustainable development by engrained unsustainable production and consumption patterns as well as infrastructures, conflicting interests, and asymmetrical power positions among decision makers and stakeholders. Integrated planning approaches have emerged since the 1990s promising to cope better with these challenges than conventional planning approaches. Collaborative integrated planning has been developed as alternative to both muddling through planning as well as expert-driven comprehensive planning (Healey, 1996; Innes, 1996). Other integrated planning approaches have later focused on overcoming conflicting sectoral development (Ravetz, 2000; Rotmans, van Asselt, & Vellinga, 2000; Wiek & Walter, 2009). Since the 2000s, integrated planning has been used in transdisciplinary case studies in collaborative settings with practitioners for designing change strategies towards regional and urban

sustainability (Scholz, Lang, Wiek, Walter, & Stauffacher, 2006; Wiek & Walter, 2009). A recent proposal adopts integrated planning for transformational sustainability planning in order to craft robust change strategies (plans) towards regional and urban sustainability (Wiek, Selin, & Johnson, 2010).

3.5.2. Fields of application. Integrated planning has widely been used in planning studies and processes on land use, urban development, transportation planning, regional development, tourism, and many other spatially explicit issues (Loukopoulos & Scholz, 2004; Ravetz, 2000; Rotmans et al., 2000; Scholz et al., 2006; Talwar et al., 2011; Wiek & Walter, 2009). In the context of transdisciplinary case studies, the integrated planning paradigm has also been used for various other issues, including business development, resource management, waste disposal, energy systems, and governance of emerging technologies (Scholz, 2011).

3.5.3. Key elements. Integrated planning puts emphasis on two types of inputs into the development of change strategies: first, conceptual models that represent the current state of the spatially explicit issue or system (for instance, urban mobility in Basel, Switzerland); and second, future scenarios that are being assessed against criteria of desirability (utility) and sustainability (Ravetz, 2000; Rotmans et al., 2000; Scholz et al., 2006). In advanced forms of integrated planning, these inputs are developed for and synthesized across different sectors of the system

(Wiek & Walter, 2009). On this basis, integrated planning develops a set of change strategies intended to making progress (if implemented) towards the desirable, sustainable scenarios and also actively avoiding the undesirable, unsustainable ones. The integrated planning paradigm specifies the necessary change actions (including decisions) to be carried out by and coordinated across various stakeholders. The organizational structure of the change strategies is conceptualized through assets (available resources), possible incentives (triggers), and specific roles that have to be taken on by key agents (Wiek & Walter, 2009). For example, in an integrated planning process on regional development in one of the cantons in Switzerland, one strategy was developed for sustainable tourism (Wiek & Walter, 2009). Existing economic pressure in the public as well as in the private domain can be utilized as triggers for recognizing the opportunity of a new tourism concept. Facilitated by a governmental unit, a public-private agent network is created and sustained, implementing professional marketing and customer services throughout the region and in cooperation with the bordering regions. New low-impact buildings and infrastructures as well as eco-efficient modernizations respect and support existing landscape patterns. The variety and solid quality of touristic activities (seminars, eco-tourism, family tourism, combinations of tourism activities) foster a sustainable long-term development of the region. The integrated planning approach has also developed a refined evaluation concept that tracks and synthesizes the

positive as well as unintended impacts of specific integrated planning projects (Walter, Helgenberger, Wiek & Scholz, 2007).

***3.5.4. Challenges*.** The integrated planning paradigm would benefit from more explicitly structuring change strategies into different phases (adopting, for instance, the phase concept of transition governance), addressing barriers to strategy implementation (as, for instance, outlined in adaptive management), and a stronger testing scheme for ex-ante evaluations and modifications of the designed change strategies (as practiced, for instance, in intervention research).

3.6. Adaptive management.

3.6.1. Background. Adaptive management is an intentional change approach aimed at transitioning a human-ecological system to a more sustainable state. The approach is driven by the use of goals and indicators to establish management plans intended to achieve desired outcomes (Olsson et al., 2008; Stringer et al., 2006). Adaptive management has been used as a regional governance tool and in conservation management for fragile ecosystems (Kenward, Whittingham, & Arampatzis, 2010; Olsson et al., 2008; Stringer et al., 2006). Studies originally focused on small management areas, but now increasingly look at multiple scales of governance and across sites (Kenward et al., 2010). While there are a variety of adaptive management approaches, key elements of intentional change can be identified that are underdeveloped in other paradigms.

3.6.2. Fields of application. Adaptive management programs exist in Europe, North America, and increasingly in developing nations (Kenward et al., 2010). Studies both assessed and recommended how fragile socioecological systems should be managed. Olsson et al.'s (2008) seminal work, "Navigating the transition to ecosystem based management of the Great Barrier Reef, Australia," focused on the adaptive management of the Great Barrier Reef in Australia. They outlined the necessary efforts to create a more reflexive and stakeholder-driven local management system that has support and oversight at the national level. Most work has not addressed multiple levels of governance and still tends to approach management one protected area at a time (Hockings, Stolton & Dudley, 2004), but there are calls for a broader multitiered approach (Kenward et al., 2010). While management of protected areas is the most common field of application, there is a movement to use adaptive management in business strategy (Linnenlueke & Griffiths, 2010).

3.6.3. Key elements. The adaptive management paradigm puts emphasis on models and simulations as key inputs to develop robust change strategies (Olsson et al., 2008). The assertion is that understanding the past and current structure of the social-ecological systems is indispensable for planning and intentionally transitioning towards a sustainable future. Models are used for representing the complexity of the system, simulating potential transition pathways, and for demonstrating the effects of possible decisions and actions. The latter is

also used for structured experiments and tests in transitioning to a sustainable future state (Stringer et al., 2006). Adaptive management provides some insights on the organizational structure of change strategies, highlighting, for example, the need to incorporate stakeholders at different scales, including national-level policy decisions, regional decision-making, and local-level processes. For example, Olsson et al. (2008) described the creation of management teams in different segments of the protected reef area, as well as a senior management forum to steer those teams. Adaptive management also recognizes barriers to change, including resources constraints, political constraints, lack of leadership, and lack of scientific certainty (Olsson et al., 2008). These barriers must be overcome through targeted actions, including communication, training, raising awareness, and networking. Adaptive management evaluates the effectiveness and efficiency of change strategies through model-based tests (Kenward et al., 2010; Stringer et al., 2006). Stringer et al. (2006) put emphasis on the role different stakeholders can play in evaluating actions. Hockings et al. (2004) documented the evaluation of change actions in order to recalibrate management plans in the Congo Basin. Evaluation methods used in intervention research could be merged with evaluative practices in adaptive management to create a holistic evaluation strategy.

***3.6.4. Challenges*.** Adaptive management does not use as a key input a holistic sustainability vision built by a diverse set of stakeholders (McLain & Lee, 1996). Instead, the approach used metrics that were often

focused on environmental and biodiversity conservation as primary input for strategy development (Kenward et al., 2010). There is also not a clear organizational structure that defines roles and responsibilities for implementing the change strategy. Lee (1999) criticized the lack of incorporating stakeholder needs, wondering if adaptive management may only be suitable for issues that have a single decision maker, such as a natural preserve. Voß and Bornemann (2011) diagnosed that adaptive management studies do not sufficiently acknowledge political considerations and related change actions. Lee (1999) described the detachment between change actions (experiments) and inputs, suggesting that the design of change actions does not sufficiently relying on the inputs. Van der Voorn et al. (2011) suggested combining adaptive management with participatory backcasting in order to develop strategies that have normative visions with broad stakeholder support. Intervention research and change management could support adaptive management in a more robust approach to selecting and designing change actions.

4. Discussion

Endeavors in sustainability science aim at developing strategies for change towards sustainability. What these change strategies should entail is the focal point of this cumulative review. We have characterized intentional change paradigms that contribute various elements to a holistic approach to intentional change for sustainability. Table 1 summarizes the

features of the six analyzed approaches and highlights the key features that indicate specific strengths.

Table 2.1

Concepts of Strategies for Intentional Change towards Sustainability

Approach	Fields of Application	Contribution to Strategy Elements *1.Inputs* *2.Sequence of phases* *3.Change actions* *4.Organizational structure* *5.Evaluation and modification*	Sources
Transition Governance	Socio-technical systems, e.g., energy, water, food systems Regions, cities, communities	**1.** Problem model and visions **2.** Distinct phases with different actions **4.** Transition manager; transition arenas **5.** Reflexivity	Loorbach, 2007 Loorbach & Rotmans, 2009
Backcasting	Regions, cities, communities Energy systems	**1.** Visions (normative scenarios) **3.** Actions derived from desired outcomes	Quist et al., 2011 Robinson, 2003
Intervention Research	Social work Public health Education	**1.** Problem model and theory of change **3.** Structured intervention actions **5.** Program evaluation	Fraser et al., 2009 Schensul, 2009
Change Management	Corporations NGOs	**1.** Motivating vision and theory of change **3.** Types of change actions (e.g., adaptation vs. reorient-ation) **4.** Transition manager	Hayes, 2007 Doppelt, 2007
Integrated Planning	Regions, cities, communities Land use	**1.** Qualitative system model **4.** Stakeholder roles and responsibilities; incentives	Wiek & Walter, 2009
Adaptive Management	Socio-ecological systems and protected areas, e.g., forest reserves and reefs	**1.** Quantitative system model **3.** Recognition of barriers in developing change actions **5.** Evaluation, monitoring, and adaptation	Olsson et al., 2008 Stringer et al., 2006

Now we will discuss all six intentional change approaches and the five elements we have used for comparatively characterizing each approach: inputs, sequence of change phases, change actions, organizational structure, and evaluation and modification.

The role of inputs, including an understanding of the present and an articulation of a desired future, is demonstrated in all six approaches. Intervention research, integrated planning, and adaptive management employ complex systems or problem models to develop change strategies, while transition governance, backcasting, and change management emphasize motivating visions as key input. However, there are some challenges to resolve. Some paradigms, such as change management and backcasting, confound the vision with the strategy itself (Doppelt, 2003; Hayes, 2007; Quist et al., 2011). Other paradigms, such as integrated planning and adaptive management, are overly focused on analysis of the system and do not sufficiently develop change actions and tactics (Kenward et al., 2010; Wiek & Walter, 2009). Both challenges need to be overcome in order to create robust change strategies that are clearly separate from the status quo and drive towards a distinctly different desired future. It seems that explicit research on intentional change strategies is slowly emerging as a distinct domain of research, and more efforts are needed to determine the most successful approaches to intentional change.

Transition governance makes an important contribution to the theory of intentional change through structuring change into a sequence of change phases (Loorbach, 2007). Adaptive management and change management both acknowledge the staged process of change (Hayes, 2007; Olsson et al., 2008), but lack creating a strategy sequence that

reflects the distinct phases of the change process. While there are valid criticisms of overly ambitious, long-term planning efforts (Hayes, 2007; Shove & Walker, 2007), transition governance's insistence to prepare for the long-term dynamic of change towards sustainability allows anticipating transition actions that are adjusted to the respective phase. For this, additional research is needed to better understand how phases are determined and monitored (Shove & Walker, 2007).

Design and selection of change actions is fully developed only in the intervention research paradigm (Fraser et al., 2009). The development of manuals, training, and monitoring schemes to carry out change actions enables structured coordination, efficient use of resources, and adaptation, if necessary. Intervention research focuses on addressing drivers in the problem constellation in order to change the status quo, while backcasting demands a focus on how actions can more directly contribute to reaching the vision (Fraser et al., 2009; Robinson, 2003). Combining both points of reference might yield the best results (Wiek, 2009). Transition governance lends the critical concepts of levels and phases to ensure that change actions are executed and at the right time and place (Loorbach, 2007). Overall, intervention research demonstrates the specificity that can be achieved with interventions, while other paradigms focus more on the inputs to create and select change actions.

Transition governance and change management clearly articulate the organizational structures necessary for implementing change

strategies, in particular highlighting the role of transition managers and transition arenas (Loorbach, 2007), while adaptive management and integrated planning emphasize the need for including all necessary stakeholders in the intentional change process and coordinating their roles and responsibilities (Olsson et al., 2008; Wiek & Walter, 2009). There is an opportunity to combine the transition governance and change management paradigms to identify and catalogue organizational structures for intentional change with intervention research in order to systematically explore and test the effectiveness and efficiency of the identified structures for particular contexts.

Evaluation and modification (if necessary) is emphasized in adaptive management and intervention research. While adaptive management focuses on measuring system-wide outcomes to evaluate the transition path of the overall socioecological system, intervention research focuses on the impacts and outcomes of specific interventions (Fraser et al., 2009; Kenward et al., 2010). Transition governance and change management suggest how to use transition arenas and transition managers to evaluate progress and make necessary changes to the strategy if the desired outcomes are not being met.

5. Conclusions

This cumulative review offers a set of converging ideas on what strategies for intentional change towards sustainability entail. Many of the

identified differences between the reviewed paradigms are terminological differences and not substantive ones. Thus, they lend themselves to the development of a unified concept of what should be included in a strategy for international change. This article demonstrates the basis for a holistic concept of intentional change strategies for sustainability.

There are different areas that require additional research to further develop a coherent concept of intentional change strategies. First, there is a need for strengthening the conceptual links between strategy inputs (current state/problem model, vision, and even alternative scenarios). Systematic explorations of barriers and tactics to overcome them (and the use of carriers) would help to enhance the design quality of change actions. Similarly, a more systematic overview of organizational structures, i.e., the most promising coordination of roles and responsibilities among different stakeholder groups, as well as the creation of strong alliances for change, could provide important guidance for change agents in the field. Finally, most of the intentional change paradigms reviewed here provide anecdotal rather than systematic evidence of success or failure, as they are guided by good practice rather than evidence-based research (e.g., change management). Formative design, testing, and evaluation of change strategies could lead to a more robust and efficient practice of intentional change.

The change necessary to overcome the sustainability challenges of the 21st century requires a rededication to understanding how societies

can intentionally change. This article brings academic literature's diffuse record of intentional change research into a converging frame so that it can be understood, improved, and crafted into a body of knowledge that assists efforts to create a sustainable future.

Chapter 3

The Concept of Transition Strategies Towards Sustainability

1. Introduction

As industrial land use, resource extraction, production, trade, and overconsumption continue to adversely affect livelihoods, social wellbeing, and natural environments worldwide, there is an urgent need for transformation and reform (Beddoe et al., 2009; Kates & Parris, 2003; Matson, 2009; Raskin et al., 2002; Reid et al., 2010; Rockström et al., 2009). Not only are inspirational visions of sustainable production, distribution, and consumption needed, but also innovative strategies and tactics for how to achieve these visions. Urban areas in particular, as they have become home to the majority of the world population, are challenged to redirect their development pathways towards sustainable patterns that secure societies' long-term viability and integrity (Beall & Fox, 2006; Montgomery, 2009). A compelling example of a city facing urban challenges is the city of Phoenix in Arizona, which has for several decades pursued an unsustainable growth agenda characterized by aggressive land development, dominant interest groups, and overconsumptive lifestyles (Balsas, 2008; Ross, 2011); yet, the city has recently started to explore opportunities for "transitioning to a sustainable future" (City of Phoenix, 2010; Wiek, Selin, & Johnson, 2010, p. 24).

Among the promising frameworks for planning and governing the complex change needed in urban areas is the transition management or

transition governance framework (Elzen, Geels, & Green, 2004; Kemp, Parto, & Gibson, 2005; Loorbach, 2007, 2010; Loorbach & Rotmans, 2010; Rotmans, Kemp, & Van Asselt, 2001; Wiek & Kay, 2012).[3] This framework is primarily prescriptive (as opposed to descriptive) and shares basic assumptions and guidelines with other intentional change approaches such as integrated planning (Ravetz 2000; Wiek & Walter, 2009), backcasting (Robinson 2003), and intervention research (Fraser, Richman, Galinsky, & Day, 2009). Transition governance, guided by the normative concept of sustainability, is here defined as *a process that initiates and coordinates actions and contributions of all relevant stakeholders to transforming the current state of a system (e.g., a city, a neighborhood, or a company) into a sustainable one*. A *sustainable* state or dynamic is here defined as *a state or dynamic that enables economic and social welfare in an equitable manner (worldwide) without compromising the viability and integrity of the supporting social and ecological systems in the long term*. The transition process is often structured across different system levels (niche, regime, or landscape) and into multiple phases (predevelopment, take-off, acceleration, and stabilization) with different dynamics (Loorbach, 2010). Transition

[3] In this article, we use the term *transition governance* instead of *transition management,* which has initially been suggested and is still being used as the prevalent label in the literature. Yet, Loorbach (2010) used the term transition governance, too and stated that "transition management . . . is a governance approach" (p. 163). In our opinion, the term *governance* puts more emphasize on and better carries the meaning of collective, deliberative, collaborative, and reflexive processes necessary for governing transitions.

governance is characterized in the prevalent literature through *process* features, including participatory, iterative, flexible, reflexive, and coordinated procedures (Loorbach, 2010). The outputs of a structured transition governance process are threefold in its planning stage: a *model* of the current state from a complex systems perspective addresses the guiding question "where are we now?"; a *vision* of a sustainable state, operationalized through goals and objectives, answers the question "where do we want to be in the future?"; and a *transition strategy* that links the model and vision and responds to the question "how do we transition from where we are now to where we want to be in the future?" (Raskin et al., 2002; Wiek, 2009).[4] The implementation of the transition strategy and accompanying monitoring, formative evaluation, and learning processes (through tests, experiments, and pilot projects) complete the iterative transition governance cycle (Loorbach, 2010; Wiek, Binder, & Scholz, 2006). It is important to note that the iterative process implies an *overlapping* or *parallel* process of planning and implementation "rather than planning and then implementation" (Voß, Smith, & Grin, 2009, p. 281).

While the overall procedural structure of transition governance is sound, a comprehensive concept of what a transition strategy actually

[4] It is critical to clearly differentiate among these components in order to conduct sound research on each component. In particular, visions and strategies are often blurred or confounded in sustainability research as well as in practical projects. In addition to these three components, transition governance would benefit from anticipating alternative future states, in contrast to the vision, that address the question what might happen if we fail to prepare for unintended possibilities (Wiek, 2009).

entails is missing. A transition strategy, guided by the normative concept of sustainability, is here defined as *a coordinated bundle of prescriptive action items that ought to be executed by various stakeholders (with their agreement)*; the action items when operating in concert are considered *to lead successfully from the current state to a sustainable system's state* (realizing the vision); the strategy *is being informed and adjusted based on continuous testing, experimentation, and learning.* The importance of strategy building within the transition governance framework is unanimously stated and the fact that transition strategies need to be adjusted over the transition cycle (phases) is being recognized (Chappin & Dijkema, 2010; Voß & Bornemann, 2011; Voß et al., 2009). Key issues such as learning, experiments, niche management, policy design, transition arenas, and the role of transition managers have been conceptualized (Chappin & Dijkema, 2010; Hendriks, 2009; Loorbach & Rotmans, 2010; Raven et al., 2010; Voß & Bornemann, 2011; Voß et al., 2009). There is an articulation of strategy building in the concept of the transition agenda, which spells out transition pathways from the problematic situation to the vision and includes "first ideas for projects and experiments"—all of which create a joint program for a transition process (Loorbach, 2007, p. 147). While this concept outlines a basic structure for transition strategies, it does not fully deliver an actionable set of

components of what a holistic transition strategy should entail with concrete specific actions and assigned roles and responsibilities.[5]

While significant progress has been made in developing concepts and methodologies for current state analysis (e.g., Alkemade et al., 2009; Rotmans & Loorbach, 2009), visioning (e.g., Quist & Vergragt, 2006; Sondeijker, 2009), and scenario building (e.g., Wiek et al., 2006; Wiek & Walter, 2009), the strategy concept and strategy construction methodology in transition governance are still each in a state of infancy. Similarly, many studies are underway that use the concept of transition governance to transform sociotechnical systems sectors such as energy, mobility, water, housing, or food as well as complex sociotechnical systems such as nations, regions, cities, and municipalities (Avelino, 2009; Huétink, van der Voorgen, & Alkemade, 2010; Kern & Howlett, 2009; Poppe, Turmeer, & Slingerland, 2009; Tambach, Hasselaar, & Itard, 2010; van der Brugge & van Raak, 2007; Voß et al., 2009). Each of these studies yields valuable insights into strategy building in transition governance; yet, the actual concept and methodology of transition strategies remains a blind spot in the theory of transition governance. Therefore, there are two objectives of this article:

[5] A broader indication of this gap is that among the several hundreds of articles written on transition management and governance over the past decade, there are only a few articles that deal with transition strategies from a practical (policy) design perspective (Chappin & Dijkema, 2010; Voß et al., 2009). A good example of this gap is the article on policy design in transition management by Voß et al. (2009), which is the most comprehensive contribution to the issue to date. While the article provides extensive arguments and information on various facets of policy design in transition management, the actual elaboration on strategies for realizing the vision is limited to one paragraph (p. 284).

1. Synthesize a comprehensive set of components of a transition strategy based on relevant literature.
2. Illustrate the concept of transition strategies with a case study in urban sustainability and reflect on the strengths and weaknesses of the proposed concept.

We expand the perspective beyond the pertinent transition governance literature and base our synthesis on different streams of research that have addressed strategies for intentional change without explicit reference to transition concepts and terminology (Fraser et al., 2009; Hayes, 2007; Olsson, Folke, & Hughes, 2008; Wiek & Kay, 2012; Wiek & Walter, 2009). We also include studies that were conducted on specific elements of intentional change strategies, including barriers and carriers (Beddoe et al., 2009; Burch, 2010), coordinating roles and responsibilities among different stakeholder groups (Wiek, Zemp, Siegrist, & Walter, 2007), and creating alliances for change (van Herk, Zevenbergen, Ashley, & Rijke, 2011).

This article provides a synthesized concept of what a sound transition strategy entails and thereby contributes to the theory and practice of transition governance. Through an empirical illustration on urban sustainability in Phoenix, Arizona, the present article provides practical guidance for what components ought to be constructed in order to build sound transition strategies.

2. Synthesized Concept of Transition Strategies

Wiek and Kay (2012) provided a cumulative review of intentional change paradigms, including backcasting, intervention research, change management, integrated planning, and adaptive management. Here, we use the insights from this review and synthesize them into a coherent concept of transition strategies—what sound transition strategies are built on and what they entail. We first discuss the inputs that go into building a transition strategy and then elaborate on the different components of transition strategies themselves.

2.1. Inputs into a transition strategy. As mentioned above, a transition strategy responds to the question "how do we transition from where we are now to where we want to be in the future?" (Raskin et al., 2002; Wiek, 2009). Thus, a sound transition strategy is built from three critical inputs: a systems-oriented *current state or problem model* ("where we are now"), a *sustainability vision* ("where we want to be in the future"), and a *theory of change* ("how do we transition from […] to […]") (see Fig. 3.1).

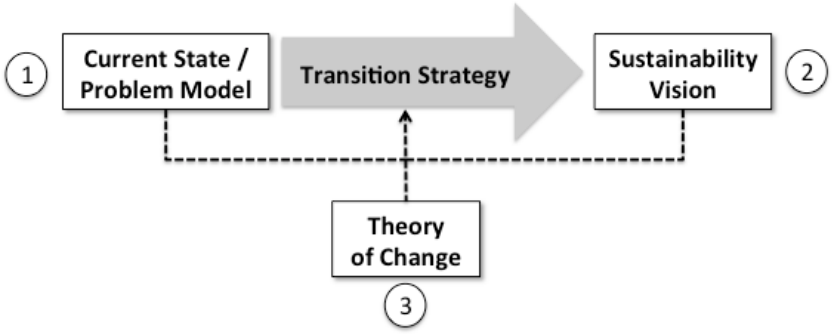


Figure 3.1. Conceptual model of strategy inputs, including a model of the current state, a sustainability vision, and a theory of change.

First, a systems-oriented model of the current state or of the problem represents the constellation of factors that is the subject of the transition process (what is being transitioned). Factors can be structured, for instance, simply into background drivers, mediating factors, and effects (positive and negative) or can be conceptualized through complex system ontologies (e.g., Ostrom, 2009). Transition governance theory adopts a systems-theoretical approach and thus conceptualizes the current state or problem under transition as a complex constellation of interlinked components (Loorbach, 2010). Loorbach (2007) suggested to use the current state analysis for building shared understanding of the problem through a “mental map of the system” in which the problem exists (p. 142). For example, obesity can be conceptualized as being directly caused by a lack of healthy eating habits and exercise with negative health, social, and economic impacts for individuals and society (Brennan, Castro, Brownson, Ciaus, & Orleans, 2011). Lack of walkable infrastructure, food deserts, industrial food production practices, and other background drivers are strong forces that negatively influence eating habits and physical activity. When designing transition strategies that target obesity, we need to consider the constellation of these factors and their interlinkages. In addition, it is advantageous to inquire how the current system or problem has historically evolved. This provides important information to be used in the participatory process for multiple reasons. First, it allows facilitating meaningful introductory dialogues and exchanges among stakeholder

groups; second, it allows developing joint understanding of the historical context in terms of path dependencies, barriers, and challenges that need to be considered when developing strategies; third, it allows developing sensitivity for complexity characteristics, difficulties of change, and the possibility for large-scale impact through strategic well-timed transition actions; fourth, it allows empowering the collective of transition actors arena through building these joint capacities.

Second, a sustainability vision ("where we want to be in the future") represents goals and objectives for the transition strategy. A vision is preferably developed as a system model as well (similar to the current state or problem model) in order to adequately represent the complexity of a desirable future state (Wiek, 2009). For instance, a vision for the obesity problem mentioned above would not only describe a desirable future state of health and social wellbeing, but also elaborate on the mediating factors and background drivers, including food production and distribution, walkable infrastructures, healthy eating education, and so forth. We focus here on transition strategies towards sustainability in accordance with the normative orientation of transition governance theory (Kemp, Loorbach, & Rotmans, 2009; Loorbach, 2010). In order to qualify for a sustainability vision, the vision ought to be based on sustainability principles and concepts (Kemp et al., 2005). Preferably, the vision would be operationalized to the extent that it offers a clear set of targets against which the performance of transition strategies could be evaluated. Both

the current state model and vision need to be reviewed and revised from a unified perspective to make sure that they correspond and allow for developing pathways that link present and future.

A theory of change is a general and ideally evidence-based concept of how the transition strategy works and succeeds in achieving the desired outcomes (Fraser et al., 2009; Meadows, 2010). A theory of change articulates the main intervention points of the transition as well as the main transition mechanism such as increasing capacity induced through educational programs, or shifting behavior through financial incentives. The theory of change does not prescribe the transition actions in any detail (that is part of the transition strategy), but provides a foundation for developing transition actions as it outlines the basic mechanism of how the current state or problem is expected to be changed (successfully). Systems theory is a critical reference point for the theory of change, too, as it allows conceptualizing transition and intervention strategies as purposeful disruptions of the current state or problem with various direct and indirect, or, in short, *systemic* impacts (if they are successful) (Midgley, 2006). In the obesity case, a useful theory of change might be based on the idea of institutional reform (here applied to industrial agriculture and food production) based on a new set of regulations, policies, and incentive structures (Brennan et al., 2011).

2.2. Key components of transition strategies. Based on Wiek and Kay (2012), we describe in the following the key components a

sounds transition strategy ought to entail, according to the literature (see Figure 3.2 and Table 3.1 below). There is consensus that a transition strategy ought to be composed of the following seven components (with guiding questions):

- Sequence of phases: How is the strategy structured sequentially?
- Transition actions: What needs to be done in each phase?
- Organizational structure: What are the roles and responsibilities for each transition action (who is doing what)? How are the transition actions coordinated?
- Required capacities: What skills and knowledge are required to carry out the transition actions?
- Required resources: What are the resources needed to implement the strategy?
- Assets: What are the currently available resources and opportunities that the strategy could take advantage of?
- Barriers: What are the obstacles that need to be overcome when implementing the strategy?

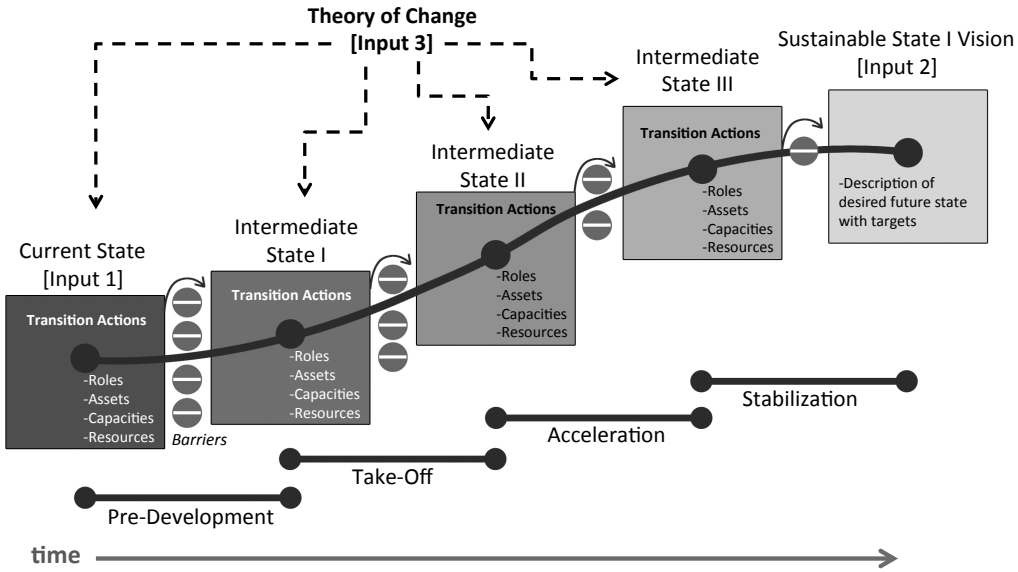


Figure 3.2. Conceptual model of strategy components, including sequence of phases, transition actions, organizational structure, required capacity, required resources, assets, and barriers embedded in the three inputs (numbers 1-3) for the transition strategy. In the following, we define each component, justify why it is relevant, outline how it could be operationalized, and provide some illustrative examples.

2.2.1. Sequence of phases. A transition strategy is sequentially structured into phases that correspond to the phases of the transition process. Intended and governed transitions do not happen over a short period of time. Rather, they are continuous and lasting processes that change character and dynamics over a long period of time (>10 years). Change strategies often do not adequately account for the dynamics that

take place during an intentional change process (Hayes, 2007). Structuring the strategy into different phases allows transition agents to plan for these dynamics over the course of a transition, anticipating future transition actions, barriers, and coping tactics (Loorbach, 2007). This does not imply the strategy needs to be spelled out in detail in a rigid, predictive plan; obviously, the strategy needs to be revisited (reflexivity) and flexibly adapted (adaptation) over the course of a transition, in particular, as transition processes might span over 10 years and longer (Loorbach, 2007; Mintzburg, 1994; Shove & Walker, 2008).

A transition process can be structured into predevelopment, take-off, acceleration, and stabilization phase (Loorbach, 2007; Rotmans et al., 2001). Accordingly, a transition strategy could be differentiated into four substrategies that pursue different goals and have different characteristics (Loorbach, 2007; Voß & Bornemann, 2011). The predevelopment strategy aims at defining the challenges of the current state, forming a sustainability vision, and adopting a theory of change. The take-off strategy raises awareness of the challenges and forms initial networks of support for the vision and the general plan of action. The take-off strategy also coordinates pilot projects and experiments that allow for small-scale implementation of the key components of the vision. The acceleration strategy transfers and multiplies the key elements of the vision (based on the insights from the pilot testing, and continuously adapted through monitoring and evaluation), continuously striving for more support and

buy-in. The overall transition strategy has the necessary political and societal backing as well as financial support to be fully implemented on all scales. The stabilization strategy completes the implementation of the vision and normalizes it—a new set of normal operations exists within the system (Loorbach, 2007). The stabilization strategy makes sure that the transition does not overshoot, creating undesirable side effects and unintended consequences. Ideally, the six components detailed below would be described for each substrategy and phase.

While it seems necessary to plan specifics for each phase (actions, tactics, etc.) in order to achieve transition objectives (vision) and coordinate actions among different stakeholder groups, transition governance literature acknowledges the limitations of a linear planning model (Loorbach, 2007). Transition processes are complex and unpredictable—they take turns, change dynamics, close pathways, and open new ones. While certain aspects of a transition strategy may be planned years in advance, it should be assumed that transition inputs and actions will need to get adapted depending on new insights, external developments, and surprises. Accordingly, transition governance literature emphasizes the importance of social learning during transition processes. This, in return, requires transition strategies to account for and create interactive learning opportunities. Social learning over the course of a transition process is not simply happening—it needs to be initiated, enabled, supported, documented, and communicated. Such learning

opportunities, as part of a comprehensive transition strategy, could include joint fact finding sessions, extended peer review of reports, open elicitation and discussion of feedback (e.g., through social media settings), and continuous monitoring and participatory evaluation.

The issue of waste management in the Netherlands provides an example of social learning that can take place over the course of a transition (Loorbach, 2007, p. 186). In the predevelopment phase, disposal and landfilling were predominant, based on the societal mindset that waste is waste. This shifted to the mindset that waste is a problem in the take-off phase, with incineration being added as a new mode of waste management. The acceleration phase saw the introduction of waste prevention as the societal mindset moved to one that thought waste is costly. The stabilization phase is still underway and headed towards the maturity of the transition process, as prevention becomes predominant and waste management shifts to resource management (waste are wasted input resources). Over 30 years, landfill diversion increased from zero to almost 90% in the Netherlands (Loorbach, 2007). These shifts in perspective during each phase meant that some practices used in early phases, like incineration, did not prove to be sustainable in the long-term and social learning enabled adaptations and changes, such as turning from downstream waste management to upstream resource management.

2.2.2. Transition actions. Transition actions are at the core of the transition strategy. They outline the necessary efforts that need to be

carried out to reach the vision. The actions are structured into the different phases of the strategy and spelled out in an action plan. Intervention research provides explicit manuals to program administrators that detail the required actions that lead to desired outcomes (Fraser et al., 2009). Change management literature articulates transition actions in an action plan with a focus on how management actions can influences employees to produce desired outcomes (Hayes, 2007). Both approaches ask which specific actions will be taken to ensure the success of the initiative and how much time and in what sequence should these actions take place. As transition actions are the focal point of the other strategy components, organizational structure, required capacities, required resources, assets, and barriers are specifically articulated for each action. It is critical that each transition action directly refers back to the set of goals summarized in the vision to ensure that all actions are outcome-oriented and guided by the ultimate aim of implementing the vision. Considering the importance of social learning in transition governance, each transition action needs to be accompanied by continuous monitoring and evaluation that allow for revision and adaptation over the course of the implementation (Loorbach, 2007).

The City of Spokane, Washington, articulated their transition strategy in a structured action plan. The actions were (not sequentially structured): improve continuously, emphasize renewable energy, promote clean mobility, enable optimal land use, conserve water, maximize energy

efficiency, optimize operating practices, and prepare through planning (City of Spokane, 2009). Each of these actions was structured into subactions. For example, the action to enable optimal land use included "encourage compact communities by amending land use policies and regulations to eliminate barriers and incentivize mixed-use, sustainable development, e.g., natural landscaping, transit-oriented development, fuel and energy efficiency, community composting and recycling, urban agronomy" and "put suitable city land to productive use, under appropriate terms and conditions, by allowing community gardens, farmers' markets, and other uses related to local food production," etc. (City of Spokane, 2009). While this is a more city-government specific plan than a comprehensive sustainability transition strategy, it demonstrates the detail and orientation of transition actions.

2.2.3. Organizational structure. The organizational structure of a transition strategy specifies by whom and in what institutional setting the transition actions and the overall strategy are being implemented. Sustainability transitions require collaboration and coordination among a diverse set of stakeholders (Loorbach, 2007; Wiek & Walter, 2009); thus, it seems beneficial to adopt clear roles and responsibilities as well as specific institutional settings that are conducive to a successful implementation of the strategy. The assignment of different roles and responsibilities avoids duplicating efforts and ensures that all critical

transition actions are being executed, and the available assets, capacities, and resources are optimally allocated (Wiek et al., 2007).

The role of the transition manager is the most prominent role in implementing transition strategies, and is used in both change management and transition governance for assigning a coordinator who orchestrates the implementation process (Hayes, 2007; Loorbach, 2007; Van de Kerkhof & Wieczorek, 2005). Importance is also put on the participation of frontrunners (or pioneers) that ensure that the transition is developing innovative practices (Loorbach, 2007). The concept of a Public Entrepreneurship Network (Laws et al., 2001), for example, defined the following roles and responsibilities needed to support innovations:

- Pioneers are innovators who seize initiative and catalyze buy-in for the transition actions
- Public venture capitalists fundraise and invest capital to implement transition actions
- Superintendents provide support for transition actions by strengthening relationships in formal and informal networks
- Mediators build agreement and resolve conflicts in developing strategy inputs as well as during the implementation process
- Stewards of the common good embrace standards for responsible and inclusive behavior in preparing and executing transition actions

The transition arena is an institutional setting that allows the different transition agents to successfully collaborate. While the transition arena

has often been described as a network of agents (Loorbach, 2007; Van de Kerkhof & Wieczorek, 2005), it seems to be more accurate to describe it as a set of collaborative agreements and rules that guide transition actors in their collaboration. The transition arena provides a virtual or real space in which interactions are coordinated across the different phases of the transition process. It is particularly critical when it comes to the implementation of the transition strategy, as this is the stage when resources are being invested and real change is expected to happen. The same transition arena can accompany the entire transition process (across all stages), but it can also be changed and adjusted during the process (e.g., based on new insights).

An example of a coordinated network of transition agents and the adoption of transition arenas is the transition process towards clean-energy vehicles in California (Laws et al., 2001). Other examples of the use of transition arenas come from the Netherlands where they support, for instance, the implementation of transition strategies in the health care sector (Loorbach & Rotmans, 2010).

2.2.4. Required capacities. Transition actions require particular skill sets as well as bodies of knowledge and experiences; the lack thereof can jeopardize the success of the entire transition process. As collaborators are recruited, and roles and responsibilities are determined, it is important to ensure that the necessary capacities are secured. Intervention research and change management rely on additional training

to ensure the necessary capacities (Fraser, 2009; Hayes, 2007). Adaptive management and transition governance also employ the more informal process of social learning to describe the capacity-building process necessary for successful strategy implementation (Loorbach 2007; Voß & Bournemann, 2011).

Loorbach's (2007) typology differentiated among strategic, tactical, and operational capacities, corresponding to different scales of strategy implementation and transition actions. Strategic knowledge and skills are necessary to develop coalitions and complex actions. Tactical capacities are required to overcome barriers and design appropriate transition actions. Operational capacities are the skills and knowledge to carry out the transition actions, for instance, the actual building of infrastructure or technologies.

An example of a set of required knowledge and skills for the implementation of a transition experiment within the context of a transition strategy are a willingness to learn, an ability to think outside a single expertise, the capacity to connect to other people (to form social networks), and the ability to communicate (van den Bosch, 2010).

2.2.5. Required resources. Transition actions often require a variety of resources (Doppelt, 2003; Hayes, 2007). Determining and acquiring (including fundraising) these resources are therefore critical components of implementing a transition strategy (Campbell, 2007). The lack of sufficient resources is obviously a key factor in unsuccessful

transition processes. Thereby, it is important to acknowledge the dynamic of required resources and financing schemes over the course of a transition process—resource needs might vary for the different substrategies as scaling effects and market forces play into the transition process (Rangeley & Davies, 2012).

Transition actions can require different types of financial resources both by direct expenditure and through hidden costs such as taxes and transactional costs. Transition actions can also result in cost savings in comparison to the current state, and therefore can also generate resources (Doppelt, 2003). From a broader perspective, resources do not only include the intentionally spent monetary funds for transition actions, but also less tangible resources such as time, emotional energy, or social support structures (Doppelt, 2003; Hayes, 2007). Additional resources might be required to cover social costs induced by transition actions, including social tension, physical harm, and time loss (Doppelt, 2003). The transition arena should include agreements and rules on how resources are comprehensively being estimated, allocated, and spending is monitored and adjusted (if necessary). Increasingly elaborated financing schemes for large-scale transition strategies are currently being developed for various cases. One prominent example is the transition to low-carbon societies (Glemarec, 2010).

2.2.6. Assets. Considering that resources for transition actions are often limited, the transition strategy ought to take advantage of existing

resources, skill sets, and opportunities (Nadler, 1982; Wiek & Walter, 2009). Mathie and Cunningham (2003) highlighted the advantages of asset-based strategy development over needs-based strategy approaches. Assets do not only directly support the strategy implementation; they often create social buy-in for the transition process, as assets anchor the transition process in a larger community of transition agents and contributors.

Assets are preexisting resources that the transition can make use of to support transition actions, including knowledge, skills, infrastructure, organizational structures, and financial resources. Even more important assets are preexisting initiatives that pursue similar goals like the transition strategy in question and allow for creating synergies and reinforcing effects.

The Dudley Street Neighborhood Initiative in Roxbury, Massachusetts, is an example of asset-based strategy development (Mathie & Cunningham, 2003). It develops land owned by local organizations, involves a local merchant association that uses resources of local businesses to develop programming, and runs the Resident Development Institute, which does financial literacy training. These actions use and further develop community assets by taking advantage of local infrastructure and organizational structures, while developing the knowledge and skills of local residents.

2.2.7. Barriers. The identification of barriers is a critical, yet often neglected, component of creating robust transition strategies. There is significant inertia towards unsustainable patterns of behavior in the form of interwoven barriers that inhibit societal shifts to a sustainable future (Beddoe et al., 2009; Burch, 2010). Identifying such barriers and creating tactics (carriers) that overcome them are critical tasks for avoiding failures and inefficiencies in transition actions.

Burch's (2010) typology, which focused on barriers within an organizational context, differentiated among cultural/behavioral, legislative/regulatory, and structural/operational barriers. Slightly generalized beyond the organizational context, cultural and behavioral barriers refer to sociocultural practices, habits, and values that may inhibit change. Legislative/regulatory barriers include both laws that may inhibit change as well as ineffective interactions between various levels of government. Structural/operational barriers refer to general (official) decision-making rules and procedures.

Burch (2010) illustrated transition barriers with the example of municipal climate change strategies in three cities in British Columbia. For instance, competitive relationships between municipalities and the regional transit authority, municipal governments beholden to special interests, and an organizational culture of risk aversion were identified as cultural and contextual barriers to meaningful action on climate change.

Table 3.1

Key Components of Transition Strategies

Component	Definition	Characteristics	Sources
Phases	Key elements of the sequential structure of transition strategies. Each phase is characterized by a specific set of actions, organizational structure, etc. (described below). Successfully overcoming main barriers to the transition process indicates entering a new phase.	Phases of the transition strategy correspond to the phases of the transition process: pre-development, take-off, acceleration, and stabilization phase	Loorbach 2007
Transition Actions	Individual interventions that tackle the sustainability problem while making progress towards the vision	Actions need to: - get specified for each phase of the transition strategy - get designed in a way to overcome barriers to the transition process - get coordinated (sequenced or in parallel)	Fraser 2007
Organizational Structure	Institutional setting for decision-making and coordination in implementing the transition strategy, including agents, roles and responsibilities, and rules	- Transition manager - Agents in the transition arena such as pioneers, superintendents, and mediators - Roles and responsibilities - Rules	Loorbach 2007 Hayes 2007
Required Capacities	Knowledge or skills required to carry out transition actions	- Strategic, tactical, operational knowledge and skills - Leadership capacity	Hayes 2007 Fraser 2007 Wiek 2007
Required Resources	Financial, human, and physical resources necessary to carry out transition actions	Funds and financing mechanisms required to execute transition actions	Doppelt 2003 Hayes 2007 Gorter and Just 2010
Assets	Available capacities or resources that can be used to carry out transition actions	Existing knowledge, skills, infrastructure, network, organizations, funds	Mathie and Cunningham 2007
Barriers	Constraints that prohibit or slow the process of the transition	- Structural/organizational - Legislative/regulatory - Cultural/behavioral - Contextual	Burch 2011

3. Case Study: Transition Strategy towards Urban Sustainability in Phoenix

The following case study illustrates a transition strategy for urban sustainability based on the seven components discussed above. We present results from a participatory research project on urban sustainability in Phoenix, Arizona. The project generated the draft of a sustainability transition strategy in collaboration between researchers at Arizona State University, the city administration, local businesses, community organizations, and citizens across Phoenix (City of Phoenix, 2010; Wiek et al., 2010; Wiek, Ness, Brand, Schweizer-Ries, & Farioli, 2012). The project ran for two years, from 2009 to 2011.

The transition strategy was intended to become a core part of the updated City of Phoenix's General Plan (City of Phoenix, 2010). The General Plan is the central long-term planning document that can be used for all specific planning processes in the city, including housing, mobility, land use, and so forth. (Because of political reasons, the Public Hearing Draft from December 2010 that included the transition strategy (City of Phoenix, 2010) was not put out for public vote; instead, the update process was continued under a different leadership team in 2011, and is ongoing (until 2014); yet, the developed transition strategy and the strategy-building process continue to inform the current update process). A second objective was to build capacity for participatory, future-oriented (anticipatory), and sustainability-oriented urban planning and governance through social learning among administrative staff, researchers, community organizations, and citizens across Phoenix.

The project addressed urban sustainability problems in Phoenix and intended to develop a transition strategy as a comprehensive solution option to these challenges. The transition strategy was developed through a methodological framework for transformational sustainability research that integrates backcasting with foresight and intervention research methods in interactive participatory settings (Wiek et al., 2012). The strategy inputs (current state model and vision), and the strategies themselves were developed in participatory settings (e.g., workshops) and were reviewed and revised with city staff, local experts, and residents (Wiek et al., 2010).

The resulting transition strategy is composed of four exemplary topical strategies, namely for anticipatory governance, vibrant urban cores, strong businesses, and efficient mobility (Wiek et al., 2010). The transition strategy is integrated to a certain extent by means of the anticipatory governance strategy, which fulfills a framing function for the other three topical strategies (they are nested in the governance strategy). Each of the four topical strategies uses as inputs the current state model and the sustainability vision specifically developed for Phoenix through participatory research as part of the overall project. All seven components were detailed for each of the four strategies. Yet, the goal was not to create a comprehensive transition strategy that would include a topical strategy for every governance domain of the city; instead, the research project intended to demonstrate the viability of the transition strategy

concept at the city level. Ideally, the resources to craft a comprehensive transition strategy based on a larger bundle of topical strategies would have been available; however, the opportunity to inform the General Plan update through the transition strategy draft was a major step forward in incorporating a transformational sustainability approach into the City of Phoenix's planning and policy-making process (Wiek et al., 2010). The practical relevance of this strategy research motivated several outreach activities and products, including strategy manuals that summarized the inputs and key components of each strategy in visually appealing formats and accessible language (Wiek et al., 2010).

We present examples from the four topical strategies (governance, urban cores, businesses, and mobility) to illustrate inputs and components of the transition strategy. All information presented in this section refers to the 2010 City of Phoenix General Plan Public Hearing Draft (City of Phoenix, 2010) and the corresponding research project report (Wiek et al., 2010).

3.1. Inputs. Each input was developed through specific research methods applied in participatory settings (e.g., workshops and focus groups) that are detailed in Wiek et al. (2010).

3.1.1. Current state model. The current state submodels for all four topical strategies were derived from the overall current state model for Phoenix (Wiek et al., 2010). The current state model for the governance strategy, for example, pointed out that residents' attachment to their local

area (in Phoenix) is weaker than their sense of national identity and frequent moves and lack of historical roots corresponds to people's limited sense of belonging. There is a general lack of civic engagement, which is also due to a paucity of opportunities offered by the city administration. The lack of stakeholder engagement affects the quality of sustainable urban governance, as city administration crafts major policies through its own lens without input from a variety of key stakeholders. For all of the topical strategies, the current state analysis mapped out the current problem constellation through activity patterns, drivers, and impacts. In some cases, historical analysis provided specific context to the current state model. For instance, related to the governance strategy, the problem model includes some indications as to how Phoenix's transient population patterns, the emergence of individually oriented lifestyles, and city policy dominated by partial interest groups have led to fractured and inconsistent civic engagement over the last decades. This is critical information for building a governance strategy intended to change the culture of civic engagement in Phoenix.

3.1.2. Sustainability vision. Similar to the current state submodels, the specific visions for all four topical strategies were derived from the overall vision of a sustainable Phoenix (Wiek et al., 2010). The vision for anticipatory governance, for example, was based on the ideal of an open and participatory democracy with citizen-focused, decision-

making processes. It was crafted into a vision narrative, including this excerpt:

> In 2050, Phoenix' city government is devoted to and organized around sustainable governance for the future. Open and inclusive governance structures are based on equal rights, responsibilities, and opportunities of and for all citizens. City government is representative of and responsive to all residents. Civic engagement is a widely practiced virtue resulting in very high voter turnout for elections, public participation in local decision-making, and self-organized community services.

Some elements of the strategy-specific visions were specified in numerical targets. The business strategy, for example, had multiple targets, including the quantitative target of achieving a business mix of 70% local, 20% regional, and 10% global businesses. Each target was justified; for example, the presented business target was to ensure that the city's economy has strong local ties while featuring regional and global competitiveness and connectivity. These targets ensure that the strategy has measurable goals to measure progress towards the vision. Both the current state model and vision need to be reviewed and revised from a unified perspective to make sure that they correspond and allow for developing pathways that link present and future.

3.1.3. Theory of change. The theories of change specific to the topical strategies rely on different change paradigms. For instance, the

theory of change that informed the governance strategy is based on ideas from new public management, in particular the structural reorganization of city administration that would enable a new set of roles and responsibilities. This theory of change suggests, for instance, that administrative structures that cut across different departments are more conducive to address complex challenges of sustainability, compared to conventional departmentalism (Dale, 2001; Smith & Wiek, 2012). A key intervention points where the transition strategy can catalyze change in the current state is, for example, the existing segmented structure of the city administration in the governance strategy. The other topical strategies feature their own specific theory of change. A key intervention point of the urban core strategy, for example, is the city's development investment policy for the urban cores (e.g., downtown).

3.2. Strategy components. The following sections illustrate each of the seven components from the transition strategy developed for Phoenix. Each section uses a particular topical strategy as an example, provides an overview of the key features, and details one of these features. Table 3.2 below summarizes the strategy components with Phoenix specific examples for organizational structure, assets, and barriers.

***3.2.1. Sequences of phases*.** Each topical strategy spells out four phases from the current state to the vision: predevelopment, take-off, acceleration, and stabilization. The strategy articulates how each phase of

the transition is linked to the following one and demonstrates how transition actions build on each other to eventually achieve the vision.

In the business strategy, the predevelopment section describes innovations that have recently taken place to frame the transition as extant in its infant stage:

> The City of Phoenix has recognized the importance of building a diverse business mix. Programs encourage and incentivize new small business enterprises, and Phoenix small business owners have successfully mobilized a large following of citizens to "buy local." In addition, the area's several universities and colleges provide entrepreneur support services in effort to retain smart people and encourage them to create businesses in Phoenix.

This stage describes key actions of the city, businesses, and non-profits to overcome the barriers of talent retention and lack of leadership for small business.

For the take-off phase (after pre-development) the business strategy describes initial pilot projects and incentives:

> Tax incentives pull several major employers from cutting-edge fields into Phoenix, and they hire from Arizona's pool of talent and recruit at Arizona universities. Simultaneously, small businesses are growing traction, as there is renewed energy and coordination with the City, and financing support from local banks.

This phase depicts the transition actions of incentives, increased coordination, and financing to overcome financial and structural barriers in achieving a more balanced business mix, which is a major target of the overall business vision.

***3.2.2. Transition actions*.** The strategy defines a range and sequence of actions necessary to complete each phase. In the urban vibrancy strategy, the take-off phase included the following transition actions:

1. Develop *Sustainability Priority Area* for urban vibrancy with key businesses, local organizations, and citizens to promote events and mixed-use developments.
2. Utilize regional networks such as *Local First Arizona* and *Valley Forward* to promote local businesses, and recommend policy changes to the Mayor and City Council.
3. Capitalize on *Village Planning Committee* structure to catalyze shade projects, cultural events, and small business development efforts within each village.
4. Develop integrated funding from federal, state, and philanthropic sources, such as the *HUD-DOT-EPA Partnership for Sustainable Communities,* to support small businesses and cultural events.

Each of these actions are designed to reach the goals of more cultural events and small businesses within Phoenix's urban cores. The Mayor of

Phoenix has recently moved forward on the first action by making urban vibrancy a priority of his *Sustainability Advisory Council* that has been supporting *PhoenixRenew*, a vacant lot program that is creating urban vibrancy through supporting small-scale food businesses and art programs (The New York Times, November 26, 2012, p. A15: “A Vacant Lot Offers Refugees a Taste of Home”). Such pilot projects, prepared and reinforced through similar transition experiments (Kay et al., 2012), are critical actions in the take-off phase of the urban vibrancy transition strategy.

***3.2.3. Organizational structure*.** The organizational structure of Phoenix’s transition strategy rests on so-called *Sustainability Priority Area* teams, composed of administrators, citizens, local organizations, and businesses to promote open governance and collective decision-making processes towards sustainability. In addition to detailing the role of these teams, each topical strategy outlines the roles and responsibilities of other key actors. In the governance strategy, for example, roles and responsibilities of specific actors are outlined as follows for the take-off phase:

> Mayor sets initial priorities (in consultation with key stakeholder groups) and champions each topical transition, including initial pilot projects
>
> City Manager and City Council move priorities forward and assign available resources to transition actions

Citizens participate in forums, planning activities, and contribute to local pilot projects

The strategy provides more details on roles and responsibilities, so that roles and responsibilities can be monitored, evaluated, and adapted (if necessary). For instance, the Sustainability Advisory Board to the Major, which is charged with defining the Sustainability Priority Areas, has specific Terms of Reference that directly relate to specific transition actions in order to motivate progress and foster accountability.

3.2.4. Required capacities. Within the business strategy, some of the necessary capacities in the take-off phase include:

- Capacity of local banks and foundations to advise and fund entrepreneurs in sustainability-related fields (socially responsible investments)
- Entrepreneurial knowledge (know-how) of sustainability-oriented business models, including cooperative models, social entrepreneurship, *Corporate Social Responsibility, etc.*,
- Governmental capacity to create a sustainability-oriented economy environment in Phoenix
- Governance capacity to create sustainability-oriented networks across different stakeholder groups, such as *Local Living Economies*

The development of entrepreneurial capacity is currently enhanced through the founding of *Seedspot*, a small business incubator that trains

aspiring (social) entrepreneurs and aids them from conceptualization to product development in order to create a local network of highly trained small business owners. Enhanced entrepreneurial capacities are critical for transitioning towards the city's goal of a high percentage of small businesses as part of the city's total business mix.

3.2.5. Required resources. The mobility transition strategy included: infrastructure costs for light rail and bus rapid transit; funding for alternative commuter programs and incentives; and the human resources of adequately compensated bus and light-rail drivers and transportation engineers. The strategy also included more intangible social costs such as issues of inconvenience including time delays in public transportation. Given recent union disputes with transportation workers, including bus and light-rail drivers, human resources are critical to the further development of a robust transportation system that is able to offer diverse, safe, reliable, and efficient transit options. While innovative financing mechanism for bus rapid transit and light rail infrastructure and incentives for using transit will be essential for reaching the ridership targets of the sustainability vision, human resources of transportation employees is a potentially overlooked, but necessary resource that may need to be cultivated through ambitious and long-standing labor agreements.

3.2.6. Assets. The urban core transition strategy identified for the take-off phase the *Roosevelt Row Community Development Corporation* and *Artlink* as critical organizations to developing urban vibrancy due to their

long-standing experience in event planning, stakeholder organizing, and urban arts programming. The strategy highlights the *Flip-A-Strip* competition at the Scottsdale Museum of Art because of the body of knowledge it compiled for best practices, innovative solutions, and possible sites for redevelopment strip malls. While strip malls are often seen as a unsightly byproduct of urban sprawl, the *Flip-A-Strip* competition featured local designers ideas of how strip malls could be adapted for live, work, play spaces that could contribute to urban vibrancy without the cost of constructing new buildings and infrastructures. The urban vibrancy strategy utilizes strip malls as existing resources for revitalizing multiple-use spaces in Phoenix's urban cores.

3.2.7. Barriers. In the anticipatory governance strategy, the use of sustainability rhetoric and lack of coordination among city departments are identified as major barriers between the take-off and the acceleration phase. Paucity of transformational leadership necessary to overcome departmentalism and muddling-through practices in government and administration seems to be the main barrier between the acceleration and the stablization phase. Phoenix, like many Sunbelt cities does not have the strong-mayor system of Northern cities like Chicago or New York. Instead, the power to restructure government is with the City Manager, who is not elected or appointed by the Mayor, but hired by the City Council. However, the fact that the City Manager can be removed from office by the City Council tends to make City Managers risk adverse in a

way that a four-term mayor is not. This structural detail of Phoenix' government is a critical barrier for the transition towards a more flexible, collective, and sustainability-oriented governance regime in Phoenix.

Table 3.2

Highlights from City of Phoenix Transition Strategies for Governance and Business

Transition Strategies	Transition actions	Organizational structure	Capacities	Resources	Assets	Barriers
Governance Transition Strategy	1.Create new data tracking and information systems 2. Install new forums for citizen input and feedback 3.. Utilize future-oriented planning and collective decision-making 4. Create action-oriented coalitions around priorities	Mayor: Sets initial priorities and champion transition City Manager and City Council: Move priorities forward and assign available resources Citizens: Participate in forums, planning activities and local pilot projects	Leadership capacity in City Hall and civil society Capacity to implement open and collective governance and planning Capacity for coalition building around transition areas	Funding for tools for open governance and data collection Staff time and technology for innovative community engagement and input mechanisms Volunteer hours and time necessary to improve citizen-government relations Changes in traditional lobbying culture	Mayor Sustainability Advisory Board Valley Leadership, Downtown Phoenix Partnership, Greater Phoenix Economic, and other business groups that can participate in collective governance efforts Civic organizations such as Downtown Phoenix Voices and Chicanos por la Causa that can represent residents	Status quo practices where traditional industries lobby government to make decisions that benefit them over public such as the construction industry Sustainability rhetoric where the government and organizations tout small pilot projects without putting necessary resources into transition
Business Transition Strategy	1. Promote creation of a balanced mix of global, regional and local businesses 2. Increase	City government: Support urban vibrancy efforts in order to create quality of life that is attractive to	Capacity of local banks and foundations to fund entrepreneurs in key fields Capacity of	Funding for incentives to improve business mix and entrepreneurship Staff time for innovative	Local Arizona First Entrepreneurship activities at Seedspot, ASU, and MCC	Deficit budgets: City and corporate budget may not give priority to sustainable business goals

	number of businesses and employees (incl. talent retention) in five key fields	entrepreneurs and creative Seedspot: Incubate small businesses and develop leadership	small business owners to lead and grow local business	business development and social responsibility efforts	Business advocacy: Downtown Phoenix Partnership, Greater Phoenix Economic Council, and Local Arizona First	Lack of agreement or synergy: A lack of coordination between City and business community
Transition Strategies	Transition actions	Organizational structure	Capacities	Resources	Assets	Barriers
Urban Cores Transition Strategy	1. Develop *Sustainability Priority Area* for urban vibrancy with key stakeholders 2. Utilize regional networks such as *Local First Arizona* and *Valley Forward* to promote local businesses, and recommend policy changes 3. Catalyze shade projects and cultural events	Mayor: Sets initial priorities and champion transition City Manager and City Council: Move priorities forward and assign available resources Citizens: Participate in forums, planning activities and local pilot projects	Need for organizations with capacity to support urban vibrancy projects Need for best practices examples of adaptive reuse, urban programming and urban desert infrastructure	Funding for incentives to improve business mix and entrepreneurship Staff time for innovative business development and social responsibility efforts Increased time and energy to fully support businesses and organizations with the cores Changes in traditional philanthropic culture to fund placemaking and urban vibrancy	Roosevelt Row, Artlink, and and First Fridays programming Flip-a-strip competition that encourages strip mall activation Urban Village Planning Committee are formed and have potential to set guidelines and goals for each urban core Strong existing public arts program with innovative arts and culture programming	City codes and ordinances slow down businesses and events by time delays and increased costs Locating investment and sponsorship Lack of developers with desire or knowledge on how to build in a way that encourages vibrancy Difficulty in increasing regular attendance beyond monthly programming
Mobility Transition Strategy	1. Multi-modal transit center pilot projects in several Phoenix Villages. 2. Develop and increase use of employee transit programs.	City Hall: Make a commitment to financing and support transit centers Villages: Supporting projects and planning that build around existing or future transit	Need for a mass transit and cycling culture Design and planning skills necessary to Develop 21st century multi-modal transit center	Infrastructure costs for light rail and bus rapid transit Funding for alternative commute programs and incentives Transit employees	Existing TOD guidelines Initial light rail segment Organizations like Valley Forward and Friends of Transit Commute Alternative Coalition Maricopa Association	Coordination with regional transportation authorities Public infrastructure spending on roads Perceptions of public transit Transit scheduling Continuing development

	3. Incentive infill and transit oriented development	centers. Citizens: Work to reduce commute times jobs near transit.	Increase number of Commute Employee programs	of Government s Pedestrian and Cycling Committee	on city fringe opposed to urban infill

4. Discussion

While transition governance has been conceptualized in various theoretical and empirical contributions over the past ten years, a comprehensive concept of what transition strategies actually entail is still missing (Loorbach, 2007; Shove & Walker, 2008; Wiek & Kay, 2012). This is critical as transition strategies can be considered a key component of the transition governance agenda (Voss and Bornemann, 2011). Based on a literature review detailed elsewhere (Wiek and Kay, 2012), this article outlines a framework for transition strategies through a set of interlinked components, with special emphasis on the relationship between inputs and transition actions and the importance of addressing barriers in transition strategies. While this initial conceptualization seems adequate in providing initial guidance to transition researchers and scholars, there are several critical issues that need further attention in consolidating the proposed approach.

First, the design of transition actions needs a strong empirical base (evidence-based strategy development). It needs to address the question,

what evidence do we have that the proposed action successfully intervenes in the current problem constellation, is capable of overcoming barriers, and indeed makes progress towards the sustainability vision? The provided empirical example of a transition strategy for Phoenix lacks of such a refined evidence base. In this pursuit it would be advantageous to adopt and integrate an intervention research approach for evidence-based and systemic selection of transition actions (Fraser et al., 2009; Schensul, 2009; Wiek and Kay, 2012). By combining intervention research's systemic approach to intervention selection with transition governance research both approaches would play to their strengths and create a synergistic relation. In an initial study we have used an intervention research approach to develop evidence-based small-scale (neighborhood) interventions in Phoenix (Bernstein et al., 2012), as a continuation from our initial work presented here.

Second, Burch's (2010) typology of barriers provides a sound fundament in considering a key component of strategy development. This is critical as the lack of barrier recognition leads to overconfidence about the potential of selected transition actions, and does not prepare stakeholders for the possibility of failure. However, barriers need to be conceptualized based on a stronger empirical base, following more closely the methodology suggested in Burch (2010). Again, the case study from Phoenix provides only an entry point for such research. This example

speaks to a broader need for specific methods and procedures to collect and analyze data on each of the strategy components.

Third, the initial capacity building among researchers and planners in the city has triggered a more informed planning practice and public discourse on transition strategies in Phoenix. The explicit place-based nature of the components based on local expert input ensured the topical strategies would be based on up-to-date and relevant content (saliency). However, there is a need for transferring ownership to key personnel in the city administration so that each component of the transition strategy is as functional, detailed, and up-to-date as possible. For example, at the time the Phoenix strategy was crafted, there was only very limited understanding of Burch's (2010) typology of barriers, which was specifically developed for urban municipalities. Ideally, this typology would be regularly applied and updated within the city administration to identify all potential barriers facing each transition and to select appropriate transition actions. For this, additional and more in-depth researcher–practitioner collaborations are necessary to cocreate evidence-based transition strategies in which transition theory, evidence, and practice converge.

Fourth, this research suggests the possibility that major cities develop comprehensive urban transition strategies. The sustainability strategies currently in use in many U.S. American cities fail to utilize the theories of intentional change and do not employ structured approaches to

strategy selection and design (Svara, 2011; Smith and Wiek, 2012). The strategy presented in this article serves as an initial example of how a city can develop a comprehensive transition strategy towards urban sustainability. While Rotmans and Loorbach (2009) have helped develop such transition practice at the industrial and regional level, there is a need to encourage official sustainability transitions that are hosted by urban municipalities but carried out by a diverse set of stakeholders. Such multi-sector and multi-level transition processes have the potential to expedite an over-arching societal transition towards sustainability.

5. Conclusions

Sustainability-oriented transition strategies provide the opportunity to coordinate efforts to tackle the sustainability challenges cities face around the world. In order for cities to fully utilize the potential of transition strategies, major efforts in urban governance research and practice are needed. This article provides a framework for what should be included in transition strategies. There is a need for methods and procedures to collect and analyze data for each component. Also, there is a need for more coordinated empirical research on strategy building for urban sustainability, in particular efforts that provide evidence for what does or does not work in urban transition strategies. Coordination among research groups to create larger case databases that allow for cross-case comparisons would be a critical factor in generating such evidence base. Finally, stronger partnerships between urban governance research and

practice are critical to embedding sound strategic procedures into administrative structures.

Chapter 4

Making A Transition Bloom: Transition Experiments and Their Role in Urban Sustainability Transitions

1. Introduction

There is ample evidence that current structures and practices of production, distribution, and consumption of food, energy, housing, mobility, and so forth follow unsustainable patterns, in particular in industrialized nations and urban areas, that jeopardize the viability and integrity of socioecological systems around the world (Kates & Parris, 2003; Montgomery, 2009; Satterthwaite, 1997). Transition governance has emerged as a promising framework for intentional change towards sustainability (Loorbach, 2007; Wiek & Kay, 2012). Transition governance coordinates actions of different groups of stakeholders, including government, business, and civic organizations, in their joint pursuit to transition from unsustainable patters in the current state towards sustainable visions (Loorbach, 2007, 2010; Rotmans, Kemp, & Van Asselt, 2001; Wiek, Binder, & Scholz, 2006).[6] In its early stages, transition research was predominantly descriptive and often reconstructed past transition processes (e.g., Geels, 2005). Recently, transition governance

[6] In this chapter, we use the term transition governance instead of transition management, which has initially been suggested and is still being used as the prevalent label in the literature. Yet, Loorbach (2010) used the term transition governance, too, and stated "transition management . . . is a governance approach" (p. 163). In our opinion, the term governance puts more emphasize on and better carries the meaning of collective, deliberative, collaborative, and reflexive processes necessary for governing transitions.

studies have become more proactive and instructional in order to motivate and support transitions towards sustainability (Loorbach, 2010; van den Bosch, 2010). Accordingly, transition governance research has begun to pay more attention to the selection and implementation of transition strategies and interventions intended to move society from its current state to a sustainable one (Kay, Wiek, & Loorbach, 2012; Loorbach, 2010; Voß & Bornemann, 2011). Among different types of transition interventions (e.g., pilot project, training program, etc.), transition *experiments* are a critical type (van den Bosch, 2010). They have been introduced as a key element within the transition governance framework meant to challenge and shift unsustainable social structures and practices in order to catalyze, motivate, and sustain a larger transition process towards a sustainable society (Loorbach, 2007; van den Bosch, 2010).

According to Rotmans (2004), transition experiments are “practical experiments with a high level of risk (in terms of failure) that can make potentially large contributions to the transition process” (p. 50). Van den Bosch (2010) pointed out that this definition is insufficient because it provides little guidance on what experiments consists of and how they need to be managed to contribute to a sustainability transition. Van den Bosch (2010) refers to bounded sociotechnical experiments and strategic niche management for a more comprehensive definition of transition experiments. Vergagt and Brown (2007) described bounded sociotechnical experiments as intended “to introduce a new technology or

service on a scale bounded in space and time" (product-oriented); as endeavors that are carried out "by a coalition of diverse participants, including business, government, technical experts, educational and research institutions, NGOs and others" (collective); and as "cognitive" processes in which "learning by doing, trying out new strategies and new technological solutions, and continuous course correction, are standard features" (p. 1110). Bounded sociotechnical experiments—with these features of being product-oriented, collectively conducted, and centered on learning—are used in examining the transition processes of mobility, energy, and housing (Brown & Vergragt, 2007, 2008; Vergragt & Brown, 2012). Similarly, strategic niche management uses experiments in sustainable innovations, including studies of electrical vehicle and biomass combustion experiments (Hoogma, 2000; Raven, 2005).

According to van den Bosch (2010), transition experiments differ from bounded sociotechnical experiments and strategic niche management because they address broader sustainability challenges and go beyond product-oriented technological innovations. Transition experiments induce or support institutional, legal, financial and social-cultural innovations, in addition to technological innovations. For instance, in Van den Bosch's (2010) study on a health care transition process, the experiments are meant to change organizational structure (e.g., roles and responsibilities among health care workers), culture (e.g., values and behavior of patients), and practices (e.g., specific health care practices).

For the purposes of this article, we define a transition experiment as *(a) a structured sequence of activities; (b) carried out by multiple stakeholders in different roles and with different responsibilities; (c) intended to challenge and shift unsustainable social structures and practices; (d) with the goal to catalyze, motivate, and sustain a larger transition process towards a sustainable society; and (e) that includes explicit design, monitoring, documenting, reflection, evaluation, and adaptation activities to ensure collective learning over the course of the experiment.*

While Van den Bosch (2010), Loorbach (2007), Brown and Vergagt (2008), Loorbach and Rotmans (2010), and others have made strides in conceptualizing transition experiments and their role in transition governance, there are still a series of open issues to be resolved. First, the majority of studies on transition experiments to date have focused on experiments with specific technologies or in specific sectors. Considering the importance of urban areas for global sustainability, there is insufficient research on the nature of urban transition experiments (e.g., on the neighborhood level) and their role in broader transition processes (city level). Second, a widely recognized challenge is how to catalyze and sustain transition processes through transition experiments, which calls for more robust empirical investigations of the connection between experiments and the wider transition process (Loorbach, 2007; Shove & Walker, 2008; van den Bosch, 2010). Third, none of the transition experiments to date has been evaluated against a set of sustainability

principles or goals, which is critical for determining the success of a transition experiment and its contribution to the wider transition process (Forrest & Wiek, 2012).

This study seeks to fill the aforementioned gaps through research addressing the following questions:

1. What activities are necessary to successfully carry out sustainability-oriented transition experiments in an urban context (neighborhood level)?
2. What barriers need to be considered in implementing urban transition experiments?
3. What are the impacts of urban transition experiments on urban sustainability?
4. How can small-scale local experiments motivate or support citywide transition processes towards sustainability?

This article addresses these research questions through the lens of the Valley of the Sunflowers (VOS) initiative in Phoenix, Arizona, where a community organization, a school, and a corporation partnered to create sunflower seed-based biofuel on vacant land. The broader objective was to trigger sustainable development in Central Phoenix, which would create opportunities for community interaction, renewable energy use, small local business revenue, and education. Recent research in Phoenix, Arizona, has initially demonstrated how to build comprehensive transition strategies for urban development towards sustainability (Kay et al., 2012). While the

initial efforts in Phoenix were important to create a framework for citywide intentional change towards sustainability, the framework needs to be translated into tangible initiatives relevant to people on the ground. This article analyzes the evolution of the VOS initiative and then proposes a template for carrying out urban transition experiments on the neighborhood level.

The article is structured as follows: the next section presents the case study context (section 2); the following section spells out the research methods employed, including experiment design, participant observation, interviews, and various analytical tools (section 3); the following section presents the results of the study (section 4); the article concludes with lessons learned to support transition experiments in urban transition governance (sections 4 and 5).

2. Case Study: Valley of the Sunflowers (VOS)

This case study description summarizes the objectives of the VOS, the main actors and leveraged assets, the main implementation activities of the experiment, and the history of previous attempts at vacant lot activation in downtown Phoenix that led to the initialization of VOS. This information is critical to understanding the context and characteristics of VOS as a transition experiment that was built on several important existing innovations.

The objective of VOS was to address the overbearing amount of vacant land in the City of Phoenix, which poses barriers to economic

development, walkability, social cohesion, and quality of life (Ellin & Turner, 2010). The issue of vacant land in urban cores is well documented throughout the world (Shahraki et al., 2011) and is a sustainability challenge faced by many American cities (Alexander & Powell, 2011). Since the economic downturn started in 2007, there were several failed attempts to develop temporary solutions to vacant property across the U.S. and in Phoenix as a way to turn abandoned dusty properties into "catalysts for urban and economic revitalization" (Ellin & Turner, 2010, p. 155). While groups of stakeholders had met and developed solution options over the years, the VOS initiative was the first large-scale intervention completed on vacant land in downtown Phoenix.

The initiative was a temporary vacant lot intervention conceived by artist Kenny Barrett and implemented in 2011 and 2012 in Downtown Phoenix that produced an attractive field of sunflowers that were in stark contrast to Phoenix's status quo of dusty trash filled lots that are a common site in the city of 520 square miles. Mr. Kay (lead author of this article), at that time a Ph.D. Student at the School of Sustainability at Arizona State University, worked with Mr. Barrett to develop the details of the project to plant two acres of sunflowers as a biodiesel production experiment on city-owned land located between the Phoenix Union's Bioscience High School and the Growhouse urban farm founded by Mr. Barrett. The project was designed around four existing assets: (a) available urban farming expertise at Growhouse (Mr. Barrett, Mr. Kay),

which is a program of the Roosevelt Row Community Development Corporation, a local organization dedicated to supporting small business, the arts and walkability in three neighborhoods in Central Phoenix; (b) six acres of vacant lots owned by the City of Phoenix that were slated for long-term development and were well-positioned for temporary use; (c) a commitment to biodiesel production and the construction of a hybrid biodiesel-solar powered car as part of Bioscience High School's project-based learning curriculum; (d) the interest of Sean Sweat, a downtown activist and Intel employee, who had strong enough connections within Intel to advocate for funding downtown Phoenix projects through Intel's *Sustainability in Action* grant program. These four assets combined enabled to create a partnership between Bioscience High School, Roosevelt Row, and Intel, which provided critical funding and project management for the transition experiment (See Figure 4.1 for a overview of the timeline of the experiment).

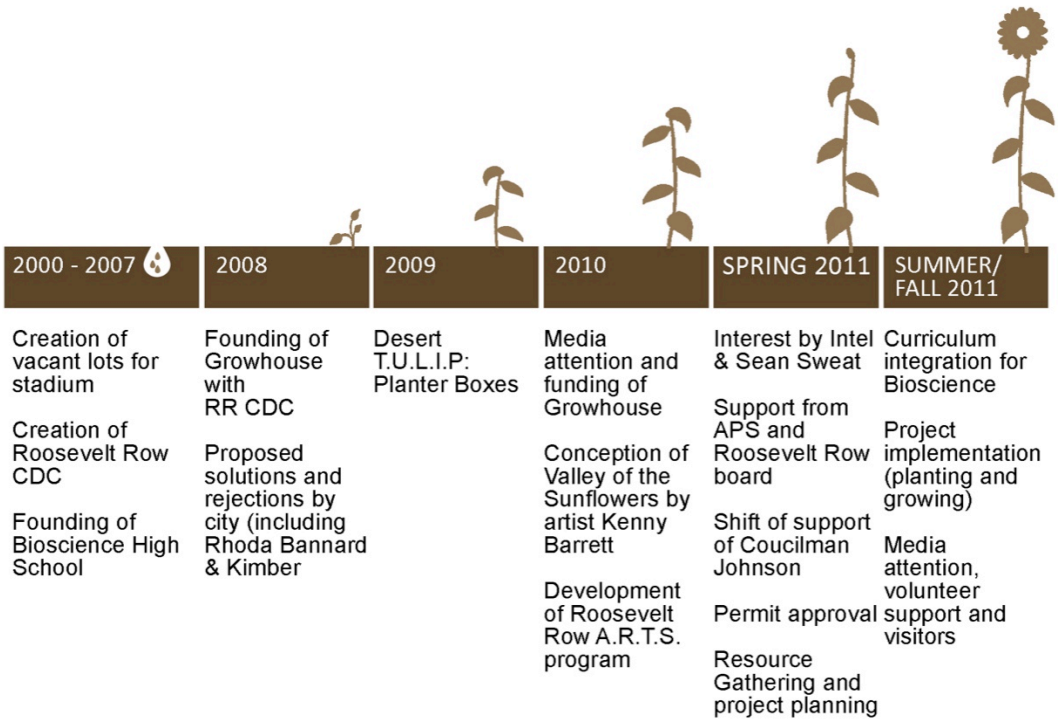


Figure 4.1. Timeline of Valley of the Sunflowers transition experiment.

The project involved the planting and harvesting of sunflowers on the vacant property for two growing seasons followed by the conversion of the sunflower seeds into fuel for use in the biodiesel car as a demonstration project on how to go from seed to engine in the production and use of biodiesel. Each planting season consisted of weekly volunteer days on Saturdays in order to prepare the soil, sow the seeds, thin the plants, fertilize the sunflowers with compost tea (an organic fertilizer), maintain the surrounding area (through weeding, trash pick up, and mulching), and eventually harvesting the flowers. The seeds were then removed from the flower heads and pressed into oil using an oil press (purchased with funding from Intel). The oil was then converted to

biodiesel at Bioscience High School for eventual use in a biodiesel car that was constructed by their engineering students.

VOS qualifies for a transition experiment according to the definition introduced above: (a) a structured sequence of activities that included organizing, planning, mobilizing, and publicizing in order to accumulate the necessary resources and permissions; (b) carried out by multiple stakeholders in different roles and with different responsibilities that included Roosevelt Row, Bioscience High School, local residents, and Intel; (c) intended to challenge and shift unsustainable social structures and practices, including lack of small and local business development, lack of educational opportunities, socially isolated residents, and traditional nonrenewable energy use; (d) had the goal to catalyze, motivate, and sustain a larger transition process towards a sustainable society through the continual messaging around innovative land use, and education; and (e) VOS included explicit documenting, reflection, and adaptation activities to ensure collective learning over the course of the experiment as demonstrated through bimonthly project management meetings, as well as data collection and reporting to Intel.

3. Research Approach

Research activities span from the experiment design to the impact evaluation, as the primary researcher (Kay) was a key participant in the preparation and implementation of the transition experiment. At times, this situation provided the researcher with exclusive access to specific sets of

data and in-depth insights into the case. Yet, this situation also challenges the researcher's objectivity—a challenge that is mitigated through coauthors not involved in the data collection. More significantly though, this type of research is an example of an emerging solution-oriented and engaged research approach in sustainability science that offers innovative links between research and practice (Lang et al., 2012; Wiek, Ness, Brand, Schweizer-Ries, & Farioli 2012).

Data was collected on all relevant aspects of the transition experiment according to the analytical and evaluative framework that will be discussed below. Data collection consisted of in situ participant observation and informal conversation during the study as well as ex-post interviews. Interviews were semistructured and in-depth with 10 participants purposively selected for their knowledge, experience, and particular vantage points of the experiment. These included, among others, the founders of Roosevelt Row; the project managers and the principal of Bioscience High School; representatives from the City of Phoenix administration, including staff from the Community and Economic Development Office, and City Council, and Mayoral staff. Not all interviewees were directly involved in the project to allow for a broader perspective and reflection on the VOS experiment, including the founder of Roosevelt 2, a vacant lot initiative that was inspired by VOS.
Based on this data collection, the transition experiment was reconstructed (Section 3.1.) and appraised (Section 3.2.), applying a method developed

by Forrest and Wiek (2012). Finally, the role of the experiment within a broader citywide transition process as viewed by local stakeholders was examined (Section 3.3.).

3.1 Reconstructing the evolution of the transition experiment. The analytical reconstruction of the transition experiment provides insights into the internal mechanisms of the experiment, identifies the types of activities, capabilities, and resources that were necessary, the range of actors involved, and other contextual factors that were critical to VOS's success, as well as barriers blocking the experiment path and actions to overcome them (see Research Questions 1 and 2). The transition experiment was reconstructed by employing the transition path reconstruction framework developed by Forrest and Wiek (2012). The overall outcomes of the experiment were identified and the pathways that led to them, i.e., the series of activities and intermediate outputs were followed back to their origins using process tracing (George & Bennett, 2005). As the experiment was reconstructed, barriers that obstructed progress, and carriers that enabled progress were identified (Burch, 2010). The reconstructed experiment is represented through a logic model, which identifies the core activities of the experiment, the direct outputs they produced, the indirect outcomes that resulted, and the initial factors (preconditions) that were critical for the activities to take place (context and drivers).

3.2 Appraising the outcomes of the experiment against sustainability criteria. The outcome appraisal indicates how successful the experiment was in terms of sustainability (see Research Question 3). We conducted a sustainability appraisal of the outcomes of the VOS experiment using Gibson's (2006) compilation of core criteria for sustainability assessment that were specified for neighborhood sustainability by Forrest and Wiek (2012). The neighborhood sustainability criteria were used to appraise the impact of the experiment on the surrounding neighborhood because project organizers intended to have impact on the sustainability of the neighborhood. The change in sustainability due to the project outcome in each of four domains including small-scale economic development, community knowledge, community cohesion, and renewable energy use was appraised and the cumulative impact on each domain and sustainability criterion was estimated. The domains represent the four main goals of the experiment as stated in the grant application to the Intel Corporation. Evidence for impacts was derived from interview data, as well as from informal observation and conversations. The sustainability criteria used are described below in terms of what they mean for the sustainability of urban neighborhoods:

1. Socioecological system integrity (integrity): Neighborhood communities should seek to improve the health of ecosystems at local, bioregional, and global scales and thus strengthen the integrity of socioecological systems. Benefits of urban ecosystems

include health (e.g., pollution absorption), recreation (e.g., parks), economic (e.g., property values), and infrastructure (e.g., flood control) as well as provisioning of food, fiber and fuel. Neighborhood communities have direct impacts on local ecosystems in, for example, utilizing private and public spaces to promote green space, or through supporting local businesses with sustainable supply chains rooted in the bioregion (Newman & Jennings, 2008).

2. Livelihood sufficiency and opportunity (livelihood): The necessities for human wellbeing should be accessible for the neighborhood at an affordable price. This includes resources and services such as water, energy, public transport, healthy food, schools, green space, and community gathering spaces. Additionally, opportunities for residents to pursue economic needs should exist such as employment, training, and local business development support.
3. Intra- and inter-generational equity (equity): All neighborhood residents should have equitable access to amenities, services, and decision-making processes. Costs, benefits, and impacts of community developments should be distributed equitably across all members. The principle extends beyond the neighborhood boundaries so that through their actions, communities should not deny similar rights to members of other communities regardless of location. Thus, for example, residents should have access to

community recreation facilities and opportunities. Further, the principle also extends to future generations: neighborhood communities should take care protects similar rights for future residents.

4. Resource maintenance and efficiency (resource use): This principle refers to the finite supply of many resources. In the neighborhood setting, there is a constant inflow of materials and energy in the form of electricity, gasoline, water, food, consumer goods, construction materials, and other items. There is an outflow of wastewater, atmospheric emissions, and trash, which ultimately cannot be sustained. Sustainable neighborhoods seek to replace linear through-flow with cyclical flows at multiple scales such as local to regional renewable energy production, supply chains and nutrient recycling.
5. Socioecological civility and democratic governance (citizenship): Neighborhood residents should be aware of their socioecological impact and should seek to reduce it through actions and decisions wherever reasonable possible. (This is not to suggest that individuals and communities shoulder all of the blame for impacts—individuals and organizations acting at all societal levels bear the same responsibility). Neighborhood level governance that is open, transparent, and that provides residents with opportunities to participate in decision-making that is important to the community

should exist. Examples of organizations that might facilitate and enact governance at the neighborhood level include community councils, neighborhood associations, housing associations, local planning committees, and community development corporations. Such organizations can play an educational role in developing greater socio-ecological oriented citizenship through community organizing and activities.

6. Precaution and adaptation (adaptability): This principle recognizes the uncertainty of the future and requires capabilities to anticipate and adapt to possible future change. Neighborhoods should seek to reduce vulnerability to potential short- and long-term threats by establishing good governance and forward planning. Projects that reduce the effects of urban heat island, like shade trees or urban agriculture are possible adaptation strategies for Phoenix neighborhoods. Education of community members is important to establish understanding of possible changes and community cohesion is necessary to decide on goals and actions.

3.3 Analyzing the role of the experiment in the wider urban transition process. The final analysis of the experiment's role in the wider urban transition process provides insights on options for designing reproducible neighborhood interventions; the support needed to develop neighborhood capabilities to implement these types of interventions; and policy areas that need to be revised to enable these types of interventions

(see Research Question 4). Key stakeholders and external experts reflected on the results of the analytical reconstruction and the sustainability appraisal. Interviewees were asked how VOS could lead to a broader land use transition in Phoenix through identifying strategy components, including further transition activities (including experiments), barriers, necessary capacities, and inputs (including a more in-depth problem understanding and a more detailed vision for land use in Phoenix). We adopted a pragmatic strategy-building framework (Kay et al., 2012) that helped to elicit feedback from interviewees on how VOS could fit into a 20-year strategy and transition process to reach a sustainable land use development model in Phoenix (see Figure 4.2).

4. Results

The results section begins with the reconstruction of the transition experiment that is followed by examining the outputs and outcomes, barriers, and activities. This is followed by the sustainability appraisal, and then the results of the strategy building for sustainable land use in Phoenix.

4.1 Reconstructed evolution of the transition experiment. As indicated in the case introduction, the VOS initiative was reconstructed backwards from the outcomes to the initialization in order to identify key milestones and activities of the experiment (see Figure 4.2).

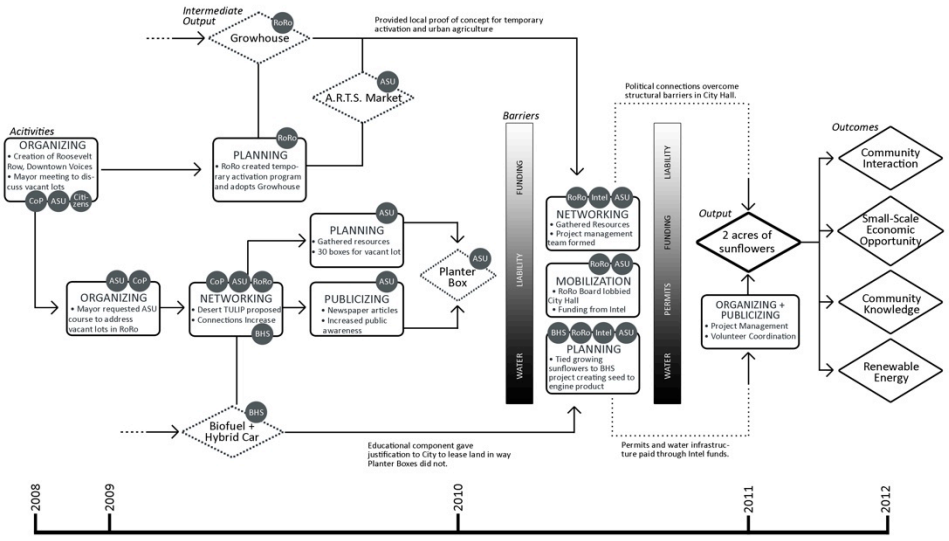


Figure 4.2. Reconstruction of transition process (with activities in boxes, outputs in diamonds, and barriers represented as bold lines). Key actors are noted for each activity (circles).

***4.1.1 Outputs and proximal outcomes*.** Outputs are defined as direct results of the project, including the number of volunteers on site, the sunflowers grown, and the biodiesel produced. Proximal outcomes are activities and events that resulted from the implementation of the project, including the capacity developed for the creation of new vacant lot projects (education). This was demonstrated through the development of the Roosevelt 2 lot, a temporary park developed by a local public relations executive who used attention, volunteering, and equipment from VOS to create a sculpture park and grassy gathering space several blocks from VOS. There was also a city-run temporary vacant lot activation several miles North of VOS that provide agricultural land for Phoenix's refugee community that was partially based on the work of VOS, which demonstrates the role of VOS in the larger capacity building process (The

New York Times, November 26, 2012, p. A15: “A Vacant Lot Offers Refugees a Taste of Home”). More projects for other vacant lots are now planned through funding Roosevelt Row obtained by applying for grants that heavily touted the success of VOS.

Table 4.1 summarizes the preconditions and implementation activities that produced the outputs, which catalyzed the proximal outcomes. These proximal outcomes are what the sustainability appraisal focuses on to determine the sustainability impact of the experiment.

4.1.2. Experiment actions. We describe selected experiment actions using the typology from Forrest and Wiek (2012) that includes networking, planning, mobilizing, and publicizing. Exemplary experiment actions and their impacts are summarized in Figure 4.2 and Table 4.1. *Networking* is defined as “working with other organizations to achieve short term or long term, specific or general, objectives, including building coalitions, negotiating, participating in peer groups” (Forrest, 2011, p. 37). Networking occurred, for example, when the mayor’s office worked with then ASU professor Nan Ellin to organize a course that addressed the vacant lots in the Roosevelt Row district and produced the concept of Desert TULIP (Temporary Urban Laboratory Infill Projects). This built upon networking with Roosevelt Row merchants and board members since the city government had torn down homes that left the lots vacant in the early 2000s. The original networking around the issues of vacant lots was critical to further developing relationships between Bioscience High

School, City of Phoenix, Roosevelt Row, ASU, and local neighborhood organizations. Another key experiment action, namely *planning*, is defined as “identifying goals and how they are to be achieved through identification of actions, their sequence and timing” (Forrest, 2011, p. 37). Planning and experimentation resulted in the prototype of the Desert TULIP planter box. The prototype was used to produce 30 planter boxes; yet, the city administration refused to allow placing them on the vacant lots. Iterative planning was undertaken to develop the idea of VOS, gain permission to use the vacant lots, and determine the logistics of growing sunflowers on previously rocky, dry, refuse-laden soil. *Mobilizing*, which involves “getting community members to participate in the transition through providing information, holding motivational events, providing support” (Forrest, 2011, p. 37), was undertaken when building the planter boxes (as highlighted in Figure 4.2) and for developing the necessary volunteer base to carry out VOS. Finally, publicizing, which is “the outward dissemination of information about what the transition community is doing, what they have achieved, what they plan to do,” (Forrest, 2011, p. 37), was undertaken, for example, through a major final event and related press release on VOS that brought the issue of vacant lots further to the public's attention. The later publicizing of VOS supported volunteer efforts and visitors as TV crews, blog posts, and newspaper articles drew attention from around the region (English, 2011; Gersma, 2011).

There were other critical experiment actions that contributed to the successful implementation of VOS. For example, the Bioscience High School teachers produce a curriculum that supported the construction of a hybrid car and biodiesel production (seed-to-engine education project). Roosevelt Row developed Growhouse for vegetables and sunflowers gardening, and thereby provided a proof of concept for growing two acres of sunflowers.

Table 4.1

Logic Model Progression for VOS Transition Components

Preconditions	Transition Actions	Outputs	Proximal Outcomes
Development of Roosevelt Row's A.R.T.S. Program Energy projects at Bioscience High School Community members with employee access to corporate sponsorship Land available in downtown core Previous efforts off Roosevelt Row, Kimber Lanning, and ASU, including planter boxes Changes in water meter policy and downtown zoning Creation of temporary solution that achieved necessary support in City Hall	Community fund raising Social and traditional media outreach Volunteer planting, maintenance and harvesting Bioscience students planting Advocacy and lobbying with City University of Arizona and local construction companies scraped gravel and trash off of the lot to prepare for growing Use of water from the City of Phoenix Trash clean up and landscaping Press releases, a public ground breaking, attending panels, and giving interviews to ensure people knew about VOS	Two acres of sunflowers First completed large-scale temporary vacant land project Activated vacant lot with landscaping, signage and a sense of purpose Visitors Newspaper articles, TV coverage, and social media Renewable energy projects such as biofuel car and biofuels that could use sunflower seeds produced	*Small-scale Economy:* Increased awareness and patronage of local businesses in RoRo, Additional funding for RoRo and future A.R.T.S. programming *Education:* Building knowledge, skills, and confidence for RoRo, BHS, and partners to contribute to sustainable urban development *Renewable energy use:* Increased attention and media coverage of renewable energy *Social cohesion:* Increased connections among local institutions and residents

4.1.3. Barriers. Key barriers were identified through process tracing of the project, based on Burch's (2010) typology of structural/operational, regulatory/legislative, cultural/behavioral, and contextual barriers. Table 4.1 outlines the predominant barriers in the implementation of VOS. Burch (2010) defined structural/operational barriers as "features of the organization's structures and procedures that influence day-to-day activities and long-term policy direction" (p. 7579), such as term limits and a lack of incentives for innovation. In the case of VOS, Phoenix' City Council was primarily interested in long-term development and a lack of funds for water and infrastructure were two critical structural barriers that had to be overcome (the planter box experiment failed because of this barrier). These and other structural/operational barriers were overcome through negotiations and an agreement on clear organizational structures for the transition experiment that satisfied the concerns of the city administration (Planning Department and City Council); and through funding from Intel and in-kind donations that provided funds for water and water infrastructure (i.e., sprinkler equipment and a back flow preventer). The structural barrier of limited political support was overcome through lobbying from the Roosevelt Row Board, which used its network to convince officials in the city administration that VOS would benefit the neighborhood. Regulatory/legislative barriers are defined as "the nature of the policy tools that the municipality has at its disposal and the interactions between

multiple levels of government" with examples such as province policy that does not align with regional goals, or a weak mayor system that makes coordination of city departments difficult (Burch, 2010, p. 7580). VOS encountered such regulatory/legislative barriers, including the Economic Development Office's policy of no temporary projects on vacant lots, and county policy to charge prohibitory dust permitting fees, mandated by the federal government (over $1,000 for the two-acre site). These barriers were overcome through networking to convince city council and mayor to maneuver around the office's policy, and through funding from Intel that paid for the dust permitting fees.

Cultural/behavioral barriers are "the relationships between individuals in various critical positions within the municipality, their personalities, and the collective ethos and customs at play within the organization" (Burch, 2010, p. 7850), such as lack of coordination and leadership. In the VOS experiment, cultural/behavioral barriers were risk aversion and lack of a collaborative culture within the city administration, as well as between city administration and community organizations. These barriers were overcome through promotion of the vetted VOS concept (publicizing) to residents and city officials through public meeting attendance, social media, and traditional media including television and newspapers.

Finally, contextual barriers are "the environment within which the municipality functions and the values and priorities of the public" with

competing priorities and resistance to change as examples (Burch, 2010, p. 7581). Resistance to change in the city administration and the disengagement of many Phoenix residents were contextual barriers that VOS had to overcome through mobilizing citizens to create a new public space to promote connectivity, and mobilizing city council and administrators.

Table 4.2

Barriers and Overcoming Actions in VOS Experiment Implementation

	Structural/ Operational	Regulatory/ Legislative	Cultural/Behavioral	Contextual
Barriers	City Council's desire to keep lots empty for long-term economic development Lack of funding and infrastructure for water necessary for public greening projects Lack of project management capacity	Property not zoned for community gardens or public space Water meters only available to residential or commercial units Liability concerns of hosting people on vacant lots	Lack of agency to change state of downtown vacant lots Lack of coordination between neighborhood groups to enable large-scale project	Phoenix is spread out with community organizations that are less established
Actions	(Organizing and Planning) Development of Roosevelt Row and A.R.T.S. Program (Networking) Establishing relationship between RoRo and Bioscience High School to frame vacant land action as educational (Mobilizing) Sean Sweat's activism and funding from Intel provided funds for water and infrastructure	(Mobilizing) Roosevelt Row Board advocacy that supported zoning changes (R/L) and lobbied City Council to overcome (S/O) barriers (Organizing) RoRo assumed liability for VOS lot	(Planning and networking) Coordination of volunteers through Facebook and media outlets to involve people in vacant lot activation (Planning and networking) Coordination between different downtown Phoenix groups to organize volunteers	(Mobilizing) Created a gathering space for people to meet and collaborate (Networking) RoRo board used project to ensure that city administrators overcame obstacles within city departments

4.2 Sustainability appraisal. For the purposes of the appraisal, the product of the experiment, i.e., a vacant land intervention to address challenges of local small-scale economy, community knowledge, non-renewable energy use, and social isolation, is treated as a long-term outcome and not, as it actually was conceived, an exploratory, temporary product. This aligns with the idea of an experiment and is done to obtain an indication of what could be expected from an intervention designed and implemented based on the VOS experiences. Table 4.3 shows the results of the sustainability appraisal for the VOS project.

The project scores highest in the livelihood and equity criteria, with improvements in the four domains (small-scale economy, community knowledge, renewable energy and social cohesion). One impact relates to direct economic benefits (small-scale economy domain), as the local development corporation reported increased business from VOS volunteers and visitors. The project also engaged volunteers in communal activity (planting, harvesting, etc.) providing increased knowledge about urban agriculture and biofuel production (community knowledge domain) and social benefits in bringing community members together for work days and for celebration events such as three potluck dinners that were held (social cohesion domain), both which support the livelihood criterion.

There were small positive impacts in the equity criterion. Firstly, as a community resource, the benefits were open to all community members (social cohesion). Secondly, community assets also benefit future

generations in that beneficial community legacies are being created if it can be shown that these outcomes are lasting (social cohesion and community knowledge). Lastly, community members of all ages were part of the process of producing biofuel and were able to learn about urban agriculture and biofuel production (community knowledge domain).

In the resource use criteria, the project gave a small boost to the local economy (small-scale economy domain) through spurring innovation and resourcefulness. Sunflower plant parts were used as raw materials by local cottage industries for diverse purposes including making paper and ceramics, as well as in construction. In the community knowledge domain, the project increased community member knowledge of biofuel agriculture (renewable energy domain). In the social cohesion domain, the community invested a great deal of sweat equity to create a new community asset. Over 400 unique volunteers in total were involved with the project. A typical turnout included 30 volunteers on each volunteer work day, and in addition, over 300 Bioscience High School students participated in at least one two-hour volunteer block. One measure of how VOS was valued by the community is the 1534 Likes on its Facebook page, mostly from locals, and the strongly positive and supportive nature of comments left on the Facebook page. Further evidence for the field being classed as an asset is in its utilitarian value. As one example, people began to use the site for photo shoots and families, weddings, and even a local clothing company utilized the space.

In the citizenship criterion, the project had small impacts across four the domains. In the community knowledge domain, the experiment was a new means for knowledge development that extended educational opportunities into local place and community, not only for Bioscience High School students, but also for all community members. In this case, the increase in community knowledge development demonstrated that vacant lots could be used as a community space and to generate discussion about local sustainability issues such as energy and land use. This was demonstrated both through the use of the lots for community events and tours and later use of other vacant land for similar purposes. It helped the Roosevelt Row to increase its capabilities through actions such as zoning code changes, lobbying, and public relations, for which assistance from community members played a part. It has drawn community members into active service. One example is the professional photographer who helped Roosevelt Row with their photographic needs after being involved in VOS. Interaction between community members (social cohesion domain) has also increased outside of VOS on other issues. Awareness of local businesses increased through their sponsorship of the project (small-scale economy domain), as evidenced by increases in customers on volunteer days as cited by local shop owners. Adaptability was slightly increased by enhanced capability of community groups to take on similar projects. In particular, one group developed a miniature park on a small vacant lot in the vicinity (community knowledge domain).

Overall, the appraisal suggests the sustainability improvements from VOS are primarily social in nature. Contrary to expectations, there was no discernible change from the actual biodiesel produced, as the quantity is insignificant relative to the community's total fuel use. Neither is there a change in the employment indicator as management and operations depend on volunteers and not on paid staff. Larger scale interventions across multiple vacant lots could change this but would also affect the social outcomes, too, as volunteer resources would become stretched as operations shifted towards an emphasis on production. Similar urban farming interventions producing other crops are likely to have similar appraisal results to VOS although food production could have an appreciable impact on the community food needs. The demonstrated impacts were in the experiment’s effect on social cohesion and community knowledge while the lasting impacts for renewable energy and local economy were small due to the scale of the project.

Table 4.3

Sustainability Appraisal of the Outcomes of VOS

Domains	Impact on Sustainability Principles	**Total Impact**
Small-scale economy	**Citizenship:** Increasing in awareness of local businesses that supported project though sponsorships and coupons for volunteers for volunteers **Resource management:** Raw materials used by local "cottage industries" **Well-being:** Increase in customers to local businesses	**Medium: Some economic benefit to local business.**
Community Knowledge	**Adaptation:** Build capacity (cognitive knowledge, instrumental knowledge, …) for community asset development **Citizenship:** Learning how to use community based asset development to educate citizens on local issues such as walkability and thermal comfort **Equity:** Educational benefits open to all community members of all ages	**Medium: Significant increases in educational opportunities for Bioscience High School and local residents**
Renewable energy	**Resource management:** Increase ability to produce biofuel crops and biofuel	**Low medium: Production of small amounts of biofuel, and an increase in awareness of biofuel production.**
Social cohesion	**Citizenship:** Increase in communication about neighborhood issues and increased interaction, strengthened / expanded internal and external networks among neighbors while volunteering **Citizenship:** Recreation asset managed and operated for, and by, the community **Livelihood:** Engaged volunteers in communal physical activity, and was a community asset valued by the community (1534 "likes" on the Facebook page)	**High: VOS brought residents together and increased communication among them.**

4.3 Using the experiment for broader transition strategy building.

In order to demonstrate how VOS could be used to catalyze or support a larger sustainability transition, interviewees were asked to help build a transition strategy for land use in the Phoenix. Figure 4.3 summarizes the key components of the strategy. Interviewees identified

transition inputs (current state description and vision), actions (including experiments), assets, and barriers.

The strategy entails policy interventions such as incentives for temporary use and penalties for vacancy. It identifies critical barriers that would remain difficult for future experiments, such as financing, liability, zoning, organizational capacity for project management, and difficult property owners who may not want to program their lots without serious financial benefits. Transition actions specific to particular phases such as the need for temporary activation experiments in several areas of the city, including the Phoenix Renews project on Central Avenue, and vacant activation by the Tigermountain Foundation in South Phoenix, are critical to demonstrating success beyond VOS. These acceleration actions are necessary to make policy makers more awareness of the potential of vacant lot activation, and to expose city and state policies that act as a barrier towards the vision. These actions need to be created and steered to produce measured against progress towards a long-term vision, which means that transition actions, like Phoenix Renews need to target specific elements of the vision such as improving walkability or reducing urban heat island. The vision itself did not develop as a final state of a fully developed Phoenix, but it reads as a set of rules to govern land use in which temporary activation inspires and leads to long-term sustainable development in a way that from the experimentation first demonstrated with VOS.

Using VOS for transition strategy building offers an opportunity for social learning in that different perspectives of VOS could be used to create new ideas for programming and to further articulate goals and visions for use in the larger land use transition. In this way VOS can play a critical role a social learning tool to a) improve problem understanding, b) develop stronger interventions (including experiments, and c) develop a strong shared vision of the future of land use and temporary land activation in Phoenix.

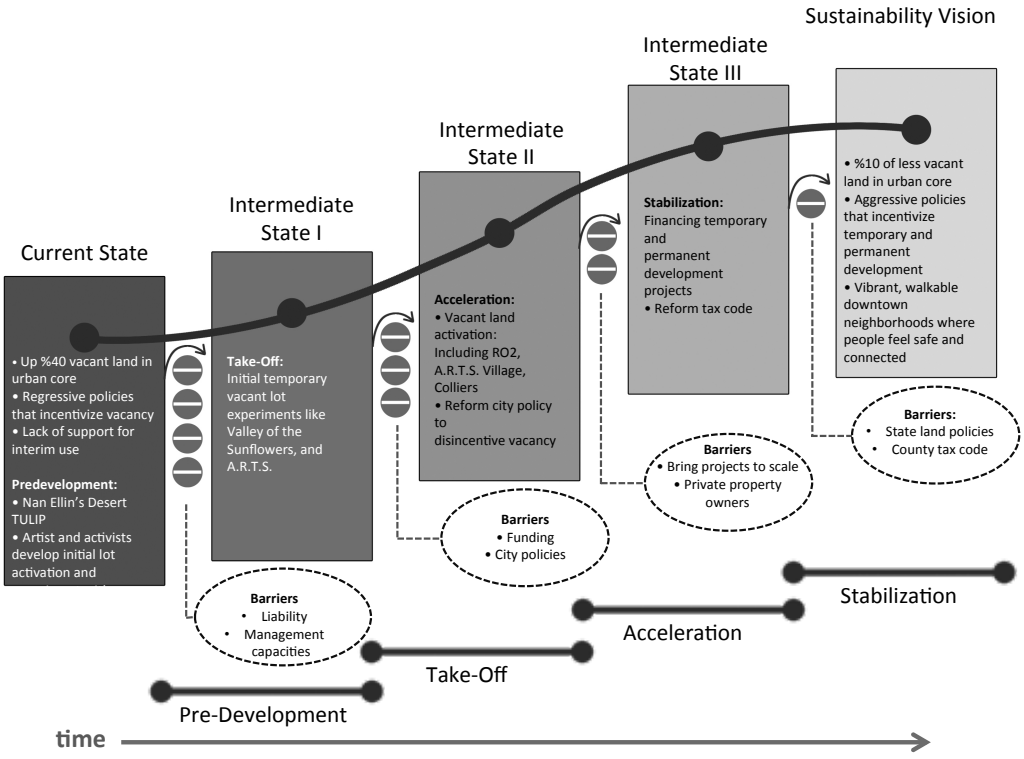


Figure 4.3. Sustainability transition using VOS as a take-off experiment for a land use transition in Phoenix as developed by interviewees.

5. Discussion

To successfully employ transition experiments in urban governance, there is a need to both determine the success of the experiment and to also determine what aspects or activities of the experiment could be further utilized to make process towards sustainability goals (Kay et al., 2012; van den Bosch, 2010). By using process tracing, activity and barrier identification, sustainability appraisal, and transition strategy building, this study demonstrates how a transition experiment can be reconstructed and evaluated in a way that allows for comparison to similar transition experiments. The study builds upon Van den Bosch's (2010) conceptualization of how a transition experiment can change organizational structure and cultural practice through clearly articulating and successful implementing key activities to overcome barriers and achieve sustainability outcomes.

The study used the empirical example of VOS to demonstrate the importance of targeted actions (organizing, planning, mobilizing, and publicizing) in order to complete a transition experiment. The completion of the Phoenix's first major temporary activation of vacant land that included diverse stakeholders, produced alternative energy and was well-publicized, makes this experiment a strong empirical example to use in examining the potential role of transition experiments in the urban context. The experiment actions are the core mechanism to allow social learning. Although social learning was not comprehensively assessed in this study,

further research needs to provide evidence of social learning; for instance, through questions like, did the networking and mobilizing that Roosevelt Row and ASU do to gather resources and overcome city barriers, make them better at working with those actors for future interventions? Social learning is demonstrated through the increased number of temporary activation of properties, such as Phoenix Renews and the Roosevelt 2 lot, and through plans to complete more projects through both Roosevelt Row and Bioscience high school. VOS built the confidence and experience necessary for a variety of local organizations and citizens to develop more experiments, and be more involved in shifting land use patterns in Phoenix.

However, experiment actions are not sufficient instructions for a comprehensive strategy to shift long standing land use patterns in Phoenix, barriers to achieving the vision need to be considered in order to select actions that can overcome them (Burch, 2010). VOS assisted in identifying key barriers, such as liability, land acquisition and zoning in a way that allowed other to learn from the experience in order to reduce the difficulty in effecting land use, and developing temporary interventions in Phoenix. VOS project managers could have done more to clearly communicate barriers to the broader public, and could have created vacant lot activation manual in order to improve awareness and social learning around critical barriers that the transition experiment exposed.

Through this attempt to use a transition experiment to support a boarder strategy-building process, the study was develop mechanism to demonstrate to stakeholders that lessons learned from a transition experiment (i.e. activities, barriers, vision articulation) can be use to build a citywide strategy. This tool could be used to determine the need for future experiments such as changing city land use policies. In this way, further development of city-specific sustainability criteria used within the appraisal could aid the production of a robust strategy that would provide the ability to select appropriate experiments and activities for each phase of a city's transition that are aligned with the city's approach to sustainability. This work is at the early stages of developing a process to create transition actions (including experiments) that relate to a city's broader sustainability goals.

A single experiment may be a building block in one transition (land use), while it is a catalyst for creating a new transition in that geographical area (energy or education). While this study does not prove that VOS was a catalyst for widespread societal change in Phoenix, it does identify a method for implementing and assessing transition experiments in urban areas that could eventually catalyze citywide intentional change towards sustainability. In this context, experiments are the only type of intervention necessary to facilitate change, but their role as a catalyst merits further research and use in practice.

For practitioners, this study demonstrates how transition experiments can be used as social learning activities in order to find out what works in attempts to move towards greater sustainability. This empirical example provides typologies of actions and barriers that can be used in initializing a transition experiment. For example, if Phoenix residents were to use VOS to start a land use policy experiment, they would now see the importance of looking for regulatory, structural, cultural and contextual barriers, and the organizing, planning, mobilizing, and publicizing activities that may be necessary to overcome them. This study also points to the importance of developing successful criteria for experiments that relate to city transition strategy and sustainability principals so that the experiments citizens take on are as intentional and effective as possible. This is a strong step towards providing evidence-based tools to support using transition experiments as a way to move cities towards increased sustainability.

6. Conclusion

This study offers an empirical example of the implementation of an urban transition experiment while using a series of analytical methods that can be used to determine both the impact of the experiment, and how it can be used to catalyze a broader strategy building process. Both practitioners and researchers can benefit from the categorization of barriers, activities, and sustainability criteria. The process detailed in this study allows for the evaluation of urban transition experiments, which is

also a tool for how to implement future experiments. However, caution should be taken in assessing the effectiveness of certain actions due to confounding variables, such as the potential causes of proximal outcomes that may have existed in the neighborhood without Valley of the Sunflowers, such as in an increase in social cohesion due to other factors. Despite some uncertainty, there is the potential for cities like Phoenix to use experiments as a key tool towards developing a more sustainable and livable city. There is further potential to increase the social learning outcomes of experiments through designing the experiment with specific learning outcomes as goals of the experiment.

In order for a city to fully utilize experiments, there is a need for (a) a culture of experimentation, (b) a research agenda geared towards future-oriented experiments, and (c) a government and accompanying governance structure that supports intentional change and collective action. Cities, their research institutions, and community development organizations have the opportunity to fully utilize transition experiments as a tool for creating sustainability transition strategies and lasting social change. In order to do this, there is a need for academic research to further define transition experiments and their role in urban sustainability transitions. However, experimentation is not enough; there is a need for experiments to be nested within a broader transition processes to ensure social learning and impact. In order for cities to move towards sustainability, cities should consider how to create a citywide collective

governance and innovation that empowers schools, universities, non-profits, and businesses to experiment and innovate in the name of sustainability. The sunflowers were beautiful and inspiring, but they are only sustainable if Phoenicians use the experience to continue to experiment, innovate, and change. Transition experiments are not a single answer to achieving a sustainable city, but they deserve further attention as being a way to motivate citizens, businesses, and governments to offer solutions towards lasting sustainable change.

Chapter 5

Where Do We Start? Initiating Local Sustainability Transitions Through Urban High Schools

1. Introduction

Two critical tensions can be observed in many schools throughout the United States and around the world. The first is the tension between a discourse that emphasizes experiential learning, problem-solving, collaborative work, team building, and so on, and the reality of a traditional educational system that promotes a banking approach to the teaching-learning process that is characterized by standardized curricula, transmission of information, rote learning, memorization, testing, and individual performance. The second is the tension between schools as insular institutions largely detached from the surrounding community, and schools as hubs for community learning and action where students, teachers, and community members interact and address real-world, local problems through solution-oriented projects.

These tensions reveal different approaches to the role that education plays, and should play, in the development of educated persons, and particularly in development of informed, critical, and engaged citizens, on the one hand, and in the type and degree of interaction with the surrounding community (if any) to address issues of concern in the local area on the other hand. The interplay between these approaches takes place in a context marked by drastic cuts to the

education system and by evaluation criteria for teachers, students, and schools that reduces education to testing and provides little freedom for social interventions, innovative projects, and creative initiatives that are difficult to assess in standardized rubrics.

Moreover, the larger context is characterized by serious social, environmental, and economic global challenges that call for a transition toward sustainability (Kates & Parris, 2003; Kates et al., 2001; Rowe, 2007). As human populations become increasingly more urban, there is a growing understanding of the need to create sustainable systems and practices in urban areas (Kates & Parris, 2003; Montgomery, 2008; Satterthwaite, 1997). This requires that cities address sustainability challenges by *transitioning* from current practices and realities to a more sustainable future. The required transitions not only involve changes in policies and regulations, but also in values and practices (Bulkeley & Betsil, 2005; Grimm et al., 2008). In this paper, we argue that schools can make a contribution to urban sustainability transitions through mobilizing teachers, students and the surrounding community around local initiatives and implementing problem-project-based learning (PPBL). We call this particular approach Transformational Sustainability Education, or TSE. This approach is inspired by the literature on sustainability education. A good portion of this literature addresses the role that education could play in supporting sustainability transitions, and discusses different pedagogical strategies to expose students to sustainability challenges

(Rowe 2007; Sipos, Battisti & Grimm, 2008; Wiek, Withycombe, & Redman, 2011) or to develop sustainability solutions (Pike et al., 2003). Moreover, initiatives to develop sustainable schools programs have emerged in the United States and other countries, including the Sustainable Schools program in the United Kingdom and the EcoSchools in Ontario, Canada. These programs show that schools can incorporate sustainability into the curriculum and some daily practices (Scott, 2009). However, not much is known yet about the potential contributions of schools to sustainability transitions in urban areas. The scarce literature on the topic discusses some recent practical examples of work headed in this direction and suggests the capacity of schools to be nodes where students and local residents can be involved in long-term city planning and development (McKoy, Vincent, & Biermaum, 2011) or ecological conservation (Krasny & Tidball, 2009). At the same time, these projects rarely address the relationship between school activities, teaching-learning strategies, local projects, and an overall city transition to sustainability.

In order to contribute to this increasing body of literature, this paper explores the potential of schools to promote urban sustainability transitions. The case study is Bioscience High School in Phoenix, Arizona. Using TSE as a conceptual framework, we examined the pedagogical and social interventions implemented by this school to support students in creating transition strategies and solutions, to collaborate with the local

community, and to connect those efforts with a city sustainability transition strategy. In particular, the paper addresses two questions:

1. How did the school implement a project to connect student learning with neighborhood sustainability transitions?
2. What were the main accomplishments of the initiative and what were the main barriers to its implementation?

The paper is organized in seven sections. The next section provides a brief description of TSE. The third presents the background of this initiative and describes the context of Phoenix regarding sustainability, the main features of Bioscience High School, and the methods used in this study. The fourth section addresses Question 1 (issues related to implementation) and pays particular attention to the curriculum and the process. The fifth section addresses Question 2 (accomplishments and barriers), with special emphasis on the views of participating teachers. The sixth sections offers recommendations for future research and practice, and final section presents the main conclusions of the study.

2. Transformational Sustainability Education (TSE)

In the last few decades, many schools and universities have developed a variety of sustainability education programs. These programs tend to combine knowledge development in sustainability issues and skill development through examining key sustainability challenges. By and large, these programs are still informed by an environmental science approach that rests on spending more time focusing on analyzing

problems than on developing solutions (Frisk & Larson, 2011). To address this limitation, there is an emerging paradigm to sustainability education that combines problem analysis, visioning, and solution development and implementation. Precursors of this alternative approach could be found in the Sustainable Schools Project by Shelburne Farms in Vermont, The Sustainable Schools Framework in the United Kingdom, and programming and training developed by Facing the Future throughout the United States (Rowe, 2007; Scott, 2009).

The TSE approach uses solution-oriented, PPBL to solve real-world challenges (Brundiers, Wiek, & Redman, 2010). Transformational sustainability education focuses on creating (a) strategic interventions that incorporate (b) an analysis based on systems thinking regarding the current state, and (c) the creation of community-based (stakeholder-driven) visions of the future. Wiek et al. (2011) identified five dimensions that need to be addressed in order for students to implement sustainable change: systems thinking, anticipatory (future-thinking), normative (values thinking), interpersonal (teamwork and stakeholder engagement), and strategic thinking (implementation-oriented). These competencies set a theoretical framework toward producing PPBL that is focused on student outcomes and real-world change through targeted projects. At will be discussed later in this paper, at Bioscience High School, this framework was translated into a Seven Step Transformative Sustainability Learning process that was implemented in three neighborhood transition arenas.

3. Context: Phoenix and Bioscience High School

3.1 Phoenix, Arizona. The sixth largest city in the United States has been given the dubious prize of least sustainable city in world due to factors like air quality, being an urban heat island, water contamination, and social isolation (Ross, 2011). While this is a harsh assessment, in his book, suggestively titled *Bird on Fire*, Ross also points to the existence of groups in Phoenix that have the potential to generate solutions to those sustainability challenges. For instance, Ross highlighted the work of the arts-based community development projects carried out by the Roosevelt Row Community Development Corporation. Ross acknowledged the sustainability planning of the city, but emphasized the importance of small-scale neighborhood transitions. Not coincidentally, Roosevelt Row was one of the main partners of Bioscience High School to address the challenge of urban vibrancy. Moreover, Bioscience High School decided to contribute to solving sustainability challenges by focusing on small-scale neighborhood transitions and local solutions that are connected to educational initiatives and to city sustainability transition strategies.

Indeed, a critical component of Phoenix's shift towards sustainability was the adoption of a General Plan Update approved by the City Council in 2010. After 30 years of little community engagement in city planning, the City of Phoenix Planning Department developed, in collaboration with a team from Arizona State University's School of Sustainability (including the first author of this paper) a community

engagement process to design a sustainability transition strategy. This process used the frameworks provided by the Dutch intentional change paradigm of transition management (Loorbach, 2007) and the transformational sustainability research model to develop collective visions and strategies created by Wiek, Selin, and Johnson (2010).

The transition strategy created through this process to address urban sustainability challenges was actually a bundle of strategies related to four main areas: transportation and mobility, governance, local business, and urban vibrancy. These transition strategies, while not necessarily supported with corresponding policies, did provide the citywide framework for sustainability transitions that were used by Bioscience High School to create neighborhood-scale transitions. Through their collaborative partnership, Bioscience High School and Roosevelt Row (both located in the same downtown neighborhood) decided to focus their efforts on urban vibrancy. This partnership provided an example of how a small urban high school can contribute local solutions to a citywide sustainability transition.

3.2. Bioscience High School: from problem-based learning to transformative sustainability. At the turn of the 21st century, the Phoenix downtown area was in need of revitalization and an identity. There was little density that often characterizes urban cores, to the extent that some people referred to it as a ghost town. In this context, Arizona leaders, in collaboration with a statewide foundation, launched a vision for

making Phoenix a global bioscience research and commercial center in 2000. Revitalization efforts for the city included the establishment of a biomedical campus in the heart of the downtown area that would include a hospital, research labs, specialized medical centers, and biomedical businesses. Phoenix Union High School District leadership joined the initiative by creating a high school in the downtown area that specialized in science, technology, engineering, and math (STEM) that opened its doors in 2006.

Over time, Bioscience High School has become a highly regarded educational institution in Central Phoenix. The school has over 300 students from diverse socioeconomic backgrounds, but predominately serves a low-income, largely Hispanic population (70%) with 66% of students receiving free and reduced lunch.

The 18 teachers at the school mostly came from other high schools in the district with the mandate of dedicating themselves to PPBL and STEM-focused education. When new teachers join the school, they must agree to work in a highly collaborative and self-reflective environment that focuses on student learning and inquiry.

The curriculum at Bioscience High School is structured to allow students in their junior and senior years to select career pathways that include anatomy and physiology, epidemiology, biotechnology, engineering, and forensics. This pathway is designed to culminate in a senior year internship in their desired field. While the entire curriculum

supports PPBL, Bioscience High School had a specific time allocation (a two-hour block on Wednesday) dedicated to interdisciplinary projects. This feature provided the necessary space to make the transformational sustainability learning initiative possible. In the past, Bioscience High School staff and students intentionally worked through PPBL Wednesdays to connect classroom learning to real-world issues. A central component of these efforts were yearlong research projects.

Originally, these yearlong projects were called transdisciplinary projects. In their initial implementation between 2006 and 2009, transdisciplinary projects ranged from traditional science experiments and research projects to internships and entrepreneurial activities by individual students or by small groups. The curriculum was intentionally designed to leave the guidelines and instructions for these projects open. Instructionally, there was a desire for students to get support for these projects in their courses, but for the most part, it was the regular two-hour period every Wednesday that served as the primary time for students to pursue this work.

After three years of transdisciplinary projects, this PPBL opportunity was reconceived as the Connections Endeavors Projects. Connection Endeavors were to be yearlong projects that would specifically address content and skills in at least two courses, and explicitly demonstrate such connections. There was also a mandated community service component in which students were required to volunteer for eight hours per semester

for an organization that related to their project. While this was an exciting foray into creating a PPBL opportunity that connected disciplines and linked student work to service learning opportunities, in practice many Connection Endeavors lacked critical thinking about the issues that the projects addressed. Moreover, there was a tenuous connection between the projects and the service-learning component, and they still lacked the interdisciplinarity that administrators and teachers desired. Teachers were frustrated with the dispersion of topics and with the amount of projects that they had to supervise. One teacher summarized these frustrations with the following words:

> We were impressed with some of our students' efforts and disappointed with others. We were frustrated along the way with the lack of attention and intention with various projects. We were confused as to how to support so many projects. We were exhausted with the sheer amount of energy spent on the journey of managing 160 projects that covered such a wide array of fields and communities.

This frustration generated the impulse to create a new approach to Connection Endeavors that was predicated on (a) reducing the number of projects in order to focus on a few critical and feasible interventions, (b) strengthening the link between the projects and the service learning component, and (c) structuring the relationships between student projects and community organizations through strategic partnerships. This new

approach, implemented in 2011 and 2012, emphasized the application of transformational sustainability principles to nurture transitions to urban vibrancy.

4. Research Design

In order to address the two questions stated in the introduction of this paper, we developed a two-phase approach. In the first phase, teachers (including the second author) and administrators with a sustainability scientist (the first author) cocreated the process during the summer while developing a rollout program to introduce the new Connection Endeavor approach to teachers. The second phase of the research consisted of observations and interviews with the participating faculty. The observations included meeting attendance, classroom observations, observations of student work in local neighborhoods, and observation of the final presentations in April 2012. The observations followed a detailed form that helped to gather data around the structure and the process of the Connection Endeavor initiative. The interviews followed a semistructured guide and included 12 teachers who participated in Connection Endeavor and agreed to be interviewed (out of a total of 16 teachers who were part of the initiative). To ensure anonymity and confidentiality of data, teachers are referred to as Respondents 1 through 12.

5. Results

5.1. Implementation strategies. Question 1 asked: How did the school implement a project to connect student learning with neighborhood sustainability transitions? As noted previously, a group of teachers and administrators decided there was an opportunity to make some changes as a result of the frustrations emerging from the original approach to Connection Endeavors. They attempted to make the projects a more central component of the school with even clearer guidelines and support for how to create an impactful community-based project. For this purpose, a core team of teachers at Bioscience High School decided to partner with graduate students at Arizona State University's School of Sustainability to create a school wide research framework to guide the implementation of Connection Endeavors for the 2011-2012 school year.

In order to create a common approach for Connection Endeavors, the core team of teachers decided to adopt an organizational structure to facilitate the implementation of student projects based on transition arenas (Loorbach, 2007) and the seven-step transformational sustainability research process based on Wiek et al. (2011). Both the transition arenas concept and the seven steps were introduced to faculty during summer professional development through reading and activities with the community partners as detailed in the guiding document created by the core team (Boyd, Palacios, & Kay, 2011).

***5.1.1. Transition arenas*.** Based on themes and interests from the 160 student projects, the core team articulated some strategic areas (arenas) for students to develop coordinated sustainability interventions (Loorbach, 2007). Instead of students attempting to generate something from nothing, Bioscience High School teachers determined that students could generate something from working with innovative community partners. The arenas were created to set goals and objectives in order to coordination the selected solutions.

Teachers clustered Connection Endeavor projects into strategically identified transition arenas in order to provide a manageable scope and focus for teachers and students. Bioscience High School arranged the arenas through connections to local organizations and service-learning opportunities in order to explore real-world challenges and develop implementable solutions. The focal point of our analysis will be the urban vibrancy arena. The urban vibrancy arena was formed in partnership with the Roosevelt Row Merchant's Association and Roosevelt Row CDC leadership to develop solutions to further create a livable, walkable, and vibrant downtown with a strong local economy. One major rationale for this arena was to establish closer partnerships and a stronger presence in the revitalization (transition) efforts of downtown Phoenix. The transition arenas, which allow students and community partners to share problem understandings, create sustainability visions, and coselect solution options, were a critical mechanism for enabling the connection between

student learning and the local neighborhood transitions in which community partners wanted to participate.

5.1.2. Transformative sustainability education process. Within each arena, students used a seven-step transformative sustainability learning process to go from problem understanding and visioning to implementation and evaluation. The seven steps embody a learning process specifically directed towards developing local neighborhood sustainability transitions through student projects. What follows is a brief summary of the main features of each step.

Challenge (sustainability problem) selection. In this step, students divided themselves into the three arenas in order to determine challenges they would address. In order to learn about the challenges firsthand from community partners, all students went on case encounter excursions (Scholz & Tietje, 2002), and learned about specific challenges in each arena. For example, students were exposed to the difficulties in sustaining small businesses in the urban vibrancy arena. Students then selected a small group of challenges within the arena that they wished to address, such as vacant lots, mobility, and teen loitering.

Problem analysis. After students officially joined an arena and chose a specific problem to address, students analyzed each problem through systems thinking to determine the main actions causing the challenge as well as the drivers and impacts of those actions. The students had an in-depth understanding of the sustainability problem, which ensured that all

student projects address specific elements of the problem (Wiek, Ness, Brand, Schweizer-Ries, & Farioli, 2012).

Visioning. To allow students to help community partners and local residents express their future vision for what things look like when their specific problem is solved, students had the opportunity to filter the vision elements through sustainability principles. Through the sustainability principles students learned, for instance, the local food and health practices that sustainability works toward are not just convenient, but take the work of future generations and the planet's resources into account. A robust visioning process will ensure student projects are designed to meet local needs, desires, and sustainability principals (Wiek & Iwaniec, 2012). All projects (interventions) were based on problem analysis and visions that were developed in each arena. For example, the urban vibrancy arena selected three challenges to develop projects including teen loitering, a lack of walkability, and vacant lots. Each of these challenges was analyzed and visions were developed to express a future where the problem was solved. For example, the vacant lot vision was:

> Our vision for the vacant lots around Roosevelt Row will be a place where you'll find a thriving cultural epicenter which includes a large variety of foods, independent bands, small business boutiques and an opportunity to connect with developing local artists, while still being a place where all ages can hang out in a comfortable shaded

area, converse and be a part of a growing urban community. (Final Student Presentation, June 2012)

These visions were used to along with the problem analysis to create comprehensive strategies and to select and implement specific interventions.

Strategy building. The objective of this step was for students to examine the difference between the state of the current problem and the student- and community-generated sustainability vision (goals). Students were then asked to research possible interventions (solutions) that could be used to achieve a desired future (vision). While the strategy building phase can take on a more detailed format (Kay, Wiek, & Loorbach, 2013) that identifies assets, barriers, tools, costs, and capacities to carry out the strategy, the students were not asked to attain that level of detail in this iteration.

Selection of interventions and intervention planning. This step had students select interventions (projects) that would help the transition arena reach its vision while solving a stated community problem using their problem analysis as carried out in YPAR and intervention research (Fraser, Richman, Galinsky, & Day, 2009; Schensul & Berg, 2004). Project selection attempted to balance student interest with community needs and focused on conditions for moving forward on specific projects such as impact, feasibility, and a strong problem analysis.

Implementation. The implementation step allowed students to carry out their selected intervention. Students were encouraged to use teamwork and project management tools to carry out their projects. A variety of projects suggested promise for the TSL model and its ability to guide students to produce community-based sustainability solutions.

Analysis, reflection, and adjustment. This final step allowed students to analyze and reflect on their interventions in order to make a presentation. The presentations were made in March to allow two months to make further adjustments to their intervention. This step fostered reflexivity and improvement, which are essential to transformative sustainability (Loorbach, 2007; Wiek et al., 2012).

5.2. Accomplishments and barriers. The second question guiding this paper related to accomplishments and barriers to implementation. The first subsection addresses achievements in five areas: process, project, student, teacher, and community. The second subsection features barriers to implementation and is organized in two parts: cultural/behavioral barriers, and structural/organizational barriers.

5.2.1. Accomplishments. There were several accomplishments of the work in terms of process achievements, project achievements and student outcomes.

*Process achievements***.** These three interventions demonstrate the potential for the transition arenas and TSL process to develop sustainability transition strategies that bundle sustainability-oriented

intervention to reach a collective community-based vision. The urban vibrancy transition arena was able to produce a bundle of projects in line with the city's urban core strategy. While more work can be done to improve the strategy building process and the effectiveness of the projects, this first attempt demonstrates the potential of using transition arenas and a solution development process to create neighborhood-level projects that represent the goals of a citywide transition strategy with a high school as a hub. One teacher commented that, "The connections now exist between students and community partners, and students approach challenges they face by thinking critically and developing effective strategies based on visioning and research" (Respondent 7). Achievements towards the goal of using a school to connect student learning towards local transitions was seen in the projects themselves, in students and teachers, and in the reaction of the community partners.

Project achievements. In this section, we present three examples of solutions developed with the implementation of the TSL process in the urban vibrancy arena. This selection of student interventions shows how a school can create a coordinated set of student projects in order to address a local sustainability challenge.

Trashketball. Students work with Roosevelt Row CDC to develop a trash collecting solution through the development of a game that residents and visitors can play while contributing to the beautification of the neighborhood. The solution, which is based off a similar innovation in

Sweden, addresses trash issues at local events such as artwalks and moves the neighborhood towards its vision of being safe and walkable.

Chicanery. Students developed a teenager-operated website for Phoenix teenagers to make young people (including the predominant Latino and Chicano populations) aware of local arts and culture events in downtown Phoenix (see http://chicanery.me). The founders referred to their intervention as a smagablog—a hybrid of social network, magazine, and blog intended to increase teen participation in downtown events (Final Presentation, March 2012). The intervention addresses the challenge of youths not having age-appropriate activities and contributes to the intergenerational and diversity goals of Roosevelt Row.

Urban Bike Nation. Students worked with local bike shops and Roosevelt to create a bike rental system for artwalk events in the Roosevelt Row District. Their endearing YouTube video (http://www.youtube.com/ watch?v=BihKCz2XPyQ) demonstrates how they brought together a group of students and community stakeholders to build their first bike in an attempt to address local connectivity issues and add to transportation options during major downtown events.

Student achievements. One teacher stated that "the Connection Endeavor learning experiences proved to be models for the students for how to problem solve, to see how they can impact the community and world around them" (Respondent 10). Whereas student outcomes were not the focus of this research, there are indications that students were

able to use the 7-steps and the transition arenas as positive learning opportunities to improve research and problem-solving skills, and that this allowed students to “be more responsible for their own learning” (Respondent 8). Learning opportunities varied greatly depending both on teacher support and student motivation. Opportunities for skill development existed both in intervention design and implementation, but these opportunities depended on the maturity and coherence of the project. Students that were successful seemed to have strong ties with teachers, community members, and an investment in the vision of their arena. For example, the students who create Chicanery, Urban Bike Nation and Trashketball were invested in working with community partners in creating a safe, clean, and vibrant environment in downtown Phoenix. The student who ran the Urban Bike Nation project said developing a collective vision for urban vibrancy with the transition arena of the Roosevelt Row Merchants Association was a “great collaborative setting to help conceptualize my idea” (Respondent 14). The student noted that the 7-step process taught them to use stakeholder perspective in the development of solutions, and made doing community problem solving less “foreign” (Respondent 14). The experience of this student demonstrates how the transformative sustainability learning process supported students in developing ‘real world’ solutions with local neighborhoods and provided opportunities that supported their learning.

Teaching accomplishments. The teachers in the urban vibrancy arena were actively involved in supporting students in community work, mentored students through stakeholder interactions, and served as support during events. Some teachers did have success using problem analysis and visioning tools that were provided. One teacher said, ”I find that I am using 7-steps concepts, including the problem constellation, to address not only student learning, but also in staff development,” (Respondent 6) which demonstrates its usefulness of the tools to teacher’s professional growth. Some teachers viewed the case encounter introduction to the arenas and the summer reading about the seven steps as use tools in preparing students to create solutions. One teacher remarked, “kicking the year off with a focus on case encounters and getting the entire BHS community out into the neighborhood for multiple eye-level explorations of it added a dimension of engagement we hadn’t seen before” in that it forced teachers into the community and changed the orientation of teachers in order to support neighborhood transition through student projects (Respondent 10). While, the transformation of teachers into facilitators of community-oriented transitions did not happen overnight, but as the co-teacher of the urban vibrancy arena said, “we are taking the first steps to walk the walk, not just talk the talk, when before we were talking about walking, and now we are stepping” (Respondent 8).

Community outcomes. Observations at Roosevelt Row CDC events and at the public market showed engaged students working with community

partners. Community partners were excited to see students involved and said they benefited from student projects and involvement. More research is needed to fully understand the impact of Bioscience High School projects on the community partners, but initial reactions to the transition arena model and Bioscience High School increased involvement with local partners was met with excitement and warmth. Students have continued participating in Roosevelt Row CDC events and are continuing to work with the organization to address urban vibrancy in the district. As one teacher commented, “Roosevelt Row (the community partners), knows that Bioscience wants to help make change happen” (Respondent 10).

5.2.2. Barriers. Two main barriers to the implementation of the TSE process at Bioscience High School were identified: structural barriers, associated with the organization of the school and its curriculum such as district requirements or existence of grade levels, and cultural barriers, which consist of the practices and behaviors of teachers and students (Burch, 2010).

Structural barriers in this case are barriers associated with the organization of the school and its curriculum, such as district requirements or existence of grade levels, while cultural barriers consist of the practices and behaviors of teachers and students.

Cultural/behavioral barriers. Interviews revealed a variety of challenges associated with the implementation of the new Connections Endeavors process that related to not feeling comfortable making the behavioral

changes necessary to adapt to the new system. A number of teachers cited difficulties with student acceptance and teachers suggested that "students don't buy into the approach" (Respondent 10) and that "you can't teach buy-in" (Respondent 12). There were also several comments concerning the initial weeks of teaching in which teachers felt that case encounters, problem analysis, and visioning were too teacher-driven with one teacher citing an "imbalance of teachers giving input and implementation" (Respondent 9). While student buy-in and a reliance on teachers are concerns, observations suggest that inconsistent teacher buy-in and implementation may have been a driver of the difficulties with students and early stage implementation cited in the interviews.

Teachers who discussed difficulties with teacher investment in the new structures, saying the process felt "all-new" (Respondent 12), supported this possibility. One teacher admitted to lack of experience with "project-based learning and community work" (Respondent 12), which suggests a shortcoming in the support and professional development of some teachers. There was also concern that given previous freedom to chose projects that some students "may get lost under the radar" (Respondent 1) or are accustomed to projects that "fit into the previous structure" (Respondent 2). There was clearly some preference for the status quo approach that allowed for more student freedom and less teacher oversight. Many students seemed to lose interest in their projects, potentially because the initial stages of the transformative sustainability

learning (TSL) process had been drawn out and differed from the select-a-project-and-make-it-happen model that older students had experienced. This evidence suggests that more needs to be done to overcome behavioral barriers among students and teachers in order to create a culture that supports the problem analysis, visioning, and community connections needed in order to create support student learning that is connected to local neighborhood transitions.

Structural/organizational barriers. The structure of the transition arenas and the seven-step process, the lack of accountability, and the management of the Connection Endeavor program were all significant barriers to teacher's perceptions that the attempt to connect student learning to small-scale community transitions was successful.

A structural barrier was identified in concerns about the new transition arena structure because it differed sharply with the previous student-driven project selection process. Teachers discussed difficulty with the arena structure saying that they were "alienating" (Respondent 11) and that the arena names "might be too specific" (Respondent 2). While the arena structure was implemented to reduce teacher's management of wide-ranging projects and to increase community connections, not all students and teachers accepted the new design of Connections Endeavors.

There were also comments that the TSL approach was not science-driven, and therefore frustrating to some students and teachers. Another

teacher cited the overly “academic nature of TSL” as a reason that it was not fully accepted at the school (Respondent 10). While the seven steps were meant to increase the evidence behind where students were selecting projects, their system of the seven steps was not seen as science by some and too academic by others. There appears to be a combination of a structural barrier in terms of how the arenas and seven steps were designed and cultural barriers that made it difficult for students and teachers to adapt to a new process.

There were also concerns raised that the management of the process was a barrier of implementation. When asked to identify challenges for students and teachers to support successful TSL projects, teachers also identified a “lack of time” (Respondents 1, 3, 10, 11, and 12), “lack of communication and coordination” (Respondents 3, 4, 5, and 12), and “faculty leadership” (Respondents 1, 2, and 12). Having time to fully support PPBL had been an issue with previous iterations of Connection Endeavors, and it continued to be a challenge in this version, especially due to increased expectations for communicating with community partners. There are structural barriers in terms of district and state guidelines for instructional time that would have to be addressed, and the teachers would need to find a more organized approach to allowing for time in class outside of Wednesdays for students to work on projects. Many teachers expressed concern about issues related to faculty

leadership and coordination, and some of them noted that sometimes the core team made decisions without broader input.

The administration has since worked to involve all teachers making decisions around Connection Endeavors in order to overcome the sense that the leadership was top-down and that the rationale behind curricular decisions such as the transition arenas and seven steps were effectively communicated.

Another significant structural barrier was exposed in comments made about the "lack of accountability" for both students and teachers (Respondents 1 and 11). There were check-ins between students and teachers at each phase, but the nature of these depended on the teacher leading each transition arena. Additionally, rubrics were not developed, so teachers did not have consensus of what the process should look like at each stage in order to guide students on whether their work was appropriate. Without clear rubrics and student accountability to meet agreed upon standards for the work, it was difficult for teachers to feel that the new TSL was as successful as it could be. Because there was not administrative leadership for regarding what the impact of these projects should have been, teachers and students were not held accountable to create work of consistent quality that was useful to community partners. One teacher mentioned there was not evaluation for how teachers were implementing the seven steps, which made it less likely that they or other teachers would be invested in effectively teaching the process or fully

supporting Connection Endeavor projects with the same motivation as they deliver instruction in the disciplinary courses at the school. The behavioral and structural barriers identified exposes the difficulties in implementing a new learning approach at the school. The requirements of working with community partners, with a specific solution development approach, were difficult for both students and teachers to accept and implement in terms of what is necessary to adapt student learning to neighborhood transitions.

6. Recommendations

6.1. Recommendations for research. In terms of a future research agenda, this study SUGGESTS at least three research areas that would improve the capacity of high schools to participate in urban sustainability transitions:

- Educational research (Evidence basis for PPBL, and quality evaluation methods).
- Sustainability science methodology (improvements in the research that supports TSL such as problem analysis, sustainability visioning, and sustainability intervention research).
- Organizational dynamics (to better understand how a city and schools can coordinate citywide transition with local transition arenas and projects.

6.2. Recommendations for practice. In terms of practice, we recommend experimentation with similar formats to determine the

potential that PPBL schools and school-based community sustainability interventions can have for contributing to the sustainability of a city. For this to happen, it is necessary to overcome the challenges of status quo pedagogy and school structure by opening up and examining teaching and learning practices to determine if our schools and curriculum are producing both improved student outcomes and if student work is producing an impact in real communities. The following are some possible practices that schools could consider when implementing Transformative Sustainability Education:

1. A faculty-wide and grade-level commitment to determining the desired outcomes of the learning experience with expectations for:
    a. Impact on community partner or target population
    b. Quality of overall strategy and the strength of the combined impact of student projects towards the vision created with the community partners.
    c. Quality of individual projects and the students ability to implement work with measurable impact
2. A commitment of the school administration to create and implement teacher and student assessments that are geared towards TSE and its accompanying competencies in order to hold the school community accountable to creating impactful projects, while developing student and teacher skillsets.

3. Demonstration of skill development (i.e., critical thinking, collaboration, creativity, cultural competence) or sustainability competency development (systems thinking, future thinking, values thinking, and interpersonal strategic competencies)
4. A community (stakeholder) engagement protocol and evaluation system that potentially include protocols for:
    a. Determining relationships with partners
    b. Site visits or case encounters
    c. Intervention and project selection with stakeholder input
    d. Volunteer opportunities and requirements
    e. Evaluation of student work
5. Implementation of the Seven-Step TSL process— or a similar research (teaching and learning) framework that supports solution (intervention) creation and experimentation. This includes further developed methods and tools for each of the seven steps as BHS teachers recommended.

If high schools are going to play a part in developing sustainability solutions, then there is a need to create a network of teachers and schools to develop these organizational structures and processes. There is already some evidence that the work at BHS has started to spread to other schools in the region, and BHS may be the basis for a new school within its district. It is critical to use the lessons learned from this example

and build a greater body of knowledge and practice around the TSL process and sustainability competencies.

7. Concluding Remarks

This paper analyzed the experience of a high school that developed a pedagogical project to address “real world” sustainability problems and solution-oriented projects. The school is located in Phoenix, AZ, a place that has been labeled the ‘least sustainable city in the world’. This project used a problem-project-based learning approach that generated cooperation with the surrounding community and aligned these efforts with a larger sustainability transition strategy. In this sense, there are two simultaneous transition strategies underway. The first one is the transition of the school from a self-contained institution to one that makes supports community-based innovations, and connects these efforts with student learning. The second one is the transition of the surrounding neighborhood and the city at large from the unsustainable conditions discussed in *Bird on Fire* (Ross, 2011) to a more sustainable and livable environment. The project suggests that it is possible for schools to initialize sustainable development transitions that are integrated with the curriculum. Conversely, it also suggests that the sustainability challenges present in cities can provide engaging learning opportunities for students.

The study builds on the contributions of three distinct but related fields: sustainability education, transformational sustainability research, and problem/project based learning. This article provides a rich empirical

example of the combination of these three approaches in a local initiative. The paper described in detail the implementation strategies, the main achievements, and the main barriers identified by teachers. Schools and local organizations are not a one-stop solution for creating local urban change, but with thoughtful organized attempts, we can continue to move toward creating systemic and strategic change in cities. Innovative teachers, administrators, students and community members have the opportunity to play a critical role in understanding and implementing intentional change toward sustainability in our cities, but this requires developing innovative educational approaches and overcoming significant barriers.

Chapter 6

Conclusion

This dissertation makes a contribution to the fields of transition governance and sustainability science through specifying and elaborating the concept of intentional change for sustainability. The contribution is based on literature review and theoretical conceptualization, but also through three empirical studies on how to build and test transition strategies across multiple urban levels (city, neighborhood, and organization). To address the central research question (How can a city build and implement a comprehensive transition strategy across different urban scales, from the city to the organizational level), the dissertation details efforts in Phoenix, Arizona, to adopt transition governance at the city, neighborhood, and organizational level.

Chapter 2 sets the stage by using six intentional change paradigms to form a converging concept of intentional change. This suggests the need for a city to have an evidence-based concept of intentional change, including inputs (problem description, sustainability visions, and theory of change) and details strategy components (including a sequence of phases, change actions, organizational structure, etc.). Chapter 2 uses the existing bodies of knowledge to support the practice of intentional change for sustainability. Having more detailed or accurate knowledge about sustainability challenges will not suffice to solve them. For cities to tackle the sustainability challenges they face, concerted efforts need to be based

on a sound practice of building and implementing intentional change strategy.

Chapter 3 builds on chapter 2 by detailing the components of transition strategies and illustrating key components through the empirical example of the City of Phoenix General Plan Update of 2010 developed by Arizona State University and the City of Phoenix. The research yielded four topical transition strategies for transportation and mobility, small and regional business, anticipatory governance, and vibrant urban development. This research suggests the possibility for a city government to articulate a series of transition strategies to guide businesses, non-profits, and citizens towards increased sustainability. The fact that these strategies were built with non-profit and business experts, and based on citizen-generated sustainability visions, suggests the capacity of a city government and a research institution to co-create transition strategies. The conceptual contribution of this work is to provide a clear set of components for transition strategies in a way that is not currently articulated in the literature. These components include: sequence of phases, transition actions, organizational structure, required capacities, required resources, assets, and barriers.

To summarize, chapters 2 and 3 of the dissertation answer the research question by outlining how a city can develop an evidence-based concept of intentional change with an accompanying bundle of topical transition strategies, co-created through a collaboration between

researchers, government, non-profits, businesses, and citizens. Chapters 4 and 5 demonstrate two potential ways to bring city-wide transition strategies to a smaller scale.

Chapter 4 provides a detailed concept of transition experiments and how they can be used as local complement to city-wide transition strategies. The empirical example of the Valley of the Sunflowers depicts the use of a transition experiment to address the neighborhood challenges of weak local businesses, lack of educational opportunities, the use of nonrenewable energy sources, and social isolation among residents. The use of process tracing to determine critical activities, barriers, outputs, and outcomes of the experiment allows the study to articulate the important building blocks of a transition experiment. The sustainability appraisal of the outcomes demonstrates how a transition experiment can be linked to the sustainability goals of the neighborhood or the city in which it is located. The chapter builds on existing literature on transition experiments and links experiments to broader urban transition strategies.

Chapter 5 uses research conducted at Bioscience High School in Phoenix, Arizona, in its attempt to attach student learning to neighborhood transitions in close proximity to the school. The research examines the school's attempt to create transition arenas and accompanying transition strategies with students and community partners around local sustainability challenges such as lack of urban vibrancy (which consists of low walkability, teen loitering, and an abundance of vacant land). This

empirical example highlights both the barriers of implementing this approach in a school setting (including teacher and student motivation); and the accomplishments of the work, which included a well-articulated urban vibrancy arena where students developed with local stakeholders a sustainability vision and corresponding student interventions (projects) to address the local sustainability challenges. This study contributes to the literature by providing transition arenas and a transformative sustainability learning process as the organizational structure for supporting a school in which student learning supports local, neighborhood-scale transitions. This example illustrates how a single organization—in this case a school—can take the citywide objectives (in this case articulated by the urban vibrancy transition strategy developed by the city), and put them into action through student projects like bike share, trash cleanup, and social media interventions.

This dissertation builds on existing transition governance research while providing rich empirical examples that were co-created with the author. More significantly, though, this type of research is an example of an emerging solution-oriented and engaged research approach in sustainability science that offers innovative links between research and practice. This coordinated effort to relate city planning strategy building to neighborhood experiments and student projects at a local school was possible through an engaged research approach that guided the author in co-creating research results and practical solutions with stakeholders at

each level. This also allows for social learning with each organization (city government, community development, and school) and encouraged each organization's leadership and project participants to acquire strategic, operational, and tactical skills as well as sustainability competencies, including anticipation, systems thinking, and interpersonal skills. More research could be done to assess the social learning that this work produces. This research is a first step in showing how social learning can result from transition activities at multiple levels in a city.

This dissertation provides empirical examples of how transition governance can be coordinated through multiple levels in a city. Research was conducted over three years and could be improved upon; therefore, the work opens the door for future researchers and practitioners to develop and implement urban transition strategies at multiple scales over longer period of time.

The research also has its limitations that include only partially addressing the importance of context, confounding factors, and the role of conflict and power within transition research. In terms of context, it is important not to assume that all lessons learned within this research are easily transferable. Each of the three case studies exists in a specific context, including a specialized high school and a dynamic, art-oriented urban neighborhood within a city with a particular governance structure and history. There is also the potential that other embedded (confounding) factors, and not the strategy building and experiment design, drove the

results that were examined and appraised in this dissertation. For example, it is possible that the sustainability contributions attributed to the Valley of the Sunflowers project resulted from other activities of Roosevelt Row or even from other organizations. Lastly, this research does not adequately address the issues of power and conflict that emerge in transitions. There are vested interests that could use some of the same experiments and transition actions for purposes and outcomes that differ from the ones highlighted in this research. For example, it is possible that the Valley of the Sunflowers project was used by the city to appease residents in the short-term, while long-term development plans prevail that could destroy the local, small-scale economy and social cohesion of Roosevelt Row. While this research was more interested in examining the potential for collective action and strategy building, there is clearly a need within transition governance and research to fully acknowledge and analyze issues of power and vested interests within urban transitions.

The strength of this dissertation is not just in the contributions it makes in aiding the organization of urban transition governance as a field, but also in the suggestion of the opportunities that cities, research institutions, non-profits (including community development corporations), businesses, schools, and citizens have to motivate and support urban sustainability transitions. For example, the City of Phoenix has the opportunity to further develop the transition strategies conceived in the 2010 General Plan update into comprehensive strategies that can be

adopted by the city council and used by the city manager to operate the city. There are clearly barriers to making this happen, but this work articulates the potential impact a well-articulated strategy could have at a smaller scale. For example, Roosevelt Row Community Development Corporation could benefit from a comprehensive citywide bundle of transition strategies by being able to coordinate its owns strategies and interventions with the City of Phoenix's plans. This would help attract further funding, and would help guide its programming to target specific challenges and reach goals that it could share with the city, including the creation of thriving small businesses and a livable, walkable district in Central Phoenix. Bioscience High School could also benefit from a citywide strategy in order to put further weight behind its first attempt to use student learning to guide and motivate neighborhood transitions. The school could also continue this work without a city strategy in the hopes that the city eventually realizes that it could make a major impact by articulating a citywide vision and accompanying strategies. Arizona State University and the School of Sustainability can use this research as a starting point to build a coordinated research agenda around creating and sustaining urban sustainability transitions in Phoenix. More support could be given for researchers to use transition governance and transformational sustainability research paradigms to develop participatory research that guides cities, neighborhoods, and organizations in creating transition strategies and experiments.

There is the potential for any city, not just Phoenix, to use transition strategies to address the sustainability challenges that urban areas need to overcome. Initiating transitions is critical, but sustaining strategies and excitement is the hard work of the 21st century. Cities have the institutions and resources necessary to tackle many sustainability challenges, but the question is whether they are able to organize and coordinate their institutions and citizens towards the common purpose of sustainability. Hopefully, this work represents the nascent stages of the research and practices necessary to support cities in developing the capacity and methods necessary to strategically address the challenges that they face now and in the future.

REFERENCES

Chapter 1

Beall, J., & Fox, S. (2006). Urban poverty and development in the 21st century. Oxfam GB Research Report. Retrieved from http://eprints.lse.ac.uk/2903/1/urban_poverty_and_development_in_the_21st_century.pdf

Broadway, M. (2009). Growing urban agriculture in North American cities: The example of Milwaukee. *Focus on Geography*, *52*(3-4), 23-30.

Brown, R. (2008). Local institutional development and organizational change for advancing sustainable urban water futures. *Environmental Management*, *41*(1), 221-233.

Bulkeley, H., & Betsil, M. M. (2005). Rethinking sustainable cities: Multilevel governance and the 'urban' politics of climate change. *Environmental Politics*, *14*(1), 42-63.

Carter, M. (2011). On the record with Majora Carter, founder of Sustainable South Bronx, a nonprofit, and the Majora Carter Group, an economic consulting firm. *Sustainability: The Journal of Record, 4*(6), 274-276.

Conroy, M. M., & Beatley, T. (2007). Getting it done: An exploration of US sustainability efforts in practice. *Practice, 22*(1), 25-40.

Hayes, J. (2007). *The theory and practice of change management*. New York, NY: Palgrave Macmillan.

Hodson, M., & Marvin, S. (2010). Can cities shape socio-technical transitions and how would we know if they were? *Research Policy*, *39*(4), 477-485.

Korosec, R. L., & Berman, E. M. (2006). Municipal support for social entrepreneurship. *Public Administration Review*, *66*(3), 448-462.

Lang, D. J., Wiek, A., Bergmann, W., Stauffacher, M., Martens, P., Moll, P., . . . Thomas, C. J. (2012). Transdisciplinary research in sustainability science: Practice, principles, and challenges. *Sustainability Science, 7*, 25-43.

Loorbach, D. (2007). *Transition management: New mode of governance for sustainable development*. Utrecht: International Books.

Montgomery, M. (2009). Urban transformation of the developing world. *Science, 319*(5864), 761-764.

Rotmans, J., & Loorbach, D. (2009). Complexity and transition management. *Journal of Industrial Ecology, 13*(2), 184-196.

Satterthwaite, D. (1997). Urban poverty: Reconsidering its scale and nature. *IDS Bulletin*, *28*, 9-23.

Shove, E., & Walker, G. P. (2007). Transition management and the politics of shape shifting. *Environment and Planning A, 40*, 1012-1014.

van den Berg, L., & Braun, E. (1999). Urban competitiveness, marketing and the need for organizing capacity. *Urban Studies, 36*(5-6), 987-999.

van den Bosch, S. (2010). *Transition experiments: Exploring societal changes towards sustainability*. Rotterdam: Erasmus University.

Wiek, A. (2009). Transformational sustainability science: Integrating foresight, backcasting, and intervention research. Working Paper. School of Sustainability, Arizona State University.

Wiek, A., Binder, C. R., & Scholz, R. W. (2006). Functions of scenarios in transition processes. *Futures, 38,* 740–766.

Wiek, A., Ness, B., Brand, F. S., Schweizer-Ries, P., & Farioli, F. (2012). From complex systems analysis to transformational change: A comparative appraisal of sustainability science projects. *Sustainability Science, 7*(1)*,* 5-24.

Chapter 2

Auerbach, S. M., & Kilmann, P. R. (1977) Crisis intervention: A review of outcome research. *Psychological Bulletin, 84(6),* 1189-1217.

Beckhard, R., & Harris, R. (1977). *Organizational transitions: Managing complex change*. London, UK: Addison-Wesley.

Berkel, D., & Verburg, P. (2012). Combining exploratory scenarios and participatory backcasting: Using an agent-based model in

participatory policy design for a multi-functional landscape. *Landscape Ecology,* 27(5), 641-658.

Brennan, L., Castros, S., Brownson, R., Claus, J., & Orleans, T. (2011). Accelerating evidence reviews and broadening evidence standards to identify effective, promising, and emerging policy and environmental strategies for prevention of childhood obesity. *Annual Review of Public Health, 32*, 199 -223.

Carlsson-Kanyama, A., Dreborg, K. H., Moll, H. C., & Padovan, D. (2008). Participative backcasting: A tool for involving stakeholders in local sustainability planning. *Futures, 40*(1), 34-46.

Carnall, C. (2007). *Managing Change in Organizations*. Harlow, UK: Pearson Education.

Chappin, E. J. L., & Dijkema, G. P. J. (2010). Transition management in energy: Design and evaluate transitions with a suitable simulation framework. In M. van Geenhuizen, W. J. Nuttall, D. Gibson, & E. Oftedal (Eds.), *Energy and innovation: Structural change and policy implications* (pp. 187-210). West Lafayette, IN: Purdue University Press.

Choi, K., & Coates, T. J. (1994). Prevention of HIV infection. *AIDS 8*(10), 1371-1389.

Cohen, M. J. (2010). Destination unknown: Pursuing sustainable mobility in the face of rival societal aspirations. *Research Policy, 39*(4), 459-470.

Connors, P., & McDonald, P. (2011). Transitioning communities: Community, participation and the Transition Town movement. *Community Development Journal, 44*(4*),* 558-572.

Doppelt, B. (2007). *Leading change towards sustainability: A change-management guide for business, government and civil society*. Sheffield, UK: Greenleaf.

Elzen, B., Geels, F., & Green, K. (Eds.). (2004). *System innovation and the transition to sustainability: Theory, evidence and policy*. Cheltenham: Edward Elgar.

Fraser, M. W., Richman, J. M., Galinsky, M. J., & Day, S. H. (2009). *Intervention research: Developing social programs*. New York, NY: Oxford University Press.

Geels, F. (2005). Co-evolution of technology and society: The transition in water supply and personal hygiene in the Netherlands (1850–1930): A case study in multi-level perspective. *Technology in Society, 27*, 363–397.

Geels, F., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy, 36*, 399-417.

Gersick, C.J. (1991). Revolutionary change theories: A multilevel exploration of the punctuated equilibrium paradigm. *Academy of Management Review, 16*(1)*,* 10-36.

Hayes, J. (2007). *The theory and practice of change management*. New York, NY: Palgrave Macmillan.

Healey, P. (1996). Consensus-building across difficult divisions: New approaches to collaborative strategy making. *Planning Practice & Research, 11*(2), 207-216.

Hockings, M., Stolton, S., & Dudley, N. (2004). Management effectiveness: Assessing management of protected areas? *Journal of Environmental Policy & Planning, 6(2),* 157-174.

Holmberg, J., & Robert, K. H. (2000). Backcasting from non-overlapping sustainability principles: A framework for strategic planning. *International Journal of Sustainable Development and World Ecology, 7*, 291-308.

Hopkins, R. (2008). *The transition handbook: From oil dependency to local resilience*. Totnes, UK: Green Books.

Innes, J. (1996). Planning through consensus building: A new view of the comprehensive planning ideal. *Journal of American Planning Association, 62*(4), 460-473.

Kates, R. W., Clark, W. C., Corell, R., Hall, J. M., Jaeger, C. C., . . . Syedin, U. (2001). Sustainability science. *Science, 291*, 641-642.

Kay, B., Wiek, A., Loorbach, D. (2012). Transition strategies towards urban sustainability. Working Paper. School of Sustainability, Arizona State University.

Kemp, R., Parto, S., & Gibson, R. B. (2005). Governance for sustainable development: Moving from theory to practice. *International Journal of Sustainability Development, 8*(1/2), 12-30.

Kenward, R. E., Whittingham, M. J., Arampatzis, S., Manos, B. D., Hahn, T., Terry, A., . . . Rutz, C. (2010). Identifying governance strategies that effectively support ecosystem services, resource sustainability, and biodiversity. *Proceedings of the National Academy of Sciences, 108*(13), 5308-5312.

Kern, F., & Howlett, M. (2009). Implementing transition management as policy reforms: A case study of the Dutch energy sector. *Policy Sciences, 42(4),* 391-408.

Kim, J., & Oki, T. (2011). Visioneering: An essential framework in sustainability science. *Sustainability Science, 6*(2), 247-251.

Lawhon, M. (2012). Relational power in the governance of a South African e-waste transition. *Environment and Planning A, 44*(4), 954-971.

Lee, K. N. (1999). Appraising adaptive management. *Conservation Ecology, 3*(3), 3-10.

Linnenlueke, M., & Griffiths, A. (2010). Beyond adaptation: Resilience for business in light of climate change and weather extremes. *Business and Society, 49*(3), 477-511.

Lönnroth, M., Johansson, T. B., & Steen, P. (1980). Sweden beyond oil: Nuclear commitments and solar options. *Science, 208*, 557–563.

Loorbach, D. (2007). *Transition management: New mode of governance for sustainable development*. Utrecht: International Books.

Loorbach, D. (2010). Transition management for sustainable development: A prescriptive, complexity-based governance framework. *Governance: An International Journal of Policy, Administration, and Institutions*, *23*(1), 161–183.

Loorbach, D., & Rotmans, J. (2010). The practice of transition management: Examples and lessons from four distinct cases. *Futures, 42*, 237-246.

Loukopoulos, P., & Scholz, R. W. (2004). Future urban sustainable mobility: Using ‘‘area development negotiations’’ for scenario assessment and for participatory strategic planning. *Environment and Planning A, 36(12)*, 2203–2226.

Markard, J., Raven, B., & Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. *Research Policy, 41(6),* 955-967.

Mason, K. & Whitehead, M. (2012). Transition urbanism and the contested politics of ethical placemaking. *Antipode, 44*(2), 493-516.

Matson, P. (2009). The sustainability transition. *Issues in Science and Technology, Summer*, 39-42.

McLain, R. J., & Lee, R. G. (1996). Adaptive management: Promises and pitfalls. *Environmental Management*, *20*(4), 437-448.

Nadler, D. (1982). Managing transitions to uncertain future states. *Organizational Dynamics, 11*(1), 37-45.

Olsson, P., Folke, C., & Hughes, T. (2008). Navigating the transition to ecosystem based management of the Great Barrier Reef, Australia. *Proceedings of the National Academy of Sciences, 105*(28), 9489-9494.

Phdungslip, A. (2011). Future studies' backcasting method used for strategic sustainable city planning. *Futures, 43*, 707-714.

Potvin, L., Cargo, M., McComber, A., Delormier, T., & Macaulay, A. (2003). Implementing participatory intervention and research in communities: Lessons from the Kahnawake Schools Diabetes Prevention Project in Canada. *Social Science and Medicine, 56*(6), 1295-1305.

Quist, J., Thissen, W., & Vergragt, P. (2011). The impact and spin-off of participatory backcasting: From vision to niche. *Technological Forecasting and Social Change, 78*(5), 883-897.

Quist, J., & Vergragt, P. (2006). Past and future of backcasting: The shift to stakeholder participation and a proposal for a methodological framework. *Futures, 38*, 1027-1045.

Raskin, P., Banuri, T., Gallopin, G., Gutman, P., Hammond, A., Kates, R., & Swart, R. (2002). Great transition: The promise and lure of the times ahead. Boston, MA: Stockholm Environment Institute. Retrieved from http://www.tellus.org/documents/Great_Transition.pdf

Ravetz,J. (2000). Integrated assessment for sustainability appraisal in cities and regions. *Environmental Impact Assessment Review, 20*(1), 31-64.

Robinson, J. B. (1982). Energy backcasting: A proposed method of policy analysis. *Energy Policy, 10*(4), 337-344.

Robinson, J. B. (2003). Future subjunctive backcasting as social learning. *Futures, 35*, 839-536.

Robinson, J. B., Burch, S., Talwar, S., O'Shea, M., & Walsh, M. (2011). Envisioning sustainability: Recent progress in the use of participatory backcasting approaches for sustainability research. *Technological Forecasting and Social Change, 78*(5), 756-768.

Robinson, J. B., & Tansey, J. (2006). Co-production, emergent properties and strong interactive research: The Georgia Basin Futures Project. *Science & Public Policy, 33*(2), 151-160.

Robinson, T. N., & Sirard, J. R. (2005). Preventing childhood obesity: A solution-orientated research paradigm. *American Journal of Preventive Medicine, 28*, 194-201.

Rotmans, J., Kemp, R., & Van Asselt, M. (2001). More evolution than revolution: Transition management in public policy. *Foresight, 3*(1), 15–31.

Rotmans, J., & Loorbach, D. (2009). Complexity and transition management. *Journal of Industrial Ecology, 13*(2), 184-196.

Rotmans, J., van Asselt, M.B.A., Vellinga, P. (2000). An integrated planning tool for sustainable cities. *Environmental Impact Assessment Review, 20*, 265–276.

Sarewitz, D., Kriebel, D., Clapp, R., Crumbley, C., Hoppin, P., Jacobs, M., & Tickner, J. (2010). *The sustainable solutions agenda*. Consortium for Science, Policy and Outcomes and Lowell Center for Sustainable Production, Arizona State University and University of Massachusetts, Lowell.

Schensul, J. J. (2009). Community, culture and sustainability in multilevel dynamic systems intervention science. *American Journal of Community Psychology*, *43*(3-4), 241-256.

Scholz, R.W. (2011). *Environmental literacy in science and society: From knowledge to decisions*. Cambridge: Cambridge University Press.

Scholz, R. W., Lang, D. Wiek, A. Walter, A., & Stauffacher, M. (2006). Transdisciplinary case studies as a means of sustainability learning: Historical framework and theory. *International Journal of Sustainability in Higher Education, 7(3),* 226–251.

Schulte, P. A., Goldenhar, L. M. and Connally, L. B. (1996). Intervention research: Science, skills, and strategies. *American Journal of Industrial Medicine, 29*, 285–288.

Shove, E., & Walker, G. P. (2007). Transition management and the politics of shape shifting. *Environment and Planning A, 40*, 1012-1014.

Smith, A., Voß, J., Grin, J. (2010). Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. *Research Policy, 39*(4), 435-448.

Spangenberg, J. (2012) Sustainability Science: A review, an analysis and some empirical lessons. *Environmental Conservation, 38*(3), 275-287.

Stringer, L. C., Dougill, A. J., Fraser, E., Hubacek, K., Prell, C., & Reed, M. S. (2006). Unpacking “participation” in the adaptive management of social–ecological systems: A critical review. *Ecology and Society, 11*(2), 39.

Svenfelt, Å., Engstrom, R., & Svane, O. (2010.) Decreasing energy use in buildings by 50% by 2050: A backcasting study using stakeholder groups. *Technological Forecast and Social Change*, *78*(5), 785-796.

Talwar, S., Wiek, A., & Robinson, J. (2011). User engagement in sustainability research. *Science and Public Policy*, *38*, 379-390.

Truffer, B. & Coenen, L. (2012). Environmental innovation and sustainability transitions in regional studies. *Regional Studies, 46*(1), 1-21.

Tukker, A., Charter, M., Vezzoli, C., Stø, E., & Andersen, M.M. (2008). *System innovation for sustainability: Perspectives on radical changes*

to sustainable consumption and production. Sheffield, UK: Green Leaf.

Van Buuren, A., & Loorbach, D. (2009). Policy innovation in isolation? Conditions for policy renewal by transition arenas and pilot projects**.** *Public Management Review, 11*(3), 375-392.

Van den Bosch, S. (2010). *Transition experiments: Exploring societal changes towards sustainability*. Rotterdam: Erasmus University.

Van der Brugge, R., Rotmans, J., & Loorbach, D. (2005). The transition in Dutch water management. *Regional Environmental Change, 5*, 164-176.

Voß, J., & Bornemann, B. (2011). The politics of reflexive governance: Challenges for designing adaptive management and transition management. *Ecology and Society, 16*(2), 9-32.

Voß, J., Smith, A., & Grin, J. (2009). Designing long-term policy: Rethinking transition management. *Policy Science, 42*, 275-302.

Wallerstien, N., & Duran, A. (2010). Community-based participatory research contributions to intervention research. *American Journal of Public Health, 10*(1), 40-46.

Walter, A., Helgenberger, S., Wiek, A., & Scholz. R. W. (2007). Measuring social effects of transdisciplinary research: Design and application of an evaluation method. *Evaluation and Program Planning, 30,* 325–338.

Wangel, J. (2011). Exploring social structures and agency in backcasting studies for sustainable development. *Technological Forecasting and Social Change, 78*(5), 872-882.

White, W. S., Keonig, K., & Scahill, L. (2007). Social skills development in children with autism spectrum disorders: A review of the intervention research. *Journal of Autism & Developmental Disorders*, *37*(10), 1858-1868.

Wiek, A. (2009). Transformational sustainability science: Integrating foresight, backcasting, and intervention research. Working Paper. School of Sustainability, Arizona State University.

Wiek, A., Binder, C. R., & Scholz, R. W. (2006). Functions of scenarios in transition processes. *Futures, 38*(7), 740-766.

Wiek, A., Ness, B., Brand, F.S., Schweizer-Ries, P., & Farioli, F. (2012). From complex systems analysis to transformational change: A comparative appraisal of sustainability science projects. *Sustainability Science, 7*(Supplement 1), 5-24.

Wiek, A., Selin, C., & Johnson, C. (Eds.). (2010). The future of Phoenix, Arizona: Crafting sustainable development strategies. Project Report, School of Sustainability, Arizona State University.

Wiek, A., & Walter, A. (2009). A transdisciplinary approach for formalized integrated planning and decision-making in complex systems. *European Journal of Operational Research, 197*(1), 360–370.

Chapter 3

Alkemade, R., van Oorschot, M., Miles, L., Nelleman, C., Bakkense, M., & ten Brink, B. (2009). GLOBIO3: A Framework to investigate options for reducing global terrestrial biodiversity loss. *Ecosystems, 3*(12), 374-930.

Avelino, F. (2009). Empowerment and the challenge of applying transition management to ongoing projects. *Policy Sciences, 42*(2), 369-390.

Balsas, C. (2008). Sustainable urban regeneration in Phoenix, Arizona: Implications for multi-dimensional governance**.** In T. Kidokoro, N. Harata, L. Subanu, J. Jessen, Al. Motte, & E. P. Seltzer (Eds.), *Sustainable city regions: Space, place, and governance* (Vol. 7, pp. 299-319). Hicom, Japan: Springer.

Beall, J., & Fox, S. (2006). Urban poverty and development in the 21st century. Oxfam GB Research Report. Retrieved from http://eprints.lse.ac.uk/2903/1/ urban_poverty_and_development_in_the_21st_century.pdf

Beddoe, R. et al. (2009). Overcoming systemic roadblocks to sustainability: The evolutionary redesign of worldviews, institutions, and technologies. *Proceedings of the National Academy of Science, 106*(8), 2483-2489.

Bernstein, M., Wiek, A., Brundiers, K., Minowitz, A., Pearson, K., Kay, B., Golub, A. (2012). Trees and neighborhood livability: Solution-oriented research in the sky harbor neighborhood in Phoenix. Working Paper. School of Sustainability, Arizona State University.

Brennan, L., Castro, S., Brownson, R. C., Ciaus, J., & Orleans, C. T. (2011). Accelerating evidence reviews and broadening evidence standards to identify effective, promising, and emerging policy and environmental strategies for prevention of childhood obesity. *Annual Review of Public Health, 32*, 199-223.

Burch, S. (2010). In pursuit of resilient, low carbon communities: An examination of barriers to action in three Canadian cities. *Energy Policy*, *38*(12), 7575 7585.

Campbell, N. (2007). Designing and evaluating complex interventions for health care. *BMJ* 334(7591), 455–459.

Chappin, E. J. L., & Dijkema, G. P. J. (2010). Transition management in energy: Design and evaluate transitions with a suitable simulation framework. In M. van Geenhuizen, W. J. Nuttall, D. Gibson, & E. Oftedal (Eds.), *Energy and innovation: Structural change and policy implications* (pp. 187-210). West Lafayette, IN: Purdue University Press.

City of Phoenix (2010). General Plan Hearing Draft Report. City of Phoenix.

City of Spokane, Mayor's Taskforce on Sustainability. (2009). Sustainability action plan: Addressing climate mitigation, climate adaptation, and energy security. Retrieved from City of Spokane website: www.greenspokane.org

Dale, A. (2001). *At the edge: Sustainable development in the 21st century.* Vancouver, Canada: University of British Columbia Press.

Doppelt, B. (2003). *Leading Change Towards Sustainability: A change-management guide for business, government and civil society*. Sheffield, UK: Greenleaf.

Elzen, B., Geels, F., & Green, K. (Eds.) (2004). System innovation and the transition to sustainability: Theory, evidence and policy. Cheltenham, UK: Edward Elgar.

Fraser, M. W., Richman, J. M., Galinsky, M. J., & Day, S. H. (2009). *Intervention research: Developing social programs*. New York, NY: Oxford University Press.

Glemarec, Y. (2010). Financing the transition to a low-carbon society. *Journal of Renewable and Sustainable Energy, 2*(3), 031013.

Hayes, J. (2007). *The theory and practice of change management*. New York, NY: Palgrave Macmillan.

Hendriks, C. (2009). Policy design without democracy? Making democratic sense of transition management. *Policy Sciences, 42*(4), 341-368.

Huétink, F., van der Vooren, A., & Alkemade, F., (2010). Initial infrastructure development strategies for the transition to sustainable mobility. *Technological Forecasting and Social Change, 77*(8), 1270-1281.

Kates, R. W., & Parris, T. M. (2003). Long-term trends and a sustainability transition. *Proceedings of the National Academy of Science, 100*(14), 8062-8067.

Kemp, R., Loorbach, D., & Rotmans, J. (2009) Transition management as a model for managing processes of co-evolution towards sustainable development. *International Journal of Sustainable Development & World Ecology, 14*(1), 78-91.

Kemp, R., Parto, S., & Gibson, R. (2005). Governance for sustainable development: Moving from theory to practice. *International Journal of Sustainable Development, 8*(1), 12-30.

Kern, F., & Howlett, M. (2009). Implementing transition management as policy reforms: A case study of the Dutch energy sector. *Policy Sciences, 42*(4), 391-408.

Laws, D., Suskind, S., Abrams, J., Anderson, J., Chapman, G., Rubenstein, E. & Vadagama, J. (2001). Public entrepreneurship network. Cambridge, MA: Environmental Technology and Public Policy Program Department of Urban Studies and Planning, Massachusetts Institute of Technology.

Loorbach, D. (2007). *Transition management: New mode of governance for sustainable development*. Utrecht: International Books.

Loorbach, D. (2010). Transition management for sustainable development: A prescriptive, complexity-based governance framework. *Governance: An International Journal of Policy, Administration, and Institutions*, *23*(1), 161–183.

Loorbach, D., & Rotmans, J. (2010) The practice of transition management: Examples and lessons from four distinct cases. *Futures, 42*, 237-246.

Mathie, A., & Cunningham, G. (2003). From clients to citizens: Asset-based community development as a strategy for community driven development. *Development in Practice, 13(5),* 474-486.

Matson, P. (2009). The sustainability transition. *Issues in Science and Technology*, *Summer*, 39-42.

Meadows, D. H. (2010). Leverage points: Places to intervene in a system. *Solutions, 1*(1), 41-49.

Midgley, G. (2006). Systemic intervention for public health. *American Journal of Public Health, 96*, 33-39.

Mintzberg, H. (1994). The rise and fall of strategic planning: Reconceiving roles for planning, plans and planners. New York, NY: The Free Press/Simon & Schuster, Inc.

Montgomery, M. (2009). Urban transformation of the developing world. *Science, 319*, 761-764.

Nadler, D. (1982). Managing transitions to uncertain future states. *Organizational Dynamics, 11*(1), 37-45.

Olsson, P., Folke, C., & Hughes, T. (2008). Navigating the transition to ecosystem based management of the Great Barrier Reef, Australia. *Proceedings of the National Academy of Sciences, 105*(28), 9489-9494.

Ostrom, E. (2009). A General Framework for Analyzing Sustainability of Social Ecological Systems. *Science, 325*, 419-422.

Poppe, K., Termeer, C., & Slingerland, M. (Eds.). (2009). *Transitions towards sustainable agriculture and food chains in peri-urban areas.* The Netherlands: Wageningen Academic Publishers.

Quist, J., & Vergragt, P. (2006). Past and future of backcasting: The shift to stakeholder participation and a proposal for a methodological framework. *Futures, 38*, 1027-1045.

Rangeley, R. W., & Davies, R. W. D. (2012). Raising the “sunken billions”: Financing the transition to sustainable fisheries. *Marine Policy, 36*, 1044-1046.

Raskin, P., Banuri, T., Gallopin, G., Gutman, P., Hammond, A., Kates, R., & Swart, R. (2002). Great transition: The promise and lure of the

times ahead. Stockholm, Sweden: Stockholm Environment Institute.

Ravetz, J. (2000). Integrated assessment for sustainability appraisal in cities and regions. *Environmental Impact Assessment Review, 20*(1), 31-64.

Reid, W. V., Chen, D., Goldfarb, L., Hackermann, H., Lee, Y. T., Mokhele, K., & Whyte, A. (2010). Earth system science for global sustainability: Grand challenges. *Science, 330*, 916-917.

Robinson, J. (2003). Future subjunctive backcasting as social learning. *Futures, 35*, 839-536.

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Lambin, E., & Foley, J. A., (2009). A safe operating space for humanity. *Nature, 461*, 472-475.

Ross, A. (2011). *Bird on fire: Lessons from the world's least sustainable city*. New York, NY: Oxford University Press.

Rotmans, J., Kemp, R., & Van Asselt, M. (2001). More evolution than revolution:Transition management in public policy. *Foresight, 3*(1), 15-31.

Rotmans, J., & Loorbach, D. (2009). Complexity and transition management. *Journal of Industrial Ecology, 13*(2), 184-196.

Schensul, J.J. (2009). Community, culture and sustainability in multilevel dynamic systems intervention science. *American Journal of Community Psychology, 43*(3-4), 241-256.

Shove, E., & Walker, G. P. (2008). Transition management and the politics of shape shifting. *Environment and Planning, 40*, 1012-1014.

Smith, R., & Wiek, A. (2012). Achievements and opportunities in initiating governance for urban sustainability. *Environment and Planning C*, *30*(3), 429-447.

Sondeijker, S. (2009). Imagining sustainability: Methodological building blocks for transition scenarios. Rotterdam: Erasmus University.

Svara, J. (2011). The early stage of local government action to promote sustainability. In: The Municipal Year Book 2011, pp. 43-60. Washington: ICMA.

Tambach, M., Hasselaar, E., & Itard, L. (2010). Assessment of current Dutch energy transition policy instruments for the existing housing stock. *Energy Policy, 38*(2), 981-996.

Van de Kerkhof, M., & Wieczorek, A. (2005). Learning and stakeholder participation in transition processes towards sustainability: Methodological considerations. *Technological Forecasting and Social Change, 72*, 733–747.

Van den Bosch, S. (2010) *Transition experiments: Exploring societal changes towards sustainability*. Rotterdam: Erasmus University.

Van der Brugge, R., & van Raak. R. (2007). Facing the adaptive management challenge: Insights from transition management. *Ecology and Society, 12*(2), 33-46.

Van Herk, S., Zevenbergen, C., Ashley, R., & Rijke, J. (2011). Learning and action alliances for the integration of flood risk management into urban planning: A new framework from empirical evidence from The Netherlands. *Environmental Science & Policy, 14*(5), 543-554.

Voß, J., & Bornemann, B. (2011). The politics of reflexive governance: Challenges for designing adaptive management and transition management. *Ecology and Society, 16*(2), 9.

Voß, J., Smith, A., & Grin, J. (2009). Designing long-term policy: Rethinking transition management. *Policy Science, 42*, 275-302.

Wiek, A. (2009). Transformational sustainability science: Integrating foresight, backcasting, and intervention research. Working Paper. School of Sustainability, Arizona State University.

Wiek, A., Binder, C. R., & Scholz, R. W. (2006). Functions of scenarios in transition processes. *Futures, 38*(7), 740–766.

Wiek, A., & Kay, B. (2012, under review). Strategies for intentional change towards sustainability: A review of different paradigms. *International Journal of Sustainable Development*.

Wiek, A., Ness, B., Brand, F. S., Schweizer-Ries, P., & Farioli, F. (2012). From complex systems analysis to transformational change: A comparative appraisal of sustainability science projects. *Sustainability Science, 7*(Supplement 1), 5-24.

Wiek, A., Selin, C., & Johnson, C. (Eds.). (2010). The future of Phoenix, Arizona: Crafting sustainable development strategies. Project Report, School of Sustainability, Arizona State University.

Wiek, A., & Walter, A. (2009). A transdisciplinary approach for formalized integrated planning and decision-making in complex systems. *European Journal of Operational Research, 197*(1), 360–370.

Wiek, A., Zemp, S. Siegrist, M., & Walter, A. (2007). Sustainable governance of emerging technologies: Critical constellations in the agent network of nanotechnology. *Technology in Society, 29*(4), 388-406.

Chapter 4

Alexander, F. S., & Powell, L. A. (2011). Neighborhood stabilization strategies for vacant and abandoned properties. *Zoning and Planning Law Report, 34*(8), 170-179.

Brown, H., & Vergragt, P. (2007). Sustainable mobility: From technological innovation to societal learning. *Journal of Cleaner Production*, *15*, 1104-1115.

Brown, H., & Vergragt, P. (2008). Bounded socio-technical experiments as agents of systemic change: The case of a zero-energy residential building. *Technological Forecasting and Social Change, 75*, 107-130.

Burch, S. (2010). In pursuit of resilient, low carbon communities: An examination of barriers to action in three Canadian cities. *Energy Policy, 38*(12), 7575-7585.

Ellin, N., & Turner, K. (2010). Recycling the city: Darning downtown Phoenix. *Critical Planning, 17*, 154-173.

English, E. (2011). Valley of the Sunflowers project drives volunteers. ABC15. Retrieved from: http://www.abc15.com/dpp/news/region_phoenix_metro/central_phoenix/valley-of-the-sunflowers-project-drives-volunteers

Forrest, N. (2011). *Discovering pathways to sustainability: Small communities in transition*. Masters Thesis. School of Sustainability. Arizona State University.

Forrest, N., & Wiek, A. (2012, in review). Linking process and outcomes in small-scale community sustainability transitions: An analytical-evaluative research framework. *Technological Forecasting and Social Change*.

Geels, F. W. (2005). The dynamics of transition in socio-technical systems: A multi level analysis of the transition pathway from horse drawn carriages to automobiles (1860-1930). *Technology Analysis and Strategic Management*, *17*(4), 445-476.

George, A. L., & Bennett, A. (2005). *Case studies and theory development in the social sciences*. Cambridge, MA: MIT Press.

Gersma, E. (2011, December, 29). Downtown harvests sunflowers for fuel. *Arizona Republic*, 1A, 6A.

Hoogma, R. (2000) Exploiting technological niches: Strategies for experimental introduction of electric vehicles. Phd Thesis. Enschede, Twente University Press.

Kates, R.W., & Parris, T. M. (2003). Long-term trends and a sustainability transition. *Proceedings of the National Academy of Science, 100*(14), 8062-8067.

Kay, B., Wiek, A., & Loorbach, D. (2012) The concept of transition strategies towards sustainability. Working paper. Arizona State University.

Lang, D. J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., Swilling, M., . . . Thomas, C. (2012). Transdisciplinary research in sustainability science: Practice, principles and challenges. *Sustainability Science, 7*(Supplement 1), 25-43.

Loorbach, D. (2007). *Transition management: New mode of governance for sustainable development*. Utrecht: International Books.

Loorbach, D. (2010). Transition management for sustainable development: A prescriptive, complexity-based governance framework. *Governance: An International Journal of Policy, Administration, and Institutions, 23*(1), 161-183.

Loorbach, D., & Rotmans, J. (2010) The practice of transition management: Examples and lessons from four distinct cases. *Futures, 42*, 237-246.

Montgomery, M. (2008). Urban transformation of the developing world. *Science, 319*(5864), 761-764.

Raven, R. (2005). Strategic niche management for biomass. PhD Thesis. Einhoven Technische Iniversiteit Eindhoven.

Rotmans, J., Kemp, R., & Van Asselt, M. (2001). More evolution than revolution: Transition management in public policy. *Foresight, 3*(1), 15-31.

Satterthwaite, D. (1997). Urban poverty: Reconsidering its scale and nature. *IDS Bulletin*, *28*, 9–23.

Shahraki, S. Z., Sauri, D., Serra, P., Modugno, S., Seifolddini, F., & Pourahmad, A. (2011). Urban sprawl pattern and land-use change detection in Yazd, Iran. *Habitat International, 35*(4), 521-528.

van Den Bosch, S. (2010). *Transition experiments. Exploring societal changes towards sustainability*. Rotterdam: Erasmus University.

Vergragt, P., & Brown, H. (2012). The challenge of energy retrofitting the residential housing stock: Grassroots innovations and socio-technical system change in Worcester, MA. *Technology Analysis & Strategic Management, 24*(4), 407-420.

Vergragt, P., & Brown, H.S. (2007). Sustainable mobility: From technological innovations to societal learning. *Journal of Cleaner Production, 15*, 1104-1115.

Voß, J., & Bornemann, B. (2011). The politics of reflexive governance: Challenges for designing adaptive management and transition management. *Ecology and Society, 16*(2), 9.

Wiek, A., Binder, C. R., & Scholz, R. W. (2006). Functions of scenarios in transition processes. *Futures, 38*(7), 740-766.

Wiek, A., & Kay, B. (2012, under review). Strategies for intentional change towards sustainability: A review of different paradigms. *International Journal of Sustainable Development*.

Wiek, A., Ness, B., Brand, F. S., Schweizer-Ries, P., & Farioli, F. (2012). From complex systems analysis to transformational change: a comparative appraisal of sustainability science projects. *Sustainability Science, 7*(Supplement 1), 5-24.

Chapter 5

Boyd, T., Palacios, L., & Kay, B. (2011). Bioscience High School Connection Endeavors Guidelines for the 2011-2012 school year. Internal curriculum document. Phoenix, Arizona: Bioscience High School.

Brundiers, K., Wiek, A., & Redman, C. L. (2010). Real-world learning opportunities in sustainability: From classroom into the real world. *International Journal of Sustainability in Higher Education, 11*(4), 308-324.

Bulkeley, H., & Betsil, M.M. (2005). Rethinking sustainable cities: Multilevel governance and the 'urban' politics of climate change. *Environmental Politics, 14*(1), 42-63.

Burch, S. (2010). In pursuit of resilient, low carbon communities: An examination of barriers to action in three Canadian cities. *Energy Policy,* 38(12), 7575 7585.

Fraser, M. W., Richman, J. M., Galinsky, M. J., & Day, S. H. (2009). *Intervention research: Developing social programs*. New York, NY: Oxford University Press.

Frisk, E., & Larson, K. (2011). Education for sustainability competencies and practices for transformative action. *Journal of Sustainability Education, 2, 1-8*.

Grimm, N., Faeth, S. H., Golubiewski, N.E., Redman, C. L., Wu, J., Bai, X., & Briggs, J. M. (2008). Global change and the ecology of cities. *Science, 319*(5864), 756-760.

Kates, R. W., Clark, W. C., Corell, R., Hall, J. M., Jaeger, C. C., Lowe, I., . . . Svedin, U. (2001). Sustainability science. *Science, 291*, 641-642.

Kates, R. W., & Parris, T. M. (2003). Long-term trends and a sustainability transition. *Proceedings of the National Academy of Science, 100*(14), 8062-8067.

Kay, B., Wiek, A., & Loorbach, D. (2013, in review). Transition strategies towards urban sustainability. *Environmental Innovation and Societal Transitions.*

Krasny, M., & Tidball, K. (2009). Applying a resilience systems framework to urban environmental education. *Environmental Education Research, 15*(4), 465-482.

Loorbach, D. (2007). *Transition management: New mode of governance for sustainable development*. Utrecht: International Books.

McKoy, D. L., Vincent, J. M., & Biermaum, A. H. (2011). Opportunity-rich schools and sustainable communities: Seven steps to align high-quality education with innovations in city and metropolitan planning and development. Berkley, CA: Center for Cities and Schools, Institute of Urban and Regional Development, UC Berkeley.

Montgomery, M. (2008). Urban transformation of the developing world. *Science, 319*(5864), 761-764.

Pike, L., Shannon, T., Lawrimore, K., McGee, A., Taylor, M., & Lamoreaux, G. (2003). Science education and sustainability initiatives: A campus recycling case study shows the importance of opportunity. *International Journal of Sustainability in Higher Education, 4*(3), 218-229.

Ross, A. (2011). *Bird on fire: Lessons from the world's least sustainable city*. New York, NY: Oxford University Press.

Rowe, D. (2007). Education for a sustainable future. *Science, 317*(5836), 323-324.

Satterthwaite, D. (1997). Urban poverty: Reconsidering its scale and nature. *IDS Bulletin*, *28*, 9-23.

Schensul, J. J., & Berg, M. (2004). Youth participatory action research: A transformative approach to service-learning. *Michigan Journal of Community Service Learning*, *10*(3), 76-88.

Scholz, R. W., & Tietje, O. (2002). Embedded case study methods: Integrating quantitative and qualitative knowledge. London, UK: Sage Publications.

Scott, W. (2009). Judging the effectiveness of a sustainable school: A brief exploration of issues. *Journal of Education for Sustainable Development*, *3*(1), 33-39.

Sipos, Y., Battisti, B., & Grimm, K. (2008). Achieving transformative sustainability learning: Engaging head, hands and heart. *International Journal of Sustainability in Higher Education, 9*(1), 68-86.

Wiek, A., & Iwaniec, D. (2012, under review). Quality criteria for visions and visioning in sustainability science. *Sustainability Science*.

Wiek, A., Ness, B., Brand, F. S., Schweizer-Ries, P., & Farioli, F. (2012). From complex systems analysis to transformational change: A comparative appraisal of sustainability science projects. *Sustainability Science, 7*(1)*,* 5-24.

Wiek, A., Selin, C., & Johnson, C. (Eds.). (2010). The future of Phoenix, Arizona: Crafting sustainable development strategies. Project Report, School of Sustainability, Arizona State University.

Wiek, A., Withycombe, L., & Redman, C. L. (2011). Key competencies in sustainability: A reference framework for academic program development. *Sustainability Science, 6*, 203-218.

APPENDIX A

PERMISSION OF COAUTHORS TO PUBLISH WORK IN DISSERTATION

Dr. Arnim Wiek, Dr. Derk Loorbach, Dr. Daniel Schurgurensky, Nigel Forrest, and Timothy Boyd gave permission to publish coauthored work in this dissertation.

APPENDIX B

IRB APPROVALS FOR RESEARCH

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Arnim Wiek GIOS Build
From:	Mark Roosa, Chair Soc Beh IRB
Date:	02/06/2012
Committee Action:	**Exemption Granted**
IRB Action Date:	02/06/2012
IRB Protocol #:	1202007364
Study Title:	Community-Focused Sustainable Solution Options for the Light Rail Corridor Segments in Phoenix

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2) .

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.

ASU ARIZONA STATE UNIVERSITY
RESEARCH AND ECONOMIC AFFAIRS

Office of Research Integrity and Assurance

To:	Susan Ledlow GIOS
From:	Mark Roosa, Chair Soc Beh IRB
Date:	04/07/2010
Committee Action:	**Exemption Granted**
IRB Action Date:	04/07/2010
IRB Protocol #:	1004005041
Study Title:	Bioscience Faculty and Staff Sustainability Assessment

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2) .

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.

ASU ARIZONA STATE UNIVERSITY
RESEARCH AND ECONOMIC AFFAIRS

Office of Research Integrity and Assurance

To:	Arnim Wiek GIOS Build
From:	for Mark Roosa, Chair SM 2/17/10 Soc Beh IRB
Date:	02/17/2010
Committee Action:	**Exemption Granted**
IRB Action Date:	02/17/2010
IRB Protocol #:	1002004827
Study Title:	Crafting Sustainable Development Strategies for Phoenix

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2) .

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.