Simulating the Nature of Cities: Ecology, Planning, and Systems Science in the Inter-Institutional Policy Simulator (IIPS) Project, 1970-1974

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Abstract

This thesis studies the intersection of ecology, urban planning and systems science in the Inter-Institutional Policy Simulator (IIPS) project between 1970 and 1974. I examine the project in the milieu of the popular environmental movements and its challenges to the established political and scientific authority in North America. While previous scholarship in the history of ecology has illustrated the Cold War's influence on the "systems ecology" research programme and its focus on computer simulation and mathematical models, this thesis examines how ecologists extended their discipline from the management of natural ecosystems to planning for "urban systems." By investigating the networking strategy of ecologists and urban planners, the first part of my thesis studies the rise and fall of IIPS as the interaction between "IIPS the Platform" and "IIPS the Product," or between the network of experts and the simulator they aimed to create. Although IIPS failed to create a product capable of simulating the urban dynamics of Vancouver, it nevertheless exemplified the efforts of ecologists and urban modellers to address the social challenges in the early 1970s. The second part of my thesis concentrates on the public programs led by project members, in which the experts attempted to reformulate the relationship between technoscience and the public through a variety of educational and participatory events. I argue that the value of IIPS was its contribution to the reimagination of information technology and systems science in an era of environmental anxiety and social transformation, and suggest that the experience of the project can offer critical insights into contemporary questions concerning scientists' roles in a challenging socio-political context.

Lay Summary

This paper investigates the history of the Inter-Institutional Policy Simulator (IIPS) project between 1970 and 1974. I analyze how ecologists collaborated with urban planners to create a model aimed at simulating the urban dynamics of Vancouver. Social contexts of early 1970s North America encouraged experts to participate in the project. Although they failed to build the simulator, the project exemplified scientists' efforts to engage the public and reorient experts' social roles. IIPS is thus relevant to the contemporary challenges that scientists continue to face.

Preface

This thesis is wholly the original and unpublished work produced independently by the author, Chia-Li Chu.

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List of Abbreviations

BASS: Bay Area Simulation Study

CIS: Community Information System

ESA: Ecological Society of America

GVRD: Greater Vancouver Regional District

IARE: Institute of Animal Resource Ecology

IBP: International Biological Program

IIPS: Inter-Institutional Policy Simulator

MSUA: The Ministry of State for Urban Affairs

RSC: Resource Science Centre

SIMSUP: Simulation Supervisor

UBC: The University of British Columbia

Acknowledgements

First of all, I would like to thank my family for their generous support and kindness throughout my study at Vancouver. I am certainly privileged to finish the program without worrying about financial or emotional support. I would also like to thank my co-supervisors, Renisa Mawani and Jessica Wang, for their intellectual guidance and friendship. Bob Brain, who helped to organize the STS program and participated in my oral exam, has provided valuable advice for my thesis. Many other professors, graduate students, and staff at UBC also help me to adapt to the academic environment and learn to engage in critical thinking and discussion. Particularly, I would like to thank the superb staff at UBC Archive for the well-kept institutional records of IIPS. This study is certainly impossible without all of the wonderful people and their patience.

This thesis only tangentially touches upon the communities of the place known as Greater Vancouver, but the historical and ongoing debate about nature, human, and society undoubtedly involves complicated and contested voices and visions. I am indebted to those who teach me to think seriously about dependence, contradictions, and justice, especially the teachers at the Xʷc̓ic̓əsəm Garden of UBC Farm, who show me the importance to honor the land—especially the ancestral, traditional, and unceded territory of Musqueam people I lived on for the past two years—and the members of the Hum101 Community Programme, from whom I learn the value of critical humanities in a situated and reflexive context.

Last but not the least, while I have not met members of the IIPS project in person, I want to express my admiration for their ambition fifty years ago. Hopefully, this research can illustrate the vision of the project and the agency of community partners, and serve as inspiration for future community-oriented study in such turbulent times.

Chapter 1. Introduction

Consider the following three scenes:

In January 1972, ecologist Crawford Holling reprinted the lines from Graham Nash's song "Be Yourself"—"We needed a tutor/So built a computer/And programmed ourselves/not to see"—in a memo about the Inter-Institutional Policy Simulator (IIPS) project that he was working on. Days later, these lines appeared in a paper prepared for the IIPS Policy Group, a workshop run by graduate students from a course that Holling taught. The goal of IIPS was to create a computer model to assist planning decisions in Greater Vancouver, but the paper warned of the harm the model could do once it was "introduced into an imperfect and unbalanced political and social system."[1] The author, Patrick Moore, thus argued that the public should also have access to the model.[2]

When IIPS was in its conceptual phase, Robert Kelly, an economic modeller for the project, attempted to engage other academics at the University of British Columbia (UBC) where the project was hosted. However, in a conversation with Dorothy Smith from the Department of Anthropology and Sociology and Ed Levy from the Department of Philosophy, he received a lukewarm reception. Specifically, Smith argued that "the presence of a model of the Vancouver urban system may be seen as representing social and human phenomena for which such a model clearly cannot provide." [3] Although it is difficult to know whether this encounter influenced Smith's thought, her works in the 1970s would

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[1] Pat Moore, "The Abuse and Misuse of Information," page 1, January 26th, 1972. Box 17, Folder 16. Inter-Institutional Policy Simulator (hereafter IIPS) fonds, The University of British Columbia Archive, Vancouver, British Columbia, Canada.

[2] Moore founded the environmental organization Greenpeace in 1971. However, decades later, he would leave the organization and become a lobbyist for the nuclear industry. "Going Nuclear: A Green Makes the Case." April 16, 2006. *The Washington Post*.

[3] Robert Kelly, "IIPS Diary Item," page 1, September 9th, 1970, Box 16, Folder 1, IIPS fonds.

unearth the ideological basis of the social sciences, illustrating how the field both privileged and *effaced* certain biases in its investigations.[4]

Finally, in 1974, programmer Lynn Hueftlein from the IIPS Computer Services subgroup arrived at the Vancouver Public Library and used a terminal, connected via a telephone line to the mainframe computer at UBC, to demonstrate how the "Community Information System" worked. This software was based on the data storage and retrieval program Hueftlein and her colleagues created for the project. Community Information Centre, a local social service organization, provided a database for the demonstration. The system allowed users to search information in the database and update its contents. For example, typing "WOMEN'S HEALTH" made the system display all organizations containing the keywords, along with the address, phone number, and function of each organization. An entry such as "THE WOMEN'S HEALTH GROUP" which contained the description "The group holds pre-and post-natal classes and provides counselling to women" could be updated with information like "Pre-natal classes start next Thursday." which would be added at the bottom of the description.[5] Following the demonstration, community organizers formed a group called "INFACT" to explore the potential of the system as a forum for social services and educational information exchange.[6]

Judging from the scenes above, one can notice how a variety of socio-political contexts of the early 1970s—environmental awareness, critiques of technoscience, and citizen's demands to participate in public affairs—converged in the IIPS project. This

[4] See Dorothy E. Smith, "Women's Perspective as a Radical Critique of Sociology," *Sociological Inquiry* 44, no. 1 (1974): 7-13.
[5] "The Computer in the Community," page 5, March 1974. Box 3, Folder 2, IIPS fonds.
[6] Nancy Kleiber, "A Computer Assisted Information System," page 5, April 23rd, 1974. Box 1, Folder 27, IIPS fonds.

thesis aims to study the IIPS project in the context of the challenges against the political and scientific authority in the late 1960s and the early 1970s. Conceived by a group of academics at the University of British Columbia (UBC), IIPS was jointly financed by the City of Vancouver, the Greater Vancouver Regional District (GVRD), the Ministry of State for Urban Affairs (MSUA), and the Ford Foundation. Its aim was to devise "a new approach to solve large scale and complex urban problems" through the creation of a computer model which could simulate and synthesize different aspects of the city.[7] Nonetheless, the project ultimately failed to produce a simulator matching its ambitions. After an unfavourable review commissioned by the MSUA, the project was terminated prematurely in 1974, a year before its scheduled completion.

Although IIPS appears to be a "failed" project, I believe its experience can shed light on several critical questions: How did the project attract its heterogeneous array of experts with diverse training and ideologies, and how did they collaborate or conflict with each other? What were the intellectual roots that influenced the conception of the project? How did project members use IIPS to address prominent socio-political issues in the early 1970s, such as environmental issues and the distrust of scientific authority? I argue that the ecologists, economists, planners, and programmers who participated in the project also attempted to redefine experts' roles in a rapidly changing society. The ecologists extended their theory of ecosystems to the management of "social systems." The economists and planners reformed urban simulation by working closely with the urban officials. The programmers tried to transform computers from machines designed for military calculation to small-scale technology for communities. By investigating the institutional, intellectual,

[7] Michael Goldberg, "Guideline for Participation in the IIPS by the Federal Ministry of State for Urban Affairs," page 1, July 14th, 1971, Box 16, Folder 10, IIPS fonds.

and socio-cultural history of the project, the thesis highlights scientists' strategy to build careers in the face of political challenges. It also contributes to the historiography of ecology by studying ecologists' self-presentation as scientific managers in an age of environmental anxiety. The following section will provide a brief discussion of my methodology and the structure of the thesis.

1.1 The Platform, the Product, and their Metaphors

In this thesis, I analyze IIPS as primarily a *platform* where experts, government officials, citizen groups, and technoscientific objects could meet, clash, and influence the ways in which the "nature" of city was conceived. IIPS the Platform was organized around a *product*—the computer model designed to simulate the urban environment of Vancouver. I argue that IIPS the Product and IIPS the Platform were connected not only by practical model-building exercises but also by *metaphors*. One such metaphor was the concept of "systems". During their collaboration in IIPS, the ecologists and planners presented their simulation approach as the best way to investigate the complexities of "urban systems," which were conceived as analogues to natural ecosystems. In addition, the meetings, workshops, and public demonstrations held by project members were also considered as "systems" that linked multiple parties and technological objects together. Finally, the computers used for modelling and display, along with the codes, software, statistics, maps, letters and memos were all parts of a larger inter-institutional system. The metaphor of systems therefore helped to connect the Platform and the Product by suggesting that both the network of experts and the technological objects they created shared the same systematic qualities.

In addition to the concept of system, another idea—"game"—was utilized as a metaphor for the project. If "system" was adopted to transform a complex reality into something that the experts could intervene in *from the outside*, the "game" was a system in which the experts themselves were participants. The ecologists and planners viewed the game they played as a "social game" where the "only immutable rule has been to stay in the game."[8] By describing planning and simulation workshops as social games, this rhetoric reflected not only the challenges of maintaining the Platform as a complex network but also the experts' beliefs concerning the role technoscience should play in helping society *adapt to* the challenges it faced. Consequently, the metaphor of game portrayed IIPS the Product as a socially relevant technology, while supporting the idea that the Platform should be organized in a socially inclusive format. There were, indeed, gaps between the vision embedded in the metaphors and the reality. Eventually, some of these gaps would become fatal cracks in the project.

This thesis draws on the records of the IIPS project stored at the UBC Archives. My sources include the project proposal, internal and external reviews, technical reports, and correspondence between institutions and between the academics of the University. I highlight different actors' motivation to join the project, their roles in organizing the Platform and constructing the Product, and their assumptions about the significance and goal of IIPS. Academic articles published by project members between late 1960s and early 1970s are also examined to shed light on the intellectual as well as socio-cultural context they are situated within. Previous scholarship in history of American ecology, planning,

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[8] C. S. Holling and A. D. Chambers. "Resource Science: the Nurture of an Infant." *BioScience* 23, no.1 (1973): 15.

and computer science serves as secondary sources, and key texts in Science and Technology Studies (STS) provide methodological guidance.

After the introduction, Chapter 2 traces the rise and fall of IIPS by exploring the multiple constructions of the "systems" concept within the project and the evolution of systems ecology. I will then illustrate the relation between IIPS the Platform and IIPS the Product. While the disintegration of the project was caused by the failure to create a desirable product, I argue that it was the (dis-)organization of the platform that led to this failure. Chapter 3 situates IIPS in the ecological anxiety of the early-1970s North America. I demonstrate that, among the experts at UBC, a similar anxiety over social-ecological disaster was also prevalent. By extending Paul Edwards' study of the Cold-War imagination of "closed world" and "green world", the chapter illustrates how the participants of IIPS envisioned a future between the two worlds by using technology to address the concerns of local citizens.[9] Chapter 4 concludes the thesis by discussing the relevance of the project to the challenges scientists face today. Although IIPS may be a project with little impact on the overall development of ecology, I argue that it captures an early encounter between systems ecology and societal values, and is thus conducive to a re-evaluation of recent history of science, technology, and politics. Specifically, I contend that experts' self-conscious efforts to address the limitations of technoscientific knowledge reflected a strategy to reaffirm experts' importance in a changing society.

Before I launch my inquiry into IIPS the Platform, I believe a short journey into the simulated world created by IIPS the Product would be helpful.

[9] Paul N. Edwards, *The Closed World: Computers and the Politics of Discourse in Cold War America* (Cambridge: MIT Press, 1997).

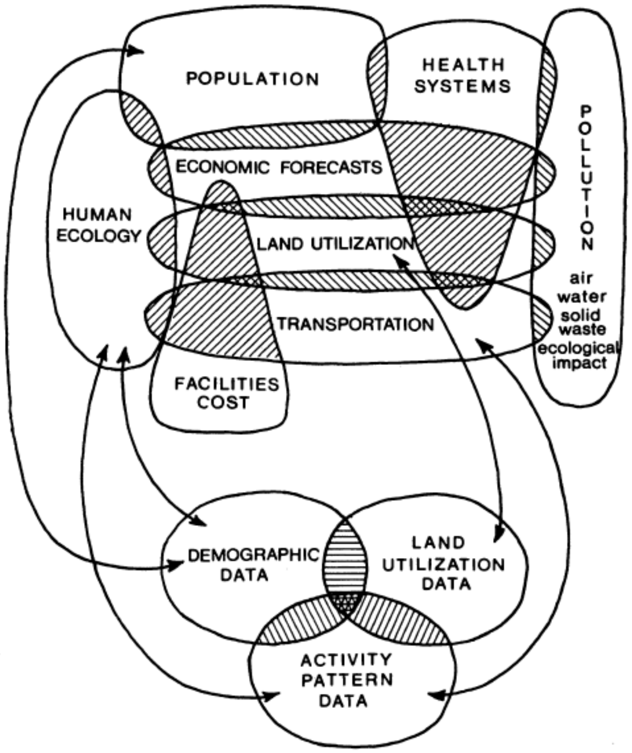

Figure 1 The Organization of IIPS subgroups as of July 1972. Michael A. Goldberg, "Simulation, Synthesis and Urban Public Decision-Making," *Management Science* 20, no. 4 (1973): 632.

1.2 "A Grad-Seminar-Writ-Large "

"It is assumed that the reader will have some familiarity with the idea of simulation, and with computers in general, to the extent that you know that the Simulator Supervisor is not a person, but a set of computer programs. (Now you know that, anyhow)."[10]

Although the government never adopted the simulation program developed by IIPS, several operational manuals do exist and provide the possibility of reconstructing the experience of using the program.[11] To create the end product of IIPS, modellers in various

[10] Lynn Hueftlein and Doug Ash, "The User's Manual for the Simulator Supervisor," page 5, August 1974, Box 13, Folder 31, IIPS fonds.

[11] The following section is based on the user manuals found in the UBC Archive. Unfamiliar with the technical details, I chiefly use this "simulation" to explore the *materiality* of IIPS. This is crucial if IIPS is to be seen as not merely the platform exploited by experts and governmental officials to create their own social and intellectual networks, but as a concrete object created by the labour of professional programmers, graduate students, computer center staffs, plus the work of machines.

“subgroups” first conceived sets of mathematical equations and flow charts to describe specific aspects of the urban dynamics of Vancouver, which would be turned into computer programs, or “simulators,” by the Computer Services members. To allow users to interact with the simulators, Computer Services built a separate program called the “Simulation Supervisor (SIMSUP)”. SIMSUP linked up the simulators of different subgroups while serving as an interface for simulation experiments. For example, the Economics simulator could adopt the value of population growth from the Population simulator in the computation of employment scenarios, which the Land Use simulator could utilize to forecast the distribution of different types of housing and business. Here, I examine SIMSUP as the representative for IIPS the Product.

SIMSUP was developed with an IBM System/360 mainframe computer housed in the UBC Computing Center and written in the computer languages 360 FORTRAN and ASSEMBLER. To run the program in the Michigan Terminal System, an operating system used to design SIMSUP, one was supposed to type:

RUN IPFI:SIM/SUP

And then the following message would appear on the screen.

<<<READY FOR COMMANDS>>>

The simplest command in the program was “LIST”, which allowed the user to navigate the existing files stored in its database. Each file contained several “fields.” For instance, a file in the population simulator might contain the fields of time, size of population, births, and deaths. To examine the current database, one would type:

LIST DATA_VALUES FOR TIME FOR 1967 IN POPULATION

LIST POLICY_VARIABLE FOR POPULATION FOR 1967

The first command created a list of all information stored in the file containing the value “1967” in its time field. The second command showed the interventions the user could make. In this case, birthrate served as one such policy variable. For example, the user could examine the impact of a 10% increase in the birthrate:[12]

DISPLAY POPULATION BY TIME FROM 1 TO 20

CHANGE BIRTHRATE TO .221

DISPLAY POPULATION BY TIME FROM 1 TO 20 SUPERIMPOSE

DISPLAY POPULATION BY TIME FROM 1 TO 20 SUPER TYPE=DASH

The above commands would display the result based on the default birthrate, recompute the population growth by the new birthrate, and superimpose the result on a graph as a dotted line. A printer connected to the mainframe computer could then print out the graph.

This simulation used only one exponential equation from the Population model. The more sophisticated functions of SIMSUP included simulating the influence of real estate development at a census tract, the impact of construction of new bridges across the False Creek, and the ramifications of abolishing the Agricultural Land Reserve Act. SIMSUP elaborated one of the possible ways IIPS the Product could realize the promise of the Platform. Even the 1974 review, which disparagingly called the project “a grad-seminar-writ-large,” praised Computer Services programmers for the “competence and understanding of the workings and functioning” of SIMSUP.[13] The biggest problem of IIPS the Product was its poor modelling quality, caused by a lack of full-time modellers

[12] The default birthrate shown in the manual is 12.1%, and thus the recomputed birthrate is 22.1%. Both are extremely high figures and do not correspond to the birthrate at Canada at that time.

[13] “Report of a Review Team to the Ministry of State for Urban Affairs,” page 43, May 1974, Box 3, Folder 16, IIPS fonds.

and substandard project management. The value of the simulator was also undermined by its failure to provide policy options "under the control of urban decision makers."[14] For instance, although variables such as sex ratio at birth, employment rate of women, and averaged housing costs were offered in the Population simulator, they were barely meaningful to policy makers who could not *determine* these values in the real world. As a result, the reviewers argued that the inter-institutional collaboration served mainly as a channel to advertise "the inputs/benefits from or for a particular contributor", rather than to explore concrete questions such as "what do the research activities contribute to politicians' and others' understanding of policy processes" or "which policy issues are addressed" by specific subgroups.[15]

How did IIPS the Platform became so ill-organized that it compromised its very own objective? Chapter 2 tackles this question by examining the key intellectual basis of urban simulation and by analyzing the institutional history of the project. My inquiry begins with the history of the research programme known as "systems ecology."

[14] "Report of a Review Team," page 29.
[15] Ibid., page 7.

Chapter 2. The Nature of Cities Revised

To understand the creation and the eventual collapse of IIPS the Platform, it is crucial to study the project within the intellectual and social milieu that the participating individuals and institutions were operating in. This chapter concentrates on two related themes in the development of IIPS: the influence of a particular philosophy of ecology on the project, and the struggle of experts to create a network capable of implementing this philosophy. Section 2.1 documents the rise of "systems ecology" in North America and introduces several ecologists who contributed to this research programme. Section 2.2 studies how systems ecology and urban planning influenced each other by focusing on the career of Canadian ecologist Crawford Holling. I then consider Holling's vision to integrate the two disciplines and his role in assembling the inter-institutional network for the IIPS project.

Since Holling utilized IIPS primarily as a platform to connect himself to other actors in the network of systems scientists, control of the project gradually fell into the hands of the economists, modellers, and urban managers who made decisions on budget allocation and research direction. Known as the "Core Group", this management team created an organizational culture that prioritized the consolidation of the Group over the construction of the simulator. However, neither the holistic ideas of systems theory nor the "systems" of organizational arrangement directly benefitted IIPS the Product. Section 2.3 analyzes the "disciplinary techniques" the project adopted and how failures to discipline the Platform led to its dissolution. Finally, a brief fourth section provides some counterfactual thoughts about the project. Could things have turned out otherwise had the

Platform included a broader array of participants? I argue that IIPS could have lived up to its potential had the experts welcomed voices and visions that were ignored at the time.

2.1 Constructing Systems Ecology

The origin of “systems ecology” could be traced back to the development of the ecosystem concept. Before crossing paths with the cybernetic theory that originated in research on complex mechanisms during World War II, the ecosystem idea played only a marginal role in American ecology. As a nascent field still struggling to distance itself from the “amateur” naturalists, interwar American ecology concentrated mainly on the scientific laws governing interactions between organisms, and how such interactions changed across time and space.

In the 1930s, the most debated idea was “biological community,” or a distinct assemblage of organisms, and the theory of ecological succession, which proposed that an initially simple community of fast growing grasses had the tendency to transform into a complex and stable forest community.[16] The organicist metaphor salient in turn-of-the-century American thought played a crucial role in the debate. For instance, plant ecologist Frederic Clements compared biological communities with organisms and the succession process with the physiological maturation of organs.[17] While Clementsian organicism had lost most of its followers by 1940, American ecologists remained eager to find new metaphors for ecological processes, and a mechanistic concept of ecosystem came to their aid.[18]

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[16] See Joel Hagen, *An Entangled Bank: The Origins of Ecosystem Ecology* (New Brunswick: Rutgers University Press, 1992), 16-22.
[17] For a review of controversies over Clementsian succession theory, see Hagen, *Entangled Bank*, 33-49.
[18] Some historians argued that the ecosystem idea became more mechanistic after its incorporation into the research programme of systems ecology. See Chunglin Kwa, “Representations of Nature: Mediating between Ecology and Science Policy: The case of the International Biological Programme," *Social Studies of Science* 17, no. 3 (1987): 427; however, others pointed out that, even in the “original” British conceptualization of

The ecosystem idea that entered American ecology in the 1940s was based on the research of British ecologists Arthur Tansley and Charles Elton. By incorporating relations not only between organisms but also between organic and inorganic processes, ecosystem ecologists added the flows of energy and materials into their agenda. Evelyn Hutchinson was a prominent figure who introduced the ecosystem concept to America. While teaching at Yale University, Hutchinson conducted field studies of lakes while studying mathematical models of ecological relations. Hutchinson's student Raymond Lindeman combined the mathematical and ecosystem research together in 1942. On the one hand he argued that trophic relations, or the relations between organisms in a "food web", could be quantified as the transfer of energy, while on the other hand he proposed that succession phenomena could be understood as changes in energy productivity in an ecosystem.[19]

As Joseph Taylor argues, after the World War II, Hutchinson and his colleagues would bring ecologists to the technocratic vision of reducing "the complexity of social and ecological relations to a single energy dial for the social engineers to adjust."[20] Hutchinson's pursuit of a mathematically and biochemically oriented ecology fostered an ideal laden with social and political values. This fusion of ecosystem concept with socio-political thoughts occurred before the field of "systems ecology" was established. Even before the "eco-" prefix was dropped, the concept of ecosystem in Hutchinsonian ecology had already absorbed some cybernetic terms.

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ecosystem, the mechanistic metaphor was already salient and blended with the organicist metaphor. See Peder Anker, *Imperial Ecology: Environmental Order in the British Empire, 1895-1945* (Cambridge: Harvard University Press, 2001).

[19] Hagen, *Entangled Bank*, 87-94.

[20] Peter J. Taylor, "Technocratic Optimism, HT Odum, and the Partial Transformation of Ecological Metaphor after World War II." *Journal of the History of Biology* 21, no. 2 (1988): 241.

Cybernetics, as a field aiming to describe, analyze, and control the behaviors of complex systems, greatly benefited from war-time research. Fire control systems that automatically calibrated the aim of guns, soldiers who received commands and adjusted their actions, and human brains that processed information were all studied as complex systems by cyberneticians. The Macy Cybernetics Conferences held between 1946 and 1953 became an important event for cyberneticians to extend such "systems thinking" to the study of social reform. In addition to engineers, physicists, mathematicians, and physiologists, social scientists were also enthusiastic about the value of cybernetics in their own fields. Among them were prominent anthropologists Gregory Bateson and Margaret Mead, who introduced Hutchinson to the conferences.[21]

At first glance, Hutchinson's Macy presentation on "Circular Causal Systems in Ecology" seemed to be a resolute step toward the completion of ecology as a "hard" science. The paper summarized two ecological approaches developed in the early 20th century: the "biogeochemical cycles" of carbon and phosphorus in aquatic ecosystems, and the mathematical models of "biodemographic" theory describing the mechanism of population dynamics.[22] By transforming the metaphor for nature from the "homeostatic communities" of interwar America into the "self-regulating systems" of the Cold War, Hutchinson's research programme sought to bring ecology closer to both the physical sciences and *technocratic planning*.[23] The dawn of the atomic age and the optimism for scientific progress also gave American ecologists unprecedented chances to advance their theories and techniques. Although the funding and networking opportunities for ecologists did not

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[21] Leone Montagnini, "Looking for 'Scientific' Social Science," *Kybernetes* 36, no. 7/8 (2007): 1012-1021.
[22] G. Evelyn Hutchinson, "Circular Causal Systems in Ecology," *Annals of the New York Academy of Sciences* 50, no. 4 (1948): 221-246.
[23] Taylor, "Technocratic Optimism," 220.

match that for physical scientists, some ecologists considered further development in the cybernetic version of ecosystem conducive for gaining a foothold in this new political-economic milieu.

The careers of the Odum brothers and Stanley Auerbach nicely exemplified how ecologists demarcated and promoted their own areas of expertise. In 1954, the Odum brothers went to study the environmental impact of nuclear tests at Eniwetok Atoll at the request of the Atomic Energy Commission (AEC). Instead of conducting a simple ecological survey, they used the opportunity to measure the net primary productivity of the coral reef ecosystem in an attempt to find empirical evidence for Lindeman's theory of biochemical and energy flows. Ironically, the Odum brothers were not familiar with coral taxonomy and "could not identify most species on the reef."[24] This disembodied and decontextualized approach was nonetheless influential in the community of young ecologists. With their schematic representation of quantified material and energy cycles, ecology in the 1950s became more and more like complex cybernetic diagrams.

Technology developed during the Cold War also gave ecologists new tools to study ecosystems. Stanley Auerbach's career at the Oak Ridge National Laboratory can reflect this context. Although his work at the Oak Ridge initially concentrated on the environmental and health impacts of radiation, in the 1950s Auerbach started a series of studies using radioactive isotopes as "tags" to trace chemical cycles in the forest near the laboratory. Auerbach also pioneered the adoption of computers to construct and test ecosystem models.[25] While Auerbach's team was not the first to use isotopic labelling or

[24] Hagen, *Entangled Bank*, 103.
[25] It should be noted that early ecosystem models were constructed by analog computers, while systems ecologists, including Holling, generally adopted digital computers for simulation tasks after mid-1960s.

computer simulation in ecological research, due to the stable funding and freedom ecologists enjoyed at Oak Ridge, his institution expanded rapidly in the late 1960s and became the stronghold for biome studies under the International Biological Program.

In an article titled "A New Ecology", Eugene Odum suggested that the use of ecosystem as a "basic unit of structure and function" in ecology, which was equivalent to the use of cells in molecular biology, helped the field reach its maturity.[26] The "new ecology" should therefore be a "systems ecology." The construction of systems ecology as a field distinct from the previous "schools" of ecology was significant as a political gesture that intended to unify the discipline through a *universal paradigm*. The strategy of systems ecologists echoed the strategy chosen by the promoters of systems thinking in general—to argue that technological conditions of society required new worldviews, while absorbing the lexicons and practices of other disciplines as one's own expertise.[27] However, while the initial spread of systems analysis and computer simulation across academia was largely sponsored by the military-industrial complex, systems ecologists chose to realize their cybernetic vision by assuming the role of environmental manager in the mid-1960s. As Kenneth Watt argued in the opening chapter of *Systems Analysis in Ecology*, after witnessing the damaging side effects of defoliants and pesticides, the mandate of ecologists should be "to study systems as whole and not just collections of fragments of systems."[28] Other authors in the volume supported Watt's argument by investigating how ecological phenomena could be approached by multiple sub-models without sacrificing systematic

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[26] Eugene P. Odum, "The New Ecology," *BioScience* 14, no. 7 (1964): 15.
[27] See Robert Lilienfeld, "Systems Theory as an Ideology," *Social Research* 42, no.4 (1975): 637-660. For later historical writings, see Geof Bowker, "How to be Universal: Some Cybernetic Strategies, 1943-70," Social Studies of Science 23, no. 1 (1993): 107-127.
[28] Kenneth E. Watt. "The Nature of Systems Analysis," in *Systems Analysis in Ecology*, ed. Kenneth E. Watt (New York: Academic Press 1966), 2.

complexities. Imagining themselves as holistic scientific managers, ecologists after Odum's "new ecology" seemed to follow the lead of systems thinking with more caution and self-awareness.

Odum's paper thus marked the high point of ecologists' technocratic ambition. Odum believed that technoscientific progress like isotopic labels and space travel could be used to secure "man's continued survival in the biosphere", and that the "net result of the atomic age should be favorable". [29] Odum's colleagues, nevertheless, were not so certain about the gospel of technoscience. While systems ecology was constructed with the vision to control social-ecological systems, systems ecologists were among the first to challenge whether such control was attainable or *desirable*. Simply describing nature and society as complex systems appeared insufficient. For ecologists with more radical views, the point would be to change the system—or at least to be critical of any description about systems.[30] For moderate ecologists, descriptions remained useful for environmental managers—if the assumptions upon which the descriptions were made remained flexible. This emphasis on the flexibility and holism of ecological knowledge would become the key feature of Crawford Holling's research programme.

2.2 From Ecosystems to Urban Systems

After graduating from the University of Toronto, Holling spent his early career in the government funded Forest Insect Laboratory in Sault Ste. Marie, Ontario. From 1952

[29] Odum, "New Ecology," 16. For a discussion on Eugene Odum's idea of "space ecology", see Peder Anker, *From Bauhaus to Ecohouse: A History of Ecological Design* (Baton Rogue: LSU Press, 2010), 83-95.

[30] Richard Levins was one of the ecologists dissatisfied with the development of systems ecology. He was especially critical of Watt's reliance on simulation. Believing that an ecological model cannot be simultaneously "precise", "general", and "real", Levins asserted that realism and generality should be the true goals of biological science. Descriptions of ecosystems based on simulation models, he claimed, sacrificed the dialectical rigor of comparing different models for utilitarian considerations. See Paolo Palladino, "Defining Ecology: Ecological Theories, Mathematical Models, and Applied Biology in the 1960s and 1970s." *Journal of the History of Biology* 24, no. 2 (1991): 223-243.

to 1967, his work focused on entomological research related to pest management. The "applied" orientation of his study did not imply that agricultural entomology was devoid of theoretical implication. For instance, in a 1959 paper which experimented on the predation of a forest pest, European pine sawfly, by small mammals, Holling aimed to understand not only the means of biological control but how predators changed their response to prey of various population densities.[31] It should be noted that the study of insect populations in the early 20th century had an important place in the development of mathematical biology.[32] By the 1950s, competing hypotheses about the mechanism of prey-predator interaction and the apparent "balance" of their populations generated debate over the relative merits of density-dependent and density-independent factors, while different models offered divergent predictions about the mechanism of predation in different life stages of prey and in the presence of multiple predators.

Compared to their American colleagues who received funding from the Atomic Age institutions like AEC and Oak Ridge, the career of Canadian ecologists was mostly confined to resource management: forestry, fishery, agriculture, and conservation. Yet, Canadian ecologists like Holling were no less eager to engage in theoretical debates or learn novel techniques. Specifically, Holling was attracted to computer simulation and programming languages like FORTRAN.[33] For instance, in Watt's *Systems Analysis in Ecology*, Holling argued that ecologists should create "an intimate feedback between experiment and theory" by building a set of malleable computer models, which enabled

[31] Crawford S. Holling, "The Components of Predation as Revealed by a Study of Small-Mammal Predation of the European Pine Sawfly," *The Canadian Entomologist* 91, no. 5 (1959): 293-320.
[32] The history of this research programme is nicely summarized in Sharon E. Kingsland, *Modeling Nature: Episodes in the History of Population Ecology* (Chicago: University of Chicago Press, 1995).
[33] Crawford S. Holling, *Bubbles and Spirals: The Memoirs of C. S. Buzz Holling* (Stockholm: Resilience Alliance, 2017), 15-20

ecologists to make frequent revisions based on empirical data.[34] Cybernetic metaphors also influenced Holling's modelling philosophy. Not only did cycles of mathematical transformations regulate ecosystems, but ecological research represented a "feedback" between simulation and fieldwork. Harnessing the power of computer models and the rhetoric of holism, Holling embarked on a new career in which he became not merely an agricultural entomologist or a theoretical biologist, but a systems scientist who could provide solutions to a variety of environmental issues.

In 1966, Holling's strategy finally paid off: the Ecological Society of America (ESA), recognizing his contribution to mathematical modelling for insect populations, awarded him the George Mercer Award for early career ecologists. Consistent with his self-presentation, the paper that earned him the honor had both theoretical and practical importance. By arguing that predators with specific functional responses to prey density could drastically lower the prey population, Holling offered a justification for biological control and reduction of synthetic pesticide use.[35] Holling's success in branding his research as both an economic solution and a scientific discovery led Gordon Harrison, director of the Resources and Environment Program at the Ford Foundation, to recruit him for the simulation project which later gave rise to the IIPS.[36]

Through his connection to Ford, Holling moved one step closer to his American counterparts in his ability to assemble networks and to garner support. Holling's rising interests in urban issues nonetheless led him to a career path different from "mainstream"

[34] Crawford S. Holling, "The Strategy of Building Models of Complex Systems," in *Systems Analysis in Ecology*, ed. Kenneth E. Watt (New York: Academic Press 1966), 213.
[35] See Crawford S. Holling, "The Functional Response of Predators to Prey Density and its Role in Mimicry and Population Regulation." *The Memoirs of the Entomological Society of Canada* 97, no. S45 (1965): 5-60.
[36] Holling, *Bubbles and Spirals*, 33.

systems ecologists. At the time, the most lucrative opportunity for ecologists was the International Biological Program (IBP) which, between 1968 and 1974, received multi-million dollar grant from U.S. Congress. While relying on simulation models, Holling's research programme parted ways with the large-scale biome studies of tundra, forests, and grasslands in the IBP.[37] If IBP ecologists concentrated on the functions of "natural" ecosystems, Holling focused instead on the *dysfunction* of human-dominated systems, which was elaborated by different urban environmental problems.

To realize his ambition, Holling spent the late 1960s searching for allies in the community of ecologists. Initially he had the support of Herbert Bormann, president of ESA in 1970 and a pioneer in the study of the ecological impact of acid rain. Holling was asked to explore "the role of ecology and the ESA in the urban crisis" and examine the feasibility of creating "a section on urban ecology and planning" in ESA.[38] The task led to the publication of a report titled "Toward an Urban Ecology", which I will discuss in detail below. Unfortunately, ESA did not continue its support for Holling's research. The networking and funding opportunities offered by the Ford Foundation subsequently made it the most crucial ally for Holling in his first five years at the University of British Columbia, where he received his first academic position in 1967.

Although Holling started his university career fairly late, he was by no means a "junior" scientist. He arrived at UBC as Full Professor and the Director of the Institute of Animal Resource Ecology (IARE).[39] IARE was founded in 1969 as an expansion of the

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[37] Kwa, "Representations of Nature" and Hagen, *Entangled Bank*, 164-188.

[38] Letter from F. Herbert Bormann to Crawford S. Holling and Gordon Howell Orians, September 2nd, 1970. The Ecological Society of America's History and Records. https://esa.org/history/wp-content/uploads/2015/06/Bormann-urban-1970.pdf. [last accessed February 21, 2020]

[39] According to Kenneth Watt, who wrote the reference letter for Holling, by 1967 Holling "received 20 university offers a year" and "could have at least one endowed chair in the Ivy League". Letter from Kenneth

Institute of Fisheries, and Holling's mission was to coordinate the group of scientists cross-appointed by departments as diverse as Forestry, Zoology, and Commerce. Peter Larkin, the last director of the Institute of Fisheries, aptly described the transition period as follows: "Things bubble here as the ecological brew begins to acquire potency."[40] In the meantime, the Ford Foundation provided two separate grants to support Holling's research programme: the first was used to create a simulation-oriented institute called the Resource Science Centre (RSC) in 1968, while the second became part of the initial budget of the IIPS in 1970.

Before examining Holling's role in creating and maintaining IIPS the Platform, I would like to study two of his theoretical papers concerning the relation between cities and ecologists, both published in 1971 and thus potentially reflecting his understanding of urban system at the beginning of the project. The first, "Ecology and Planning," was co-authored with Michael Goldberg, a UBC economist and modeller who served with Holling as Co-Director of IIIPS until 1972. Focusing on the environmental and socio-economic problems caused by the use of DDT for malaria and agricultural pest control, the article criticized policies that applied simplistic solutions to complex systems. Since a system retained its characteristics only when the disturbances it received were within a certain *boundary*, changes exceeding this boundary could lead to a new system where the initial equilibrium was no longer attainable. The authors argued that urban projects that utilized "the simplest and most direct intervention" similarly failed because they neglected the complex nature of cities. Freeway projects that stimulated "urban sprawl and inner city

E. Watt to Peter A. Larkin, April 10th, 1967. Box 10, Folder 18, Peter A. Larkin fonds (hereafter Larkin fonds), The University of British Columbia Archive, Vancouver, British Columbia, Canada.
[40] Letter from P. A. Larkin to C. S. Holling, July 10th, 1967. Box 10, Folder 18, Larkin fonds.

decay," ghetto removals that "disrupted social interaction," and industrial tax cuts that contributed to "pollution deteriorating the quality of life" were all examples of practices which falsely simplified the urban system.[41]

The second paper, "Toward an Urban Ecology", was written with University of Washington zoologist Gordon Orians in 1970 for ESA's inquiry into urban problems. It began with a discussion about the properties shared between ecosystems and urban systems, and attempted to present ecologists as a unique class of urban experts whose mandate was less "improving the efficiency of the urban system" than "maintaining the resilience" of the ecological and socio-economic components of the city.[42] While the authors acknowledged the limited predictive power of ecosystem models, they argued that, since solving urban issues required an interdisciplinary approach, ecologists could contribute to this endeavour by working "in conjunction with economists, sociologists, or engineers."[43]

A common thread ran through both articles—the presentation of ecology as a systems science studying "boundary" and "resilience", the assertion that urban issues demanded the examination of the systematic complexity of cities, and the conclusion that ecologists could make unique contributions to this interdisciplinary problem. To study the boundary in which a system could remain resilient in the long run was more desirable than "fixing" the system at an "equilibrium" in the short run. The strength of ecology, as reflected in Holling's papers, lay in its recognition of the limitation of one-size-fits-all solutions and its potential to apply the complexity of a system to remedy its own systematic

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[41] Crawford S. Holling and Michael A. Goldberg, "Ecology and Planning," *Journal of the American Institute of Planners* 37, no. 4 (1971): 226
[42] Crawford S. Holling and Gordon Orians, "Toward an Urban Ecology," *Bulletin of the Ecological Society of America* 52, no. 2 (1971): 5
[43] Holling and Orians, "Toward an Urban Ecology," 6.

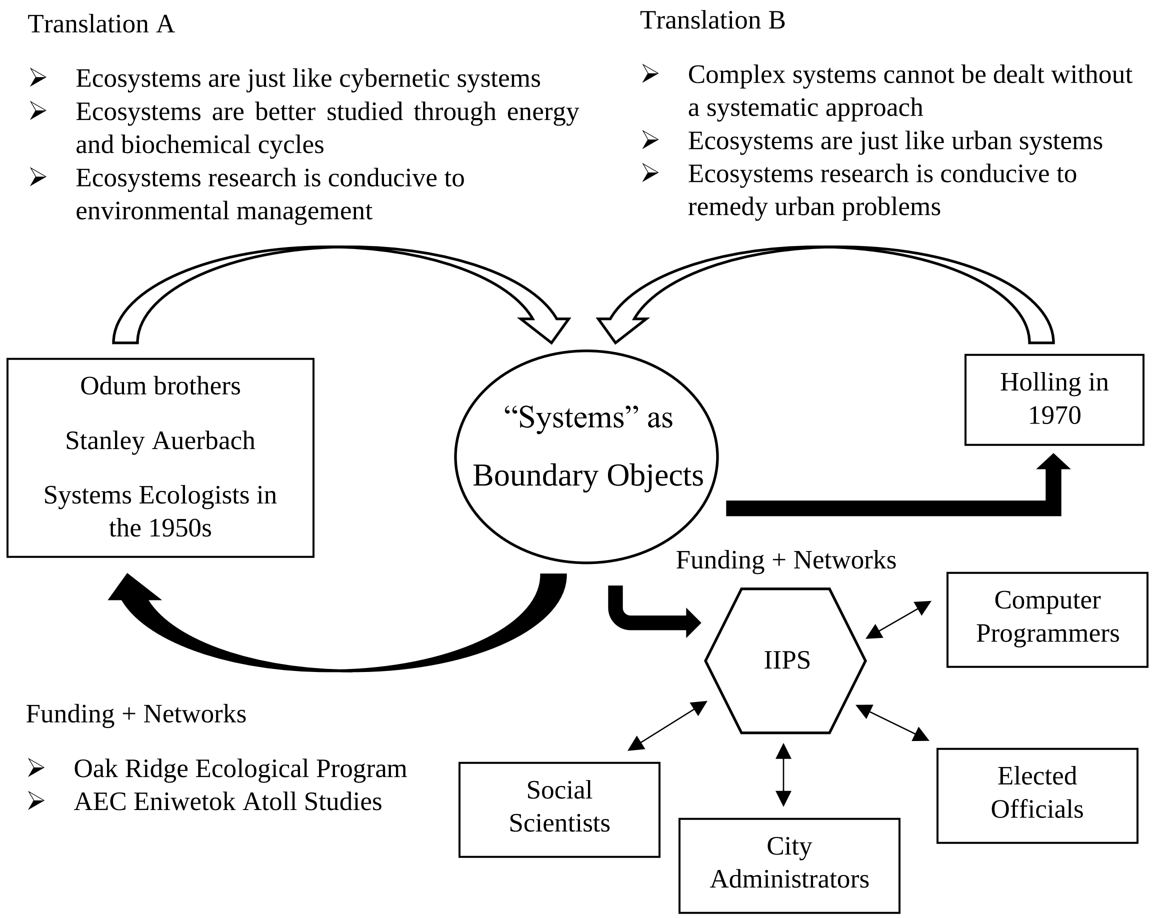
problems. Compared to mid-century cyberneticians' ambitions to make their field "universally and eternally true because its Moment had arrived,"[44] or to the technocratic vision systems ecologists inherited from cybernetics, Holling's ecologist-as-systems-scientist advocated for caution in urban research. While the strategy Holling used to make room for ecology—translating the discipline into a branch of systems science—was not new, the goal of this translation was less about the advancement of ecological theory than the reform of urban planning.

To further compare Holling's strategy with that of earlier systems ecologists, I argue that ecologists advanced their careers by using "systems" as "boundary objects." Susan Leigh Star and James Griesemer defined boundary objects as "scientific objects which both inhabit several intersecting social worlds" and "satisfy the informational requirements of each of them."[45] For instance, the radiated atoll in Eniwetok could be considered an operational risk by the command and control system, but it was also an ecosystem with energy and material cycles. The different but compatible meanings of "systems" thus enabled various "translations" which allowed ecologists to make certain knowledge claims and expand the scope of their research. Just like systems ecologists in the 1950s appealed to the authority of systems science to fund the research on energy and biochemical flows, Holling presented his expertise in systems ecology as conducive to the study of urban systems in the early 1970s. As a result, it may be suggested that the "systems" in systems ecology functioned as boundary objects in the construction of the discipline (Figure 2).

[44] Bowker, "How to be Universal," 117.

[45] Susan Leigh Star and James R. Griesemer, "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39." *Social Studies of Science* 19, no. 3 (1989): 393.

Figure 2 Network Strategies of Systems Ecologists



However, IIPS differed from the previous collaborations because of its multiple and partial methods to *discipline* the Platform.

2.3 Disciplining the Platform

“You have to have idealism in your system and the system has to be set up so that it will listen to the dreamers. But on the practical side of it you have to be awfully careful at what point you bring your ideals into a discussion and how you bring them in.”—Drew Thorburn in an interview with Gil Evans, communication manager of IIPS.[46]

What is the relationship between boundary objects and the techniques designed to “discipline” the network that relies on these objects? Star and Griesemer’s paper used the works of ecologist Joseph Grinnell to elucidate this connection. Grinnell’s research on the

[46] “IIPS Newsletter,” page 7, February 16th, 1973. Box 4, Folder 10. IIPS fonds.

evolution of the California landscape through scientific classification of species was impossible without the cooperation of diverse actors—his patron Annie Alexander, the collectors and trappers, the university administrators, and the animals themselves. The specimens became boundary objects which retained different meaning for different actors, and to ensure the "autonomy and communication between worlds" embodied by these objects, Grinnell devised "a clear set of methods to 'discipline' the information obtained" by non-scientist actors.[47] As the only ecologist in the network, Grinnell used the *standardization* of specimen quality to discipline other actors' activities. He could then affirm his authority while enlisting other actors into his own research programme.

Seen in this light, when ecologists like Odum or Auerbach entered the field of cybernetics and systems science, their agenda perhaps resembled that of trappers' and collectors', which was viewed as less "scientific" by cyberneticians from the physical sciences. It was only after systems ecologists turned their field into a matured branch of systems science that ecosystem models became an authoritative form of knowledge production. In projects like IBP, systems ecologists assumed the "Grinnellian" role and disciplined the data collected by field assistants based on the design of computer models. Holling's position in IIPS was more complicated. Although he might attain the role of Grinnell at IIPS the Platform through his self-presentation as a systems scientist, when constructing IIPS the Product, Holling's lack of knowledge in urban models made him mostly a project manager serving as a liaison between IIPS and its patrons.

Instead of a network stabilized by a set of standardized methods and expanded through those "disciplined" boundary objects, IIPS improvised, tested, and discarded

[47] Star and Griesemer, "Institutional Ecology," 404.

multiple disciplinary techniques to accommodate its changing organizational structure. I divide the project into three phases and highlight the disciplinary techniques adopted in each phase. The first phase (1970-71) included the beginning and rapid expansion of IIPS, in which the systems scientists tried to control the project membership by defining the project mandate as creating a computer simulation model. The second phase (1972-73) witnessed the departure of the two Co-Directors and efforts to preserve the Platform through the consolidation of the "Core Group." The last phase (1973-74) documented the directorship of Drew Thorburn, who struggled—and eventually failed—to reorient the research activities and satisfy the patrons of IIPS.

A document nicknamed "The Proposal" offered a snapshot of the conception of the project.[48] Prepared in May 1970 by Holling and Goldberg, it mentioned the rationale of creating a simulation project in Vancouver, the methods the project would adopt, and the expected outcomes. Interestingly, the proposal started by highlighting the physical geography of Vancouver, especially its well-bounded topography, and the absence of large-scale planning projects in its history. Both factors made the region "rarely suited as a laboratory for studying urban systems."[49] The authors then provided a review of urban simulation studies in North America and explained the limitations of past projects. The pitfall in transportation planning, for example, came from an overemphasis on the road network: even if modellers could draft meticulous plans for a "highway system", such a system remained a "subsystem of a total transportation system of the larger urban subsystem of the more general urban ecosystem."[50]

[48] Michael Goldberg and C.S. Holling, "The Vancouver Regional Inter-Institutional Policy Simulator," May 27th, 1970, Box 10, Folder 7, IIPS fonds.
[49] Goldberg and Holling, "Policy Simulator," page 3.
[50] Ibid., page 4.

Subsequently, the Bay Area Simulation Study (BASS) served as an example of a more comprehensive and holistic simulation project. Created by a Berkley team which included Goldberg, BASS built a multi-model simulator based on a computer database of employment records, demographic data, and land use patterns. Designed for regional economic forecasting, BASS nonetheless failed to attract users from local government due to a lack of collaboration between the academics and city officials. To remedy the flaws of BASS, the authors suggested that a "continual feedback between hypothesis, model, and experiment" should be included in IIPS as an *interactive network* between the modellers exploring policy options and the officials who tested these alternatives.[51]

As a result, IIPS was conceived as an experiment of institutional arrangement. The early organizational structure included Holling and Goldberg as the Co-Directors, the subgroups working on different simulators, and a "Core Group" where academics and urban administrators discussed the goals of the study. However, tensions between IIPS the Platform and IIPS the Product surfaced in this early stage. It was true that, at the Platform level, IIPS aimed to recruit as many "experts" as possible into the network. Nevertheless, since the mandate of the project was to construct a simulator, those who challenged the primacy of models were unlikely to join the Platform even if they were considered potential contributors.

For example, the project had difficulty in winning support from the Department of Anthropology and Sociology. Although the Department Head, Cyril Belshaw, along with faculty members Dorothy Smith and George Gray, attended the "Open Meeting" held in June 1970, the Department remained reluctant to participate in the project in the following

[51] Ibid., page 5. This "feedback loop" type of research design indeed reflects the influence of Holling and of systems thinking in general on the project.

months.[52] The short exchange between Kelly, Smith, and Levy mentioned at the beginning of the thesis indicated how experts outside the IIPS network addressed concerns related to models. However, Kelly viewed Smith's critique as "being political and jurisdictional in origin",[53] and Levy's objection as "unrealistic" since the project could not "exercise control over simulation once it has become public property."[54] By defining the goal of IIPS as the creation of a simulation model that had to be adopted in policy making, a first set of disciplinary techniques was invented to draw boundaries between those who were welcome by the Platform and those who were not.

How effective were such techniques? IIPS did succeed in attracting academics and graduate students who formed various subgroups and tackled different aspects of the city. Participants appeared to treat IIPS the Product as a variety of boundary objects. As long as their agenda affirmed the importance of computer models, they could stay in their own subgroups and pursue ideas that were translated as models or modelling: from writing computer programs to collecting social statistics, from creating conceptual diagrams to chatting with city officials. The focus on systems and models enabled some members to adopt a highly decontextualized approach to the city. The Human Activity Systems Model (HASM) conceived by Robert Kelly's Human Ecology subgroup was a good example. HASM aimed to transform individuals' daily routines into probability matrices that simulated the spatial-temporal distribution of human activities, and thus enabled planners to optimize urban land use. Assuming that "individuals in a population share common

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[52] The Open Meeting well reflected the interdisciplinary ambition of IIPS the Platform. For instance, the invitation letter for the meeting stated that since no expert can have the knowledge for all the "subsystems" the project aimed to study, the project was "most interested in inviting the broadest possible University participation." "Open Meeting," June 19th, 1970, page 1, Box 17, Folder 3, IIPS fonds.
[53] Kelly, "IIPS Diary Item," page 1.
[54] Ibid., page 2.

needs, have relatively similar stocks of resources, have similar cultural and social origins, and perceive their urban environments in much similar manner,"[55] HASM simulated not only the location but the *sequential order* of activities—working, recreation, and shopping—conducted by specific populations in Vancouver.[56]

The challenge to create such a simulated urban system was both technical and organizational. How could one coordinate the subgroups and distribute tasks such as data-gathering, modelling, and programming? What were the policy options useful to the local government? How could the project ensure the interaction and compatibility between submodels? These issues emerged in the first phase of IIPS, and by 1972 they threatened the continuation of the project. If the first set of disciplinary techniques built IIPS the Platform by maximizing participation and preserving the centrality of IIPS the Product, the second set shifted focus from the Product as a potential boundary object to the prevention of an organizational crisis. This crisis was manifested, but not limited to, the withdrawal of the two Co-Directors. Here I focus on Holling's side of the story.[57]

Holling's reason to quit IIPS was twofold: one was the difficulty of coordinating the ecological subgroups and the economic subgroups in the project, and the other was the role conflict he experienced as the director of both IARE and IIPS. The ecologists' marginal position in IIPS was reflected in the fact that, among the eight subgroups, only

[55] Robert Kelly, "Human Ecology Subgroup," page 1, November 1972, Box 3, Folder 5, IIPS fonds.
[56] Intriguingly, it was in HASM that IIPS has the chance to collaborate with Department of Anthropology and Sociology, primarily through the liaison between Kelly and urban sociologist George Gray. However, while Kelly considered Gray's participation one step toward breaking "the functional boycott," he also defined Gray's role, and that of the Department in general, as data collector but not theoretical modeller; as Kelly admitted, he recruited Gray primarily because "this co-operative effort will substantially reduce the amount of fieldwork we will have to do internally." Robert Kelly, "IIPS Diary Item," page 1, November 2nd, 1970, Box 16, Folder 1, IIPS fonds.
[57] Goldberg's resignation in early 1973 was mainly due to disagreement with other Core Group members concerning the research direction of the project.

two of them—the health system subgroup and the pollution subgroup—included IARE faculty or students. This situation might have been caused by ecologists' lack of interest in urban simulation, but it also partially implied the *overwhelming interest* IIPS aroused among the modellers from the Faculty of Commerce and Business Administration, who essentially dominated the project. Although these urban modellers were influenced by the ideas of "boundary" and "resilience,"[58] their professional network remained largely separated from that of the ecologists.

By July 1972, the ineffective communication between subgroups compelled the Core Group to take the organizational flaws seriously. A special meeting was held to discuss issues such as "objectives of participating institutions, minimum standards for Core Group members, management versus advisory functions, and public participation and communications."[59] As a result, the Core Group acquired more management power, a full-time communication manager was hired to produce monthly operational reports, and public-oriented programs became a focus of the project. However, the Core Group enhanced its power by creating a group of salaried staff whose job was solely to provide secretarial and programming services, rather than by recruiting professional modellers who could coordinate the research activities in the subgroups. To make things worse, in late 1972 a debate broke out within the Core Group concerning the relative merits of "studying carefully one or two runs of a highly disaggregated model" and "glancing at many runs of quick, highly responsive inter-acting models."[60] Eventually the modellers decided to

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[58] Holling and Goldberg, "Ecology and Planning," See also Michael A. Goldberg and Robert F. Kelly, "Correlates of Natural and Urban Systems," *The Annals of Regional Science* 4, no. 2 (1970): 26-35.
[59] Drew Thorburn, "Summaries of Core Group Meetings," page 2, October 18th, 1972, Box 5, Folder 14, IIPS fonds.
[60] J.L. Parker, "A Short Summary of the IIPS Six Month Research Plan," page 1, December 29th, 1972, Box 5, Folder 14, IIPS fonds.

experiment on both kinds of models, which delayed the development of the actual simulator. Goldberg later lamented that although IIPS "successfully avoided the product oriented pitfalls" of BASS, it "had fallen prey to a host of new *process related* dangers."[61] To put it another way, IIPS had "too much concern for form" but "too little concern for, and support of, modeling activities."[62]

A paradox thus appeared. By shifting the focus from the production of models, the Core Group attempted to save the Platform through an emphasis on consensus and communication processes. However, what this disciplinary technique actually achieved was further consolidation of the network of urban modellers and city managers *within the Core Group*. This consolidation could not strengthen the already weak connection between ecologists and the rest of the project members. As the dominance of business modellers impeded Holling's original goal of using IIPS to create a network of systems scientists across UBC, he had few incentives to remain in the project. Moreover, while IIPS used the physical infrastructure of the Resource Science Centre (RSC), RSC and IIPS were funded by two separate Ford Foundation grants. This was a disadvantage for Holling, since IARE relied on the computer hardware in RSC not only for data storage and analysis but for graduate-level courses.[63] The computer-intensive research program that Holling pursued

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[61] Michael A. Goldberg, "Simulating Cities: Process, Product, and Prognosis," *Journal of the American Planning Association* 43, no. 2 (1977): 151, emphasis mine.

[62] Goldberg, "Simulating Cities," 152. Another account on the lack of modelling work was provided in the third annual report: "The end result of the Core group based administrative system was leadership less forceful forceful than it should have been with too great a proportion of total energies devoted to administration and too little research." R.F. Kelly, "Third Year Report," page 7, October 1973, Box 14, Folder 12, IIPS fonds.

[63] In addition to IARE, the Department of Zoology and Botany also shared the computer infrastructure at RSC. The computer was rented from IBM, and users were charged for "computer time", memory cores, and punch cards. See "Minutes of the Second Meeting of the Institute of Animal Resource Ecology Steering Committee," page 1, November 1st, 1972, Box 6, Folder 1, Fisheries Centre fonds. The University of British Columbia Archive, Vancouver, British Columbia, Canada.

easily became a source of conflict. For example, Charles Krebs, a mammal ecologist, protested that the Institute was "heavily committed to computing facilities" but not to "facilities for field ecology."[64] Holling's commitment to IIPS thus threatened to disrupt his graduate courses and strain his relationship with colleagues. Seen in this light, his critique of IIPS during an IARE meeting—"programmes like IIPS should be completely divorced from the Institute due to lack of surety of its success"—were understandable.[65]

After the 1972 reorganization, IIPS entered its third phase under the directorship of Drew Thorburn, a GVRD planner and former Core Group chair. In the beginning of the third phase, the relationship between IIPS and its patrons appeared to be fairly good. Harry Swain, an economic geographer serving as liaison between IIPS and MSUA, had suggested that MSUA would continue funding the project even if the local governments withdrew their support, and that the virtue of IIPS was to allow "a general overview of what might happen under certain conditions."[66] It seemed that the Core Group retained faith in the unique status of the project—an intellectual exploration as well as a practical exercise—and the struggle to discipline the Platform would be rewarded once the model was operational and the computer program fully developed. According to Robert Kelly, the interim Project Director before Thorburn's appointment, organizational crises were "inevitable in a project such as IIPS" because its complicated and experimental nature was prone to "discouragement, recriminations, and an absence of clear-cut and easily-attained objectives." [67] As the project had survived the stages of conceptualization and

[64] Letter from Charles J Krebs to CS Holling, page 1, November 2nd, 1972, Box 6, Folder 1, Fisheries Centre fonds.
[65] "Remarks at the First Meeting of the Institute of Animal Resource Ecology Steering Committee," page 3, September 14th, 1972. Box 6, Folder 1. Fisheries Centre fonds.
[66] "Core Group Meeting," page 4, April 30th, 1973. Box 4, Folder 10. IIPS fonds
[67] "April-May Operation Report," page 1. June 8th, 1973. Box 4, Folder 10. IIPS fonds.

specialization—the expansion, downsizing, and stabilization of its membership, Kelly believed that it was now time for the participants to focus on practical model-building, apply the model to real scenarios, and engage local communities. Instead of discovering scientific truths about the "nature of cities", the goal of IIPS had become the fulfillment of the contract with its sponsors. The final set of disciplinary techniques thus focused on the reorientation of the Platform to the sponsors' expectations about the Product.[68]

This set of techniques was nonetheless the least successful as the representative of the sponsors began challenging the management power of the Core Group. A crisis broke out after Barry Wellar was appointed as the liaison between IIPS and MSUA in late 1973. Wellar was disappointed with the communication procedures of the project, in which decisions were made frequently without consulting him or the Ministry. For example, when the Core Group decided to offer an honorarium of $5,000 to compensate Kelly's volunteer work as the interim Project Director, Wellar opposed this practice.[69] The Core Group nonetheless made the compensation without Wellar's knowledge. Two communication-related controversies in early 1974 further damaged the trust between IIPS and MSUA: a surprise visit of William Armstrong, Deputy President of UBC, to MSUA, and the Core Group's participation in a conference at the request of the Ford Foundation. Insisting that Thorburn should notify him in advance about these activities, Wellar warned that "IIPS' hopes for success" depended on "frank and full disclosure on the part of all parties."[70] From the Core Group's perspective, Armstrong's visit was a strategy to deepen the connection

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[68] For an overview on how scientists translate their patrons' interests, see Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Harvard University Press, 1987), 108-121.
[69] In fact, Wellar considered doing uncompensated research part of the freedom academics enjoyed. See "Core Group Meeting Verbatim," page 2. November 21st, 1973. Box 1, Folder 30, IIPS fonds.
[70] Letter from Barry Wellar to Drew Thorburn, page 3, February 1st, 1974, Box 1, Folder 30, IIPS fonds.

with the Ministry, while the Ford conference was an opportunity to expand the inter-institutional network. For Wellar, these unreported actions reflected at best another sign of poor project management, and at worst attempts to bypass him in the liaison with the sponsors.[71] Tension between the two institutions rose to the extent that Thorburn asked all "meetings and other conversation involving members of the Core Group, and in particular Barry Wellar" to be tape-recorded, and he cautioned that failing to do so may cause a disaster "equivalent of the Watergate tape fiasco" and "destroy whatever little credibility" IIPS retained with the Ministry.[72]

Wellar's criticism of IIPS subsequently extended from its management style to its technical accomplishments. As an external review called by MSUA was approaching, he requested complete project documentation, arguing that the reviewers should have "read and digested the materials" before they evaluated the simulator at UBC.[73] Wellar seemed to imply that without the model structures and computer programs examined in advance, the simulator demonstration would be used by the Core Group as a chance to impress those ill-prepared reviewers while obscuring technical flaws. Eventually the review was, as I mentioned in Chapter 1, largely unfavorable.

Certainly, factors independent of Wellar's hostility toward the Core Group also contributed to the unfavourable review of IIPS the Product. For example, according to the review team, the Project Director was unable to "set priorities, meet deadline [sic], and demand some measure of quality in the work produced" because of the "reliance on

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[71] The conference the Core Group attended was related to the preparation of Confex—latter known as Habitat I, or the first United Nations Conference on Human Settlements, which was held at Vancouver in 1976. Had the IIPS continued to 1975, it might really benefit from the urban focus of the conference and create new institutional alliance. See the letter from Drew Thorburn to Barry Wellar, March 7th, 1974, Box 1, Folder 30, IIPS fonds.
[72] Letter from Drew Thorburn to Charles Levy, page 1, March 19th, 1974. Box 1, Folder 30, IIPS fonds.
[73] Letter from Barry Wellar to Maurice Egan, page 1, March 27th, 1974, Box 1, Folder 30, IIPS fonds.

volunteers" to build submodels.[74] This reliance on volunteers had been an issue since the second phase of the project. In fact, the Computer Services was the only subgroup whose members were salaried, which might explain the high quality of their program. Other UBC academics remained volunteers, and their works constituted the foundation of IIPS the Product. Nevertheless, as Thorburn would admit in the final report of IIPS, each "University Department was very reluctant to reward their staff for work done in IIPS because that work gained few papers or reports that could be reproduced under the name of that Department."[75] The consolidation of the Core Group in 1972 essentially failed to engage and discipline the volunteer modellers whose activities determined the ultimate fate of the project.

It should be noted that Wellar, as the representative of MSUA, became the first *sponsor* who directly engaged in the disciplining of the network. Neither the expansion of project membership during the first phase of IIPS, nor the shift from productivity to consolidation during the second was scrutinized by its sponsors. While the flaws in IIPS the Product originated in long-term organizational problems with the translation of the ideas of systems to the simulator, these problems were exacerbated when the sponsors started questioning the integrity of the whole Platform.[76] Thus, the authority of the Core Group was severely damaged after the failure of its disciplinary techniques was revealed. The Platform then unravel in the summer of 1974.

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[74] "Report of a Review Team," page 15.
[75] Drew Thorburn, "Final Report of the Inter-Institutional Policy Simulator (IIPS) Project," page 11, 1976, Box 14, Folder 15, IIPS fonds.
[76] In a sense, IIPS may be considered a "boundary organization" which relied on multiple sets of patrons to survive. The relative autonomy of the project in the first three years nevertheless seemed to make the Core Group downplayed the influence of their patrons. See David H. Guston, "Boundary Organizations in Environmental Policy and Science: An Introduction." *Science, Technology, & Human Values* 26, no. 4 (2001): 399-408.

2.4 Some Counterfactual Thoughts

"Instruments of vision mediate standpoints; there is no immediate vision from the standpoints of the subjugated. Identity, including self-identity, does not produce science; critical positioning does, that is, objectivity. Only those occupying the positions of the dominators are self-identical, unmarked, disembodied, unmediated, transcendent, born again."[77]

In the year that IIPS was initiated, on the other end of the continent, a biology student at Yale had just started her dissertation. Frustrated with laboratory routines, she encountered an ecologist who allowed her to conduct historical and philosophical study for the degree. "He was a kind of British feminist of the old school, basically just a pro-woman person, especially intellectual women." Recalling her doctorate supervisor G. Evelyn Hutchinson, Donna Haraway commented: "It is in many ways the Hutchinson school that shaped American ecology, particularly theoretical ecology."[78]

Did systems ecologists' attempt to create a research programme by grafting the cybernetic metaphors onto organicist ecology necessarily lead to the construction of a mechanistic, decontextualized, and disembodied ecosystem? Did planners' embrace of simulation models require the exclusion of radical critiques of social knowledge? And was the collaboration between systems scientists and city managers doomed from the start because of the abuse of the "systems" metaphor and the false promise of models? This brief section explores these questions by arguing that the history of IIPS reflects not only the gaps between vision and reality in systems science, but also the *boundary work* in which systems scientists engaged.[79] Such boundary work was elaborated by a paper written by

[77] Donna Haraway, "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective," *Feminist Studies* 14, no. 3 (1988): 586

[78] Donna Haraway and Thyrza Goodeve, *How like a Leaf: An Interview with Thyrza Nichols Goodeve* (New York: Routledge, 2000), 19.

[79] See Thomas F. Gieryn, "Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists," *American Sociological Review* 48, no. 6 (1983): 781-795..

Goldberg and Kelly which contrasted their systems approach and the "urban ecology" programme created by interwar "human ecologists," composed mostly of sociologists from the University of Chicago.[80]

The two authors first criticized interwar human ecology as "a sample of pitfalls of transplanting concepts from one discipline to another."[81] However, eager to utilize ecological ideas themselves, they argued that their own method, which focused more on "how the system behaves in the aggregate" than on "how its various parts interact", provided better insights into cities.[82] Systems scientists performed boundary work by placing the study of systems mechanisms—frequently through simulation—above the study of particular entities within the system. Similar to systems ecologists' privileging of ecosystem models over field research, urban systems scientists reduced ethnography to the collection of "behavioral data" that only became meaningful via the mediation of models. The postwar introduction of cybernetic ideas into interwar organicist biology and sociology thus emphasized not the ontological transgression and ambiguity of the cyborg, but the disembodied command and control of the technocrats.

Indeed, as I highlight in Chapter 3, the systems scientists of IIPS were also wary of the limitations of technoscience and the technocratic obsession with efficiency. And yet

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80 For a review on how planners and real estate developers appropriated the research of Chicago School sociologists, see Jennifer S. Light, *The Nature of Cities: Ecological Visions and the American Urban Professions, 1920–1960* (Baltimore: Johns Hopkins University Press, 2009).; for a study of how sociologists like Robert Park and Ernest Burgess used interwar community ecology to advance a "scientific" sociology modelled on biology, see Emanuel Gaziano, "Ecological Metaphors as Scientific Boundary Work: Innovation and Authority in Interwar Sociology and Biology." *American Journal of Sociology* 101, no. 4 (1996): 874-907.

81 Goldberg and Kelly, "Correlates of Natural and Urban Systems," 28.

82 Ibid., 31. Nevertheless, as economic modellers, Goldberg and Kelly also reduced the "diversity" of ecosystem to the "diversification" of infrastructure and business sectors by comparing the high-income suburbia to unstable, high-energy-demand monoculture that attracted "thieves", "muggers", and other "urban pests"; if zoning practices of 1950s aimed to protect privileged neighborhood from the urban "succession", such practices were attacked by Goldberg and Kelly through another set of ecological idea—but the goal of maintaining the well-off sector of the society persisted. Ibid., 34

the Core Group attempted more to preserve the experts' status in a changing socio-political context than to challenge the centrality of "systems" through a reflexive and situated critique. Thus, the social movements of early-1970s North America, especially the women's rights movement and environmental movement, were excluded from both IIPS the Product and the Platform. However, I would like to make some counterfactual speculations to illustrate the potential of such (missed) connections.

If the Department of Anthropology and Sociology, especially the faculty who were more critical of the "system" concept, had been included from the beginning, the project might have taken a different path. Instead of creating a Core Group focusing on the theoretical aspects of modelling in 1972, the sociologists might have devised a more robust public program which would have brought the information systems developed by Computer Services to the community in early 1973 instead of 1974. This might have redefined IIPS the Product as an information system design *together with* grassroots organizations. However, in this scenario the MSUA would have terminated its support, and the simulation program would still be wasted.

A more radical scenario might have been a different kind of "Open Meeting" in 1970, in which subgroups were not formed by university academics but by grassroots organizations—environmental groups collaborating with ecologists to create pollution models, neighborhood associations taking the lead in the conception of land use models, women's health groups formulating a health care system based on computer networks and self-help clinics—and the coordination between groups was not mediated by a Core Group but conducted through direct participation and deliberation.[83] This scenario is undoubtedly

[83] The potential for IIPS to collaborate with green groups was impeded after the withdrawal of Holling, but the strong ties between IARE and local green groups made the counterfactual scenario possible. As for

a fiction, and yet the vision of systems science and its boundary work also relied on certain fictions of science and society. The real issue is who tells the story.

women's rights movement, Nancy Kleiber, member of Computer Service, was also an organizer of the Vancouver Women's Health Collective, and the Information System might be used by the Collective.

Chapter 3. Between the Closed World and the Green World

"C. S. Holling, called 'Buzz' because of an early and fortunately unsuccessful interest in bombs"—statement about Holling in his reception of the 1966 Ecological Society of America's George Mercer Award.[84]

Holling's nickname "Buzz" may have been derived from the "buzz number" used by the United States Air Force to designate military aircraft in the early Cold War. As Paul Edwards has argued, fears of bomber raids permeated American society and culture even after intercontinental ballistic missiles became the most critical nuclear threat in the 1960s. The three decades following the end of World War II were certainly an era of dramatic technoscientific development and of technology-related anxiety. The result was the proliferation of a "closed-world" discourse that "articulated geopolitical strategies and metaphors (such as 'containing' Communism) in and through military systems for centralized command and control."[85] From *Dr. Strangelove* (1964) to *2001: A Space Odyssey* (1968), closed-world dramas illustrated such fears about Cold-War technoscience, especially computers.

However, another form of fiction also emerged to respond to the closed world: that of the "green world" which made plants, animals, and life forces "palpably present, frequently as active agents" and explored the "frontier and the inner spiritual journey" in an open universe.[86] This chapter studies IIPS as a dialogue between the closed world and the green world. Section 3.1 examines how academics and officials in Vancouver responded to the environmental anxiety in the early 1970s, and Section 3.2 scrutinizes the metaphor of "social game" in the public program of IIPS. By investigating how the project

[84] "The George Mercer Award for 1966," *Bulletin of the Ecological Society of America* 47, no. 4 (1966): 168.
[85] See Edwards, *Closed World*, xiii.
[86] Ibid., 311.

redefined the experts' roles in society, I argue that the experience of IIPS can illustrate scientists' strategies to adapt their research and practices to social contexts.

3.1 Jeremiah-Technocrats in Vancouver

Politician: "In the long-run we are all dead."
Systems Scientist: "Precisely, unless…"
Politician: "The silly bastard isn't even listening to me."[87]

In a speech delivered during a Ford Foundation conference which included the above excerpt, Robert Kelly argued that one of the hindrances to governmental adoption of simulation techniques was the discrepancy between the officials' preoccupation with "immediate problems" and the scientists' focus on "long-term phenomena and indirect consequences".[88] This conflicting interpretation of Keynes's famous quote shed light on a crucial difference. While the "long run" was viewed by the politician as a symbol of inefficient planning, the systems scientist contended that the reverse was true: our survival cannot be ensured *unless* we have long-term planning. By the early 1970s, the fear of nuclear fallout in North America was coupled with the danger of environmental pollution, urban unrest, and a global population "explosion" which together induced a certain pessimism in the society, especially among the university-educated middle class. Intellectuals such as Paul Ehrlich, Barry Commoner, and Buckminster Fuller further galvanized the public with their warnings of the environmental crisis, even though their understanding of the roots of, and solution to, the crisis differed significantly.[89]

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[87] Robert Kelly, "On Technology and Resource Management Decisions", page 2, November 5th, 1973, Box 8, Folder 3, IIPS fonds.
[88] Kelly, "On Technology," page 2.
[89] For example, while Ehrlich predominantly focused on population control, Commoner expanded the scope of environmental issues to social justice. See Michael Egan, *Barry Commoner and the Science of Survival: The Remaking of American Environmentalism*, (Cambridge: MIT Press, 2009), and Paul Sabin, *The Bet: Paul Ehrlich, Julian Simon, and our Gamble over Earth's Future* (New Haven: Yale University Press, 2013). For a discussion on Fuller, see Anker, *From Bauhaus to Ecohouse*, 68-82.

The academics at UBC also expressed their fear of environmental disaster in their writings. For example, when Peter Larkin was invited to speak at the Society for Industrial and Applied Mathematics, he suggested that mathematicians could enable the ecologists to "foresee the many consequences of man's bumbling efforts to control his environment and himself."[90] He discussed the case of DDT and called attention to the importance of simulation studies, which could create mathematically robust models for pest control. Larkin nonetheless concluded his lecture in a pessimistic tone. Asserting that "the threat of world population explosion" was approaching and "a slow attrition of human resources and spirit" had already started, he warned that eventually people would live in a world where only "a famine or plague" could make the situation "get a bit better for a while", and that scientists ought to find "solutions to the problems while there is yet the possibility of steering events down a different course."[91]

Systems scientists' warnings about the limitations of technology reflected not only their concerns over societal issues but also their ambition to reform the relationship between science and society. If previous technoscientific methods—the pesticide that harmed the ecosystem and the highway planning that caused urban sprawl and blight—failed because of their ignorance of socio-ecological complexity, then a paradigm shift in scientific management was necessary. By proposing ideas such as "boundary" and "resilience," systems scientists argued that the goal of planning must be changed "from maximizing the probability of success to minimizing the chance of disaster."[92] The new

[90] Peter Larkin, "The Possible Shapes of Things to Come." *SIAM Review* 11, no. 1 (1969): 1.
[91] Larkin, "The Possible Shapes," 6.
[92] Holling and Goldberg, "Ecology and Planning," 226.

paradigm rejected one-size-fits-all solutions and instead adjusted technoscience to the complexities of reality.

Since the practical content of IIPS focused predominantly on the economic and infrastructural aspects of the city, the environmental issues by and large did not receive much attention in the modelling or networking processes. However, some examples did exist. They provided a glimpse into how project members understood the implications of systems science and promoted it to suit IIPS's goals. Here, I use a slideshow created by systems ecologist Pille Bunnell for the education workshops of IIPS as an example of the integration of environmental concerns and systems approaches.

The slideshow began its narrative at a strange place called "Simuville." "You", the audience, are transformed into a visitor into Simuville. One inhabitant greets you and explains what life in Simuville looks like. Everyday the inhabitants move through various paths, each of them leading to different "houses." Smaller inhabitants enter a "growth" house and their size increase significantly. Larger inhabitants follow the same path, but grow modestly. Those who are large enough enter a second house and multiply. But in a third house, whoever goes in never comes out. You investigate the house and find a creature that grows by feeding upon the previous group of inhabitants. To preserve both groups, you decide to separate their paths. The consequence of your action turns out to be very serious: the population of Simuville explodes (Figure 3).

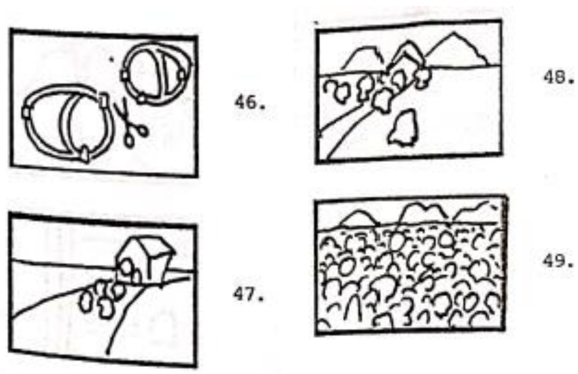

Figure 3 Adapted from Pille Bunnell, "What is a Simulation Model", page 6 and 7, 1974, Box 14, Folder 20, IIPS fonds.

The reason behind this disaster is simple: "The external influence removed the interaction, a negative feedback, which was important to the stability of this system."[93] Thus the narrator cautions against careless intervention in complex systems, and points out the virtue of adopting simulation in testing management options. In the end of the slideshow, you are depicted as standing on top of a hill with a seemingly "holistic" view of the landscape of Simuville. Armed with fresh knowledge about feedback loops and the power of simulation models, you should now be able to plan the real world.

The story of "Simuville" indeed simplified the functions of simulation models. Its educational value might lie more in its cartoonish familiarity than its elaboration of what IIPS was. To help the audience appreciate the basic techniques of simulation and the use of models, it dramatized the impact of a negative feedback, and yet managed to present the "disastrous" consequence of a population boom as a "lesson to learn" rather than the prelude to a total socio-ecological breakdown. This image of computer models as a friendly and comprehensible, but not trivial, technology, and the representation of environmental issues as serious but solvable, reflected the effort to make IIPS relevant to contemporary social issues while also reinforcing the primacy of models in crafting the remedies. This strategy of navigating a middle ground between responding to public concerns and maintaining the authority of experts, I argue, was mirrored by the political milieu of 1970s Vancouver.

After World War II, the Government of British Columbia established the Lower Mainland Regional Planning Board (LMRPB) and put unincorporated land under the regulation of new municipalities.[94] In 1968, LMRPB was dissolved into four regional

[93] Bunnell, "What is a Simulation Model," page 7.
[94] Gerald Hodge and Ira M. Robinson, *Planning Canadian Regions* (Vancouver: UBC Press, 2013), 332-334.

bodies, including GVRD. GVRD spent the early 1970s on creating the "Livable Region Plan," which aimed to balance the growth of urban and rural areas through economic planning.[95] Power struggles in the province helped to promote this agenda. From 1972 to 1975, the ruling New Democratic Party devised a series of environmental policies to distinguish itself from its predecessor, the pro-development Social Credit Party. The successful boycott against a freeway in downtown Vancouver in the late 1960s further promoted a new planning philosophy that valued community and density, rather than the "environmentally destructive" suburbia and automobiles.[96]

While the incorporation of public concerns offered opportunities to transform political structures, the reforms in GVRD probably reflected as much voters' demands for social change as the government's intention to stay in power by collaborating with experts. Many planners such as Drew Thorburn were thus attracted to the region in the 1970s. In addition, The Electors' Action Movement (TEAM), a party formed by middle-class professionals, won the municipal election of 1972, and a TEAM councillor, UBC geographer Walter Hardwick, became instrumental in developing a "professional and politically accountable planning process to deliver urban design objectives."[97] He also hired planner Ray Spaxman, whose False Creek South project pioneered a philosophy that stressed "a social mix to reflect the diversity of incomes in the Greater Vancouver region, enclaves of clustered housing to promote social contact, and hierarchy of open space" which was "linked by paths to a large public park."[98] By framing environmental issues as

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[95] Hodge and Robinson, *Planning Canadian Regions*, 335-338.
[96] One such "growth limiting" policy was the creation of Agricultural Land Reserve surrounding the residential areas. See Nathanael Lauster, *The Death and Life of the Single-Family House: Lessons from Vancouver on Building a Livable City* (Philadelphia: Temple University Press, 2016), 95-111.
[97] John Punter, *The Vancouver Achievement: Urban Planning and Design* (Vancouver: UBC Press, 2010), 56.
[98] Punter, *The Vancouver Achievement*, 35.

a problem of "quality of life", which in turn could be tackled by good planning, the experts in Greater Vancouver transformed the pessimist discourse of "survival" into a positive discourse of "livability", all the while retaining the power and authority of technoscience.

3.2 The Social Game and the Black Box

The attempt to "rebrand" the role technoscience played in society also aimed to reformulate experts' relationship with the public. According to Goldberg, IIPS differed from previous projects like BASS not only in its focus on the process of communication between academics and city managers, but in its inclusion of local citizens by providing "information in a form that is meaningful to them" and by showing "that all decisions that affect their lives are political in nature."[99] Goldberg went further and compared the "boundary-oriented" emphasis in ecology with the virtue of pluralistic democracy, and equated the maximized efficiency of monoculture with dictatorship or technocracy:

> "The democracy is boundary-oriented (like the grassland) and the dictatorship is equilibrium-centered (like the wheatfield). Democratic systems appear purposeless, oozing from one compromise decision to another, but persisting. Dictatorships, or technocracies, are much more purposeful and goal-oriented (equilibrium-centered) but also much more vulnerable to overthrow or disruption."[100]

Furthermore, he believed that simulation research could not be only about the creation of models. The model that academics deemed useful could be useless to the public. City officials and citizens should both have the knowledge to use the model and participate in the modelling process. Thus he claimed:

> "If the resulting model was both useful and usable, and remained an ideal *black box*, our efforts would have been largely worthless. To be useful and usable, the model has to be *used*."[101]

[99] Goldberg, "Urban Public Decision-Making," 642.
[100] Michael A. Goldberg, "On the Inefficiency of Being Efficient." *Environment and Planning A* 7, no. 8 (1975): 937.
[101] Goldberg, "Urban Public Decision-Making," 630, emphases mine.

The reference to the “black box” is worth examining. While Goldberg clearly used the term in its original, cybernetic sense, which referred to the practice of tackling a complex entity or mechanism in a system by analyzing its input and output alone, the term was later used by Bruno Latour to illustrate the source of the unique authority of technoscientific facts and objects. In Latour’s view, the most powerful black box is an automaton which makes the many elements it contains “act as one” and which “cannot be opened without going wrong.”[102] It seems that the very reason behind the failure of IIPS the Product arose from its inability to act as a sealed black box. The 1974 review essentially dismembered the Product and exposed its shaky foundation. However, what Goldberg questioned was not the black-boxing of IIPS the Product but the black-boxing of the Platform. His criticism focused not on technoscientific objects per se but on how they were constructed and used—how a *social arrangement* could be devised in which no single party could monopolize the black box. Holling had an answer in mind, which he called the “social game”.

A paper authored by Holling and Alan Chambers, the director of RSC, described modelling workshops as a “social game in which the rules and the players of the game jointly evolve as the game progresses.”[103] The main focus of the paper was the “systems approaches” that enabled experts from various fields to “break a complex problem into constituent components” and used computer models to “generate better questions”.[104] This argument was in line with the simulation research Holling had been pursuing since the 1960s. Nevertheless, two suggestions stood out: the first contended that “rather than

[102] Latour, *Science in Action*, 131.
[103] Holling and Chambers, “Resource Science,” 14. While IIPS was not directly mentioned in the paper, one of the workshop experience it cited resembled the setting of the “Open Meeting” of IIPS.
[104] Ibid., 18

confining use of the model to specific 'legitimate' vested interests, it has to be open for use by all vested interests", while the second proposed, somewhat ironically, that "truly open access to information" may induce "a change in political and institutional structure that can threaten but also *improve* the political process."[105]

The "game" was consequently conceived by Holling and Chambers as a process that could, and probably should, be extended to settings other than the academic ones. Although the authors did not discuss how, in practice, such modelling workshops could be reproduced elsewhere,[106] the rhetoric about public participation in, and the political potential of, workshops was significant. The power of "social games" derived not from technoscience alone but from how technology was used under specific arrangements. Holling had conveyed similar ideas in the proposal for IIPS: since the participants of RSC workshops were from different fields, "communication had to be done in ordinary English" while "graphs, pictures and plain words were the order."[107] Moreover, since the whole workshop would share the same mainframe computer and CRT display, the proposal suggested that demonstrations of modelling processes and simulation results created "a common frame of reference" which could facilitate interaction, debate, and learning among the participants.[108] The RSC computer center was thus envisioned as a semi-public place where individuals, after agreeing to follow certain rules on the proper use of evidence ("graphs and pictures" derived from empirical data or simulation) and language (the supposedly rational and scientific "plain words"), could collaborate with the experts in

[105] Ibid., 17, emphasis mine.
[106] Consider the cost and knowledge required to operate a computer system in early 1970s, it was very unlikely that a simulation workshop can be held without the support of a university.
[107] Goldberg and Holling, "Policy Simulator," page 7.
[108] Ibid., page 8..

policy-making. Consequently, the social transformation promised by the workshops was based not on decentering the experts but on *expanding* the spectrum of expertise relevant to planning issues.

The vision of social games influenced the public programs of IIPS at most in indirect ways. At the Platform level, while simulation or modelling processes were sometimes referred to as "games" or "gaming",[109] not all participants considered "game" the most suitable metaphor for IIPS. Some even argued that the project had too many *inappropriate* metaphors: "playing games", "control of", "optimize", "forecast", and "predict", were all listed as "verba non grata" by the student-led IIPS Policy Group in early 1972.[110] Moreover, the delay in model development prevented the organization of workshops featuring the actual IIPS simulators. IIPS the Product was thus unable to provide the social game its most crucial component: namely, the computer system.

Nevertheless, IIPS did succeed in creating an environment resembling that of the social game during the demonstration of the Community Information System (CIS). As discussed in Chapter 1, the CIS was a computer database that aimed to offer local communities a digital system for information exchange. The computer program greatly intrigued the grassroots organizations. For example, Arts Access attempted to create an information databank for art events based on CIS, while the Vancouver Free University tried to use the system to provide enrollment services. The participants then complied a

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[109] For example, Pille Bunnell described models as "something you can play with" and pointed out that models are "easier to play with than the real world" in the slide series. Pille Bunnell, "What is a Model," page 1, 1974, Box 14, Folder 20, IIPS fonds.
[110] "The IIPS Policy of Use Group Final Report," page 5, March 1972, Box 17, Folder 16, IIPS fonds.

catalogue listing the features each group added to the database, and planned to turn the CIS into a “community-operated computer utility.”[111]

In addition to the CIS, Computer Services facilitated the development of other computer programs in mid-1970s Vancouver, which included Community Memory, a bulletin board system, and CONFER, a computer conferencing system. Moreover, the subgroup helped to set up a computerized voter registry for the nearby Dunbar-South and Point Gray electoral districts.[112] If Computer Services and its partners integrated these computer programs, they might have created an information system owned by the communities, accessed via terminals at public libraries, updated real-time, and utilized by grassroots groups to provide social services, alternative education, and volunteer opportunities. The experts’ game was certainly not the only game in town.

Other less elaborate programs deserve mention as well. In 1972, three programs were created to inform, educate, and engage local citizens through activities related to urban planning, model-building, and simulation technology. The first sought to promote the scientific visions and *social arrangement* embodied by IIPS through documentary films and television programs. Richard Bocking, a filmmaker focusing on urban issues, proposed a project that included two films—one explaining the technology of model-building, and the other recording the development of IIPS—plus an experiment on an “inexpensive process for making ‘rough’ films” intended to enhance efficiency “in the building of the model or in its communication.”[113] Reporter Stanley Burke proposed a televised program called WITTENAGAMOT. Named after the political assembly of medieval England, the

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[111] “Report of the Applications Committee of Information Action (INFACT),” page 1, April 16, 1974, Box 1, Folder 27. IIPS fonds.
[112] See Gil Evans, “Communications,” 1975, Box 14, Folder, 17, IIPS fonds..
[113] Gil Evans, “IIPS Communications,” page 2, June 28th, 1972, Box 16, Folder 5, IIPS fonds.

program aimed to advertise the use of "communication systems in dealing with public affairs" by bringing grassroots groups, IIPS participants, and city managers together in a TV program featuring conversations on the use of models in urban planning.[114] Neither Bocking's documentary film nor Burke's television program materialized. However, this attempt to utilize films and broadcasting to engage local communities did echo the trajectory to extend systems theory to public participation and communication among urban intellectuals in the 1970s.[115]

The second public program in 1972 was the "dustfall study" that provided local communities a chance to participate in the construction of IIPS the Product. This study was conceived by members of the Air Quality section of Pollution subgroup. A series of educational sessions targeting local high schools were held by ECO, an activist group formed by IARE students. In each session, ECO members explained the science behind air pollution and handed out sampling devices. Of the 353 devices distributed, 240 were returned, and 71 of them contained useful data. While the sample size was deemed by academics in the Air Quality section as too small to draw conclusions from, the study was considered "useful as a pilot project," and a second stage involving 5000 devices was proposed for the following year.[116] The study was later discontinued due to the changing focus of the project, but its experience remained important: by showing that "laypeople" could participate in the scientific aspects of IIPS, this program suggested that model-building processes might become a public endeavor.

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[114] Gil Evans, "WITTENAGAMOT by Stanley Burke," page 1, June 1972, Box 9, Folder 8, IIPS fonds.
[115] See Jennifer S. Light, *From Warfare to Welfare: Defense Intellectuals and Urban Problems in Cold War America* (Baltimore: JHU Press), 163-194.
[116] Craig Runyan, "IIPS-Centennial Museum Dustfall Study," page 6. August 2, 1972, Box 2, Folder 1. IIPS fonds.

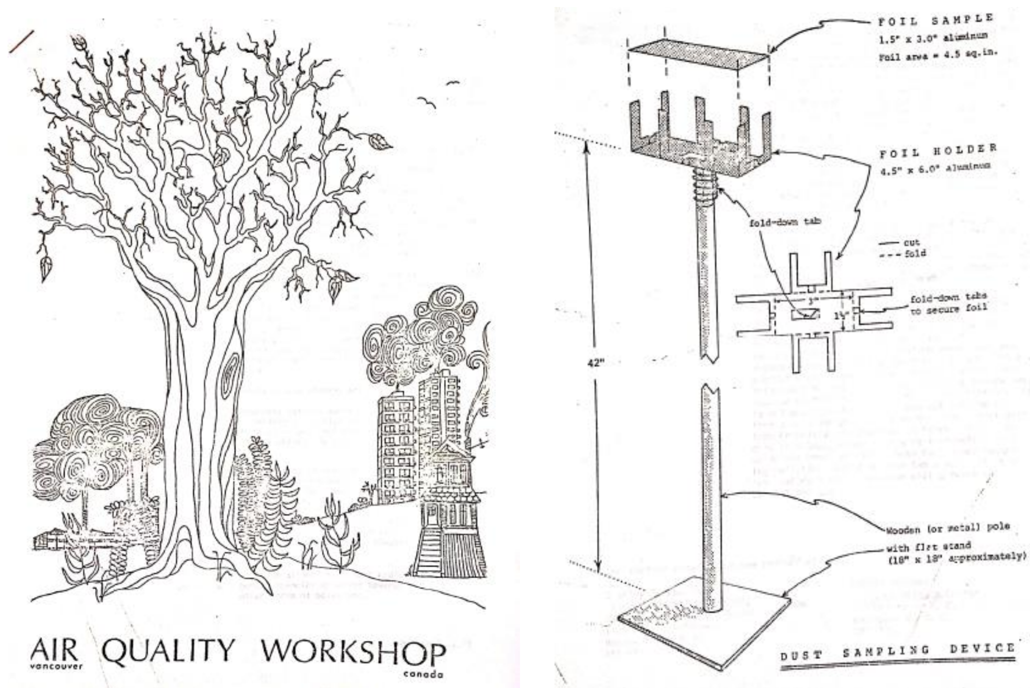

Figure 4 (Left) Cover page; (Right) Dust Sampling Device. "Air Quality Workshop," page 4, 1972, Box 14, Folder 39, IIPS fonds.

The last example is an exhibition held by IIPS at ART PROBE, a program of the Vancouver Art Gallery. Conceiving IIPS as a "probe" of urban environment which could raise "questions about cultural assumptions" of the city, communication manager Gil Evans and a few graduate students created a booth featuring a variety of installations: a documentary film by Richard Bocking about cities, "a series of mobiles, boxes, cubes" showing texts about planning issues "hung from the ceiling of the gallery", "a collage of the graphic output of IIPS", and "a photo-mosaic of the Vancouver Region."[117] Evans was also developing a board game to be "played on a contoured relief map" that would simulate the process of urban decision making, but as the game was not finished before the exhibition, another game called "Re-design The Region" was set up, with the IIPS Land

[117] Gil Evans, "IIPS at Art Probe," page 1, June 28th, 1972, Box 16, Folder 5, IIPS fonds.

Use maps serving as its "board".[118] While this was the only program that featured artwork, the ART PROBE exhibition shew the possibility of promoting IIPS not through technical demonstration but through artistic imagination, which allowed more ambiguity and creativity. Art, in contrast with computer codes or mathematical models, engaged the audiences directly by invoking their imagination about the city.

Nevertheless, none of these public programs helped the IIPS to survive the harsh criticism of the 1974 progress report. If the "social game" was devised to prevent the monopoly of computer models as the "black boxes" of technocrats, this game could not continue if the models ceased to act as black boxes or the "players" could not agree on the social settings arranged by the game. Despite the efforts to find alternative ways to communicate the project to the public and *within* the Platform, IIPS the Product failed to act as the black box desired by MSUA. Neither an efficient technocracy nor a resilient democracy, the Core Group was seen by the project staff as a dysfunctional bureaucracy. In May 1974, seven staff members signed a letter stating that they had lost "confidence in Drew Thorburn to direct, lead, or properly represent IIPS " and criticizing the project management as "confusing and demoralizing."[119] This time, the Core Group failed to come up with any disciplinary technique. After the MSUA withdrew its support, IIPS was formally terminated in October 1974.

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118 Evans, "IIPS at Art Probe," page 2. However, Evans's board game was never completed.

119 Letter from IIPS staffs to Maurice Egan, page 1, May 28th, 1974, Box 1, Folder 30, IIPS fonds. Notably, the staff criticized the Core Group for its failure to keep "promises made to staff members regarding appointments", and pointed out that "some of the female members of the staff have felt an intensification of the personnel problems outlined above." The inequity between managers and staffs, and between male and female employees, were indeed also factors that led to the difficulty of maintaining the "social game"—the existent social arrangement was already too complicated and uneven. "Resolution of a Meeting of Staff," page 2, May 13th, 1974, Box 1, Folder 30, IIPS fonds.

While the Core Group failed to implement the "social game" in the management of the project, the public programs it created illustrated the possibility of realizing this vision in local communities. The various computer products designed by Computer Services, the television and film programs, the dustfall study, and the art exhibition all highlighted alternative ways of creating an environment where technoscientific objects and practices were situated in a more inclusive and interactive social arrangement. The public programs in IIPS thus continued the experiments on community engagement and organization since the end of World War II.[120] However, compared to the programs led by government experts, members of IIPS emphasized the limitations of technocratic intervention and the value of grassroots initiatives. Embedded in the political contexts of 1970s North America, project members were aware of the challenges and the *potential* of public demand to participate in science and politics. Although IIPS was not created as a community project, it experimented on the use of information systems for local communities, and should be analyzed as part of the transformation of computers from military-industrial machines to small-scale technology.[121]

[120] For the adoption of information technology in community organization, see Jennifer S. Light, *From Warfare to Welfare*; for a recent study of community programs led by the Canadian government, see Tina Loo, *Moved by the State: Forced Relocation and Making a Good Life in Postwar Canada* (Vancouver: UBC Press, 2019).

[121] For the influence of the counterculture on the individualism embodied by personal computers, see Fred Turner, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism* (Chicago: University of Chicago Press, 2010).

Chapter 4. Conclusion: Beyond the Reflexive Critique

The experience of IIPS appears to be a familiar story. First, actors with diverse interests are brought together in a network through the recruitment of people, objects, and institutions. Second, various strategies emerge to stabilize and expand the network, and disputes over truth claims need to be settled. Finally, if the strategies succeed and the network is disciplined, discovery and invention can be attained, otherwise the actors leave and the network collapses. IIPS can therefore be seen as a failure story of a network that started with promising strategies and highly mobile actors, but eventually fell apart because of disagreement between key actors (the Co-Directors), the failure to construct a well-sealed black box (the simulator), and poor communication between the scientists and their patron (the MSUA).

Although the story of IIPS as a network is rather conventional, how its members interacted with the surrounding political milieu generates interesting questions about the role of scientists in a rapidly changing society. In the conclusion of Yaron Ezrahi's book on the connection between Western democracy and the "attestive visual culture" of modern technoscience, he suggests that "reflexive visual orientations, supported by pessimistic theories of knowledge and reinforced by the ascent of normative pluralism" could erode the ideological edifice of liberal democracy.[122] Cold-War anxieties over technology-induced disasters and social movements in the 1960s both challenged the authority of technoscience and politics. The IIPS project thus depicted how systems scientists in the 1970s struggled to translate their field—one that was highly influenced by the military-

[122] Yaron Ezrahi, *The Descent of Icarus: Science and the Transformation of Contemporary Democracy* (Cambridge: Harvard University Press, 1990), 289.

industrial-academic complex—in a context drastically different from what gave rise to the discipline three decades earlier.

On the one hand, the systems scientists tried to protect their authority from more radical critiques of the ideological foundation of scientific knowledge by drawing and guarding a boundary that excluded those who might disrupt the centrality of models and computer simulation in the project. On the other hand, the same group of scientists acknowledged the limitations of dominant technoscientific practices, and attempted to adjust their research programme to the needs of society through public engagement and interdisciplinary collaboration.[123] These reforms also aimed to respond to critiques of urban simulation in particular, and of systems theory in general.

Although IIPS ultimately failed to apply simulation models or systems theory to urban issues, and the theory remained, to its critics, neither a robust empirical science nor a robust metaphysics but an ideology "disguised in terms of the public good",[124] the project did illustrate the social arrangement in which the "systems" performed well: namely, when individuals had incentives to become part of the system and to participate in its construction. This was how the initial group of academics and city administrators gathered around the computer and anticipated a simulation study that was different from previous projects, and this was how the Community Information System succeeded in attracting grassroots users and creating a certain "legacy" for this ill-fated project. Even though the network succumbed to poor project management and faulty communication processes, the

[123] See also Kelly Moore, *Disrupting Science: Social Movements, American scientists, and the Politics of the Military, 1945-1975* (Princeton: Princeton University Press, 2013), for a review on how scientific community in United States conceived their relationship with the public during the Cold War.
[124] Lilienfeld, "Systems Theory as an Ideology," 659.

momentary burst of creativity and imagination still made IIPS stand out among the many simulation studies conducted in the 1960s and 70s.

Holling's career after his stint in the IIPS highlights another kind of context in which "systems" found their place. In 1973, he joined the newly created International Institute of Applied Systems Analysis (IIASA), and created an Ecology Project with a focus on simulation study of spruce budworm, a forest pest. IIASA was an organization that, by bringing together American and Soviet scientists, promised great funding and networking opportunities for systems scientists. This endeavour gradually drew Holling away from his urban research programme, but he did not simply revert to his old image of an entomologist enthusiastic about simulation.[125] Rather, the spruce budworm study actually reinforced his self-representation as a holistic environmental manager.

Throughout the 1970s, Holling kept expanding his institutional network beyond North America, while recruiting the ecologists at IARE into the field of environmental management. Figures like William Clark, a sustainable development pioneer, William Rees, who coined the "ecological footprint" concept, and Carl Walters, a proponent of adopting ecosystem models in fisheries and marine conservation, all extended the use of "systems" to different technoscientific and political contexts. Interestingly, Holling's idea of "resilience" was later incorporated into the burgeoning field of socio-ecological systems research, and had since become a "buzzword," as well as a target for criticism, in other fields such as urban planning and geography.[126]

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[125] Holling, Bubbles and Spirals, 43-47. See also Michael Hutter, "Ecosystems Research and Policy Planning: Revisiting the Budworm Project (1972–1980) at the IIASA," in *Planning in Cold War Europe: Competition, Cooperation, Circulations (1950s-1970s)*, ed. Michel Christian, Sandrine Kott, and Ondrej Matejka, (Berlin: De Gruyter Oldenbourg, 2018), 261-284.

[126] For some example, see Jack Ahern, "From Fail-Safe to Safe-to-Fail: Sustainability and Resilience in the New Urban World." *Landscape and Urban Planning* 100, no. 4 (2011): 341-343, and Jonathan Joseph, "Resilience as Embedded Neoliberalism: a Governmentality Approach." *Resilience* 1, no. 1 (2013): 38-52.

Similar to the original elasticity of cybernetics and systems analysis, Holling's ideas of resilience were utilized by dominant political and technoscientific discourses to tackle new types of challenges. Since the 1980s, resilience theory has been adopted as a metaphor and tool to create an "adaptive" society in the face of disturbances from civil war to climate change. Other trajectories that ran parallel to, and sometimes intersected with, the dominant narrative also emerged. The proponents of "Traditional Ecological Knowledge (TEK)" offer a good example. By arguing that diverse cultural mechanisms are instrumental to context-specific management practices, and that such practices can better maintain biodiversity and the resilience of socio-ecological systems, TEK scholars in the 21st century not only extend the systems idea to new socio-political settings, such as co-management programs which engage local communities, but also open up possibilities to challenge and complicate dominant technoscientific practices by asking why traditional knowledge has been ignored or marginalized historically.[127]

As a result, while IIPS has largely failed to construct new technoscientific ideas or objects, and its organizational history is not significantly different from the familiar stories about assembling and maintaining networks, project participants' awareness of the limits of both science and politics, as well as the attempts to turn such limitations into potential *virtues* that the project would embody, have demonstrated the particular values IIPS possesses for historians of science and technology. While the cultures of technoscience today remain deeply immersed in a "reflexive critique" that disrupts and polarizes political

[127] For a more "mainstream" way to advocate Traditional Ecological Knowledge, see Fikret Berkes, Johan Colding, and Carl Folke. "Rediscovery of Traditional Ecological Knowledge as Adaptive Management," *Ecological Applications* 10, no. 5 (2000): 1251-1262. However, why such knowledge is "lost" and needs to be "rediscovered" also asks the scientists to take seriously the problem of the historical and ongoing suppression of alternative forms of knowledge, especially the knowledge of Indigenous people.

processes, the five decades after 1970 may contain rich materials to study how scientists have attempted, and continue to try, to confront such challenges.

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