Chapter 2

RESEARCH: CONCEPTS, HYPOTHESES, TESTS

"A cobblestone is more real than personal relationships, but personal relationships are felt to be more profound because we expect them yet to reveal themselves in unexpected ways, while cobblestones evoke no such expectation."

Michael Polanyi
Personal Knowledge

Research can provide deeper insight into a topic, better understanding of a problem, more clearly defined opportunities for and constraints on possible action, measurement of regularities, and ordered descriptions. Designers face many problems in which they can use environment-behavior (E-B) research to control effects of what they do. What street layout, sign system, and landmark location in a new town will make it easy for residents to feel at home? Why do teenagers vandalize isolated buildings in parks that they themselves could otherwise enjoy? Does high-density living make people friendlier or meaner? What does *density* actually mean?

What is research? It is more than just searching (which can be haphazard) or just solving problems (which can remain merely pragmatic). What researchers want to do is systematically use their experience to learn something to identify and help solve new problems. Presented with a problem, researchers draw on theory, training, accumulated knowledge, and experience to generate tentative ideas about how to solve it. Exploratory hypotheses serve as the basis first for observing and gathering data about the topic and then for describing and understanding it. Making visible the implications of the data leads to improved hypotheses, further data gathering, and so on until the problem is sufficiently redefined and a tenable solution is found.

In the course of their work, investigators develop concepts, formulate hypotheses, and test their ideas. During a research project, investigators carry out these activities in various sequences and combinations and in various ways. This complex activity is called "research."

Anyone can become a researcher by doing normal, everyday things in an orderly way and for interesting, generalizable purposes. The orderly way to do research can be learned rationally and impersonally. The ability to develop interesting concepts—to go beyond the information given—can also be learned. But it is a creative ability, to be learned as one learns a skill.

Doing Research
Developing Concepts
Characteristics
Approaches
Preconceptions
Formulating Hypotheses
Classifying hypotheses
Explanatory hypotheses
Empirical Testing
Observing
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DEVELOPING CONCEPTS

In a research project investigators want to define a concept with which to order information. A research concept does not pop out of the data; it is formed slowly. Investigators may have had a faint vision of it when their project began. They may have glimpsed it when they started to analyze a particular bit of data. They may have realized how to organize their study findings only when the last piece of information became clear.

In the beginning of a project, emerging concepts are visions defining what data to gather. In the middle, information clarifies the concepts. At the end of a successful research project, clearly stated concepts summarize increased insight and define areas where further research can increase precision.

Characteristics

Creative researchers invent and discover. Invention in E-B studies has given us new concepts to order what we see: Sommer gave us personal space (1969), Hall the hidden (spatial) dimension (1966), Gans urban villages (1962), and Lynch the image of the city (1960). Sommer, Hall, Gans, and Lynch carried out research to its full creative potential, giving others new images with which to illuminate part of the world.

The concept "personal space" helps us to see why low lighting levels in bars bring couples closer together, why others get upset when we read over their shoulders, why psychiatric clients feel that counselors who sit far away are not receptive, and why passengers waiting in airports feel uncomfortable when seats bolted to the floor prohibit adjusting their seating arrangements. The concept "city images" helps us understand why most of us see cities in terms of elements like the Eiffel Tower and Times Square (which Lynch calls "nodes"), the Charles River and Lake Michigan (which he calls "edges"), the Los Angeles freeways and the Amsterdam canals ("paths"), and Greenwich Village and Chinatown ("districts").

Polanyi concisely defines the intangible activity of discovery by which an investigator describes something he cannot see:

> How can we concentrate our attention on something we don't know? Yet this is precisely what we are told to do: 'Look at the unknown!'—says Polya [1945]—'Look at the ends . . . *Look at the unknown*. Look at the conclusion!' No advice could be more emphatic. The seeming paradox is resolved by the fact that even though we have never met the solution, we have a conception of it in the same sense as we have a conception of a forgotten name . . . *we should look at the known data, but not in themselves, rather as clues to the unknown, as pointers to it and parts of it*. We should strive persistently to feel our way towards an understanding of the manner in which these known particulars hang together, both mutually and with the unknown [1958: 127–128].[1]

Explanatory concepts tend to be *holistic;* that is, they describe entities that cannot be analyzed into the sum of their parts without residue. Personal space is not merely the sum of body movements, cultural habits, and attitudes toward one's own body. A designer's office cannot be fully defined by describing the people there, the settings, the rules, the services, and the output. The holistic character of concepts is like that of a chord in music: "The musical chord . . . as long as it is a chord, is utterly different from its component tones. It does not even have tones until it is analyzed. Indeed, one cannot say that it is a synthesized whole until this is done; otherwise it is an elementary phenomenon" (Barnett, 1953: 193).

By reasonably extending creative research concepts, investigators generate new problems to study and new hypotheses. For this reason such a concept is sometimes called a *generating formula:* "a formula capable of summing up in a single descriptive concept a great wealth of particular observations" (Barton & Lazarsfeld, 1969, p. 192). Gans' "urban village" concept is just such a formula. In describing the group of people living in Boston's primarily Italian West End neighborhood during the 1960s, Gans points out an essential contradiction in their lives. Social relations among residents are almost like those in a rural village: people know one another well, they get their news from friends at local bars, and they know who does and does not "belong." But economic and political life are embedded in an urban context: residents work in the city, they elect representatives to the city council, and university students from the city come to the West End to live.

Summing up this neighborhood in the term *urban village* raises a host of

[1] From *Personal Knowledge: Towards a Post-Critical Philosophy*, by M. Polanyi. Chicago: University of Chicago Press, 1958.

questions: If village residents hold mainly local values, how do they react to the constant influx of outsiders? Does the village nature of the neighborhood result in tighter social control over crime? What pressures does the urban context exert on family life? With this generating formula in mind, one can identify urban villages in other cities as well. Before Gans' invention these districts were not clearly seen.

Approaches

If research aims at developing concepts, how do researchers do this? One way to go about this murky task is to become as intimate as possible with data and also as distant as possible from them.

Intimacy for one researcher may mean stewing over a particular photograph or staring at a map a respondent has drawn to find what sense can be made of it. Another investigator may look over one computer printout a dozen times or read through a large number of completed questionnaires from beginning to end, getting a feel for what to ask the data. These methods enable an investigator to focus her attention on particulars of diverse phenomena until she begins to see them as a coherent whole, just as a musician practices a piece until it comes together for him. The term *indwelling* is used to refer to these methods, to make clear that they are attempts to become as close as possible to the data—to dwell in them (Polanyi, 1967: 16).

When researchers achieve such internal awareness, they cannot necessarily articulate it—either verbally or diagrammatically. Another step is required to articulate the tacit knowing that indwelling can bring.

Using *analogies* as organizing principles can be this step. Doing so enables researchers to articulate how they envision fitting data together, because analogies help them to use related past experience. In analogies "there is a sameness of relationship—but a substitution of its parts. These parts may be things, or they may be behaviors or ideas. In any event, there is a change of the content . . . but a retention of its shape or form because of the retention of relationships" (Barnett, 1953: 267).

Thinking of analogies to summarize a large body of information enables investigators to temporarily picture and use what they do not know by substituting known elements for gaps in their knowledge. For example, the idea of map reading may help someone describe the way people envision the future, and the idea of a theater lobby may help someone else describe the channeling operations carried out in a hospital emergency room. Analogies provide holistic mental models that can be used to loosely organize data, although these models may not be derivable from the data.

Discovering scientific images and generating scientific concepts demand inspirational, imaginative, and intuitive skills:

> True discovery is not a strictly logical performance, and accordingly, we may describe the obstacle to be overcome in solving a problem as a 'logical gap,' and

> speak of the width of the logical gap as the measure of the ingenuity required for solving the problem. 'Illumination' is then the leap by which the logical gap is crossed. It is the plunge by which we gain a foothold at another shore of reality. On such plunges the scientist has to stake bit by bit his entire professional life. . . .
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> Established rules of inference offer public paths for drawing intelligent conclusions from existing knowledge. The pioneer mind which reaches its own distinctive conclusions by crossing a logical gap deviates from the commonly accepted process of reasoning, to achieve surprising results [Polanyi, 1958: 123].

Preconceptions

Researchers do not approach problems with empty minds. Each researcher knows something about his problem from related empirical work and theories. We have all had personal experiences that influence how we look at the world: early family life, school, trips, friends, professional training, books. As we think and talk, we draw on a mental picture of our topic, either vague or clear, held either consciously or subconsciously (Korobkin, 1976). When our topic is a physical environment, we call our mental picture a "cognitive map"; when our topic is less tangible and more conceptual, a related term—*cognitive image*—can be used (Boulding, 1973). The more we think we know about a topic, the more detailed is our cognitive image of it. The preconceived images that investigators begin research projects with can distort what researchers see, bias explanations, and limit how concepts develop. But they do not have to.

Preconceptions can be helpful if they are made explicit as a first step in research projects. For example, in a study of how people work and feel in open-plan offices—offices without walls—one researcher might begin with a preconception that everyone will be miserable because there is no privacy. Another investigator expects everyone to be smiling and happy because the lack of walls brings people together. These preconceptions, or advance guesses, no matter where they come from, can be used as reference points for future observations.

Explicit preconceptions like these can sensitize researchers to see and to be surprised by what they see. In our hypothetical open-plan office, because both researchers thought about workers' happiness, both will look for indicators of attitudes: smiles or frowns, backslapping, chatting, angry looks, fights. Both researchers will be able to improve their pictures of the situation. Each preconception made explicit at the beginning of an investigation serves as a useful sensitizing tool and as a beacon pointing out realms for fruitful data gathering.

FORMULATING HYPOTHESES

To improve concepts and preconceptions, investigators confront them with empirical evidence and other concepts. This is possible if concepts are presented tangibly and testably—whether they be statements about possible resolutions to an investigator's problem, diagrams, drawings, or even buildings.

Investigators first formulate hypotheses in an exploratory way based on theory and previous empirical data; then they use preliminary, unfocused investigation to decide with what specific data to confront these hypotheses. As data are gathered and made more visible, exploratory hypotheses are developed into descriptive ones with which investigators seem to say "This is what I think I see." More-detailed information determines the tenability of such hypotheses. The more-tenable ones tend to help investigators organize, simplify, and explain ever greater amounts of related information. Testing these explanatory hypotheses in turn enables investigators to make explicit the holistic conceptual framework they have been developing.

Complex and sophisticated possible solutions to a problem—that is, hypotheses—can be thought of as conceptual models analogous to the physical models that designers use. Designers' models, often constructed of lightweight wood, clay, fiberboard, or colored paper, are systematically built as scaled reductions of the intended final product. Physical models represent abstract attributes of a concept: massing of buildings, openness of space, clustering of elements. Sometimes they represent what the actual final building might look like. Designers' models constructed early in the process are usually inexpensive and easily dismantled. Such working models change rapidly as designs develop, just as hypotheses change under the impact of newly gathered information when a research project develops.

Models represent the intended resolution of problems in mathematical, symbolic, physical, or some other form. Investigators and designers can therefore learn from models by observing what happens to them under different conditions, as if they were the final research or design concept. Developing and testing working hypotheses and working models allows researchers to make major adjustments in approach before it is too late—before such changes would mean destroying the whole project and starting from scratch.

The following discussion points out some important types of hypotheses, moving from simpler to more sophisticated ones.

Classifying Hypotheses

Classifying hypotheses order available information so that researchers can more clearly define their problem and can decide how to study it further. Explanatory hypotheses try to get at the roots of a problem and identify possible solutions.

List of types. A simple way to order information is to classify it into a list of types. When Weiss and Bouterline (1962) wanted to understand why exhibits at the 1962 Seattle World's Fair differentially interested visitors, they started by noting how much time visitors spent at each of 33 exhibits in five pavilions. They felt, however, that describing each exhibit separately would not lead to better general rules of thumb about how to design interesting exhibits.

Latent explanations, once formulated, are also testable. But they are harder to formulate because they are unexpected by participants and often are based initially on a researcher's theoretical expectations rather than empirical observation (Zeisel, 1978).

Gans' *Levittowners* (1967) provides a basis for hypotheses about the possible latent effects of adjacent driveways. Gans found that neighbors next door or across the street do tend to meet often. But he also found unexpected consequences of contact between neighbors at Levittown: It is not always as friendly as planners might predict. When neighboring children ride bikes, roller-skate, and play together on driveways, they sometimes fight. Children soon forget fights and go back to playing; parents do not. Parents expect the aggressor—usually the neighbor's child—to be punished, and punished in the same way they would punish their own child.

Levittown neighbors—although earning roughly equivalent salaries—came from different cultural backgrounds with different attitudes toward child rearing and punishment. Some parents believed more in hitting children, others more in giving the children a stern talking-to. Gans found neighbors fighting because they were not satisfied that a child had been sufficiently punished or were unhappy that the punishment was too severe. Brolin's shared driveways, by bringing neighbors together, might drive them apart.

Research that generates and tests both manifest and latent explanations is likely to provide new insights into a problem.

EMPIRICAL TESTING

You may test hypotheses by confronting them with empirical data and other hypotheses. If no data have yet been gathered, you might do so by carrying out empirical research. If all data in a study have been collected, however, hypotheses are tested by reassessing those data from another point of view—by analyzing and ordering them in new ways. Testing hypotheses leads to their replacement, improvement, and refinement and to reformulating them for further testing.

Part Two of this book will describe observation and interview techniques that can be used to help develop and test hypotheses about E-B problems. This section, therefore, will focus on reasoning useful to organize such research—no matter which technique one uses.

Observing

The term *observation* as used here means looking at phenomena connected to a problem by whatever means necessary: looking with one's eyes, asking questions, using mechanical measurement devices, and so on. We use the term in

the same way as when we say that a patient goes into a hospital for "observation." Doctors and nurses do more than just look: they measure temperature and blood pressure; they take X rays; they make specimen analyses.

Single observations. One observation may be thought of as the simplest research datum: a smile, Central Park, a movement, an answer to a question, an event. Single observations that surprise the observer tend to indicate interesting research avenues because such observations conflict with exploratory hypotheses formulated from theory, from other empirical research, or from common sense.

As a researcher it is useful to keep your mind open to things you do not see—to be surprised by what does not happen. Given some direction, commonplace observations of things most people do not notice become strange and problematic. "The ability to take a commonplace fact and see it as raising problems is important because it can lead to . . . enlightenment" (Barton & Lazarsfeld, 1969: 168).

Whyte's research on how people use open spaces, plazas, and streets in New York City (1980) provides an illuminating example. Whyte wanted to provide city planners with information to help them design pedestrian zones that would accommodate the large diversity of needs of users, like pedestrians, window-shoppers, people watchers, and peddlers. During preliminary research on busy sidewalks, he noticed that pedestrians chose to converse in places where they most disrupted other pedestrian traffic—in the middle of traffic and near crosswalks.

This seemingly common observation raised problems: Was it a freak occurrence or part of a recurring pattern? What type of conversation was going on? Why were conversants apparently so unreasonable as not to get out of the way? Further research led to the hypothesis that finding a more convenient place to stand would commit the talkers to continue for a long time. Standing precariously in traffic made it easy for either person to break off the conversation at any moment.

Regularities. One way to test a hypothesis developed from a single observation is to look for other observations like it—for example, other people conversing in traffic. This is particularly relevant if the problem you are studying aims toward doing something to affect such a pattern: designing sidewalks to accommodate regular uses or designing schools to avoid major types of nonmalicious property damage.

Looking for a regularity and not finding it makes visible another regularity—its absence. If, for example, Whyte had first observed one couple speaking near a wall and looked for this as a pattern, he would have naturally been led to notice the recurrence of in-traffic conversations.

When investigators find no other observations like the first, this too may be useful. For example, a planner may find no park as large as New York's Central

Park in other U.S. cities. If she is studying problems associated with designing urban environmental legislation, it may be helpful to know why no other landscape architect since Olmsted achieved this unique feat.

A surprising regularity or unique event raises questions: Why does it occur? What effect does it have? What does each one mean? How can it be used by others? What can be done to change or accommodate it? To improve one's answers to such questions, it is often helpful to look not for more of the same but at other things connected to it—namely, its context.

Contexts. To test an explanatory hypothesis of an observed event, researchers use its context—how the event is linked to it and how isolated from it. The context of Whyte's sidewalk talkers included at least others around them, their motives and attitudes, their destination, time of day, and location. Although not everything in the context of an event is significant to solving a researcher's problem, some things are likely to be.

For example, a team of researchers in Baltimore studied an urban rowhouse neighborhood with small playgrounds behind the backyards and stoops in front of the houses. They wanted to know whether these playgrounds were used, and if not, why not. They observed more people using the front stoops than the playgrounds in back (Brower, 1977). To understand why, the research team looked to the context. Brower noticed that when residents sat on the stoops, they talked together, visited each other, watched strangers passing by, and supervised children playing on the sidewalk. On the basis of these findings, he developed, tested, and refined the hypothesis that residents felt that their neighborhood network included people who lived on the vehicular and pedestrian street in front rather than the people on the physical block whose backyards were adjacent to the common playground areas.

In sum, testing your hypotheses against empirical data requires that someone first make interesting observations that shed light on your problem. To do this, no matter what observation techniques and methods you use, it is essential to see significant single events, to perceive regularities over events, and to take into account the context of your problem. This approach will help you use the real world to improve the way you look at it, what you know about it, and the actions you take in it.

Sampling

When you test an idea by gathering empirical evidence, you *may* be able to examine every instance in which the idea is relevant. For example, when studying the 212-unit Charlesview housing development, Zeisel and Griffin (1975) used this "census technique" to test the hypothesis that residents were more likely to decorate and personalize enclosed front yards than nonenclosed backyards. They found that, of the 49 residents with enclosed front yards, over 80% planted grass and flowers or kept furniture there, whereas fewer than 10% decorated their backyards.

It is not always possible, however, to observe every instance in which your hypothesis might apply. You may not have the resources to find all the people or situations that have a certain characteristic. The group you want to study may be too undefined, as were the crowds of New Yorkers Whyte (1980) observed on sidewalks. Or you may want to say something about the likelihood of future events that are clearly impossible to observe.

Because of limitations such as these, researchers who have to generalize take a sample of people, places, or events to say something about a larger group. Generalizing always entails some error, however. Researchers may generalize too much, too little, or in the wrong way.

Festinger, Schachter and Back (1950) probably generalized too much. They observed that MIT married students living in apartments or houses whose location forced them to cross paths with certain neighbors tended to choose those neighbors as friends more often than neighbors living the same physical distance away whose paths they did not have to cross. These researchers and others used these observations to develop a more general principle—that physical distance, together with "functional distance" (the likelihood of daily chance encounters), leads to increased liking among residential neighbors. It took Gans (1967) to point out that the generalization probably holds only when housing residents are homogeneous in background and interests—as were most of the MIT married students Festinger and his team studied. Gans found that neighbors in the New Jersey planned community of Levittown tended to choose as their friends those neighbors they considered most compatible, whether they lived adjacent to them or across the street.

Certain *sampling procedures* can help to reduce errors that you know you will have when you test hypotheses and generalize the results. *Randomizing* procedures help control error from sources you do not anticipate. *Matching* or *stratifying* procedures are used to reduce the chance of errors from conditions that previous knowledge says are likely to influence your results. Randomizing and matching procedures can be combined to reduce overall generalization error in a particular situation.

Randomizing. E-B researchers often study diverse groups of people, places, and environments they know little about relative to the hypothesis being tested. For example, if you wanted to study people buying tickets at an airport in order to plan an airline terminal, you probably would not know in advance what about them influences their ticket-buying behavior: their age, cultural background, how they feel that day. Randomizing procedures are used to disperse such characteristics in the sample as they are dispersed in the population, so that the generalization error they cause is reduced. Interestingly, you don't have to trace how a characteristic is dispersed to control its effects.

Randomizing is not only a useful idea but a surprising one. If you draw a random sample from a large group, you can generalize or project results from the sample to the group within statistically definable limits. For example, from a randomly selected sample of 1500 people, political pollsters can predict within an accuracy of 3% how 70 million people will vote. Another surprising attribute of randomizing is that the accuracy with which you can project from randomly chosen sample data to a population depends mostly on the absolute size of the sample, not on the ratio of the sample size to the size of the population. In other words, generalization error from a suitable sample of 1500 will be the same whether you project your results to a town with a population of 50,000 or to a city with a population of 5,000,000.

"Random" in this context does not mean haphazard, helter-skelter, or unsystematic, as it does in everyday usage. Its meaning is actually closer to "unpredictable" or "by chance." Specifically, the word "random" as used in statistics is a technical term describing the process by which a sample is chosen. The principle of random sampling is simple: selection of the sample group must be left to chance, so that every member of the population and every combination of members have the same opportunity of being selected.

A common-sense way to select a random sample is to put names or numbers of elements on pieces of paper, throw them into a hat, and have someone choose a few with eyes closed. But this procedure can be inexact: if some pieces of paper stick together, that group of elements has a higher chance of being selected than any other group; if the hat is not thoroughly shaken, numbers or names put in last have a higher chance of being chosen. We could go on thinking of things that can and do go wrong when sampling is carried out manually.

Researchers who want to select random samples for actual projects can use a "Table of Random Numbers" generated by a computer. In E-B research, the simple device of taking every *n*th name from a list will often suffice as a "systematic" random sampling procedure, assuming that the interval *n* is unconnected to what you want to test. If there is no list, you can make one somehow —for instance, by observing every tenth person in line at a ticket agent's counter.

Matching. When you want to observe a sample from a larger population with which you are familiar, and you think that a characteristic of the larger group will affect what you observe, you can match the sample to the larger group on that characteristic. For example, suppose you are interested in what the residents of a neighborhood feel about having a playground located near where they live. You are likely to get different answers when interviewing women, especially women with children, than when interviewing men. Stratifying the proportion of men and women you include in the sample to reflect the proportion of men and women actually living in the neighborhood will reduce error when you project from your sample to the whole neighborhood.

The same principle applies when observing behavior over time. You would get a very unusual picture if you observed airline ticket counters only on Friday afternoons and Monday mornings, the peak traffic hours. Because experience says that air traffic varies with the cycles of the day, week, and year, you want to

be certain to include all periods of the day, days of the week, and possibly months of the year in the random sample of times you choose to observe.

Researchers carrying out experiments match groups before observing them, constructing experimental groups in which an experimental change is introduced, and control groups, in which no planned change is made. For example, an experiment might be designed to test the hypothesis that people's reactions to interviews vary with an increase in the size of the room. If the researchers think that age and professional experience with interviews could affect the results, they would match the two groups to make certain that the experimental group did not have mainly older doctors and lawyers, while the control group contained mostly college freshmen. Otherwise, should the researchers find a difference between the groups, they would not know how to generalize the results: is the observed difference due to the experimental manipulation or to the different makeup of the groups?

Combining randomizing and matching procedures. When researchers want to reduce generalization error from both known and unknown causes, they use a mixture of randomizing and matching (or stratifying) procedures to select their sample. For example, suppose the population you want to find out about contains five important subgroups. After dividing the population into these subgroups, you would randomly select individuals from each subgroup for your sample. Similarly, after grouping the times of day, week, and year, you would use randomizing procedures to decide what particular times you were going to observe.

When researchers test a hypothesis by confronting it with empirical data, they will want to generalize these results to new situations. Using randomizing and matching procedures to organize empirical tests enables them to reduce, estimate, and control the errors inherent in making generalizations.

OVERVIEW

Research is essentially a creative endeavor requiring a subtle blend of personal skill and impersonal order. Relying only on order in research minimizes individual responsibility and risk, although it shows that you know how to play the game. It also limits the contribution research can make to new knowledge.

This chapter stresses the importance of personal knowledge (Polanyi, 1958) and skill in developing concepts, formulating hypotheses, and testing them. The chapter proposes that researchers can achieve the results they want by systematically presenting and testing concepts as they are developed.

The principles presented for organizing research are intended to enable the investigator to control his or her own research activities and their consequences.

The next chapter discusses reasons designers and researchers work together, occasions they have for cooperation, and problems they resolve by doing so.