The focus on integration has progressed from identifying the relevant disciplines and their insights, to tracing connections and conflicts between them, and to creating common ground among them. Next to creating common ground, the most critical and most demanding Step of the entire interdisciplinary process is using the common ground theory, concept, or assumption to integrate disciplinary insights. Nikitina (2002) admits that attempting “any kind of synthesis” on the undergraduate level “is no small task” (p. 40). Klein (1990) speaks of the “complex actuality of doing interdisciplinary work” (p. 184). And Gordon F. Vars (2002) says that the words “integrate” and “synthesize” describe “an extremely complex mental process” (p. 66). Nevertheless, though admittedly difficult, integration is achievable. Integrating disciplinary insights is Step 9 of the interdisciplinary research process.

Step 10 explains the purpose of the research process: how to produce an interdisciplinary understanding of the problem and then test it. Achieving this intended outcome depends on the quality of the decisions the researcher makes at each of these last Steps of the process.

Commonly, integration is defined as “the combining of the constituent elements of separate materials or abstract entities into a single or unified entity” (Random House Dictionary). Similarly, Benjamin S. Bloom (1956) and his committee of college and university examiners defined synthesis as “the putting together of elements and parts so as to form a whole.” The committee also distinguished among various types of synthesis, primarily on the
basis of the characteristics of the end product. The two characteristics that are most relevant to the focus on integration are these:

- The end product shall be derived from a set of abstract relations (that interdisciplinarians call the common ground or integrating theory, concept, or assumption).
- The end product shall reflect the results of an investigation that are integrated into an effective plan to form a unified entity (i.e., a comprehensive understanding of the problem). (pp. 168–184)

Bloom’s (1956) committee recognized that all thought involves some elements of synthesis or integration: “Every experience involves a combination of parts of previous experience with the present in such a way that the organism is permanently changed, however slightly” (italics added). The committee also recognized that integration “is the category in the cognitive domain which most clearly provides for creative behavior on the part of the learner” (pp. 168–184).

Four salient concepts offered by Bloom’s (1956) committee contribute to a more comprehensive definition of interdisciplinary integration than was offered in Chapter 5. Interdisciplinary integration is an activity or process that

- is the result of an “investigation” or research effort.
- involves using a “set of operations” (hence, the interdisciplinary research process).
- enables the creative “putting together of elements and parts so as to form a whole.” (However, the committee emphasized that this is not completely free creative expression because generally the student is expected to work within the limits set by particular problems, materials, or some theoretical and methodological framework.)
- yields “an effective plan or solution to solve a problem.” (pp. 168–184)

Conclusively, integration (as defined in Chapter 5) is the cognitive activity of critically evaluating and creatively combining ideas and knowledge to form a new whole.

Cognitive Qualities and Internal Dispositions Needed to Engage in Integration

Along with the traits and skills of interdisciplinarians identified in Chapter 2, there are several cognitive qualities and internal dispositions of learners essential to perform integrative work successfully.
Cognitive Qualities and Internal Dispositions

- Ability to isolate analytically the defining elements of the perspective of each discipline, interdiscipline, or school of thought
- Ability to compare and contrast different insights to generate an integrative understanding or meaning of the problem
- Desire to find commonalities among disciplinary insights and explain how the differences in insights relate to the problem
- Provocation to find a better theory or approach when encountering difficulty in reconciling dissimilar elements (Nikitina, 2002, pp. 39–40)
- Engagement in a higher level of analysis and multilevel thinking about complex problems or questions
- Development of a critical stance toward scholarly claims of completeness and willingness to suspend disciplinary certainty
- Awareness that any integration achieved is likely to be limited and/or that other approaches may well result in a more comprehensive understanding. It is unlikely that the undergraduate student will arrive at a conclusive or all-inclusive understanding of the problem.

The Role of Intuition

Interdisciplinarians are of two minds concerning intuition. Some see interdisciplinarity as primarily a step-based process versus an intuition-based one. The division over this issue, however, is not as deep as the rhetoric may imply. One prominent advocate of a step-based process, for instance, also includes language in his model of the interdisciplinary research process such as “creating common ground” and “producing a model (metaphor, theme) that captures the new understanding” (Newell, 2001, p. 15). Intuition is involved when attempting to create common ground among several apparently disparate theories, concepts, or assumptions and devising a metaphor that comprehensively describes the new understanding or model.

The interdisciplinary process must leave room for, and indeed encourage, intuition, reflection, and creative imagination. The interdisciplinary research process is not strictly a linear or step-based or rule-based procedure; it is a combination of step taking and intuition.

In the middle of the twentieth century, post-positivist philosophers of science moved away from a step- or rule-based view of scientific research toward one that incorporated an intuitive view in which hypotheses could emerge from hunches, intuition, and even dreams. Subsequent research in learning theory and cognitive science increasingly supports the importance of intuition. “If this is true for science,” says J. Linn Mackey (2002), “it must certainly be true for interdisciplinary work” (p. 127).
The Necessity of Creativity

In his recent study of creativity and its relation to the interdisciplinary process, Marc Spooner (2004) has found that the choice of term used to describe creative activity “appears largely to be a function of the discipline with which one is associated.” The natural sciences typically prefer discovery, the applied sciences prefer invention, business and high technology prefer innovation, and the social sciences and the humanities prefer creativity (pp. 87–88). Nevertheless, there is considerable consensus on the following definition of creativity, from P. E. Vernon (1989):

[Creativity is the] capacity to produce new or original ideas, insights, restructurings, inventions, or artistic objects, which are accepted by experts as being of scientific, aesthetic, social, or technological value. In addition to novelty as our major criterion, we must incorporate in our definition the acceptability or appropriateness of the creative product, even though this valuation may change with the passage of time. (p. 94, italics added)

Creativity, says Klein (1996), starts with partial information. It develops through exploration and experimental application of familiar techniques to new situations (p. 222). “Excellence” of the creative result, she says, is measured in terms not of fidelity to disciplinarity but of interdisciplinary originality. Disciplinary accuracy and clarity are important, but...the creation of new meaning [is] of primary importance. . . . Interdisciplinarity is most successful when it is most creative. (pp. 222, 224)

Creativity and the Integrative Process

Recent research has identified the connections between creativity and integrative thinking. Creativity, says David Sill (1996), draws from the richness of the subconscious in relying on nonlogical and nonlinear thought processes (i.e., intuition), not mechanical rules. Our subconscious provides the raw material for creative combinations in the form of ideas, images, or concepts. The ripeness of these ideas, images, or concepts encourages creative insights that tend to be ambiguous, novel, meaningful, incongruent, and divergent (pp. 140–141).

Sill (1996) notes that creativity is an apt analogue for integrative thought, and he points out that research into creativity suggests that it occurs in stages (p. 130). For example, Gary A. Davis (1992) finds that the “creative process typically refers to (1) steps or stages, (2) perpetual change or transformation, or (3) techniques and strategies that are used to inform or produce the creative act” (p. 5).
Sill (1996) also notes, “Without the initial idea or impetus, without saturation in the ideas, the background, the culture, and the social order, and without time to allow creativity to occur, creativity cannot occur” (p. 129). Sill makes four important points about creativity that warrant the attention of interdisciplinarians:

- Creativity occurs in stages.
- Creativity begins with an initial idea.
- Creativity results from saturation in the insights and theories relevant to the problem.
- Creativity takes time. (pp. 145–149)

Just as some theorists argue that creativity progresses in stages, adds Deborah Vess (2004), “the ability to think in an integrative fashion may also occur in stages” (p. 5).

According to Spooner (2004), a basic set of tools undergirds and guides creative thinking. Each tool may enter into the interdisciplinary process at various steps and make a useful contribution to the end goal of developing interdisciplinary integration or synthesis.

For example, in order to draw on various disciplinary perspectives, observation and abstraction are useful tools. Likewise, in order to integrate disciplinary insights, the ability to recognize patterns, to form patterns, to analogize, to think dimensionally, to develop models, to transform, and finally to synthesize information is very valuable. (p. 98)

The result of the creative and integrative process is “the production of something that is both new and useful” (Houtz & Patricola, 1999, p. 1). Creativity combined with using the research process described in this book should result in an interdisciplinary understanding of the problem.

How Integration Is Achieved

What Is Integrated

Chapter 5 noted that what must be integrated are disciplinary insights, including those that are theory based. This is achieved by creating common ground from the theories, concepts, and assumptions embedded in these insights.

The Importance of Integration to the Interdisciplinary Research Process

The previously recounted stories of the blind men and the elephant and of building the elephant house illustrate the primary importance of integrating
insights. Like the blind men in the first story, scholars each represent a separate discipline earnestly attempting to explain a complex phenomenon represented by the elephant. The result of their combined efforts is merely setting various disciplinary perspectives side by side, represented by their description of various parts of the elephant (i.e., a complex phenomenon). More fundamentally, their fragmented views of the elephant prevented them from achieving a comprehensive understanding of what they were investigating, leaving them the poorer for their efforts.

A similar failure occurs in the story of the elephant house. Once again, each disciplinary specialist uses a method and contributes an insight appropriate to that discipline. But their collective failure to combine and integrate their disciplinary insights results in a product that fails the ultimate test: the product’s utility.

Both stories point up the importance of integration in solving a complex problem, designing a complex product, or answering a complex question. The interdisciplinary effort will prove a hollow exercise unless some measure of integration is achieved.

Paying Attention to Process

Achieving integration requires that students pay careful attention to process. In practical terms, this means three things:

1. Examine how the insights to be combined are obtained and interrelated. Achieving integration to produce an interdisciplinary understanding must be grounded in the commonalities but still take into account the differences (Klein & Newell, 1997, pp. 404, 406).

2. Reconcile the conflicting theories, concepts, or assumptions of the conflicting insights, some of which may appear to be identical but may be merely similar and some of which may deceptively appear to be so dissimilar as to render integration difficult or even impossible.

3. Leave room for nonlinear thinking. “The progression of integrative strategies from learning the disciplines, tracing connection and disconnection among them, to pointing out the limitations of any single view and attempting a synthesis is not to be viewed linearly” (Nikitina, 2002, p. 41).

Devotion to process is not the end but merely the means to an end. The interdisciplinary process must remain flexible to leave room for creativity and intuition. The interdisciplinary research process, then, is a combination of step taking, decision making, intuition, process, and creativity.
The Basis of Integration

Insights cannot be integrated until common ground among them is first established. This means deciding which common ground theory, concept, or assumption is the one that addresses all or most of the conflicting insights. The objective of creating common ground is not to eliminate tension altogether between the insights of different disciplines, but to reduce the level of tension. Tension, even conflict, will remain, reflecting the differing assumptions and epistemologies by which the disciplines and their theories operate (Newell, 2007, p. 260).

Once common ground is created, the student can confidently proceed to Step 9, which calls for integrating the insights identified earlier. The common ground that undergirds these insights should reflect the most basic theory, concept, or assumption upon which the problem or object rests. This theory, concept, or assumption operates much like a magnet, pulling all of the known variables toward itself. It is—to use another, though imperfect, metaphor—the glue that enables the interdisciplinarian to begin the process of integrating the known variables or causal factors of the different insights, setting the stage for producing the interdisciplinary understanding.

The Interdisciplinarian’s Work

In integrating insights, the interdisciplinary student is doing work that disciplinary students seldom do. Disciplinary majors typically focus on only those parts of a problem that fall within the discipline’s research domain. The interdisciplinary student, however, has the responsibility of studying the problem comprehensively, of studying those parts of the problem that fall between the disciplines, or of studying the linkages between all the parts. The disciplines use a divide and conquer strategy of disciplinary reductionism that simply ignores what is not of interest to them. Unless the interdisciplinarian addresses these ignored linkages and conflicting insights into a given problem, there will be no overall problem, merely “smaller” and separate problems, each one studied separately by those disciplines interested in it. Worse, the reductionist strategy of the disciplines would prevail, leaving us ignorant of the possibilities of integrative thinking and problem solving (Newell, 2007, pp. 260–261). Though students working in multidisciplinary programs are trained to study the parts of the problem from various disciplinary viewpoints, they are not charged with the responsibility of integrating them.
When Integration Occurs

When exactly does integration occur? According to Szostak (2002), “Integration occurs when the insights of each particular theory and method are delineated, and it is shown how, in combination, they yield a better explanation than any in isolation” (p. 115). Klein (1996) adds that because achieving a working relationship between differentiation and combination is an ongoing task, the boundaries between stages also blur. “Synthesis is not reserved for a final step. The possibilities are tested throughout, moving in zigzags and in fits and starts as new knowledge becomes available and new possibilities and limits arise” (p. 223).

How do we know when integration has occurred? Practitioners offer these criteria:

• When an interdisciplinary understanding is achieved (Klein, 1996, p. 223)
• When the integrated result is greater than the sum of its disciplinary parts (Shin, 1986, p. 99)
• When “a new object that belongs to no one” is created (Carp, 2001, p. 85)

Examples of Integrating Insights

In each of the following examples drawn from a problem-based course project, published work, and undergraduate student papers, interdisciplinarians are careful to identify the insights that they are seeking to integrate. The integrative techniques used in each case to achieve integration are in italics.

From a Problem-Based Course Project:
The Causes of Suicide Terrorism

In the problem-based course project on the causes of suicide terrorism, common ground among the six conflicting theory-based insights was achieved by expanding Self-Sanction Theory so that it can address all of the causal factors of this phenomenon. Once expanded, the theory is able to integrate the other five theories. Integrating these theories proceeds serially, as follows.

• The focus of Terrorist Psycho-logic Theory is on individuals who are drawn to the path of terrorism to commit acts of violence. Their behavior is explained “as a consequence of psychological forces,” and more specifically by “their special psycho-logic” that enables them to construct rationalizations for their actions that they are “psychologically compelled to commit” (Post, 1998, p. 25). Expanding Self-Sanction Theory to include the moral cognitive restructuring of individuals allows it to integrate Terrorist Psycho-logic Theory with its similar focus. The common ground between the two theories is the rationality of individual decision making, which is influenced by multiple factors that are internal and external to the individual.
• The focus of Martyrdom Theory is on individuals who are ready to die while committing violence against others. According to Ariel Merari (1998), these persons “wish to die for personal reasons” that include “personality factors” and “broken family backgrounds” (pp. 206–207). Though a product of cognitive psychology, the theory takes into account factors that one does not readily associate with this subdiscipline, such as cultural factors (including the influence of religion), indoctrination (which may include charismatic political, military, or religious leaders, as well as family members), and situational factors (which may include a variety of social, political, and economic circumstances).

• Expanding Self-Sanction Theory to include the moral restructuring of individuals allows it to integrate Martyrdom Theory, with its intense focus on individual personality factors that influence a rational decision-making process.

• Collective Rational Strategic Choice Theory, a product of political science, takes a “big picture” view of suicide terrorism, understanding it as an expression of a sophisticated political strategy, whether that strategy involves secular or religious goals. For Martha Crenshaw (1998), terrorism follows logical processes that are discoverable and explainable (p. 7). The theory, she says, is unlike conventional rational choice theories of individual participation in political rebellions because it focuses on (a) “collective behavior” and (b) the “strategic reasoning” driving this behavior. The theory also addresses the degree to which “strategic reasoning” may be “modified by psychological and other constraints” (p. 9). The common ground between this theory and the expanded theory of Self-Sanction is that the decision-making process used by suicide terrorists is a rational one (whether it is “strategic” in a secular sense or intensely personal in a religious sense). The rational decision-making (or “strategic reasoning”) aspect of Collective Rational Choice Theory, along with its emphasis on the psychological modification that occurs in the process of transforming a person into a suicide terrorist, allows it to be integrated with Self-Sanction Theory.

• “Sacred” Terror Theory, also a political science theory, focuses on the “special justifications and precedents” that religiously motivated terrorists use (Rapoport, 1998, p. 107). These “special justifications,” designed to dispel the doubts of recruits, concern the religious importance of martyrdom that is based on sacred writings and commentaries on these (both oral and written; p. 122). The common ground between this theory and Self-Sanction Theory is the belief that terrorists engage in a rational process of decision making despite this process being heavily influenced by religion. The expansion of Self-Sanction Theory to include the role of mental accounting and emotion (as defined in Chapter 11) allows it to integrate “Sacred” Terror Theory with its particular focus on the influence of religion on the process of moral cognitive restructuring.
• Kin Altruism Theory, a cultural anthropology theory, holds that suicide terrorists act out of a universal heartfelt human sentiment of self-sacrifice for the welfare of the group or culture (Atran, 2003, p. 2). Scott Atran rejects the notions that suicide terrorists have a special psychopathology, that religion “or even religious-like motivation” can explain this phenomenon, or that “utility” (i.e., transitive preferences) motivates terrorist behavior. Rather, Atran argues that Kin Altruism Theory offers the best way to understand suicide terrorist behavior because it addresses psychological and cultural relationships and shows how these, rooted in rationality, are “luring and binding thousands of ordinary people into terrorist organization’s martyr-making web” (p. 8). This theory, he says, explains “why nonpathological individuals respond to novel situational factors in sufficient numbers for recruiting organizations to implement [their] policies” (p. 3). The expansion of Self-Sanction Theory to include the role of emotion and mental accounting as part of the process of moral cognitive restructuring allows it to integrate Kin Altruism Theory, with its emphasis on how cultural factors inform the terrorist’s psychology and decision-making process.

Clearly, the common ground theory in this example does not erase all differences between the conflicting theories but instead focuses on their fundamental commonality, namely, that terrorists’ decision-making processes are rational, complex, and influenced by factors both internal and external to the individual.

From the Natural Sciences: Watson (1968), The Double Helix: A Personal Account of the Discovery of the Structure of DNA

Watson (1968) is careful to identify each insight and decision point that ultimately led him and Crick to solve the complex structure of the DNA molecule. These insights and decisions about research pathways include the following:

• The insight that X-ray crystallography was the key to genetics and that Bragg’s law could be applied to studying DNA in 3-D (p. 8)
• The insight of Avery’s theory that genes are the key components of living cells, pointing to the need to understand how genes act and that future experiments could show that all genes are composed of DNA (p. 14)
• The insight that working out DNA’s chemical structure might be the essential step in learning how genes duplicate (p. 23)
• The decision by Watson to study viruses to get at genes, hoping that the combined techniques of chemistry and genetics would yield biological dividends in the form of unlocking the secret to the structure of DNA (p. 22)
• The decision to use Wilkins’s theory that genes could crystallize and thus must have a regular structure that could be solved in a straightforward fashion (p. 33)
• The decision to use Crick and Cochran’s mathematical model of diffraction of X-rays, proving that DNA has a helical structure, and confirming Pauling’s α-helical model developed through manipulating physical models (much like tinker toys) based on which chemical elements like to sit next to each other (p. 50)

• The insight from astronomer Tommy Gold’s “The Perfect Cosmological Principle” that far-out ideas could be applied to the problem of the structure of DNA (p. 126)

• The insight (i.e., hypothesis) by Watson that the TMV structure was helical and comprised of a central RNA core surrounded by a large number of identical small protein subunits (pp. 112, 124)

• The decision to apply to DNA the principle that important biological objects come in pairs (p. 171)

These insights could not be integrated and a model of DNA produced, however, until Watson and Crick determined the angle and radii at which the DNA strands twisted about the central axis. The specific problem they faced was finding spaces large enough along the length of the helix that would accommodate clusters of atoms without forcing them closer together than the laws of chemistry allowed. As Watson explains, “Positioning one atom the proper distance from its neighbor often caused a distant atom to become jammed impossibly close to its partners” (p. 99). This problem was solved when Watson extended the concept of “cozy corners” in the chemical structure of the similar tobacco mosaic virus (TMV) to DNA, as noted in Chapter 11. This breakthrough allowed Watson and Crick to begin rapidly integrating their research.

The first major integrative breakthrough came from Rosalind Franklin, the lab’s expert on X-ray crystallography, who developed a new 3-D form of DNA (called the B structure), which occurred when the DNA molecules were surrounded by a large amount of water. This new structure produced much sharper black cross reflections via X-ray crystallography than the A form Watson and Crick had been working with. The black cross reflections confirmed the Stokes-Cochran-Crick theory that such an image could arise only from a helical structure (p. 169). The remaining critical problem was arriving at a structural hypothesis that would allow them to pack the bases regularly in the inside of the helix. This problem was ultimately overcome when Watson and Crick abandoned two long-held assumptions: that the helix could be either a three-chain or a two-chain model, and that the backbone of the helix was in the center of the helix. Knowing that they did not have time to explore both a three-chain and a two-chain hypothesis, Crick urged Watson to focus on two-chain models. Watson agreed and also decided to relocate the backbone of the helix on the outside. Doing so showed that there was “no difficulty in twisting an externally situated backbone into a shape compatible with the X-ray evidence” (pp. 178–179).

The remaining integrative breakthrough, and the key to ultimately revealing the atomic structure of the helix, was figuring out the composition of
the bases or clusters of atoms that held the two chains together. Watson describes the problem like this:

There was the vexing problem of how the intertwined chains might be held together by hydrogen bonds between the bases. Though for over a year Francis [Crick] and I had dismissed the possibility that bases formed regular hydrogen bonds, it was now obvious to me that we had done so incorrectly. . . . The crux of the matter was a rule governing hydrogen bonding between bases. (p. 183)

One day, Watson recalls, “a nontrivial idea” emerged.

It came while I was drawing. . . . Suddenly, I realized the potentially profound implications of a DNA structure in which the adenine residue formed hydrogen bonds similar to those found in crystals of pure adenine. If DNA was like this, each adenine residue related to it by a 180-degree rotation. Most important, two symmetrical hydrogen bonds could also hold together pairs of guanine, cytosine, or thymine. I thus started wondering whether each DNA molecule consisted of two chains with identical base sequences held together by hydrogen bonds between pairs of identical bases. (p. 184)

Watson’s insight provided the final integrative element that unlocked the secret of the structure of DNA. The only remaining task was to model their integrative understanding of the DNA molecule to show that it conformed to all the known rules of chemistry.

*From the Natural Sciences: Nagy* (2005),
*Anthropogenic Forces Degrading Tropical Ecosystems in Latin America: A Costa Rican Case Study*

In her study of anthropogenic forces degrading the tropical ecosystems of Latin America, and Costa Rica in particular, Nagy (2005) achieves common ground by redefining “wealth” in a way that addresses the need both for economic development and for ecosystem health. Wealth, in an environmental sense, can refer to biological diversity and ecosystem health. By contrast, wealth, from an economic perspective, usually means financial prosperity, often derived from exploiting natural resources. The way Nagy integrates these diametrically opposed positions is instructive. The lines between these conflicting positions begin to blur when she places them on a continuum that stretches from “anti-development” (the natural science/environmental position) to “pro-development” (the social science/economics position). On the end opposing development are the environmentalists who focus primarily on conserving natural resources and who seek to minimize human interaction with the environment. At the opposite end of the
continuum is economic activity that seeks to exploit natural resources for human benefit and that promotes capitalist activity (p. 106). Across the continuum is a universal focus on meeting basic needs. On the anti-development end, the primary needs of the ecosystem are included for all organisms, as well as the physical features of the community. A healthy ecosystem, she says, allows exchange and regulation of both the abiotic and the biotic communities. The basic needs of humans on the pro-development end are derived from the same basic needs of ecosystems. Both require food, water, shelter, and sanitation. These needs can be derived only from a healthy environment. Human life and development is directly related to meeting the most basic needs of the environment.

Essentially, she says, the problem becomes how to maximize jointly human and ecosystem needs. Her integrative insight is that one can look at the problem like this: the needs of the human species alone (“I”) versus the needs of all living species (“We”). Seeing where their needs overlap on the continuum is a starting point for addressing the problem in a comprehensive way. Armed with this broadened definition of wealth, and using the integrative technique of the continuum, Nagy is able to integrate the conflicting insights produced by environmental science and economics.

From the Social Sciences: Delph* (2005), An Integrative Approach to the Elimination of the “Perfect Crime”

Delph’s (2005) study is an example of some insights conflicting while others do not. Whenever there is conflict, common ground must be created to overcome it, at least to the extent possible. On the one hand, Delph found “no apparent contradiction” between the insights generated by forensic psychology and criminal investigation, making the integration of these insights relatively easy to achieve. On the other hand, she found substantial conflict between the approaches of the physical sciences and the behavioral sciences concerning the standard practice of criminal profiling, meaning recreating the criminal act so as to obtain insights into the personality of the criminal. The physical sciences privilege empirically derived insights of investigative profiling, whereas the behavioral sciences prefer intuitively derived insights. Delph argues that many more crimes could be solved if the disciplines of criminal justice, forensic science, and forensic psychology “better understood each other’s needs and integrated their theories and methods” (p. 29).

Integration of these very different approaches to profiling, of course, is predicated on creating common ground between the conflicting insights. More specifically, integration is predicated on creating common ground between the conflicting physical science and behavioral science views on profiling. Delph (2005) accomplishes this by redefining the meaning of profiling used by each field so that the broadened term integrates the specialized kind of knowledge that criminal investigation, forensic science, and
forensic psychology each privileges. What is actually integrated is “the unique knowledge possessed by each of these areas of expertise” (p. 30). She proceeds to describe each kind of knowledge so that she can show how their integration provides the “more comprehensive solution” of so-called perfect crimes (discussed later in this chapter).

The Practice of Cultural Analysis: Exposing Interdisciplinary Interpretation

Bal’s (1999) objective is to expose the full meaning of an enigmatic graffito that appeared on a brick wall in Amsterdam:

Note

I hold you dear
I have not
Thought you up (p. 2)

As noted in an earlier chapter, Bal uses the interdiscipline of cultural analysis to arrive at new and more comprehensive understandings of cultural artifacts and texts. As applied to the graffito, this approach centers on the verb “to expose,” which refers to the action of “making a public presentation” or “publicly demonstrating.” The verb, says Bal (1996) in Double Exposures: the Subject of Cultural Analyses, “can be combined with a noun meaning opinions or judgments and refers to the public presentation of someone’s views; or it can refer to the performing of those deeds that deserve to be made public” (p. 2). Bal creates common ground by extending the meaning of the verb “expose” from a specific and literalized definition to a broader, more ambiguous, and metaphorical one by combining it with the nouns “exposition,” “exposé,” and “exposure.” The graffito is a particular form of discursive behavior that is characterized by the posture or gesture of exposing. She integrates the various gestures of exposing, gestures that point to things like the graffito that seems to say, “Look!”—often implying, “That’s how it is.” The “Look!” aspect involves the visual availability of the exposed graffito as a bright yellow handwriting on the red bricks of the city wall. The “That’s how it is” aspect involves the authority of the author, who knows from experience the heartbreak of loss. The concept of exposing, she says, integrates the two gestures. “The possible discrepancy between the object [i.e., the graffito] that is present and the statement about it creates the ambiguities” that she examines (p. 2). Armed with these analytical tools, Bal attempts to expose the meaning of the graffito by integrating not only the insights of cultural analysis but also the insights of other relevant disciplines.

Bal’s study of the graffito generally conforms to the integrative process outlined in these chapters. She identifies the problem, identifies the relevant
disciplines and their insights, identifies those that conflict, and creates common ground among them using the technique of extension.

**From the Humanities: Silver* (2005), Composing Race and Gender: The Appropriation of Social Identity in Fiction**

Creative writing, says Silver (2005), like all other disciplines, sees the world through its own “peephole” or perspective. “I love this peephole deeply,” she confides, “but I also want to see the entire truth [because] truth is fundamental to fiction” (p. 75). For Silver, seeing the “entire truth” as a writer of fiction involves boundary crossing. One way fiction writers cross boundaries is by appropriating social identities, which are reflected in their characters. Silver uses the integrative technique of *redefinition* to resolve an ethical dilemma that exists when fiction writers, actors, and filmmakers regularly and uncritically appropriate a person’s identity. That dilemma is how to engage in this practice in an ethical, by which Silver means truthful or authentic, way. The disciplines that Silver finds most relevant to the problem are sociology, psychology, cultural studies, and creative writing. The challenge for Silver was finding common ground among the conflicting disciplinary insights concerning this problem. Silver redefines the concept of “implicature” to mean the ultimate level of empathy that one person can have with another. Implicature, she says, is what makes appropriation ethical rather than hypocritical. What she integrates are “the rules of fiction” with the social and historical implications of appropriation” (p. ii). These rules include characterization, point of view, and trusting the author. Silver’s discussion of the historical and social implications of appropriating a social identity is informed by “the power dynamics and guilt feelings of race and gender relations” (p. 15).

The integration of insights is foundational to Silver’s (2005) ultimate objective, “a cohesive set of guidelines” for writers, actors, and filmmakers that would govern their fictional appropriation of race and gender (p. ii). These guidelines express her integrative understanding of the topic (discussed later in this chapter).

**Summary**

The concern in this part of the chapter is not so much with the specific theories, concepts, and assumptions that are being integrated but with the principle of integration at work. This principle is that the student must have an adequate grasp of the disciplinary insights and the corresponding theories, concepts, and assumptions that are to be combined. As has been emphasized, the most relevant disciplines and their perspectives usually produce the most relevant insights.

The portion of an interdisciplinary essay that identifies the relevant theories, concepts, and assumptions performs two critical functions: It validates the
choice of disciplines, and it lays the groundwork and provides the raw data for the integrative portion of the study. To the extent that the student has been thorough and balanced in identifying and examining these important disciplinary data, the integrative effort should proceed relatively smoothly, as these examples demonstrate. At the very least, the integrative phase of the project will most certainly reveal any oversights in the interdisciplinary process that need to be addressed. The integrative phase itself provides an internal assessment of the research and analysis that has occurred up to this critical point.

Producing an Interdisciplinary Understanding

Step 10: Produce an interdisciplinary understanding of the problem and test it

In this Step of the integrative process, the student is working with information already known from having successfully performed earlier Steps, particularly 8 and 9. Step 10 affords the student an opportunity to review and validate decisions made in earlier Steps.

A Definition of Interdisciplinary Understanding

Interdisciplinary understanding is “the capacity to integrate knowledge and modes of thinking in two or more disciplines to produce a cognitive advancement” that would not be possible using single disciplinary means. This advancement includes “explaining a phenomenon, solving a problem, creating a product, or raising a new question” (Boix Mansilla, 2005, p. 16).

The interdisciplinary understanding and its application is the end product of the interdisciplinary enterprise. Boix Mansilla (2005) identifies four core premises that underlie this concept:

1. “It builds on a performance view of understanding—one that privileges the capacity to use knowledge over that of having or accumulating it [emphasis added].”

2. It “is ‘disciplined’—i.e., deeply informed by disciplinary expertise.”

3. “It involves the integration of disciplinary views.”

4. It “is purposeful” leading to “cognitive advancement”—e.g., a new insight, a solution, an account, an explanation.” (pp. 16–18)
Ways to Express the Interdisciplinary Understanding

The remaining Step in the research process is to produce the interdisciplinary understanding of the problem and test it. This Step may take one of several forms, or some combination of these, but there may well be others.

- Introduce a metaphor (a figure of speech in which a word or phrase literally denoting one kind of object or idea is used to describe another to suggest an analogy between them) that illustrates how the common ground or integrating theory, concept, or assumption actually provides an integrative understanding of the problem.
- Create a model (an example, pattern, archetype, or prototype that can be set before one for guidance or imitation) that shows how the common ground theory, concept, or assumption provides an interdisciplinary understanding.
- Write a narrative (a written or spoken account or story) that explains how the common ground theory, concept, or assumption provides an understanding that is more comprehensive than using single disciplinary approaches.
- Pose a new question or develop a new avenue of research.
- Create a new process or physical product that is derived from the practical application of the new understanding.
- Apply the new understanding to the problem to (1) explain the implications of the interdisciplinary understanding for an existing policy, plan, program, or schema; and (2) propose a new policy, plan, program, or schema.

The interdisciplinary understanding is the product of, but distinct from, the various disciplinary insights into the problem. The resultant “interdisciplinary ‘whole,’” says Boix Mansilla (2005), “stands as more than the sum of its disciplinary ‘parts’” (p. 17). The metaphor, model, narrative, new question or avenue of research, new physical product, new policy, plan, program, or schema each expresses the integration between the parts and whole of the problem established in Step 9.

Testing the New Understanding

Advanced undergraduate or graduate courses typically encourage or even require using metaphors, models, and narratives to capture creatively the new understanding in all of its richness. This final Step in the research process affords the student an opportunity to review and validate decisions made in earlier Steps.

However one chooses to express the new understanding, it should be inclusive of each discipline’s insights but beholden to none of them. That is,
each relevant insight, theory, or concept should contribute to that understanding but not dominate it. The objective of this Step is to achieve unity, coherence, and balance among those disciplinary influences that have contributed to the interdisciplinary understanding (Newell, 2007, p. 261).

In effect, the new understanding and its various expressions tests whether it is coherent, unified, and balanced, and thus, truly interdisciplinary. A metaphor, for example, “brings out the defining characteristics of that understanding without denying the remaining conflict that underlies it” (Newell, 2007, p. 261). Metaphors are particularly useful in the humanities, where meaning cannot be adequately expressed using quantitative and empirical approaches. However, the social sciences and even the natural sciences make use of metaphors (Lakoff & Johnson, 1980). An interdisciplinary understanding has been reached when the metaphor is consistent with (1) the contributing disciplinary insights as modified to create common ground, (2) the interdisciplinary linkages found, and (3) the patterns observable in the overall behavior of the complex system (Newell, 2007, p. 261).

A model also may capture the unity, coherence, and balance contained in the interdisciplinary understanding. The model may be a tinker toy-like model of a molecule, such as the model of the DNA molecule that Watson and Crick built or Nagy’s model of sustainable development for Costa Rica.

Narratives are essential components to integrative learning, thinking, and research. The narrative expressing the new understanding or new meaning should explain how it is, in fact, new and more comprehensive than the understandings offered by the participating disciplines or how the meaning is new compared to the meanings offered by the disciplinary insights examined. This may involve comparing the new understanding to each insight in serial fashion, insight by insight or discipline by discipline, to show how the insight, because of its narrow perspective, is unable to capture the more comprehensive nature or meaning of the new understanding.

Creating a new process or product is another way to test the new understanding. One of the drivers of interdisciplinary research in the sciences and engineering is the stimulus of generative technologies “whose novelty and power not only find applications of great value but also have the capacity to transform existing disciplines and generate new ones” (National Academy of Sciences et al., 2005, p. 35). A recent example is the development of the Internet and the cyberinfrastructure that is rapidly transforming the economy. Other examples of interdisciplinary products are buildings that incorporate the principles of aural architecture (an emerging interdisciplinary field) and the use of “green” building materials to improve energy efficiency. Products may also be a play, poem, sculpture, or painting. These products are the result of extracting relevant information from disciplines and applied fields and integrating their contributions (Blesser & Salter, 2007, p. x).

Application of the new understanding may be in the form of a critique of an existing policy to show how it is failing to meet a societal need.
because of its disciplinary or conceptual narrowness. This may be followed by a proposed new policy, program, or schema that, because of its inclusiveness, is more likely to solve the problem.

Examples of Interdisciplinary Understandings

In each of the following examples drawn from professional works and undergraduate student projects, interdisciplinarians are careful to articulate the understanding derived from their integration of the relevant insights. The forms used to express this understanding—metaphor, model, narrative, or conclusion—are in italics.

*From the Natural Sciences: Watson (1968), The Double Helix: A Personal Account of the Discovery of the Structure of DNA*

For Watson and Crick, the final step in their quest to solve the mystery of the structure of DNA was building a *model* of this complex molecule. This required knowing its atomic structure and particularly the composition of the bases or clusters of atoms that held the two chains in the helix together. Once they figured out this rule, they were able to build the model. Watson’s *narrative* of the integrative steps taken and the critical decisions reached is instructive for interdisciplinarians, particularly those working in the natural sciences. For one thing, the scientific process, like the interdisciplinary research process, is not straightforward, logical, and linear, as is commonly supposed. Working with complex problems is messy. One may encounter dead ends and follow false leads, as Watson and Crick did. Trial and error and following “hunches” is inexorably part of many research processes. Second, and this applies to most interdisciplinary work, Watson and Crick did not need much expertise in unfamiliar fields in order to draw upon them effectively. They drew insights from specialized disciplinary literature and from disciplinary experts. Their experience shows the importance of achieving adequacy in the discipline one is working in, to at least know what is not known and be able to ask disciplinary experts appropriate questions, as Watson did repeatedly. Third, solving complex problems often requires that one break with conventional wisdom, as Watson and Crick did when, for example, they decided to build a scale model of the DNA molecule before knowing all of its atomic components and how they were arranged. Finally, Watson and Crick carefully considered every insight that appeared to be relevant to the problem. Inclusiveness, especially early in the research process, is preferable to excluding insights that may later prove useful.

Watson and Crick’s discovery conforms to the overall approach of the interdisciplinary process described in this book. They focused on a complex
problem (the structure of DNA) and drew insights from disciplines they knew (physics and biology) as well as from disciplines they knew nothing about (biochemistry, chemistry, X-ray crystallography, and even astronomy) in order to produce an integrative model that expressed their new understanding of DNA. Though model building preceded new understanding, it nevertheless expressed this understanding when it was successfully completed. Indeed, it was through the tedious, technical, and slow process of model building that the new understanding eventually came.

From the Natural Sciences: Nagy* (2005), Anthropogenic Forces Degrading Tropical Ecosystems in Latin America: A Costa Rican Case Study

Nagy (2005) characterizes her interdisciplinary understanding as “sustainable development.” It amounts to an integrative model that is designed to meet the needs of people now, but in a way that will not mortgage the ability of future generations to get their basic needs met. Sustainable development, she says, considers not just the environment and economic development, but social and cultural aspects as well. The components of her model include “resource conservation, ecosystem protection, economic motivation, cultural celebration and protection, and social considerations” (p. 107). Nagy believes that her integrative model makes it easier to incorporate cultural diversity and protection of indigenous peoples, for the simple reason that the practices of these groups, often linked myopically to endangered ecosystems, are also in need of economic development to ensure their survival. Within her continuum, cultural science (and thus the needs of indigenous peoples) would fall between economic development and environmental protection. Perhaps, she says, by focusing on conservation rather than preservation, sustainability could be achieved for these people as well. This insight is drawn from recognizing that it is unlikely that countries like Costa Rica, which need more economic development in order to meet the needs of their growing populations, will continue to set aside large tracts of land for these small groups as they have been doing. “Rather than emphasizing the preservation of land in a pristine and untouched condition, it is more realistic that activities allowing for multi-purpose land use (for ecosystem and cultural protection and economic development) will progress towards sustainability” (p. 108).

Nagy’s work conforms in almost every respect to the integrative research process discussed in these chapters. She identifies a complex problem, avoids the pitfall of siding with either the extreme environmental or development camp, dispassionately identifies and evaluates all of the relevant disciplines and their conflicting insights, creates common ground among them by using one of the integrative techniques discussed in this chapter, integrates these insights, and then constructs an integrative model that proposes a realistic solution to the problem.
From the Social Sciences: Delph (2005), An Integrative Approach to the Elimination of the “Perfect Crime”

Having created common ground and integrated conflicting disciplinary insights and approaches to criminal profiling, Delph (2005) offers her integrated understanding of the problem in narrative form. Criminal profiling, she writes, could achieve its greatest potential if profilers from forensic psychology and forensic science integrate their analytical techniques and share them with local criminal investigators. If achieved, this integrated approach will produce four likely outcomes: (1) quickly reduce the list of possible suspects, (2) predict the prime suspect’s future behavior, (3) offer investigative avenues that have been overlooked by police, and (4) empower local law enforcement agencies to use these integrated profiling techniques themselves (p. 32).

Delph’s study of criminal profiling meets all three criteria noted earlier. First, the understanding is interdisciplinary because it is based on the insights offered by the three disciplines most concerned with this topic. In fact, Delph’s new understanding fills an important gap in the literature on profiling from forensic psychology that, surprisingly, is virtually silent on how it can interface with forensic science. Second, the integrated result is greater than the sum of its disciplinary parts, meaning that the four outcomes transcend purely disciplinary approaches and are achievable only if these approaches are transcended. Third, Delph models good interdisciplinary practice by carefully keeping conflicting perspectives in balance. Her understanding belongs to “no one,” in the sense that it does not privilege one discipline or one insight over another.

Delph’s study illustrates two important practices urged in this book. First, she is clear about the disciplinary knowledge she is integrating. Second, by her detailing this knowledge, the reader can appreciate both the challenge of the integrative task and the importance of the integrative achievement.


Cultural analysis, as noted earlier, stands for an interdisciplinarity that is primarily analytical. Bal (1999) uses narrative to express her integrative understanding of the graffito’s meaning. It is, she says, “a good case for the kind of objects at which cultural analysis looks, and—more importantly—how it goes about doing so” (p. 2). The graffito is a letter both visually and linguistically. Though the literal translation of the opening from the Dutch is “Note,” the more usual address that comes to Bal’s mind is “Dearest” or “Sweety” (p. 3). “This implied other word fits in with the beginning of the rest of the text that says something like ‘I love you’” (p. 3). With the “discourse
of the love letter” firmly in place, the graffito shifts to epistemic philosophy by continuing with “I did not invent you” or “I did not make you up.” “The past tense, the action negated, the first-person speaking,” observes Bal, “all indicate the discourse of narrative only to make a point about what’s real and what is not” (p. 3). What is striking is that the address changes a real person, the anonymous writer’s beloved, into a self-referential description of the note: A referential “Dearest” becomes a self-referential “Note” or short letter. “This turns the note into fiction,” says Bal,

and the addressee into a made-up “you,” after all. Yet, by the same token, this inscription of literariness recasts the set of characters, for the identity of the “you” has by now come loose from the implied term of endearment that personalized him or her. So, the passerby looks again, tripping over this word that says “YOU!” . . . Addressed as beloved and not as a guilty citizen, the city dweller gets a chance to reshape her or his identity, gleaming in the light of this anonymous affection. But is it real? (p. 3)

One possible meaning, and one Bal (1999) considers plausible, is that the addressee is real if the beloved cannot be found; “she or he is irretrievably lost, and the graffito mourns that absence” (p. 4). For Bal, the graffito is an autographic poem. “Moreover, it is publicly accessible, semantically dense, pragmatically intriguing, visually appealing and insistent, and philosophically profound. Just like poetry” (p. 4).

Bal’s understanding extends to linking the graffito to the interdiscipline of cultural analysis itself. It is the interest in more than the public self-exposure of the subject (author) and object (the lost beloved) of the poem that makes the exposition an exposure of the self. Such exposure, says Bal, is an act of producing meaning (1996, p. 2). Cultural analysis is also interested in moving from a literal meaning of the poem to its broader and metaphorical meaning. Exposing meaning, as Bal does, creates a subject/object dichotomy. The dichotomy enables the subject (in this case, the author of the poem) to make a statement about the object (in this case, the lost beloved). The object is there, explains Bal, to substantiate the statement and enable the statement to come across (p. 3). There is an addressee for the statement: the reader. In expositions like the poem, a “first person,” the exposor, tells a “second person,” the reader, about a third person, “the object” or lost beloved, who does not participate in the conversation. But, Bal says, “unlike many other constative speech acts, the object, although mute, is present” (1996, p. 4). In this sense, the poem is a sign. A sign stands for a thing or idea in some capacity, or for someone. In this instance, the poem is a sign for the writer’s beloved, who is now lost. It is also a sign for the culture that produced it, the reader that reads it, and the field that examines it.

Bal follows the usual interdisciplinary process. She identifies all relevant disciplinary perspectives on the poem, creates common ground among their
Bal’s understanding of the meaning of the graffito meets the three criteria for integration identified earlier. Her understanding is indeed comprehensive, far more comprehensive than would be possible relying on a single-discipline approach. The integrated result is greater than the sum of its disciplinary parts, and the new understanding belongs to no one discipline.

Silver uses a brief case study to communicate her integrative understanding of appropriation and its importance beyond the realm of fiction writing, acting, and filmmaking. An example of appropriation is when a person in the social majority takes on the character of a person in the minority. Silver’s understanding is in the form of an extended discourse, in which she presents three general principles that are necessary to achieve implicature.

Before proceeding with appropriation, she says, a person must consider the element of implicature. “It is only through implicature that one’s work will be able to reach a level rewarding for both themselves and society. Reaching this high level,” she cautions, “is a very challenging process” (Silver, 2005, p. 61). The key is emotion. Emotion is the universal tie and the universal state of being. “Through emotionally implicating oneself within a given social identity—writers should potentially be capable of appropriating a voice within that identity” (p. 63).

The most striking example of implicature, Silver (2005) finds, is not from the world of fiction as one might suppose, but from the world of biography. Dr. Paul Farmer, the subject of Tracy Kidder’s Pulitzer Prize-winning biography *Mountains Beyond Mountains*, revolutionized the health care systems of Haiti and other developing nations. Kidder (and Silver) see Farmer as the ideal “global man” who believes in the universality of humankind and sees all the people of the world as having the same emotions. Silver describes Farmer’s unique ability to identify emotionally with the people he is trying to help. Reflecting on how he is able to love the poor children of the area as much as he loves his own daughter, Farmer wonders whether it may be the result of the unique childhood his eccentric father imposed on him. His home was either a bus or a boat dock, so he never developed a sense of place. This experience, Kidder (and Silver) suspect, accounts for Farmer’s ability to engage in hyper-connective thinking, meaning that he is able to function without being influenced by limiting considerations of time and national identity (pp. 63–65, 218).

Silver’s (2005) understanding, expressed in an extensive narrative that includes two illustrative case studies, reflects the three criteria for integration noted earlier. It is more comprehensive because it is based on insights...
from all the principle disciplines interested in the topic. Second, the integrated result is greater than the sum of its disciplinary parts because her three “general principles of implicature,” the core finding of her study, clearly transcend disciplinary boundaries. These include awareness of ethnocentric feelings, extended exposure to social identities outside one’s own, and hyper-connective thinking (p. 65). Third, the study models the interdisciplinary practice of avoiding advocacy of disciplinary points of view by keeping these views at a professional distance. Silver’s study truly belongs to “no one” because it keeps conflicting perspectives in balance and does not privilege one disciplinary insight over another. Her conclusions are her own.

**CHAPTER SUMMARY**

This chapter explains the last two Steps of the interdisciplinary research process: integrating insights (Step 9) and producing an interdisciplinary understanding of the problem and testing the understanding (Step 10). What is integrated are insights produced by the disciplines. Integration, a distinguishing characteristic of interdisciplinarity, requires paying close attention to process. A key insight concerning the interdisciplinary research process is that all practitioners do not apply it in the same way. In fact, one is struck by the variety of integrative approaches that published work and student projects use.

The last Step in the research process is producing the interdisciplinary understanding. Throughout this book, the phrases “interdisciplinary understanding,” “more comprehensive understanding,” “integrative understanding,” and “new meaning” are used interchangeably to describe the goal or product of the research process. This goal is to arrive at a result that is new and “more comprehensive” compared to available disciplinary insights. The student should explain how the integrative result, even if only partially achieved, is, in fact, new and more comprehensive and thus interdisciplinary. For Watson, it was to narrate the construction (at least initially) of a model of the DNA molecule to show that it conformed to all the known rules of chemistry. For Bal, it was using the graffito as a metaphor to express the theory and methods of cultural analysis.

Students need awareness that any integration achieved is likely to be limited and that methods other than those demonstrated here may well produce a more comprehensive understanding of a particular problem.

**NOTES**

1. For a detailed discussion of the term “understanding” from a social science perspective, and an explanation of the difference between the verstehen (and the more recent interpretive) approach and the predictive approach, see Frankfort-Nachmias & Nachmias (2008), pp. 10–11.
2. To some, these differences are frustrating, while to others, they are acceptable or even invigorating.

3. Examining the insights, concepts, and theories advanced by various disciplines relevant to the problem will develop an awareness of the limits of a single expert view. Interdisciplinarians are prone to skepticism of “expert views”—and indeed, should be—because in their regular crossing of disciplinary boundaries they are uniquely positioned to see the limits of expert views on particular topics. Skepticism is intellectually healthy and can embolden students to challenge traditional or well-entrenched views, freeing them to explore new lines of inquiry. Skepticism is the wellspring of new understanding.

**REVIEW QUESTIONS**

1. What is integration in interdisciplinary terms?
2. What cognitive qualities and internal dispositions aid integrative work?
3. What is the role of intuition in integration?
4. What role does creativity play in Steps 9 and 10 of the research process?
5. Why is creativity necessary in research, whether disciplinary or interdisciplinary?
6. What does research by Spooner, Vess, and Sill suggest about creativity and the integrative process?
7. What exactly is integrated?
8. What is the importance of creating common ground and integration to the interdisciplinary research process?
9. When exactly does integration occur?
10. When does integration occur in the example of the problem of suicide terrorism?
11. How is Watson’s narrative of the integrative steps taken instructive for interdisciplinarians?
12. How does Bal’s study of the graffito conform to the integrative model of the interdisciplinary research process used in this book?
13. What exactly is “an interdisciplinary understanding”?
14. What are some of the ways that one can express an interdisciplinary understanding?
15. How may proposing a new policy constitute a test of whether the new understanding is unified, coherent, and balanced?
16. How does Delph and Silver’s integrative work meet all three integrative criteria?