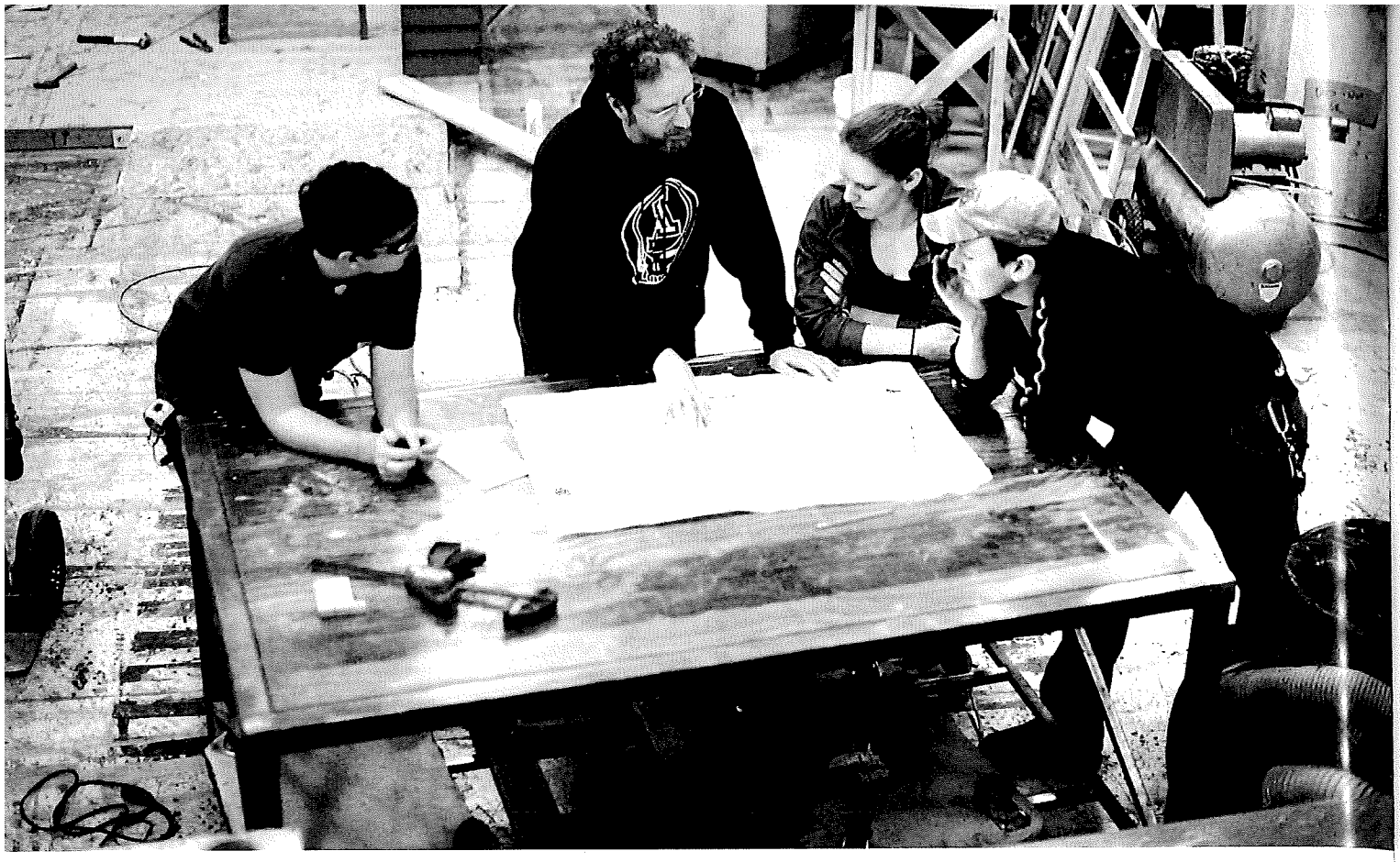

The author, with graduate students Ruth Richardson, Jack Meng, and Dan Movick in the University of Arizona scene shop. Photo by Jacob Chinn/ UA Alumni Association.

Critical Thinking and Decision Making

How developing and honing these skills aids in better choices in technical design

BY TED KRAUS

Sometimes, decision making and critical thinking are so intertwined that it is difficult to know where one process starts and the other ends. As an assistant professor in technical direction at the University of Arizona, I repeatedly have that realization almost every day. As I interact with my students, from freshmen to graduate students, I field questions about if (or why) I prefer one building technique over. Sometimes the questions are posed in terms of my knowledge, as in "How did you know to do that?" Sometimes the question is posed as a solicitation of my opinion, as in "Should I build that flat out of 2x4?" These can be difficult questions to answer because the larger truth is that what these students need is not an explanation of my choices, but rather an exploration of how they could make the choice.

These questions present opportunities to help students, mentees, and new employees develop their own distinct decision-making processes. Consider the theories and research surrounding critical thinking and decision-making, how those apply to the practice of teaching, and how to teach people to develop their own decision-making process. While the examples used in this article come from education, these techniques can be used in a variety of workspaces and situations where inexperienced employees are struggling to find the "right" answer instead of the best solution.

CRITICAL THINKING

Effective decision making exists within the framework of our critical thinking process. The product of a critical-thinking process is a decision based on the consideration of multiple points of view assessed in a thorough, rational, and definable manner (Browne & Keeley, 1994). Furthermore, throughout the critical thinking process, several questions can help determine if the conclusions drawn are valid, including:

1. Does the conclusion I came to make sense?
2. What is the quality of the information I used to support the conclusion I reached?
3. Why or why not?
4. Did I ask the right questions? Did I ask enough questions?
5. Should I review the information?
6. Was there more than one possible conclusion (solution)? (Clayton, 2007)

Consider the example above regarding the construction of the flat. My initial response might be to say that building a flat out of 2x4 is excessive. However, if the flat is serving as the support structure for something heavy, then my answer might change. Before offering an answer, I need to know what is driving the question and, more importantly, if the student knows what is driving the question. Can the student define the governing value that will determine if the right conclusion has been drawn? Most of the time, students know what they want to do, but they do not always seem to know why. Identifying the "why" is the process of understanding the journey from urge to choice and to end result. While it is important that students are empowered to identify and respect that instinctive tug to one choice over another, it is essential that they can identify and articulate what defines a successful end result. Articulating the "why" is at the heart of critical thinking and ultimately leads to successful decision making.

DECISION MAKING

The decision-making process is defined as the ability to make and carry out informed choices by efficiently utilizing your lifetime of knowledge, schooling, experience, reasoning, intuition, common sense, and confidence (Clayton C., 2007). This definition is based on "Rational Choice Theory" (a long-held staple of economic theory) that states that when armed with all the information about the options, rational individuals will always choose the option that maximizes the utility of the available options to fit the individual's need. A "maximizer," therefore, will approach decision making with the goal of achieving the best possible outcome (Peng, 2013). Yet this is frequently not the case.

To effectively explore the topic of decision making, it is vitally important to recognize that humans are seldom rational and rarely choose things in absolute terms. There is no internal value meter that dictates how much things are worth. Rather, we tend to focus on the relative advantage of one thing in relation to another and then estimate the value

accordingly. This relativity helps us make decisions in all aspects of our lives as we make comparisons to readily available alternatives (Ariely, 2008). Our minds are not perfect machines and this affects our ability to process information and remember facts. Consequently, information about alternatives is often incomplete, making our understanding of them unclear. Our memories are not perfect and are affected by our inherent biases so we often do not understand, or cannot fully project, the consequences of our decisions (Plous, 1993).

An example is a young assistant technical director who is struggling to lead his crew because he is resisting considering all of his options thoughtfully, because of a preconceived notion that decisions must be made quickly; this increases the pressure he feels. He can become trapped while trying to implement his version of the rational choice theory. He may find himself stuck in a swirl of options, all of which have merits, with no way to land and move forward because he was looking for the perfect solution. If we encourage our students to accept that no solution is perfect, we can help them shift their focus away from searching for the "right" solution to looking for one that satisfies enough parameters to allow the project to move forward. To give them this perspective, we must reinforce the idea that there will always be more than one possible "right answer" available to any problem. Their goal, then, is to find the solution that best fits the given situation. We must also help students understand that in addition to finding solutions to the problem, as much, if not more time, needs to be focused on identifying what defines the best solution for a particular situation.

CONTEXT AND FRAMES

Context is crucial in understanding and developing criteria for decision making. Think of context as "the 'working set' of information that you are dealing with at a given point in time" (Hunt, 2008). If the context changes, then so might the criteria defining the choice, as well as the subsequent decision. For instance, a flat made out of 2x4s might make sense in one context (supporting a platform) but not in another (a standalone wall). It is the interplay between context, stated goals, and the criteria that defines success. When any of these three values are not considered fully or are ignored because of the implementation of a poor critical thinking process, the result can be an ineffective decision-making process, leading to inappropriate decisions. In the context of building a show, the goal may be simply stated as bringing the designer's vision to fruition. However, the criteria for determining success might include finishing the set within the materials and labor budget and on schedule. If we succeed in making the set look like what the designer drew but it is over budget and late, can we still say we succeeded?

The idea of framing is closely related to, and some-

times confused with, the idea of context. We make decisions within particular contexts, and "frames" are mental models that simplify our understanding of our situational context (Roberto, 2009). This concept has relevance for how we, as decision makers, ask questions, consider the context of our decision-making situation, and define the criteria for success. When situations are framed as opportunities, people tend to be more flexible in how they think about solutions. On the other hand, when situations are presented as threats, people become more rigid while working harder to overcome the threat. Ironically, while we are working harder, we are using the same techniques that got us into trouble in the first place (Roberto, 2009). We try to work faster, we throw money at a problem, and we negotiate more time onstage—none of which guarantees a successful outcome.

Characterizing one method of framing as being better than another, however, would be incorrect. The most efficient methodology may be to engage a combination of the two methods (Roberto, 2009). After identifying and acknowledging the threat (budget overruns, falling behind in the build schedule, poor quality of the work in the shop, etc.), finding a way to frame the threat as an opportunity provides decision makers the opportunity to employ a more flexible approach to solving a problem. Of course, it is essential that we do not simply fall into a pattern of framing bad situations in positive language, but rather that we find real opportunities within the situation. Instead of simply rewording a troubling situation, we must first honestly assess the situation. If we see an opportunity, we should embrace it and change our behavior accordingly—not because we want to create an illusion of positivity, but because research has shown this approach to be more effective in finding new solutions within the troubling situations.

DELIBERATIVE VS. THE INSTINCTUAL

By and large, two methods govern how we make decisions: The "deliberative process," when we think through our options, and the "automatic process," when we rely on our gut feeling or intuition. It is tempting to think that these two types of decision making exist as two completely separate and distinct processes and that the emotional process (our gut feeling or intuition) is in conflict with our linear, cognitive, or rational process. This train of thought generally characterizes the emotional system as one that is primitive, ingrained to react with our most basic emotions, and driven by our amygdala, while the deliberative process is characterized as being controlled by our pre-frontal cortex, which reins in our emotional amygdala as part of the dialogue that takes place in our limbic system. But this dichotomy is not always the case. In fact, research has shown that these two systems are highly interactive and interdependent (Frank, Cohen, and Sanfey, 2009; Lennick and Kiel, 2007). Information stored in the sub-regions of the pre-frontal cortex

work to create a balance between the immediate and substantive information coming in from the amygdala and a lifetime of preferences and experiences. This balance affords us the opportunity to resist the strong pull of the emotional decisions by offering alternative options (Frank, Cohen, and Sanfey, 2009)—an explanation for those times when we are drawn to an option without having a rationale for doing so. Consider the following two scenarios:

Scenario One: You are trying to decide between two construction methods. After your analytical process, you are left with two choices of equal merit. You are leaning towards one choice over the other, so that is the one you choose. The "lean" is your instinct influencing you.

Scenario Two: You are trying to decide between two construction methods. For some reason, you are drawn to one option over the other, so that is the one you choose. You then use your critical thinking process to validate and confirm your choice or to find reasons why the choice will not succeed. This must be an honest assessment and not simply an exercise in legitimizing your decision. Rather than asking, "why will this idea work?" it is better to approach the problem with the question, "what is wrong with this idea and why won't it work?" The goal is to poke holes in the idea until you are sure it is valid. We see an example of this when consider the previous example of the young TD who was deciding what material to use for her flat. There was something pulling her toward building the flat out of 2x4s, but it broke our conventions for flat construction. Through our conversation, she used a process of critical thinking to explore the various aspects of her choices. In the end, she saw that while there may not be a need for to build it out of 2x4, there was nothing wrong with that decision, and she gained peace of mind. Her analytical side supported her intuitive side.

These two scenarios show the relationship between the analytical and rapid cognition processes, even though the "lean" described in scenario one may not feel very rapid at the time. The process described in the second scenario becomes easier and more common as we gain proficiency in a field. In fact, a person's expertise is the cultivated sensitivity to the patterns that occur within a domain and the ability to distinguish what information is pertinent and meaningful within a given context (Bransford, Brown, & Cocking, 2000). This capacity is at the core of a person's ability to engage in rapid cognition (Gladwell, 2005). We all have stories about walking through the shop, seeing something wrong, and fixing it before we know exactly what is wrong.

The feeling of unease one feels when experiencing cognitive dissonance is another example of this intuitive sense. We all undergo times when we are confused, but we

don't know exactly why. Something just doesn't look right. When my students encounter this feeling, I encourage them to turn into it and embrace the sense of confusion so that they can better identify its root cause and then analyze and determine a course of action. Ignoring it only serves to leave them blind to the consequences, rarely making the feeling of unease go away. In this way, we can see that instinctive processes are also essential to responsible decision making.

GUIDED DECISION MAKING ASSIGNMENT

One of the exercises I give my Intro to Stagecraft students is the task of drawing a series of hardcover Broadway-style flats. We start with a standard 4x8-foot flat and then move on to more complicated ones. Inevitably, the question of where to put the structural framing arises. Rather than telling them where the framing should be placed, I direct their decision-making process by asking them to consider three questions:

1. What do you know?
2. What do you need to know?
3. What are you doing?

I use these three questions in all my classes because, regardless of the topic, they seem to get to the heart of figuring out how to move through a problem. However, I could add a fourth question: "How do you know if you succeeded?" This would make the students circle back and check the criteria for success as defined at the outset of the assignment. In the case of the flat drawing problem I give the Intro students, here is what typically happens.

1. What do you know? This is vital because it identifies what the students are gleaning from either the designer drawing or the assignment description/instructions. Usually, they can identify such things as:

a. The size and shape
b. The type of flat
   i. Broadway as opposed to Hollywood, providing an opportunity to discuss corner-blocks and straps
   ii. Hard covered as opposed to soft covered
c. Construction material. I specify the material (1x3 pine) so I can reinforce information from a prior lecture. They may remember the term 1x3, but do they understand that:
   i. The phrase 1x3 represents a nominal dimension?
   ii. That in our shop, the actual measurement of a 1x3 is 3/4 of an inch by 2 and 5/8 inches?
   iii. Or at a more basic level, do they understand the difference between the terms nominal and actual?
d. Whatever else comes up over the course of our conversation.

2. What do you need to know? This vital question serves to help students identify what they are doing with the information from the previous question, as well as any gaps in information. Overtly asking this question makes them real-

ize that they can, and likely should, ask for specific details. I work with them to understand some basic guidelines of flat construction like:

a. The need for there to be framing to the outer edges of the flat
b. The need for framing to support the seams of the lauan being used as the hard cover (if the flat is larger than 4 x 8 foot
   i. This discovery leads them to see the need to figure out the lauan layout before we can identify where the framing needs to be placed.
   ii. At this point, the three-question cycle may start again around the question of how to arrange the lauan covers.
c. Is there necessary information that has not yet been supplied? This often leads to a discussion about the dialogue between technical directors and designers.

3. What are you doing? This question is asked at the end of the process as a way to re-center the investigator, who at this point is potentially so full of information that the path is still unclear. In the case of this flat drawing, the answers range from "trying to get through this assignment" to "trying to understand the thought process that a technical director goes through when building flats."

There is no wrong answer to question three because the answer helps inform everyone involved in the discussion about the level of commitment and investment the respondent has made to the project. Because this introductory class is filled predominantly with first-year students, I find that many of the students have never before been challenged to express their level of interest in a project. Admitting (acknowledging) their level of interest and commitment is an important step in establishing the context and identifying the framework within which the decision-making process is being developed. And to be clear, it is an effective process that is being developed, rather than an emphasis on the product or output. Many times, we make bad decisions because we are focused on the decisions as singular events rather than processes. We spend too much time focusing on making the right decision rather than focusing on choosing the right decision-making process (Roberto, 2009). The three questions are tools that help students break the larger question into its key components, making the information easier to process and the context easier to see.

The flat drawing assignment helps define the context within which the decisions need to be made. A flat of a different size and shape, with a different material, or of a different style will change the context, resulting in different choices. And even within the prescribed context, there can be more than one answer. The word "choices" is intentional: We do not make decisions in a vacuum of absolute terms. Rather, we make decisions based on available choices. Therefore, we can help students develop their de-

cision-making skills by helping them identify the available choices, as well as the benefits and consequences associated with those choices.

We must empower students to embrace their instincts, acknowledge them, and find the necessary tools to confirm or challenge the validity of their options and subsequent choices. If we do not, we will foster the misconception that students must be experts before they can make good decisions. We need to foster a spirit of creativity that allows our students the freedom to try new things and to trust their instincts within a process that includes time for honest self-assessment. We must model our own critical-thinking and decision-making processes to reinforce that we are not all experts all the time. There is no magic moment when you become good enough to start making choices. These illusions can be crippling for young decision makers. Obviously, the more time we spend developing our skills in an area, the more expertise we develop. But the question should not be "Do I know everything about this topic before I can make a decision?" but rather, "What information do I need about this situation so that I can move forward?"

WINDOW OF TOLERANCE

Students also need to learn to think effectively in stressful situations. Most people, when called upon to make decisions under stressful circumstances, have difficulty staying calm and instead start feeling anxious and less in control of the situation. This anxious feeling is a symptom of the "autonomic arousal model" (Ogden, Pain, and Fisher, 2006). When under stress, we enter a state of hyperarousal and our cortex goes off-line, leaving us without the ability to think clearly. It is vital that teachers recognize signs of hyperarousal in students so that we are better able to help them get back into their "window of tolerance." This window of tolerance is characterized by an ability to think and feel simultaneously, to cultivate tolerable feelings and reactions that are adaptable to the individual situation.

One way to coax students back to their window of tolerance is to encourage breathing. When we feel stress (being chased by a bear, the fear of being indecisive in front of our peers, facing a deadline), our autonomic system responds automatically, typically by speeding up. Our heart rates increase, prompting our breathing to increase as well. This increased breathing rate has the effect of under-oxygenating our systems, leaving us feeling like we are gasping for air. What is required in these stressful situations is to breathe more slowly and more deeply so that we re-oxygenate our systems. As we slow down our systems, our prefrontal cortex can regain control of the decision-making process (Porges, 2016).

BIASES AND ASSUMPTIONS

Just as stressful situations can influence our thinking, so can cognitive biases, which represent the subtle, or even

subconscious, ways our thinking is directed when we are exploring potential decisions. We are all affected by our cognitive biases, which influence the way we argue and think. Unless otherwise directed, our minds take the path of least resistance. Biases are how our minds group and catalog information. We rely on our cognitive biases to create guideposts for our minds to follow (Novella, 2012). Sometimes these biases are based on our experiences (either professional or personal) and sometimes on logical fallacies that lead us into patterns of invalid or erroneous thinking (Novella, 2012). It is imperative that we be aware of our biases so that we can assess the effect they have on our decisions. Left unchecked, biases can grow into full-fledged prejudices. Humans will never fully get rid of their biases (Roberto, 2009). When teaching decision making and critical thinking, it's important to recognize when biases show up in the decision-making process, and to help students become aware of their own biases. Remember that in a state of hyperarousal, we are more likely to be influenced by our biases. Consider these examples of common biases that affect decision making.

- **Confirmation bias** is the tendency to gather and rely on only the information that confirms our existing view. The consequence of this action is clear: If we avoid or downplay information that disconfirms our hypothesis, then we are not able to look at the whole picture. This can be a pernicious bias to combat because we tend to do this subconsciously (Roberto, 2009). One way to resist the pull of the confirmation bias is to keep our focus on honestly assessing the validity of our ideas and decisions.
- **Anchoring bias** occurs when we allow an initial point of reference to distort our estimates. For instance, I once built a levitation arm for a production of *A Christmas Carol*. In previous productions, the shop had used box tube. I continued to work through the problem with the image of box tube (to the exclusion of other materials) in my mind. And I was successful. I found a piece of box tube that held the actress up at the end of 7-foot, 6-inch arm. It was 4-inch box tube with a one-half-foot wall and it weighed 81 pounds per foot—so heavy that it was extremely difficult to move. Had I not been anchored by the assertion that this was a problem that could be solved with box tube, I may have looked at other options, like trusses, earlier.
- **Availability bias** and the related "recency" effect takes place when we put too much emphasis on the information and evidence that is relevant to us when we are making the decision. The "recency" effect occurs when we fail to look at an entire range of information and rely too heavily on recent data (Roberto, 2009). The recency effect can take many forms. An example from the management viewpoint is when we judge employees (or students) on their most recent work without looking at the whole range of work products. Someone does horrible work one day and gets fired, even though the bad work is an anomaly when compared to their entire work history. Another employee gets a raise because of great work one day, even if history may indicate that this is a fluke. Of course, in either example, the behavior is actually another data point in the person's work history, if you do not fall into the recency effect.
- **Sunk Cost Effect** is the tendency for people to continue escalating their commitment to a course of action in which they have made substantial prior investments of time, money, and other resources (Roberto, 2009). The tight schedules and the integrated nature of the work in constructing the designed set on time makes this bias extremely difficult to combat in a typical scene shop.
- **The Overconfidence Bias** can lead us to be overconfident in our abilities or the abilities of our teams (Roberto, 2009). Build schedules are fraught with this bias, such as when a technical director states, "It will take two weeks to build the portals," even though the shop is down two carpenters and there is no space to lay them out.

Biases also show up when we are assessing completed work. Four specific biases to be aware of are:

- **The Myth of the Specific Cause** is characterized by our inherent desire to find the one reason that a project failed. The reality is that no matter how comforting it is to believe that only one thing went wrong when a project fails, this is rarely the case (Roberto, 2009).
- **The Illusory Bias** occurs when we make connections between variables when no such relationship exists (Roberto, 2009).

- **Hindsight Bias** is when we look back and say that "we knew it all along" or believe that what just occurred was bound to happen. This is rarely an accurate assessment, and is rarely helpful.
- **Egocentrism** affects us in two ways. The first is when we give ourselves more credit for an outcome than an outside party would attribute. The second occurs when we take more blame for an outcome than would an outside observer. In either case, it can be difficult to remember that neither success nor failure is due to the efforts of just one person (Roberto, 2009).

HERDING AND SELF-HERDING

External stimuli also influence decision making. Herding is what happens when we see a group of people lined up to purchase something we have not yet tried; there is a presumption of quality assigned to the desired product simply because people want it. Our actions are influenced by the determinations of other people's decision-making process (Ariely, 2008).

Self-Herding is what happens when we make decisions based on our previous behavior. In short, every time we make a choice without processing the pros and cons, we are effectively "lining up" behind ourselves. The more we engage in that action, the longer the line becomes and the easier the decision becomes until we have stopped thinking about the whys altogether. When a choice is first presented, ideally we would take the time to reflect on the pluses and minuses of the choice. We would think about the cost associated with taking the action, as well as the benefits (Ariely, 2008). The next time we are faced with the same choice, the deliberation process takes less time, and so on. At some point, we are not actively engaging in a decision-making process.

Like biases and assumptions, the processes of Herding and Self-Herding are not inherently good or bad. It is simply a phenomenon that humans experience. Imagine how difficult life would be if every time we were faced with a decision, we took time to engage our decision-making skills, especially if we have already come to a decision regarding the matter at hand. We would be paralyzed and unable to move through our day, appearing perhaps as someone who has a damaged prefrontal cortex. On the other hand, blindly relying on our history of decisions seems equally reckless. Develop an awareness as to when we are being effected by either of these phenomena. That awareness can remind us to establish a clear set of criteria when we are making that first [keystone] decision, because that decision may be the first one in a long line of decisions (Ariely, 2008).

Teaching decision making to our students and improving our own decision-making process is a tricky task because we are imperfect

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and unable to make the "right" decision at all times. As the research shows, many factors affect our ability to make decisions in a good or efficient manner. Many of us find ourselves in the situation of having to make decisions in conditions that are less-than perfect, based on information that is, at best, incomplete. As is the case with self-herding, we commonly reinforce our decisions by our own actions, in part because we form strong emotional attachments to them (Browne & Keeley, 1994). The stronger our attachments, the harder it can be to hear contrary views, even when those contrary views are self-generated. If we teach students to identify these and other pitfalls inherent in their process, we can then help them to find the best way to counter these pitfalls as they develop an efficient, effective, and repeatable process. Over time, they will understand how to:

- Identify the context and framework within which their decisions are being made.
- Identify and adapt either the idea or the context, if they determine one or the other is not appropriate.
- Develop and/or identify the criteria and/or governing values driving the decisions.
- Develop a set of goals that allow them to know if or when they have satisfied the criteria so that they know when a solution satisfies enough of the stated criteria.

These lessons in decision making exist within the larger goal of helping students become better critical thinkers, and critical thinking cannot take place without the development of a good decision-making process. Decision making is an evolving skill and we must periodically review and refine our processes throughout our lives. Decision making, like anything else humans master, is a learned process. We can help ourselves and our students engage in the process more effectively if we help them develop the proper tools.

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