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Thinking Inside the Tool Box: Creativity, Constraints, and the Colossal Portraits of Chuck Close

ABSTRACT

This article presents a problem-solving model to examine the often problematic relationship between expertise and creativity. The model has two premises, each the opposite of a common cliché. The first cliché asserts that creativity requires thinking outside-the-box. The first premise argues that experts can only think and problem solve inside the tool boxes of their expertise. The second cliché, that creativity requires freedom from constraints, points to the problem with expertise. Free to do anything, experts repeat what has worked best in the past. A solution is suggested by the second premise: to circumvent the liabilities of expertise, creativity requires constraints of a particular paired kind. The model is introduced as an expansion of prior process models focused on problem identification and construction. Problem-finding is reanalyzed as constraint-finding. A case study shows how one recognized creator, painter Chuck Close, uses constraints as a tool to solve the expertise-creativity problem.

Keywords: creativity, expertise, problem-solving, problem-finding, problem construction, paired constraints, tool box.

Many problem-solving models have focused on the so-called "first step" in the creative process (Csiksentmihalyi & Getzels, 1971; Mumford, Medeiros, & Partlow, 2012; Mumford, Mobley, Uhlman, Reiter-Palmon, & Doares, 1991; Reiter-Palmon, Mumford, O'conner Boes, & Runco, 1997; Runco, 1994; Ward, Smith, & Finke, 1999). The step has been alternatively defined as *problem-finding* (Getzels & Csikszentmihalyi, 1976; Runco, 1994), *problem identification,* and/or *problem construction* (Reiter-Palmon & Robinson, 2009). The paired constraint model presented in this article, based on seminal work by Reitman (1965) and Simon (1973), expands on these models in three ways.

First, it redefines problem-finding as constraint-finding (Stokes, 2011). Second, it specifies how paired constraints direct construction of solution paths in a problem space (Stokes, 2007). Third, it helps examine the relationship between expertise and creativity by demonstrating how one expert—thinking inside the tool boxes of his expertise—uses paired constraints to solve the perennial problem of getting "stuck" in successful solutions (Stokes, 2008).

The following section defines the terms in the model and itemizes the contents of the "tool box" in the title.

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DEFINITIONS

PROBLEM SPACES

A *problem space*, defined by Newell and Simon (1972), is how a solver represents a problem. It has three parts, an initial state, a goal state, and between the two, a search space in which a solution path from initial to goal state is constructed. The goal state includes a criterion for knowing if the goal has been reached. In traditional problem-solving models, the path is constructed using operators. An operator is an "if… then" rule that specifies the action (then) to be taken in a given (if) situation. In the current model, operators are replaced by constraint pairs that limit and direct search for a solution path.

In a *well-defined* or *well-structured problem*, all the information needed to construct the solution path is given to the solver (Greeno & Simon, 1988; Robertson, 2001). Tic-tac-toe is a well-structured problem. The initial state is an open grid with six empty spaces. The goal state is three of those spaces filled with *x*s or *o*s that form a straight line. The goal criterion specifies that the line may be horizontal, vertical, or diagonal. As shown in Table 1, there are two constraint pairs. The first precludes successive turn taking and promotes alternating. The second precludes removing or replacing an *x* or *o*, and promotes one mark per open space.

A well-defined problem like tic-tac-toe is identical to what Csiksentmihalyi and Getzels (1971) called a *presented problem.*

In an *ill-defined* or *ill-structured problem*, there is insufficient information to construct a solution path (Simon, 1973; Stokes, 2009; Stokes & Fisher, 2005; Voss & Post, 1988). An ill-defined problem corresponds to what Csiksentmihalyi and Getzels (1971) called a *discovered problem*. In the current model, what the solver discovers are the constraint pairs that structure a novel solution path.

PAIRED CONSTRAINTS

The dictionary definition of constraint is one-sided. Constraints are considered solely as confinements or restrictions. In contrast, the problem-solving definition is *two-sided*. Constraints come in pairs. One of each pair maintains its function as restriction, *precluding* something specific, an element say of an existing solution. The other *promotes* search for its substitute (Reitman, 1965; Simon, 1973; Stokes, 2006).

The word specific is very important. Creativity requires precluding reliable, predictable solutions—the ones experts get "stuck in"—and promoting new, unexpected ones. How

TABLE 1. Paired Constraints for Tic-Tac-Toe

	Description		
Initial State	Grid with four lines and six empty spaces		
Constraint Pairs	Preclude		Promote
	1. Successive turns	→	Alternating turns
	2. Removing or replacing an *x* or an *o*	→	One mark per empty space
Goal State	Three spaces filled with identical marks that form a straight line. Criterion: The line may be horizontal, diagonal, or vertical.		

do you get to "new"? In the current model, you select one thing from an existing situation, style, or solution to preclude. You must then identify and specify a substitute. The process is, as Weisberg (2006a) argues, incremental. In the current model, the increments are substitutions. The solution path is constructed *substitution by substitution* (Stokes, 2011).

TOOL BOXES AND EXPERTISE

There are two things inside all tool boxes: basics and borrowings.

The *basics* are the first things that go in. They define expertise, and they come in two kinds. The first are tools in your head or what you know. The second are tools in your hands or what you can do with what you know. The first involves what we call semantic memory; the second, procedural. For example, inside an expert painter's tool box, we would find things painters know (about current and past painting styles), and things painters do (techniques and skills to reproduce, or recombine elements from those styles to create new ones).

The *borrowings* are secondary elements from outside domains. For example, Andy Warhol's famous Brillo box and Campbell soup can images are elements from his pre-painting career as an advertising illustrator. Alexander Calder's education as an engineer made his mobiles possible. A color wheel published by a Parisian chemist showed Monet how light breaks up. It was the borrowing that begat Impressionism.

THINKING INSIDE THE TOOL BOX

There are two very important things to remember about tool boxes.

The first is this. Experts can only problem solve by thinking *inside* the tool boxes of their expertise. This helps explain why expertise is necessary for creativity (Ericcson, 1998, 1999; for a review, see Weisberg, 2006b). As the idea of borrowings suggest, an expert can make his tool box bigger, but he cannot think outside of it. Thinking outside-the-box is an oxymoron.

The second thing is that the creativity of a solution depends on the contents of the tool box. To demonstrate that this is so, I will apply the constraint model to creators in the same domain, but with quite different tool boxes. The first creator is a novice, an anonymous art student. The second is a master, a recognized and highly regarded painter.

FIRST DEMONSTRATION: A NOVICE AND A STILL-LIFE DRAWING

Here, Getzels and Csikszentmihalyi's (1976) seminal study of problem-finding, defined as the posing and formulating of problems, is parsed into the paired constraint model. Problem-finding becomes constraint-finding, and problem construction is specified as the construction of a solution path from initial to goal state.

Table 2 presents a possible problem space for our novice, a hypothetical stand-in for one of the students in the study. The goal is to create a drawing of a still-life. At this stage, the goal criterion, the style of the drawing, would be unspecified. The choice of constraints will create the style, the elements of which appear in the promote column.

The first two constraint pairs in Table 2 show that our student has selected three glass bottles, which now must be rearranged into a still-life. If he opts for the third constraint pair, precluding asymmetry and promoting symmetry, he will most likely line up the

bottles in a row. Selecting a black marker rather than charcoal as media and contour lines over chiaroscuro would in turn promote stylization over naturalism and two-dimensionality over three. The product of these constraint pairs might look like Figure 1, the style of which could be categorized as "starkly stylized."

Consider, however, what would happen if our student reversed two of the constraint pairs (3 and 5), promoting asymmetry over symmetry, and shadowing over stark outlines. The product might look like Figure 2. The style is still starkly graphic, but it includes shadow shapes as well as outlines.

A final consideration here concerns the contents of our student's tool box. Getzels and Csikszentmihalyi (1976) did not report that any student had created a novel drawing style. This is not surprising. Most drawings by students, even those by quite talented ones, are variations of styles practiced in studio classes. It also supports the idea that the creativity of a solution depends on the contents of the tool box. To create a new style requires, as our second demonstration will show, both the basics and the borrowings that make the tool box bigger.

TABLE 2. Paired Constraints for Still-Life Drawing

	Description		
Initial State	Assortment of possible objects for still-life		
Constraint Pairs	Preclude		Promote
	1. 30 still-life objects	→	3 glass bottles
	2. Original placement	→	Rearrangement of 3 objects
	3. Asymmetry	→	Symmetry
	4. Charcoal	→	Black marker
	5. Chiaroscuro (shadows)	→	Contour (outlines)
	6. Naturalism	→	Stylization
	7. Three-dimensional	→	Two-dimensional
Goal State	Still-life drawing Criterion: Starkly stylized		

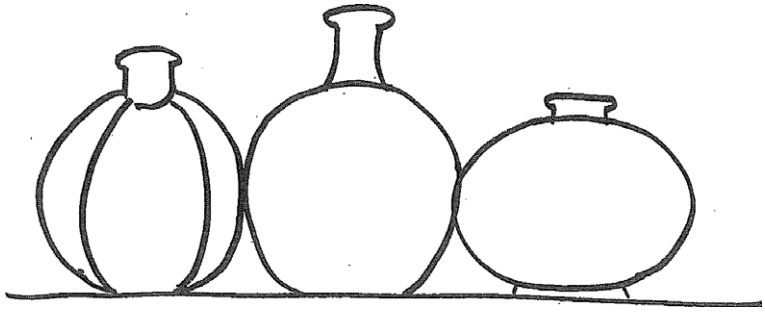

FIGURE 1. Still-life drawing with contour lines.

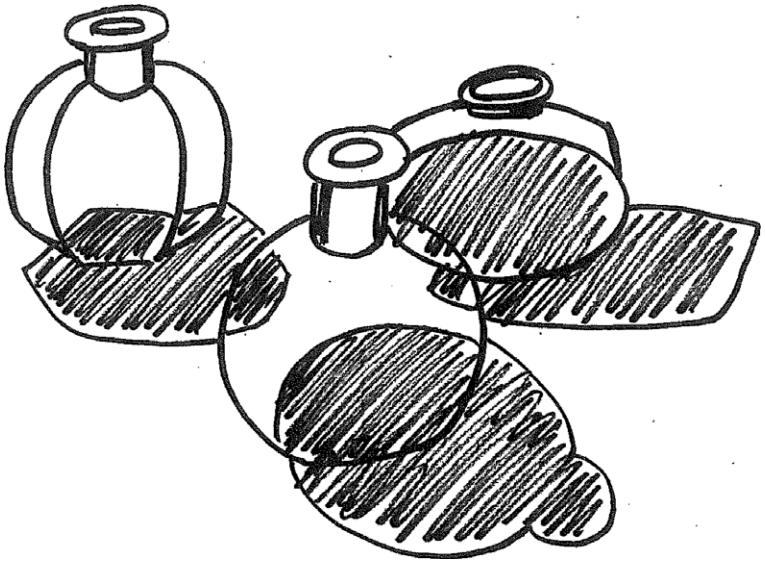

FIGURE 2. Still-life drawing with shadows.

SECOND DEMONSTRATION: AN EXPERT AND A SERIES OF NEW PAINTING STYLES

There is one more thing to be noted about the contents of the tool box. In addition to directing how particular experts solve problems, it also directs their attention to specific aspects of the world. This is a basic finding about perception: we recognize what we know. Its extension to problem-solving is this: *we notice what we need* (Austin, 2003) In this demonstration, we will follow painter Chuck Close noticing and borrowing what he needed to make his tool box bigger. Close was an obvious choice for this article. He has often spoken about restrictions, limits, and tools. "I'm interested," he said, "in restrictions. You move much more by what you don't do… Every change begins with a new rule" (Brehm, 1994, p. 63). To date, Close has changed his painting style three times. Thus, our analysis has three sections, each detailing the successive substitutions that solved his painting problems and re-created his painting style.

SOLUTION BY SUBSTITUTION 1: BLACK AND WHITE ENLARGEMENTS

Close learned to paint like an Abstract Expressionist when he was a student at Yale. Emulating Willem de Kooning who used house paint brushes to layer wet paint on wet paint, his brushwork was skilled, his paint application virtuosic. These were the basics in his tool box. His first self-imposed restriction was on Abstract Expressionism. The restriction was partial. Close precluded particular aspects of the style, i.e., the personal, the improvised, the abstract, and the painterly. He did not preclude the emphasis on process, albeit of an entirely different kind.

His substitutions were based on borrowings that made his tool box bigger and uniquely his. One was from his own domain. Painter/printmaker Jasper Johns modeled how repeating recognizable motifs in multiple ways made the ways more

interesting than the motifs (Friedman, 2005). Johns' ubiquitous American flag images were printed or painted, in oils or encaustic, on single canvases or superimposed, a smaller canvas atop a larger one, both with the same image. In like manner, Close repainted and reprinted portraits of unknown individuals made recognizable by his repetitions. Another, more critical borrowing, came from a related, realistic, but non-painterly domain, black and white photography. This borrowing made Close's tool box much bigger: providing the painter with non-art tools and reiterative processes that he worked with in his first stylistic phase, and worked against, in different ways, in his second and third.

Table 3 suggests the constraint pairs that, by making his tool box bigger, produced Close's first stylistic phase. Bigger can take different forms. One is *physical*, for example, introducing a non-art tool like the airbrush. Another is *procedural*, involving the construction of a novel solution path. The path is the fully specified promote column. A third is *stylistic*, defining the new goal criterion. Notice the criteria for the initial and goal states. Close's objectivity replaced Abstract Expressionism's emotionality, the emphasis on process remained. The other substitutions constitute the solution path that created the new style, and defined the new goal criterion.

Considering the first three constraint pairs, we see that in lieu of improvised, painterly abstractions Close substituted planned representations, portraits of a photographic kind. These, in turn, required a cascade of subsequent constraints (Reitman, 1965). Black and white replaced color. A non-art tool, the airbrush replaced the paint brush. Interestingly, the airbrush came from commercial photography: its use was removing blemishes from head shots in models' portfolios and in print ads. In contrast, Close used the airbrush to include, indeed emphasize, every pore and more.

The last three constraint pairs pit Close's black and white enlargements against their commercial sources. His signature pose was the unflattering, sharply lit, sharply focused mug shot; the antithesis of the flattering, softly lit, softly focused professional head shot.

TABLE 3. Paired Constraints for Black and White Enlargements

	Description		
Initial State	Abstract Expressionism		
	Goal criterion: Emotional/emphasis on process		
Constraint Pairs	Preclude		Promote
	1. The abstract	→	The representational (the portrait)
	2. The painterly	→	The photographic
	3. The improvised	→	The planned
	4. Color	→	Black and white
	5. Art tools (brush)	→	Non-art tools (airbrush)
	6. The pretty and posed	→	The mug shot
	7. Softness	→	Sharpness
	8. Portrait size	→	Extreme enlargement
Goal State	Black and White Enlargements		
	New goal criterion: Extreme objectivity/emphasis on process		

Its extreme size emphasized its extreme objectivity, compared to the also oversized but retouched faces seen on advertising billboards and the un-retouched, but softly focused, black and white portraits of artists taken for museum retrospectives exhibit by photographers like Arthur Mones (1981). *Phil*, a representative big black and white airbrushed painting from 1969, is 108 by 84 inches and, like the other paintings referenced in this article, can easily be viewed on line.

Not listed, because it was not precluded, is a traditional tool continuously used by Close. It is the grid employed to enlarge and transfer the image from photo to canvas. In this phase, it is visibly superimposed on the original image, but invisible in the finished painting. Later, it becomes a highly visible, integral part of the painting.

SOLUTION BY SUBSTITUTION 2: THREE-COLOR SEPARATIONS

The initial state in Close's second stylistic phase was his own initial style. Table 4 suggests the constraint pairings that precluded the black and white enlargements. The artist now chose to replicate in paint the three-color separation process used to produce full color photographs. This was a new borrowing from the same outside domain, photography. Like the first, it made his tool box bigger, allowing Close to avoid getting stuck in his own successful solution.

The emphasis is still on process and restrictions. To quote the artist again, "form is the product of formulas…" (Storr, 1987, p. 16). However, the objectivity is less extreme, softened in the new way of processing. The first two constraint pairs substitute full color for black and white, and replace the airbrush with the more traditional art tools, hand and brush. However, instead of mixing colors, Close superimposed them, mimicking the three-color separation process of commercial printing.

The three colors are magenta, cyan, and yellow. Cyan is bluish, magenta is pinkish, and yellow is, well, yellow. In photographic printing, the colors are transparent dyes, which, one atop the other, can replicate any color in the spectrum. As each hue is added, the image get richer, darker, and finally, fully colored. Close replicated this dye-transfer process, painting the full image in magenta, then over-painting it, first in cyan and finally in yellow. Cyan turns the magenta purple and darkens, heightens the shadows on, the image. Yellow magically adds everything else.

TABLE 4. Paired Constraints for Three-Color Separations

	Description		
Initial State	Black & White Enlargements		
	Criteria: Extreme objectivity/emphasis on process		
Constraint Pairs	Preclude		Promote
	1. Black and white	→	Full color
	2. Airbrush	→	Hand and brush
	3. Mixing colors	→	Superimposing colors
	4. Hard edges	→	Soft edges
	5. Figure-ground separation	→	Continuity figure-ground
Goal State	Three-Color Separations		
	Criteria: Modified objectivity/emphasis on process.		

These so-called continuous-tone portraits (Finch, 2010) are, like the black and white enlargements, over-sized. *John*, from 1971 to 1972, is 100 by 90 inches. As in the black and white enlargements, Close painted over the grid used to enlarge and transfer his images. However, as the last two constraint pairs indicate, the images are more painterly —not only in the sense of being painted rather than airbrushed but also in the softer edges that modulate the harshness of the first phase and make the figures continuous with their backgrounds.

SOLUTION BY SUBSTITUTION 3: PRISMATIC GRIDS

Like Monet (Stokes, 2012), Close retained elements from his earlier stylistic phases: full color and painted-by-hand from the second; representation, enlargement, and the emphasis on process from both first and second. Table 5 presents the differences.

The goal criterion has shifted from objective to expressive. The grid, used as always for enlargement and transfer, is now visible, an "increasingly bold compositional element" (Brynstyn, 2006, p. 110) incorporated into the final image. Instead of the smooth, continuous surfaces of both black and white and three-color separation portraits, the surface is fragmented into the uniform shapes (squares, diamonds, circles) formed by the grid. The fragments are over-painted with smaller, multi-colored shapes, lozenges, circles, squares. The grid has become a prism, breaking light into rainbows of its constituent colors.

For Close, the act of painting is now both incremental and improvisatory. To quote the artist: "It's a kind of problem solving…an invention of means. I invent thousands of little solutions to a myriad of problems every day rather than the big solution and, in that way, the whole problem eventually gets solved" (Brehm, 1994, p. 97).

Instead of being pre-planned, the "thousands of little solutions" are invented square by square, starting at the upper left and ending at the lower right of the canvas. Each unit of the grid is first painted in a solid hue. The hues are supposedly arbitrary, but to my eye, their values are not. For example, reproductions of a 1977 *Self-Portrait* show both the under-painting (the painting in progress) and the finished version (Finch, 2010, pp. 232–233). The under-painted hues are darker in the areas of the artist's beard and hair, lighter on his cheeks, and lightest where highlights fall on temple and forehead. The under-painting is then over-painted with multi-colored shapes, each adjusted to the colors and shapes of the units that surround it.

TABLE 5. Paired Constraints for Prismatic Grids

	Description		
Initial State	Three-Color Separations		
	Criteria: Modified objectivity/emphasis on process		
Constraint Pairs	Preclude		Promote
	1. Hidden grid	→	Visible grid
	2. Continuous surface	→	Fragmented surface
	3. Complete planning	→	Improvisation
	4. Complete objectivity	→	Emotionality
Goal State	Prismatic Grids		
	Criteria: Expressivity/emphasis on process		

FIGURE 3. Grid with dark and light areas.

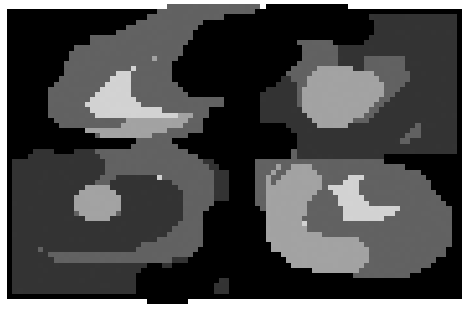

FIGURE 4. Over-painting on four squares of the grid.

My gray scale approximations to a Close of this period are shown in Figures 3 and 4. Figure 3 shows the light and dark areas of the under-painting. Figure 4 suggests the way the areas might be over-painted.

In effect, Close has returned to Abstract Expressionism, but this time at the level of the individual units—each one "a tiny, but highly expressive non-figurative painting" (Finch, 2010, p. 202). The result is that up close, we see non-figurative shapes and colors; backing away, we see flickering lights and shadows, shifting values that form and reform in-depth, in-and-out of focus, images. The scintillations as well as the units suggest Seurat and Pointillism as precursors, but the artist refers to heads in Roman floor mosaics: "When you look at them you can feel the artist's insistence that all their

incremental units should be seen as the same time as the images he made by combining them. You keep flipping back and forth from the parts to the whole" (Friedman, 2005, p. 127).

The images are magical; the flickering is, in effect, a new kind of chiaroscuro (Finch, 2010, p. 172). They are also moving. By making his tool box bigger, the painter once again solved the expertise-creativity problem, reinventing his process and our response to his paintings.

EVALUATION: HOW WELL DID PAIRED CONSTRAINTS SOLVE THE EXPERTISE-CREATIVITY PROBLEM FOR CHUCK CLOSE?

To evaluate the effect of the substitutions that made his tool box bigger, Close's solutions were sorted into three kinds, each with different effects, initially only on the creator, and ultimately—at the highest level—on the domain.

CREATIVE SOLUTION 1: NOVEL AND APPROPRIATE

The first kind of solution is useful: it solves a problem in a new way (Amabile, 1996; Cropley, 1990; Eisenberger, Haskins, & Gambleton, 1999; Mumford, 2003; Sternberg & Lubert, 1999; Weisberg, 2006a). Close has prosopagnosia, he can see the individual elements of a face, but not recognize whose face it is. "Overwhelmed by the whole of the face" (Close, 2010), his solution, his way to commit a face to memory, is to paint it, simplifying the face by flattening it like a photograph and organizing its elements on a gigantic grid. In the artist's words, "I have an almost photographic memory for something two dimensional and almost no memory for something that's moving about and changing" (Storr, 2007, p. 52). Does the solution solve the problem? Yes, and in a completely novel way. Close says he can recognize the faces he has painted, but only two-dimensionally, as painted. It is useful to recognize people.

CREATIVE SOLUTION 2: NOVEL AND GENERATIVE

The second sort of solution is germinal, expansive, a catalyst for further variations and permutations (Stokes, 2009). Photography supplied Close not simply with a specific subject, i.e., the person portrayed, but also—and more importantly—with a continuing subject, how images are processed/produced, first as black and white enlargements, later as three-color separations. The grid too has proved particularly generative. Initially, a tool for enlargement, it evolved into a critical compositional element, an armature for amalgamating abstraction in the units and figuration in the overall image.

CREATIVE SOLUTION 3: NOVEL AND INFLUENTIAL

The third sort of solution enlarges, expands its domain (Csiksentmihalyi, 1996; Simonton, 2004); it changes the way others think about, look at, or make things like it (Stokes, 2006). Close has done this in multiple ways. We touch on three. First, and most generally, he expanded the criteria for the category of painting called portraiture. The representation of the person became secondary to the presentation of the process. Second, as already discussed, Close reinvented chiaroscuro. Third, he revisited and reversed de Kooning's figuration-in-abstraction. In graduate school, Close said he made more De Koonings than De Kooning. "Doomed," he continued, "to be lesser or be different" (Close, 2010), he chose, as we know, not to be an Abstract Expressionist.

What de Kooning had done in his *Women* series was embed figurative elements in an abstract painterly field; what Close did with his prismatic grids was embed painterly abstractions in a figurative field.

CLOSING THOUGHTS

In closing, I touch on the construction of meaning, reconsider artistic freedom, explain why expertise is necessary to solve the expertise-creativity problem, and reiterate the role of the tool box.

CONSTRUCTING MEANING

The constraint model, as presented, emphasizes the process of constructing a solution path. A question raised by an astute reader is this: does it also address the construction of meaning? The answer depends on the definition of meaning. My dictionary defines it as "what is intended to be expressed or understood by something." In the constraint model, the intention is given in the goal criterion.

For a painter, that intention can be broadly perceptual. Matisse's goal was to understand how sensation is condensed (Stokes, 2013); Monet's, to understand how light breaks up. (Stokes, 2011). Alternatively, for artists like the Abstract Expressionists, the intention can be an emotional rather than a perceptual response to reality. For example, Robert Motherwell (1944/1992), p. 31) described his goal as "express[ing] the felt nature of reality." As the current analysis shows, the intention can also be more narrowly perceptual. The emphasis here is on understanding the painting process per se. For Chuck Close, as for Jasper Johns, how the subject/object is painted takes precedence over the person/thing painted.

Given that the goal criterion is the product of the solution path, my answer is that meaning is embedded in, indeed emerges from, the mechanics of the production.

RECONSIDERING ARTISTIC FREEDOM

The issue here is obvious. Is artistic freedom possible in a model based on constraints?

The answer is not so obvious. It depends on the contents of the individual's tool box. Novices, who are acquiring the basic tools of their domains, have their constraints chosen by their teachers. In the study on which our novice demonstration was based, the still-life assignment was a task constraint imposed by experimenters rather than by teachers (Csiskzentmihalyi & Getzels, 1971). Artistic freedom, in this view, is earned by experts who have mastered the basic tools that define their domains. Only experts can choose their own constraints. Some choose constraints that have worked for them in the past. This is the liability of expertise. Others choose constraints that, by making their tool boxes bigger, circumvent that liability.

WHY EXPERTISE IS REQUIRED TO SOLVE THE CREATIVITY-EXPERTISE PROBLEM

This article examined the often problematic relationship between expertise and creativity through the lens of a problem-solving model. The problem is a paradox. High-level creativity, the kind that changes domains, requires high levels of expertise (Ericcson, 1998, 1999; Weisberg, 2006a,b). However, as experts can only think and problem solve in the tool boxes of their expertise, they often get "stuck" in successful solutions (Stokes,

2008). This is simply operant conditioning. Free to so anything, we all repeat what has worked best in the past.

Paired constraints were suggested as a solution to the expertise-creativity problem. The case study demonstrated how such constraints can circumvent the liabilities of expertise, allowing the expert to get "un-stuck" by making the tool box in which the expert thinks and problem solves bigger. There are a few observations that I would like to add to that analysis.

All the substitutions were based on expertise. Close was a professionally trained painter. Given a new goal, he "knew" which elements of a current style to preclude. His expertise also allowed him to notice what was needed, what could be substituted in their places. In all three phases, his substitutions were not randomly chosen. Rather, they were the opposites of the precluded elements. This helped make the new solution paths, the promote columns *in toto,* maximally different, precluding earlier successful solution and solving not only the current painting problem but also the larger expertise-creativity conundrum as well.

Only experts can do this.

THE ROLE OF THE TOOL BOX

A basic tool box, as conceived in the current model, contains everything a solver has learned about his domain. Some tools are semantic, what the expert knows about current and past solutions and styles. Others are procedural, the tools and skills the expert uses to produce or vary within those styles. From our analyses of Chuck Close's development from and back to Abstract Expressionism, come two critical thoughts about creativity and expertise.

One, constraints chosen by an expert can make a basic tool box bigger, and make novel solutions and styles possible. This can occur *physically* when basic tools are used in new ways or when new tools are borrowed from related domains. It can also occur *procedurally,* when existing tools are used to construct novel solution paths, or *stylistically*, when a solution path defines a new goal criterion.

Two, as an expert can only think and problem solve inside the tool box of his expertise, the creativity of a solution depends on the contents of the tool box (Stokes, 2010). Importantly, these include the paired constraint process presented in this article, which can be used both prospectively to construct a solution path, and retrospectively (as in this article) to understand paths already constructed.

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AUTHOR NOTE

The constraint model is presented from the view of a practitioner, meaning both the artist and the author, who earned her MFA in painting and graphics from Pratt Institute, for whom stylistic change is a visual, technical problem, and not a theoretical, aesthetic, or historic one.