

# Constructionism and Creative Movement: A Manifesto

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## Abstract

The lens of constructionism has traditionally been focused on the learning of topics such as mathematics, science, and computation. Of the arts, only music has played a significant role in the development of constructionist ideas. In this paper, we present a manifesto based on our belief that dance pedagogy can both exemplify and expand the current views of constructionism, and we contend that choreography and creative movement improvisation can be viewed as constructionist pursuits. The diagram below, for instance—which lays out the cues given and followed by dancers during a piece—is just one example of a constructionist-style representation that has been used to great advantage by dancers and choreographers.

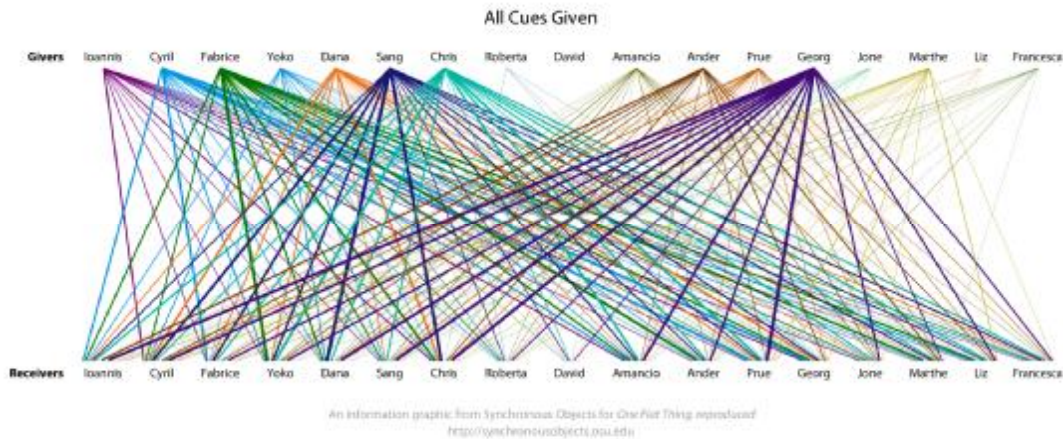


Figure 1. A chart of the interactions of individual dancers in “One Flat Thing, Reproduced” by William Forsythe (reproduced, with permission, from *synchronousobjects.osu.edu*)

In our work together—as dancer and choreographer, computer scientist, and math educator—we have all stretched our worldviews and forged unanticipated intellectual bonds. Our goal in this paper is to share our excitement and discoveries, by not only examining dance from a constructionist view, but also inviting the traditional constructionist community into the world of creative movement. This expansion of the boundaries of constructionist inquiry, we believe, will provide the constructionist community with new metaphors, new dilemmas, and new collaborative potential.

## Keywords:

Representation, Motion, Dance, Choreography, Improvisation

## Introduction

A basic tenet of constructionism is that learning is most effective when it arises as part of an activity that the learner experiences as constructing a meaningful product. Often this product is computational or mathematical: a geometric model, a piece of software that accomplishes a personal goal, a video game, a small robot that reacts to external stimuli. A “meaningful product,” however, can just as easily be a piece of music, a novel, a movement improvisation, a dance. And while we don’t always think of these as “learning activities”—perhaps because they don’t take place in a classroom setting with explicitly stated learning goals—it is hard to imagine creating an artistic object without learning something. In fact, many artists understand their creative process specifically as research: asking questions and “constructing” answers that function in their medium.

The process of artistic creation easily exemplifies another common aspect of constructionism: that creating something tangible provides the learner/creator with the opportunity to revisit her product and “debug” it. While we don’t often think of writing music as involving debugging, any composer will tell you that a piece of music goes through many iterations during its creation. Moreover, the creator’s goal is often in flux, via an ongoing “feedback loop” between the product/answers and the goals/questions. Thus, as the product is brought into being, it is continuously creating new parameters for debugging. Choreography, in virtually all of its many forms and approaches, fully embodies this process via its creation of “knowledge” in the form of movement structures.

While the field of constructionism is comfortable focusing on science, mathematics, and computation, examining dance — an art form that uses human movement as its medium—from the constructionist perspective introduces challenges for constructionist thinking. How can constructionist vocabulary be extended to authentically describe both the learning of movement skills and concepts, and the creative design of movement constructions? What new problems and contradictions arise from using constructionist principles to examine dance? What insights might choreographers and dance teachers gain from this interdisciplinary endeavor? And what insights can teachers of other disciplines gain from behaviors and processes that exist in the dance field?

## Learning and designing dance

While there are separate words for “dancing” and “choreographing,” modern dance—understood as a generative approach to the study and creation of movement rather than as a received movement or choreographic style—regards learning movement skills and learning to create original movement constructions as deeply connected activities. That is, learning to dance, in the modern dance paradigm, involves both acquiring the ability to execute received movement patterns and being involved in the ongoing articulation of new movement ideas. In this approach, therefore, “dancing” fundamentally connects performance skills with choreographic investigation: any execution of movement is fully integrated with the conceiving of movement ideas, ideals, and approaches. Dance, then—from pedagogy to performance to artistic creation—can be understood as a fundamentally constructionist learning activity in which the student acquires performative and creative skill simultaneously, intertwining the conceiving, doing, evaluating and revising of the materials of the form. From this perspective, we can look at a finished, performable dance as the result of a spiralling creation, execution, and reflection process: one that has a vocabulary, an epistemology, and a changing spectrum of goals, all informed by a rich historical set of subtexts.

The deep structure of modern-dance training clearly embodies these ideas. It is organized around the pedagogical subtext that every dancer should be both a creator and an executor of

movement—as much during preparatory training as in fully professional behavior<sup>1</sup>. Improvisation is used early on in order to open students' minds and bodies to physical possibilities, and to create an immediacy of movement that reflects a creative mindset. Often, the movement creation process involves an iterative dialog between student, teacher, and perhaps other performers. The teacher has five primary pedagogical goals for his or her students:

- to look at movement from an aesthetic/artistic standpoint
- to learn basic kinesiology
- to become versed in the wide variety of movement concepts and skills
- to establish an ongoing creative relationship among those elements
- to combine all of these knowledge bases in order to mobilize the body in an articulate, creative, expressive, and intelligent fashion

The conceptual vocabulary of dance concerns time (rhythm, form), space (facing, location, direction), dynamics (effort, weight, force), anatomical function (mechanical efficiency and articulateness of the instrument), basic movement patterns (walk, run, jump, fall, and other “pedestrianisms,” among many other elements) and more-advanced movement patterns that are considered an evolving “lingua franca” in the field. While conveying this multi-valent vocabulary to his or her students, a modern-dance teacher strives to plant “seeds” of knowledge for movement, which the students then are asked to use both in practicing given action patterns or set phrases and in constructing their own movement—through improvisation, spontaneous choreography or other student-created artifacts.

The teaching/learning strategies involved in this are process oriented: imaging a position or its derivative, for instance, exploring a movement direction using different parts of the body, or sensitizing the kinesiological function of joints. Some conceptual structures exist to scaffold this process: Rudolf von Laban's grid of time/space/energy elements, for instance—which is described at more length in the following section—provides the opportunity to experience a movement concept in many self-directed ways. For example, the spatial concept of *forward* can be explored through a variety of strategies—gesture of various body parts, locomotion, facing and focus—within a fully variable grid of dynamics and rhythms. Similarly, a student can focus on abrupt and sustained rhythms while creatively utilizing a wide variety of spatial and dynamic qualities. In so doing, the knowledge of the movement concept is mobilized in such a way as to give the student agency over her or his investigation.

The overarching goal of this arena of dance instruction is not only to teach students how to do steps, such as *pliés*, but to understand *why* one does *pliés*—what they are “about” (*viz.*, verticality and weight)—and therefore how they might be applied in new environments or experiences. This intentionally generalizes the student's kinaesthetic and aesthetic knowledge about the step, making it into something that she or he can adapt to a new situation. An imperfect analogy would be to the concept of recursion; students learning to program need to learn the meaning and function of recursion, not just how to write a program in a particular language that accomplishes it.

After each class exercise—and sometimes during or before it—a modern-dance teacher, like someone who is teaching programming, will often unpack the pedagogical subtext that he or she had in mind. Likewise, he or she often provides a phrase of movement that intentionally mobilizes the concept or element at hand, so that the student also learns to apply the experiential knowledge to received movement that might be part of a performed dance. From the students' perspective, this activity is a constant interweaving of concept and experience. This

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<sup>1</sup> Other genres, and even some modern “techniques,” are somewhat different: in these, there is no connection to experiential creativity, dancers simply execute pre-defined movement, and there is little expectation that they will create it—or modify it very much.

structure of alternating constraint and exploration is typical of constructionist approaches to teaching and learning.

Movement improvisation, a critical element in modern-dance training, establishes an experimental structure that aims to mobilize skills and understanding without imposing a specific outcome. This exercise aims to nurture the flexibility of body and mind that is central to the ideals of humanistic education. It also seeks to entrain a level of expressivity and artistic acumen that is central to the role of creative collaborator as well as the role of performer of choreographed dances. Improvisation is equally central to the training of choreographers who aim to create a personalized movement language and constructions. In all four roles—student, collaborator, performer, and choreographer—the constructionist perspective on knowledge is central to the modern-dance paradigm. The “product” is, in the case of training for a dancer, increased ability to use the body imaginatively. In the case of a choreographer interested in making an ultimately repeatable dance, improvisation can generate new movement behaviors that will become material for elaboration.

## Representation in Dance

While dance is inherently an embodied representation of movement ideas, choreographers also use varied graphic representations of movement. These representations differ along several axes: choice of “vocabulary,” conception of time, and, most importantly, whether they intend to specify a dance precisely or to generate a new dance every time they are performed. A brief history of dance notation exemplifies these contrasts.

Most dance representations specify motion and therefore represent movement over time, not position at a single time. In the Baroque era, for instance, Feuillet notation was used to record the floor plan and movement sequences of European court dances. An example is shown in Figure 2(a). In this notation, symbols referred to fairly complex predetermined movement sequences—“steps” like a *demi tour* (half turn). They were placed along maps of the movement of the body as a whole through space, and often keyed directly to notations of musical accompaniments. Importantly, this system relied on foreknowledge of the steps themselves, which for the most part had verbal names that were central parts of training methodologies for dancers. Steps that were not in this vocabulary could not be represented with this notation.

In the 20th century, Rudolf Benesh and Rudolf von Laban created movement representations that were much more general and expressive. Both were designed to be style-neutral, relying solely on knowledge of the spatial, temporal and energetic dynamics of the human body, rather than on experiential familiarity with the subject movement itself and its specialized semantics (e.g., names of specific steps, such as *pliés*.) These notational systems are harder for humans to learn than Feuillet notation, because they break the movement down into small, abstracted components, but they are much more widely useful. Benesh notation, currently utilized particularly by ballet dancers, graphs positions on a staff similar to musical notation, using symbols to indicate posture, body part by body part. A single position is shown in Figure 2(b). Time is represented moving from left to right on a staff, with the equivalent of musical “rests” and time signatures indicating the duration of transition from position to position.

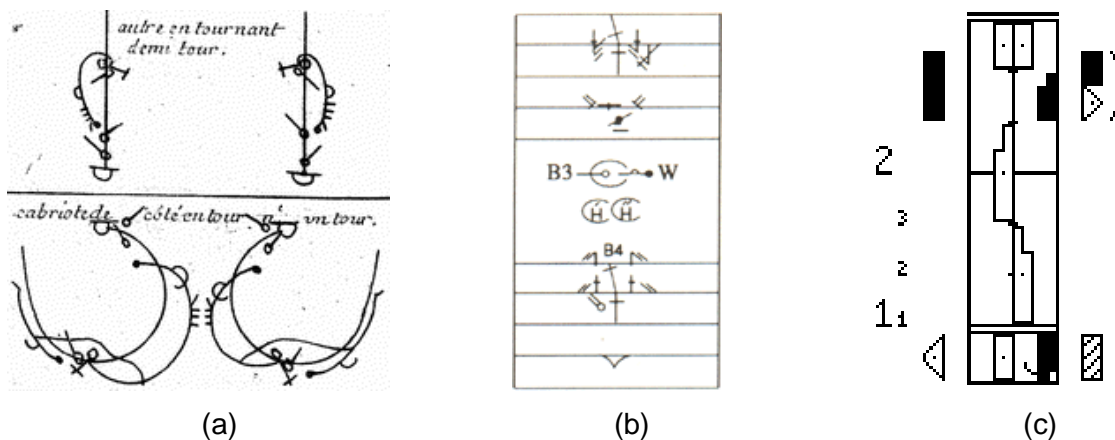


Figure 2. Dance notation: (a) Feuillet (b) Benesh (c) Labanotation. These images are reproduced, with permission where copyright exists, from [Feuillet 1700], [www.benesh.org](http://www.benesh.org), and [www.dancenotation.org](http://www.dancenotation.org), respectively.

Labanotation, widely used in a variety of movement disciplines and shown in Figure 2(c), also indicates time via a linear staff. Unlike Benesh notation, the staff is vertical, moving from bottom to top. It focuses not on sequences of positions, but on directional actions through space: a particular symbol describes a direction of movement in relation to the core and front facing of the body, and the placement of the symbol within the staff attaches that action to a particular body part. The vertical scale of the symbol indicates the duration of the action; a lexicon of graphic modifiers specifies details such as degree of rotation, degree of contraction or extension, and contact with objects or other bodies. Significantly, Labanotation places information about the action of the weight bearing structures (typically feet, but possibly knees, shoulders, pelvis) at the core of the staff, so that displacement through space (locomotion), indicated by the same symbols applied to body parts, can be immediately visualized. von Laban also devised a separate system of analysis and description of performative qualities of movement, mentioned earlier in this paper, which generalizes the actual actions but specifies in great detail the experiential qualities of the movement. In this “Laban Movement Analysis” scheme, observations of time (fast/slow), space (indirect/direct) and force (light/strong) are combined to generate a grid of possibilities such as punch (fast, direct, strong) or flick (fast, indirect, light), which are indicated in the score via specialized symbols.

The tension between these different notational approaches—particularly the trade-off between expressiveness and unwieldiness—brings up a variety of issues that are interesting from a more general perspective on representations. Many dancers and choreographers find Labanotation difficult to use, for example. The decomposition of the body into parts is just not a natural way for people to think about motion. Style-specific representations like Feuillet notation, on the other hand, are much more natural for their user communities, but they obviously fail if the movement to be described does not pre-exist in their vocabulary. Labanotation can capture arbitrary, unfamiliar movements, but its reductionist process makes it awkward for dancers who for the most part approach movement tasks via an integrative and kinaesthetic knowledge process. This same tradeoff arises in many disciplines, of course: languages that describe objects at a small grain size can represent a wider range of objects, but require more complex “interpreters;” languages with a smaller vocabulary, in which the objects that are described are more “intuitive” are limited in what they can describe, but easier to understand. Machine language, which few of us ever see or use anymore, is at one end of the spectrum. The formal language of quantum physics might be at the other end of the spectrum.



The representations in Figure 2 are intended to specify movement sequences precisely. Other representations are more like jazz charts, in that they generate a new dance every time they are performed. All of the realizations of such a representation are related in fundamental ways but can be very different in actual execution. A famous example of this kind of semi-specified motion is choreographer William Forsythe's recent piece "*One Flat Thing, Reproduced.*" The piece is "defined" deterministically via specific rules about how each dancer's actions serve as cues for other dancers. The cue sheet in Figure 3 is a detailed representation of this: what each action is and how each one is triggered by specific actions of other dancers<sup>2</sup>.

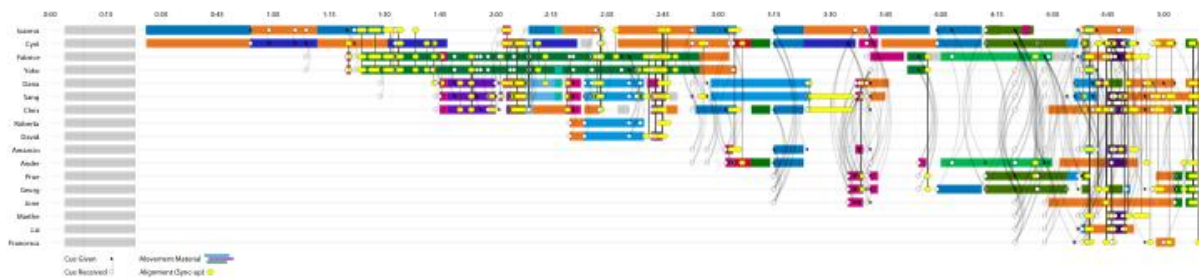


Figure 3. A portion of the cue sheet from "*One Flat Thing, Reproduced*" by William Forsythe (reproduced, with permission, from [synchronousobjects.osu.edu](http://synchronousobjects.osu.edu))

Each time these rules are executed by a group of dancers, a new version of the dance emerges. The variations among executions of the dance arise from the inevitable small differences in the ways dancers move: in movement timing and conscious decisions made in the moment of performance. Because each dancer's motion takes place as a response to other dancers' motions, small and large shifts in behavior can "snowball" in unpredictable ways. Some choreographers—Forsythe in *One Flat Thing*, for instance—use this in explicit ways, specifying rules that govern the interaction of each member of a group of dancers. As is the case in agent-based models such as those of birds and vehicles, the behavior that emerges from these individually simple rules can be rich—and often unpredictable. In dance, this often catalyzes an iterative creative process, wherein choreographers and dancers work out the effects of different rules via collaborative discovery. Note that this agent-based dynamics is more complex than most of the classic NetLogo examples, in which a group of identical agents carry out identical procedures. In these systems, patterns arise (*viz.*, bird flocks or traffic jams) as the agents simultaneously follow their rules. There are examples of parallel agents that behave probabilistically and generate predictable statistical structures, such as normal curves. Neither of these is isomorphic to the creative technique exemplified by *One Flat Thing*, where individual agents follow different rules, and those rules vary in time and space.

There are fundamental differences underlying the different dance representations and choreographic behaviors that are described above. Benesh, Feuillet, and Labanotation are generally used in cases that involve a central omniscience—e.g., a teacher or choreographer—or a traditional, fixed sequence of steps. In this context, movement sequences are pre-determined and the dancer's responsibility is simply to replicate them as accurately as possible. In other situations—e.g., Forsythe's composition—the dance is not generated by a central omniscience, but rather *in the moment* by the disseminated action of agents following individual rules. Importantly, traditional forms of ritual or performative dance forms, such as ballet, may not be distinguishable from, or differently pleasing than, dances that made with agent autonomy. But there are *huge* differences in the experience of dancers as they learn the different kinds of

<sup>2</sup> The chart in the abstract is an overall summary of who interacts with whom in the same dance.

dances—and tremendous cultural dissonance if one has been trained in the genre at the other end of the spectrum.

All of these ideas and observations have direct parallels in traditional constructionist concepts regarding primitives and the ways in which they can be combined. Various mathematical systems are built on different sets of axioms and rules. Programming with Scratch is different from programming with Logo, for instance, because of differences in:

- the primitives,
- the representations of primitives (i.e. visually, with shapes and colors vs. with words), and
- the rules for combining them.

In current modern dance parlance, the word “technique” describes access to movement potential and the ability to mobilize elements like forward, rotation, flow, verticality, etc.. The dancer/performer must be able to embody as diversely as possible movement ideas like turning, gesturing, and locomotion, just as we hope students who use programming environments can use primitives as diversely as possible in their pursuit of a meaningful goal.

## A Future Synergy

In this paper, we have argued for moving beyond the traditional “movement simply in service of mathematics” view and breaking out of the purely visual representation. In the long run, the benefits of opening the boundaries of constructionist inquiry should accrue to both the constructionist field *and* to the field of dance. Co-author Capps’ involvement in this work, for instance, has led him to new procedural ideas as well as new vocabulary for his work as a dancer, teacher, and choreographer, including a computer-human duet that explored the notions of theme, variation, and chaos (see Figure 4).



Figure 4. A scene from “Con/cantation: chaotic variations,” by David Capps and Elizabeth Bradley.

Co-authors Rubin and Bradley have found modern dance to be a compelling arena for studying constructionism “in the wild.” We have all learned that modern dance pedagogy is constructionist in its view of the power of construction, the relationship of process to product, the value it places on self-examination and revision, the investment of the learner in the process, and the hope it embodies that learning is a source of joy.

This work has also brought to the fore many issues that connect computer science, mathematics, and education—and, indeed transcend those fields. As a start, here are four hopefully provocative questions for us to all consider together:

- What new forms of representation for traditional constructionist topics do dance representations suggest?
- What is the relationship between design and performance, e.g. between choreography and realized dance?
- How does improvisation fit into a constructionist perspective?
- What is the parallel in other fields of “technique” in dance?

## References

Feuillet, R. (1700) *Chorégraphie, ou L'art de d'écrire la dance, par caracteres, figures et signes desmonstratifs, avec lesquels on apprend facilement de soy même toutes sortes de dances*, Chez l'auteur...et chez Michel Brunet, 1700.