Approaches to Processes of Building in Software Construction Kits

Carol Strohecker

Adrienne H. Slaughter

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This copy includes an Appendix describing a range of structures for interactive building processes.

Abstract

We have developed a genre of software construction kits characterized by two main processes: players' building of objects from graphical elements, and the software's activation of the constructions. Five kits demonstrate a range of techniques for constructing objects. Different approaches to construction may address different thinking and learning styles.

Approaches to Processes of Building in Software Construction Kits

Carol Strohecker
MERL - Mitsubishi Electric Research Lab
stro@merl.com

Adrienne H. Slaughter
Stanford University
ahs@alum.mit.edu

Abstract

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1. Introduction

We are developing software kits based on the notion of "microworlds" [4] and the theory of "constructionism" [2, 3]. In this view, people construct rather than acquire knowledge, actively inventing ideas for themselves. Idea invention (or knowledge construction, or *learning)* is based on internalization of actions and experiences in the world [4]. Therefore the nature of particular activities becomes interesting, and activity design has become a specialization in learning research. Some of the designs find their ways into creative toys, puzzles, and software.

In our playful software construction kits, users build and activate 2D graphical objects. Dinosaur skeletons balance as they walk and run, maps transform into street-level views, colorful tiles spread into geometric patterns, animistic creatures simulate the push-pulls of social dynamics, and dancers' breathing rates form a cycle for a shared dance. These kits focus on domains as varied as geometry, symmetry, physical forces, mechanical structures, time/space relationships, and system dynamics; yet they incorporate common strategies in activity design and interaction design. Players effect the constructions through direct manipulation of graphical elements, but the manner of access and assembly of the elements varies.

2. Construction Techniques

In the *Bones* kit, the player creates a skeleton by dragging bones into the work area and arranging them into the form of a dinosaur [5]. The player can then activate the construction by choosing a speed for walking or running. Although the bone images are based on those found in texts on dinosaurs, the parts are not programmatically designated as skulls, pelvises, vertebra, etc. This means that any of the bones in the kit can be used anywhere in a skeleton. It also necessitates a two-phase construction process, including both assembly and leg identification.

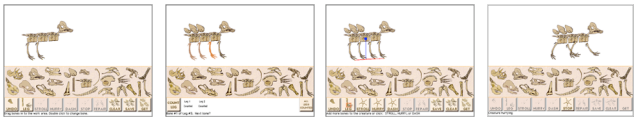

Figure 1. *Bones* players assemble parts into skeletons and identify which parts constitute the creature's legs. The software locates the construction's center of mass in order to determine whether the creature can balance as it moves.

In the *WayMaker* kit, a second phase of construction is optional. The player arranges representations of districts, edges, paths, nodes, and landmarks into the form of a city map. The player can then activate the construction by triggering the software's display of street-level views, or continue building by adding detail to the imagery. Landmarks can become towers, edges can become mountains, and so on. In either case, upon activation, the software maintains relative placements of the elements as it generates street-level views along pathways through the mapped domain [5, 6].

Figure 2. *WayMaker* players arrange abstract elements into a map and optionally specify pictorial details. The software then displays frame-by-frame views along the pathways.

In *PatternMagix* a four-part grid supports exploration of geometric symmetries as players reflect tiles around the x- and y-axes and rotate tiles within quadrants [1].

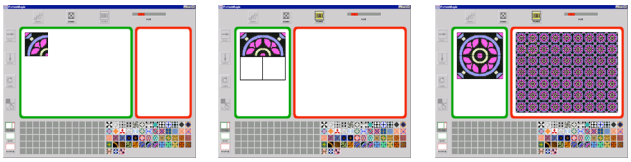

Figure 3. *PatternMagix* players experiment with reflections and rotations. The software replicates a resulting tile, and surprising patterns emerge.

In *AnimMagix* a tripartite column guides assembly of the perceptual, social, and mobile behaviors of animistic "bots" [1]. Sliders enable further adjustments, such as to the degree of a behavior. Perceptual fields can be deep as well as broad, attraction can be strongly or mildly positive or negative, and sweeping movements can be slow or fast.

Figure 4. *AnimMagix* players work within a tripartite column to specify ways in which bots will interact with one another.

We are employing a similar technique in *Zyklodeon*. Players create humanistic figures and endow them with properties that effect timing for a shared dance [8]. Replacing a default body part with a more colorful representation is similar to element specification in *WayMaker,* though the default head, torso, arms, and legs are already in place rather than being arranged by the player. Associated with each torso are slider-controlled settings, like those in *AnimMagix,* with which the player can adjust breathing and other choreographic parameters.

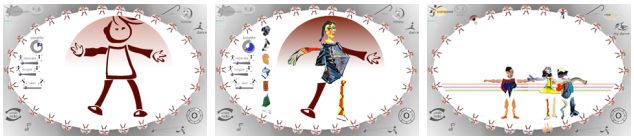

Figure 5. *Zyklodeon* players replace default elements and set parameters that characterize dancers' movements.

Thus the prototypes exemplify a range of construction strategies: freeform construction, freeform construction with a functional designation or pictorial specification phase, structured construction, and structured construction with a transformation or specification phase. What remains constant from one prototype to the next is the importance of the relationship between the build and activate processes, which typically plays out as an alternating pattern, usually with greater player control in the building and greater algorithm control in the activating.

3. A Typology of Construction Techniques

Experiences with these kits, and further inquiry among colleagues interested in creating similar kits, suggest a range of reasonable construction techniques [7]. Structures that guide building can be useful when constructions within a kit take consistent rather than arbitrary forms. Phased construction may include specification of image details, functional roles, or behavioral properties. Additional possibilities include reversing a construction process for an existing object and adjusting or completing a partially started construction process.

Younger builders, builders of complex forms, and builders within settings that do not allow much time for interacting may benefit from guided processes such as grids and clearly defined phases. Currently we are framing study of such construction techniques within usage trials of various kits at Boston's Museum of Science. We are focusing on how different approaches to building may involve visitors' varying thinking and learning styles. For example, psychological concerns such as senses of security and loci of control may pertain to preferences for negotiational vs. unilateral interaction [1]. Both styles can promote cognitive growth, but they require different artifactual supports.

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5. References

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APPENDIX

Of particular interest are the individual differences that emerge as people work within the structures provided to invent ways of building – they build different things, combine properties in different ways, and interpret emergent effects differently.

Supporting different kinds of building may be a good way to address different thinking styles (corresponding to different ages, genders, cultures, etc.):
- freeform vs. pre-fab, recipe-style construction - novel construction (from scratch) vs. reversing the construction process of an existing object
- novel construction vs. adjusting or completing a partially started construction process

	ASSEMBLE FROM SCRATCH	**GUIDED ASSEMBLY**	**COMPLETE EXISTING OBJECT**	**REPLACE PARTS**	**REVERSE EXISTING OBJECT**	**OPERATE EXISTING OBJECT**
DETERMINED OUTCOME		LEGO models				Furby
OPEN-ENDED **(though # of pieces limits possibilities)**	LEGOs WayMaker (phased with element specifications) Bones (phased with leg designations)	PatternMagix AnimMagix	Mr. Potato Head	Zyklodeon		