Blocks Languages for Creating Tangible Artifacts

Lyn Turbak (for the TinkerBlocks team)
Computer Science Department
Wellesley College

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TinkerBlocks Team

Erin Davis  Smaranda Sandu  Olivia Kotsopoulos  Karishma Chadha
Emily Erdman  Johanna Okerlund  Marie Vasek
What We Did

1. Graphical microworlds
2. Laser cutter and vinyl cutter

1. Blocks programming
2. Improvements to typing and naming
Graphical microworlds

Laser cutter and vinyl cutter

1

Blocks programming

2

Improvements to typing and naming
Wellesley & Engineering Connections

Wellesley College

MIT

Olin College

VLHCC'12, Oct. 2, 2012
Rapid prototyping @ Wellesley

Laser cutter

3D Printer

Desktop vinyl cutter

VLHCC’12, Oct. 2, 2012
Intro to Engineering: Bottle Openers
Personal fabrication

Silhouette vinyl cutter: $250

MakerBot Replicator 3D printer: $2000
Graphical microworlds

1

Blocks programming

2

Improvements to typing and naming

Laser cutter and vinyl cutter
Wellesley CS111 TurtleWorld
Peter Henderson’s Picture Language
Picture Combinators

- \textbf{bw}
- \textbf{clockwise90(bw)}
- \textbf{flipHorizontally(bw)}
- \textbf{flipVertically(bw)}
- \textbf{above(bw, rk)}
- \textbf{beside(bw, rk)}
- \textbf{overlay(bw, rk)}
- \textbf{overlay(rk, bw)}
Wellesley CS111 PictureWorld
Graphical microworlds

1

Blocks programming

2

Im Improvements to typing and naming

Laser cutter and vinyl cutter
Engraving is Easy

design

print from engraving

wood engraving
Problem: How to Specify Cut Lines?

[Diagrams of a star object with and without cut lines]
Turtle Operations and Boundaries

boundary

fill

thick pen

boundary
These operations are provided in Java!
Combining Cutting and Etching
Graphical microworlds

1

Blocks programming

2

Laser cutter and vinyl cutter

Improvements to typing and naming
Text vs. Blocks Turtle Programs

Turtle

t = new Turtle();

for (int i = 1; i <= 7; i++) {
    t.forward(75);
    t.length(360.0 / 7);
}

repeat 7 [fd 75 lt 360 / 7]

Logo

Java TurtleWorld (Wellesley CS111)

TurtleBlocks
Blocks Languages: Growing in Popularity

**Scratch:** multi-media programs, animations, and games

**MIT App Inventor:** apps for Android smartphones

**StarLogo TNG:** simulations

**Blockly:** Being developed as User PL for Google products
Graphical microworlds

Laser cutter and vinyl cutter

Blocks programming

1

2

Improvements to typing and naming
TurtleBlocks

TurtleBlocks program

Turtle drawing

cardstock

acrylic

drawing boundary
TurtleBlocks Artifacts
PictureBlocks: Cutting

PictureBlocks program

wood artifact

picture boundary

resulting picture
Sketcher: an easier way to create designs
PictureBlocks: Sketching & Engraving

user sketch → PictureBlocks program → resulting picture

print from engraving → wood engraving
PictureBlocks: Engraving + Cutting
PictureBlocks Artifacts
Workshops

- Four 70-minute TurtleBlocks workshops with 85 total CS111 students.
- Two 70-minute PictureBlocks workshops with 40 total different CS111 students.
- One 2-hour TurtleBlocks workshop with 8 non-CS Wellesley students (6 with no prior programming experience).
- One 3-hour TurtleBlocks/PictureBlocks workshop with 6 high school students and 2 non-CS Wellesley students (none with previous programming experience). These results not in paper.
- Workshops emphasized designing tangible artifacts, not blocks programming features.
- Students asked to complete online survey about experience:
  - 29/125 CS111 students completed survey
  - 15/16 non-CS111 students completed survey
Tangible Output is Motivational

41/44 respondents found tangible output more compelling than designs on screen/paper:

- “creating the physical artifact was definitely the highlight of my week and I immediately texted a picture of it to my parents and showed my owl to everyone I knew for the next couple of days.”

- “The ability to actually hold what you created was a lot more motivating than just making a picture on a computer screen.”

- “I feel that these designs are definitely more compelling than on screen or on paper because once the designs are cut, they are physical and permanent representations of a design. They become real, instead of just ideas on paper.”

- “I found it to be more interactive as well as more intellectually compelling. I thought that the idea of printing the design out in wood inspired me to want to construct better, more creative images.”

- “The combination of man's artistic nature with innovative technology is simultaneously appealing and nostalgic.”
Other Feedback

- Desire to sketch is important for many designs
- Many CS111 students found blocks too tedious
- Easier to make designs in TurtleBlocks than PictureBlocks.
- Designing robust structures is challenging
Graphical microworlds

Laser cutter and vinyl cutter

1

Blocks programming

{2

Improvements to typing and naming
Turtle/PictureBlocks Implementation

TurtleBlocks & PictureBlocks
StarLogo TNG    App Inventor
OpenBlocks Java Framework (Roque MIT Masters, 2007)
Types in Scratch

```
join (3 + 4) 1 = 2
```

```
join cat 1 = 2
```

```
join 3 + 4 1 = 2
```

```
join 3 < 4 true
```

```
join 3 + 4 7
```

```
join cat cat
```

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Types in App Inventor

- Programming time error!
- Runtime error!
Connector Shapes in PictureBlocks

- **number**
  - 1
  - +
  - sqrt
  - atan

- **boolean**
  - true
  - not
  - and

- **string**
  - abc
  - num to string
  - join

- **color**
  - Red

- **picture**
  - wedge color
  - clockwise angle pic
  - Load picname
  - fourPics pic pic pic
Polymorphism in Turtle/PictureBlocks

Polymorphic plug

polymorphic sockets

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Broken Procedure Parameter References

Example: Procedure Parameters in StarLogo TNG (similar in AppInventor)
Variable Scope in Turtle/PictureBlocks
How to Define pushRight?
pushRight: Create Declaration and Call

function declaration

function call
pushRight: Add Parameters
pushRight: Rename Function & Params
pushRight: Start Function Body
pushRight: Specify Base Case
pushRight: Complete Declaration and Call
Future Work

- Evaluate new blocks features
- Improve App Inventor blocks language & environment
- Explore blocks typing in blocks-based functional language; Marie Vasek has already made progress on this with her TypeBlocks work:

- Environments for 3D artifacts and popups
- Support for debugging and visualization of dynamic program execution in blocks languages.
- Blocks language generators
More Info: www.tinkerblocks.org