Language Design: Back to the Future?

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2008/07/08
Overview

1. Where are we at today?
2. Why are we where we are?
3. A glance backwards and sideways.
4. A gaze forward.
Part I: Where are we at today?
Where are we at today?
We’ve come a long way

- Always remember: software today is pretty good.
- Many programming languages to choose from.
Lisp sucks
Facing reality

Smalltalk sucks
Python sucks
Facing reality

Ruby sucks
Facing reality

Converge sucks
Facing reality

It sucks too!

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The situation

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- In C:
  ```c
  for (int i = 0; i < 10; i++) {
  ...\n  }
  ```
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In Java:

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In Java:

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In D:

```d
for (int i = 0; i < 10; i++) {
    ...
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```
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```

In Java:
```java
for (int i = 0; i < 10; i++) {
    ...
}
```

In D:
```d
for (int i = 0; i < 10; i++) {
    ...
}
```

In Cyclone:
```cyclone
for (int i = 0; i < 10; i++) {
    ...
}
```

Is this a problem?
Every programming language has flaws.
Programming languages vary little.

In C:

```c
for (int i = 0; i < 10; i++) {
    ...
}
```

In Java:

```java
for (int i = 0; i < 10; i++) {
    ...
}
```

In D:

```d
for (int i = 0; i < 10; i++) {
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}
```

In Cyclone:

```c
for (int i = 0; i < 10; i++) {
    ...
}
```

Is this a problem?
If language A isn’t good for your problem, language B probably isn’t either...
Part II: Why are we where we are?
History is written by the victors.

- Winston Churchill (1874 - 1965)
The gene pool

Homogeneity

- Most languages draw influences from the same small pool.
- A cliché (but true): syntax is often the main differentiator.
- Differences are perceived as much larger than they really are.
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- A cliché (but true): syntax is often the main differentiator.
- Differences are perceived as much larger than they really are.
- Why do languages vary so little?
Language communities

- Prefer languages ‘to look familiar’.
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- Language communities are insular.
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- Language communities are *tribal*?
- Informed comparisons are rare.
- Language communities beget language designers.
Language designers

- The obvious culprit?
- Problem #1: *really* learning a language is hard.
- Tend to have one dominant influence.
The obvious culprit?

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The obvious culprit?

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Problem #2: designer vs. implementer.

Implementation considered hard and expensive but vital for feedback.

Problem #3: fear of failure.
Examples of a narrow perspective

- Scoping.
- Statements vs. expressions.
Examples of a narrow perspective

- Scoping.
- Statements vs. expressions.
- Python: confusion of class meta-levels.
- Ruby: blocks aren’t first-class.
- Converge: brain-dead class hierarchy.
The risk of innovation

- New features are risky. Will they work?
- Most languages either:
  1. Have no new features.
  2. Have one or two new features.
The risk of innovation

- New features are risky. Will they work?
- Most languages either:
  1. Have no new features.
  2. Have one or two new features.
  3. Didn’t mean to have new features but bad design introduced them.
- Little risk of ‘failure’ if there are no new features.
An example

- Java checked exceptions.
- Possibly Java 1.0’s only novel feature.
- `public void f() throws X;` means callers of `f` have to catch `X`.
- Common user solution?
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Common user solution?

```java
try {
    f();
} catch (X) {
    // Empty catch statement. Ouch.
}
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An example

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```

- Checked exceptions: a bad idea.
- The fate of most novel language features: ridicule.
Language paper writers

- People who write papers: designers, extenders, pedants.
- Nearly always framed in terms of one language...
- ...its syntax, semantics,
People who write papers: designers, extenders, pedants.

Nearly always framed in terms of one language...

...its syntax, semantics, *and culture*.

Extracting widely applicable ideas is extremely difficult.
Language communities are tribal and ignorant.
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Language designers are timid and ignorant.
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Paper writers are obfuscators.
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Language designers are timid and ignorant.
Paper writers are obfuscators. And ignorant.
Part III: A glance backward ands sideways.
Icon

- The (indirect) successor to SNOBOL4.
- Dynamically typed PASCAL-ish language. But with unique expression evaluation system.
- Particularly intended for string processing.
- Expressions *succeed* (and produce a value) or *fail* and don’t.

```
if x := f():
    g(x)
else:
    // x has no value
```
Generators:

```icon
procedure upto(x)
    i := 0
    while i < x do {
        suspend i
        i := i + 1
    }
end

procedure main()
    every x := upto(10) do write(x)
end
```

Conjunction:

```icon
every x := upto(10) & x % 2 == 0 do write(x)
```
Print all words (from the Icon book):

text ? {
  while tab(upto(&letters)) do
    write(tab(many(&letters)))
}

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Problem #1: `text.split(" ")`.
Problem #2: regular expressions.
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Integrated pretty much wholesale into Converge.
Problem #1: `text.split(" ")`.
Problem #2: regular expressions.
Conclusion: much innovation, but only generators and failure in `if` useful.
Compile-time meta-programming

- A.K.A. macros.
- They came from Lisp.

...and they ended with Lisp. Why?

Until: MetaML (and Template Haskell).

Simple inversion of Lisp: 'macros' are normal functions but 'macro calls' are special.

$\texttt{\langle f \rangle}$ is a macro call.

Code isn't lists; $\texttt{| 2 + 3 |}$ evaluates to an AST $\texttt{\langle \texttt{plus}(\texttt{int}(2), \texttt{int}(3)) \rangle}$.
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- Why?
- Until: MetaML (and Template Haskell).
- Simple inversion of Lisp: ‘macros’ are normal functions but ‘macro calls’ are special.
- $<f>$ is a macro call.
- Code isn’t lists; [ | 2 + 3 | ] evaluates to an AST:
  `plus(int(2), int(3))`. 
An example

```plaintext
func expand_power(n, x):
    if n == 0:
        return $c{1}$
    else:
        return $c{x} \times $c{expand_power(n - 1, x)}$

func mk_power(n):
    return $c{expand_power(n, [x])}$

power3 := $c{mk_power(3)}$

means that power3 looks like:

```plaintext
power3 := func (x):
    return x \times x \times x \times 1
```

by the time it is compiled to bytecode.
The macros dark ages

- Oh the irony.
The macros dark ages

- Oh the irony.
- An example of insularity?
- Sometimes other communities see things our own can’t.
Nowadays a language needs good libraries.
Same principles.
Converge needed an XML library. XML is easy, right?
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XML is simple if you don’t care about being correct.
Standard answer: roll your own.
Think outside the box: steal from XOM.
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XML is simple if you don’t care about being correct.
Standard answer: roll your own.
Think outside the box: steal from XOM.
Thought: libraries effect users almost as much as languages.
Part IV: A gaze forward.
History will be kind to me, for I intend to write it.

- Winston Churchill (1874 - 1965)
Conclusions

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  - Orthodoxies aren’t always right.
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- Language designers need to experiment more.
  - Look back as well as sideways.
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- Language communities need to look outside their own box more.
  - Orthodoxies aren’t always right.
- Language designers need to experiment more.
  - Look back as well as sideways.
- Paper writers should focus less on an individual language and more on generic issues.
Success is not final, failure is not fatal: it is the courage to continue that counts.

- Winston Churchill (1874 - 1965)