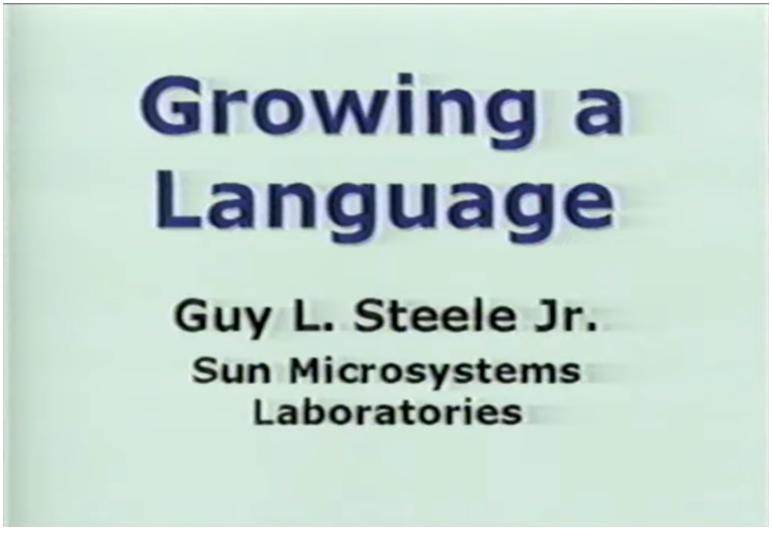
How do we grow our languages?


Growing a
Language
Guy L. Steele Jr.
Sun Microsystems
Laboratories

OOPSLA 1998

Growing a Language

I stand on this claim: I should not design a small language, and I should not design a large one. I need to design a language that can grow. I need to plan ways in which it might grow—but I need, too, to leave some choices so that other persons can make those choices at a later time.

Guy L. Steele Jr.

Growing a Language

(very reductively)

Userland *types*, *functions* and *methods* should naturally integrate into the language; as if they were part of it

A programming language should be a *pattern* for how to create a dictionary of primitives to write programs with

This applies to *all* programming languages

So what is this talk about?

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Loose bag of ideas and opinions about modern programming languages

Operator Overloading

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Java BigInteger example

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This one does not spark joy

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((a + b) * (c + d)) / e
```

Operator Overloading

Java BigInteger example

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a.plus(b).times(c.plus(d)).divide(e)
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((a + b) * (c + d)) / e
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To this day many languages do not support operator overloading

Operator Overloading

Arguments against:

- It can obfuscate logic

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- ...?

James Arthur Gosling, Lead Designer of Java Programming Language™
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[1] `http://www.gotw.ca/publications/c_family_interview.htm`

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Zig Documentation
There is no operator overloading. When you see an operator in Zig, you know that it is doing something from this table, and nothing else.

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Odin Documentation FAQ
The design goals of Odin were explicitness and simplicity. Operator overloading is very easily abused and can be used to do many magical things. A procedure is clearer and more explicit.

[1] `http://www.gotw.ca/publications/c_family_interview.htm`

A procedure is clearer and more explicit.

```
divide(times(plus(a, b), plus(c, d)), e)
```

Zig tries to enforce no hidden behavior, including allocations

```
const BigInt = struct {
  data: []u8,

  fn add(
      self: BigInt,
      other: BigInt,
      allocator: Allocator,
  ) BigInt
}
```

But one can already hide the allocator in the structure

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const BigInt = struct {
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So is then this

```
fn +(self: BigInt, other: BigInt) BigInt
```

so different?

And what about non-allocating number types?

```
const Rational = struct {
  numerator: i64,
  denominator: i64,
};
```

On the other hand

Programmers can definitely abuse tools in a wrong way

```
std::ostream& operator,(std::ostream& os, const DB& db) {
  return os << ","
            << db.select("database_name").from("metainfo");
}

// ...
std::cout, db;
// ...
```

But should we restrict expressivity because it could be abused?

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But should we restrict expressivity because it could be abused?

I don't think so

Error handling

Error handling

No error handling story — we are back to C land

Error handling - C++

Exceptions

Over abused in the standard library and by programmers

```
std::unordered_map<int, int> map;
int res = map.at(1); // throws
std::optional<int> mbyRes = map.try_at(1); // does not exist
```

Error handling - C++

Monadic errors

- `std::optional` - C++17
- `std::expected` (equivalent of `Either`, `Result`) - C++23
- Monadic operations (`and_then`, `transform`, `or_else`) - C++23

Still no first-class syntax for monadic errors

Error handling - C++

Sidenote - **Error code**

```
std::error_code ec;
std::filesystem::copy("file1", "file2", ec);
if (ec) { /* Handle error */ }
```

Error handling

Modern languages are often striving away from exceptions

Error handling - Zig

Single type signifying that error could happen

```
fn parseInt(buf: []u8) error{InvalidChar, OverFlow}!u64 {
  // ...
  if (ch < '0' or ch > '9') return error.InvalidChar;
  // ...
  if (overflow) return error.OverFlow;
  // ...
}

parseInt(buf) catch |err| // handle error
```

Error handling - Zig

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```

Essentially an integer - what about payloads?
(*e.g.* where did the error happen?)

Error handling - Go

```
res, err := Process()
if err == nil {
  // Handle err
}
```

Universal pattern. Should it be part of the language?

Error handling - Go

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Universal pattern. Should it be part of the language?

After so many years of trying, with three full-fledged proposals by the Go team and literally hundreds (!) of community proposals, most of them variations on a theme, all of which failed to attract sufficient (let alone overwhelming) support, the question we now face is: how to proceed? Should we proceed at all?
We think not.[2]

[2] `https://go.dev/blog/error-syntax`

Other ways languages grow

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  - namespacing problem (monkey patching)

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Other ways languages grow

- Extension methods
  - namespacing problem (monkey patching)
- ”The feature of month”
  - generators, async, coroutines, explicit IO, …
  - maybe there should be a universal way to express all of these?
  - (monads, algebraic effects, capabilities, …?)

The ”good” - Scala

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Scala is a massive language

- fully OOP, FP
- classes, traits, mixins, singletons, ADTs
- generics, variance, bounds, dependent types
- type classes, implicit parameters, type functions
- by-name parameters, lazy values, currying, monadic for-comprehension, pattern matching
- operator overloading, infix methods, extension methods
- experimental capture types

(non-exhaustive list)

The ”good” - Scala

Yet it does not feel unmanageable

- It evolved over time
- Features are regularly updated, deprecated and removed
- New features are added first as experimental
- The language has a vision[3]

[3] Martin Odersky has vision

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The ”good” - Scala

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(operator overloading, extension methods)

Any userland type can do what a built-in type can*

* apart from not being reference-based

The ”good” - Scala

On the other hand

The bad - C++

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Another massive language with tons of new features with every release

- concepts
- compiletime programming (`constexpr`, `constinit`)
- three-way comparisons
- modules
- coroutines
- receivers and senders
- metaprogramming (first part)

The bad - C++

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- concepts
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- metaprogramming (first part)

Yet they often feel very half-assed
Often it is a band-aid on top of band-aid

The ugly - The Truth

There is never going to be a perfect language

There is never going to be a perfect language

But we have to try out best

There is never going to be a perfect language

But we have to try out best

Or maybe programming languages are obsolete because of AI

probably not

In Summary

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Thank you!