The C++ Core Guidelines Project

Bjarne Stroustrup

Morgan Stanley, Columbia University

www.stroustrup.com

The big question

- **“What is good modern C++?”**
    - ***Many*** people want to write ”Modern C++”
- What would you like your code to look like in 5 years time?
    - “Just like what I write today” is a poor answer
- The C++ Core Guidelines project
    - https://github.com/isocpp/CppCoreGuidelines
    - Produce a ***useful*** answer
        - Implies tool support and enforcement
    - Enable ***many*** people to use that answer
        - For most programmers, not just language experts
    - Please help

C++ Core Guidelines

- We offer complete type- and resource-safety
  - No memory corruption
  - No resource leaks
  - No garbage collector (because there is no garbage to collect)
  - No runtime overheads (Except where you need range checks)
  - No new limits on expressibility
  - ISO C++ (no language extensions required)
  - Simpler code
  - Tool enforced
- "C++ on steroids"
  - Not some neutered subset

Caveat: work in progress

Morgan Stanley

Work in progress

- General approach
  - Guidelines
  - Library
  - Static analysis
- Not all production ready
  - Some experimental
  - Some conjectures
- Many parts in use
  - Not Science Fiction

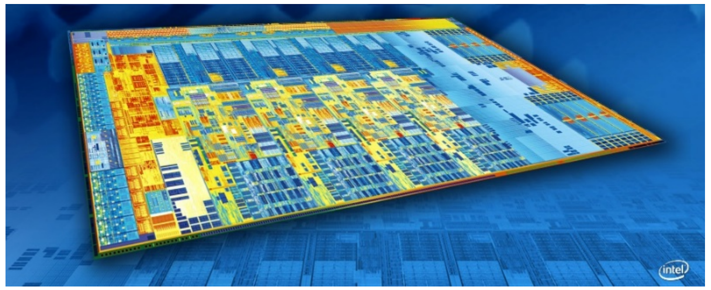
Morgan Stanley

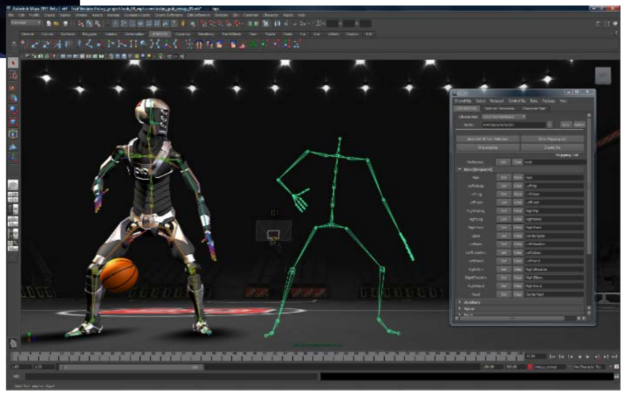
Why not just "fix" C++?

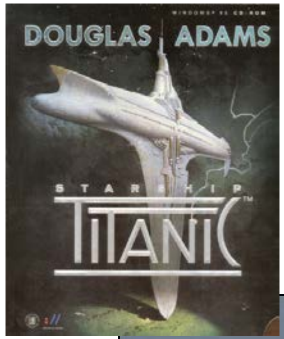
- C++ is too big and complicated
  - Obviously
  - With many features dating back to the 1970s and 1980s
- Everybody wants "just two more features"
  - And not the same two features
- Don't break my code!!!
  - Nobody wants their code broken, however ugly
  - There are hundreds of billions of lines of C++ code "out there"
  - There are millions of C++ programmers
- Stability/compatibility is a feature
  - We can't simplify C++, but we can simplify the use of C++

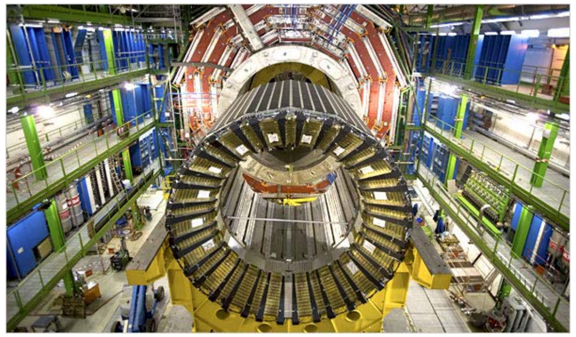
C++ use

- About 4.5M C++ developers
- 2007-17: increase of about 100,000 developers/year
- www.stroustrup.com/applications.html









Why open source?

- Some things are suspect unless done in public
- We want everybody to benefit
- We want everybody to be able to contribute
  - Initial contributors: Morgan Stanley, Microsoft, Red Hat, Facebook, CERN
  - 230 contributors so far

Taste

- A crowd doesn’t have taste
- People with taste don’t have the same tastes

- How to maintain coherence, integrity of design?
  - Articulate design principles
  - Have a stable team of gatekeepers

Morgan Stanley

Guidelines: High-level rules

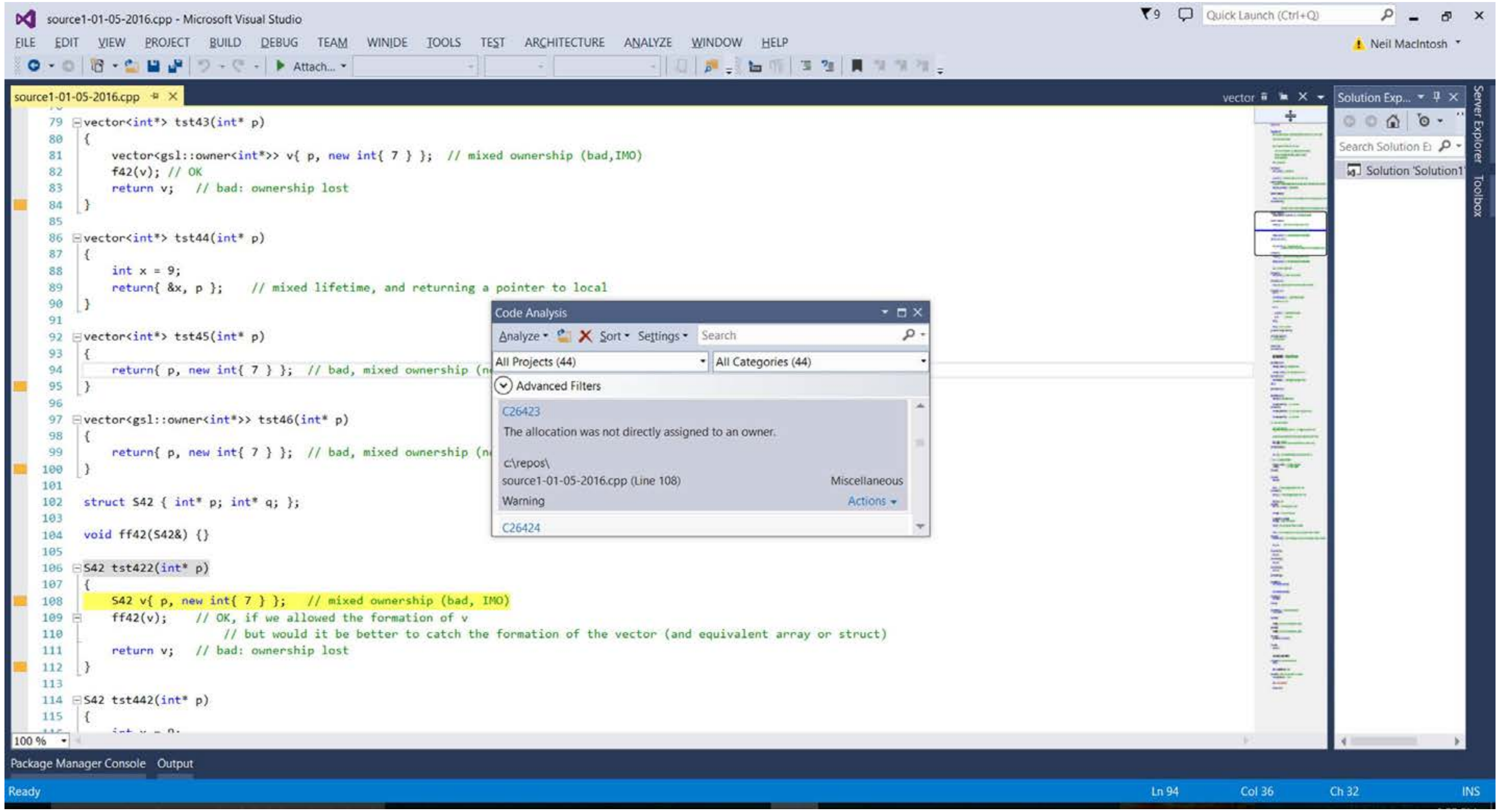
- Provide a conceptual framework
  - Primarily for humans
- Many can’t be checked completely or consistently

  - *P.1: Express ideas directly in code*
  - *P.2: Write in ISO Standard C++*
  - *P.3: Express intent*
  - *P.4: Ideally, a program should be statically type safe*
  - *P.5: Prefer compile-time checking to run-time checking*
  - *P.6: What cannot be checked at compile time should be checkable at run time*
  - *P.7: Catch run-time errors early*
  - *P.8: Don't leak any resource*
  - *P.9: Don't waste time or space*

Guidelines: Lower-level rules

- Provide enforcement
  - Some complete
  - Some heuristics
  - Often easy to check “mechanically”
- Primarily for tools
  - To allow specific feedback to programmer
- Help to unify style
  - *R.1: Manage resources automatically using resource handles and RAII*
  - *R.2: In interfaces, use raw pointers to denote individual objects (only)*
  - *R.3: A raw pointer (a T*) is non-owning*
  - *R.4: A raw reference (a T&) is non-owning*
  - *R.5: Prefer scoped objects, don't heap-allocate unnecessarily*
  - *R.6: Avoid non-const global variables*
- Not minimal or orthogonal

Static analyzer (currently integrated)



```
vector<int*> tst43(int* p)
{
    vector<gsl::owner<int*>> v{ p, new int{ 7 } };  // mixed ownership (bad,IMO)
    f42(v); // OK
    return v;   // bad: ownership lost
}

vector<int*> tst44(int* p)
{
    int x = 9;
    return{ &x, p };    // mixed lifetime, and returning a pointer to local
}

vector<int*> tst45(int* p)
{
    return{ p, new int{ 7 } };  // bad, mixed ownership (n
}

vector<gsl::owner<int*>> tst46(int* p)
{
    return{ p, new int{ 7 } };  // bad, mixed ownership (n
}

struct S42 { int* p; int* q; };

void ff42(S42&) {}

S42 tst422(int* p)
{
    S42 v{ p, new int{ 7 } };   // mixed ownership (bad, IMO)
    ff42(v);    // OK, if we allowed the formation of v
                    // but would it be better to catch the formation of the vector (and equivalent array or struct)
    return v;   // bad: ownership lost
}

S42 tst442(int* p)
{
```

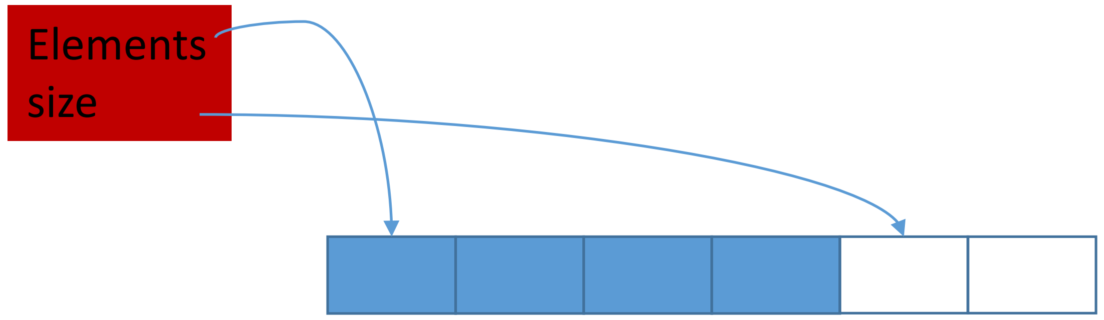
```
C26423
The allocation was not directly assigned to an owner.

c:\repos\
source1-01-05-2016.cpp (Line 108)                Miscellaneous
Warning                                          Actions
C26424
```

Morgan Stanley

GSL – Guidelines support Library

- Minimal, to be absorbed into ISO C++
- **not_null**, **owner**, **Expects**, **Ensures**, …
- **span**
  - Non-owning potentially run-time checked reference to a continuous sequence
    - Implemented as a pointer, integer pair

```
int a[100];
span s {a};             // note: template argument deduction
for (auto x : s)        // note: no range error, not nullptr check
        cout << x << '\n';
```



Overview

- Maintain static type safety
  - Avoid cast and un-tagged unions
- Be precise about ownership
  - Don’t litter
  - Use ownership abstractions
- Eliminate dangling pointers
- Make general resource management implicit
  - Hide every explicit delete/destroy/close/release
  - “lots of explicit annotations” doesn’t scale
- Static guarantees (run-time is too late)
- Test for **nullptr** and range
  - Minimize run-time checking
  - Use checked library types