Simplify your code

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LArSoft Workshop 2019

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  - Lack of knowledge or experience in designing software.
  - Lack of discipline.
  - Lack of time to clean things up.
  - etc.

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  - etc.

- As software projects evolve, they often get larger. This isn’t a bad thing, *per se*, but it has consequences:
  - The code takes longer to build
  - The installed software takes up more space
  - The code becomes harder to keep working
  - The code becomes hard to understand

“Keep it simple” … ?

- Unless developers proactively take steps to keep things maintainable, the code base will continue to grow until it becomes too unwieldy.

- LArSoft contributors often add code, but rarely remove it.

- Today I want to discuss simple ways of cleaning up LArSoft code. Specifically, **the changes today do not relate to software design**. They are guidelines that can be adopted as you go.

- For this talk I will focus primarily on simplifications, not conventions.

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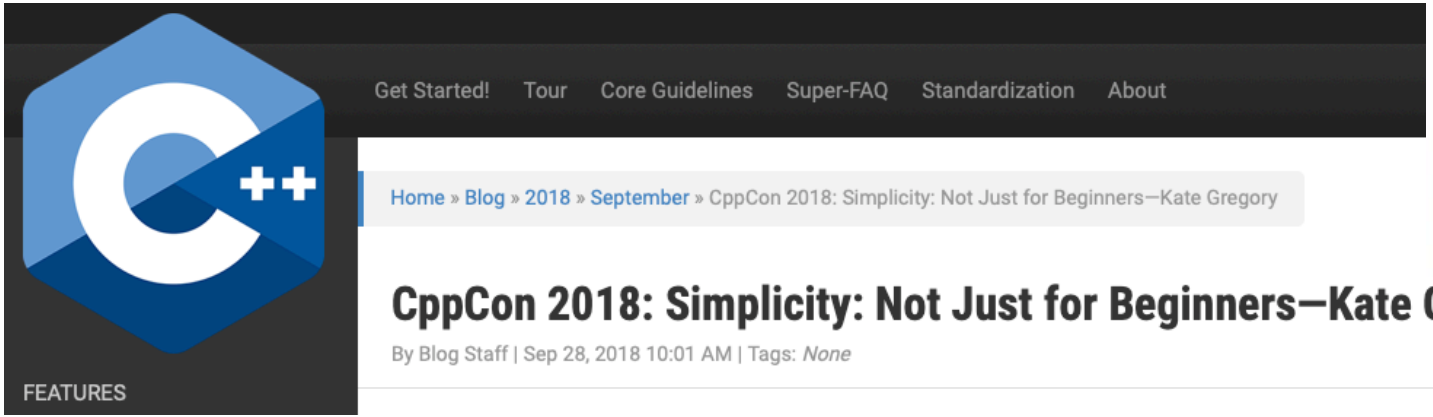
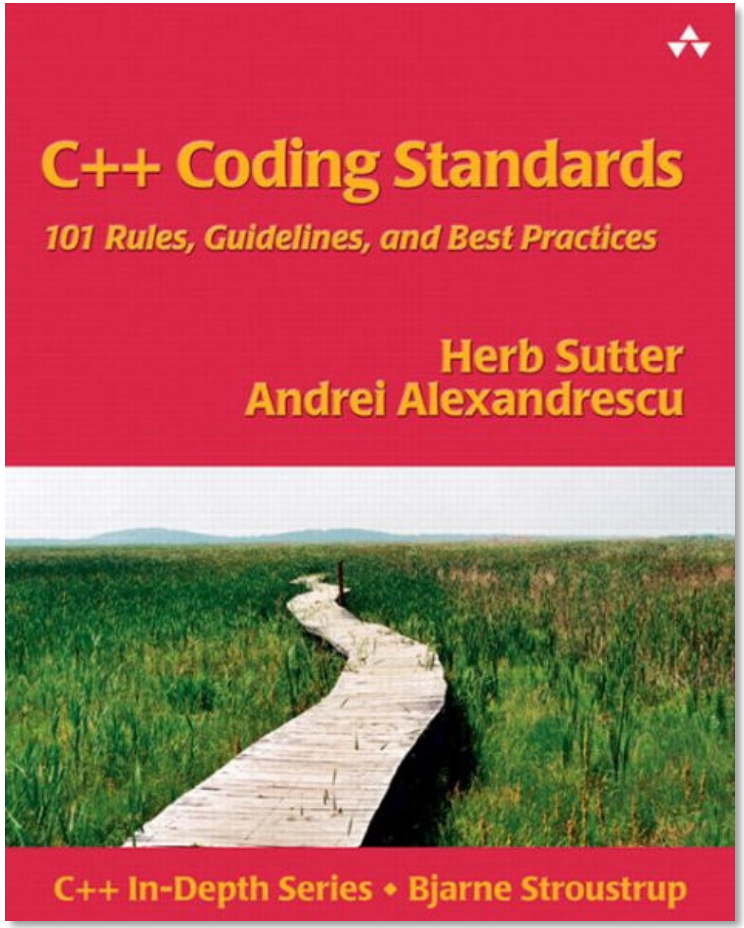
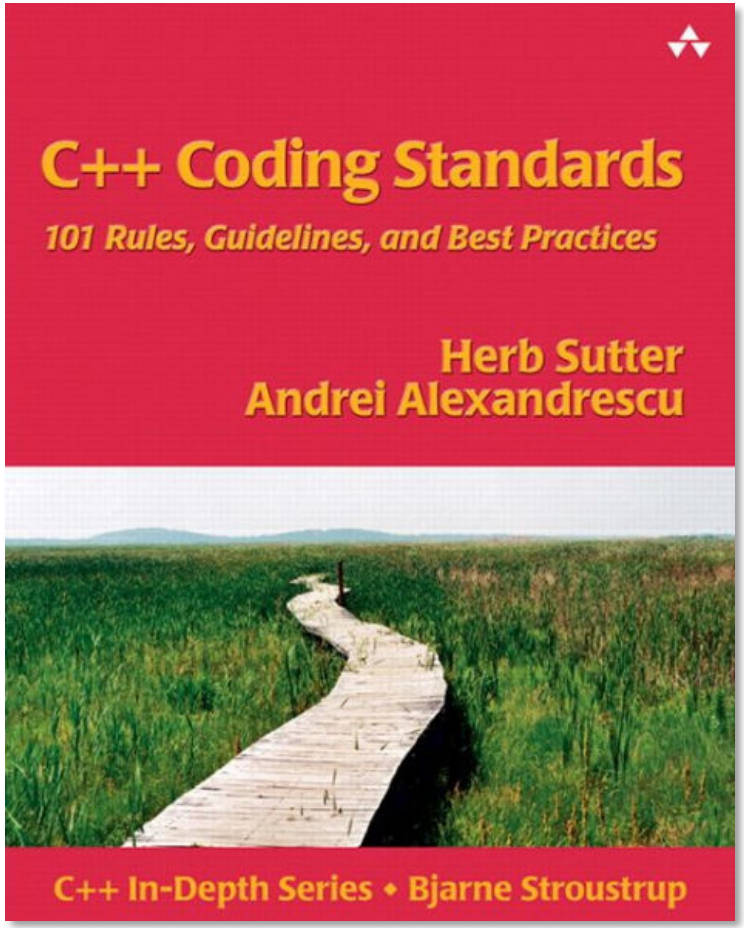




- **Please, read this!**
- Fermilab library has a few copies.
- Almost 15 years old; still relevant today.



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- **Rule 6: Correctness, simplicity, and clarity come first.**

"Fools ignore complexity. Pragmatists suffer it. Some can avoid it. Geniuses remove it."

- Alan Perlis

"The importance of a simple design cannot be overemphasized."

- Jon Bentley

Estimating LArSoft's complexity level

- Various metrics of estimating how complicated a body of code is.
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Date	Tag	Lines of **code**[1]	Lines of **comment**[1]
2016-08-11	v06_03_00	251138	95712
2017-07-25	v06_45_00	289929	111898
2018-07-30	v07_00_00	347079	137420
2019-06-08	v08_22_00	354545	141201

[1] *As computed by the `cloc` utility.*

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- How do we reduce the maintenance burden?

Remove unnecessary files

- Remove files *that you know* are not needs. This may take approval from the collaboration.
  - LArSoft took these types of steps last week.

- Examples of this include:
  - Code that is not built/installed
  - Empty files (or those only with comments)
  - Any *art* module separated into a header and a .cc file (only .cc needed)

Remove unnecessary header dependencies

- I did a test to see how much time it takes to build SimWire_module.cc. I then systematically removed code to gauge the effect of the headers vs. the code in the file.

Built code	Build time[1]
Entire file	11.3 s
Only headers	8.0 s
Only *art* headers	5.0 s
Empty file	0.4 s

[1] The build time includes the overhead of running `ninja`, as well as preprocessing, compiling, and linking.

- Due to header guards, it's difficult to know who contributes the most.
- Bottomline, **remove unnecessary headers**.

Remove unnecessary header dependencies

- But what's an unnecessary header?
  - Straightforward to .cc files. But if someone is relying on a header dependency in a header file, then removing an "unused" header can break downstream code. So be it.

- **Only include headers in the file that are required for that file.**
  - No courtesy headers!

Discouraged

```
// MyService.h
//   The following headers are used
#include <vector>

//   The following headers are not used
#include "mf/.../MessageLogger.h"
#include "art/.../ServiceHandle.h"
```

Encouraged

```
// MyService.h
//   The following headers are used
#include <vector>
```

Remove unnecessary link-time dependencies

- The SimWire test from earlier:

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- All steps included linking time. If we reduce the number of linked libraries…

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Empty file + only art libraries	**0.3 s**

- Reducing number of linked libraries generally results in minor savings in build time. The benefits are seen elsewhere (library sizes, run-time overhead, maintenance).

Remove unnecessary functions

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- A common pattern:

```
class MyProducer : public art::EDProducer {
public:
  MyProducer(fhicl::ParameterSet const&);
  ~MyProducer();

private:
  void produce(art::Event&) override;
  void beginJob() override;
  void endJob() override;
};
```

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};
```

- And then:

```
MyProducer::~MyProducer() {}
void MyProducer::beginJob() {}
void MyProducer::endJob() {}
```

Remove unnecessary functions

- If there is no work to be done in the following functions, remove them:
  - `beginJob`
  - `beginRun`
  - `beginSubRun`
  - `endSubRun`
  - `endRun`
  - `endJob`
  - Destructor

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To reconfigure or not to reconfigure…

- Consider this code:

```
class MyProducer {
  LargeObject obj_;
  unsigned counter_;
  unsigned importantConstant_;

public:

  MyProducer(ParameterSet const& pset)
  {
    reconfigure(pset);
  }

  void reconfigure(ParameterSet const& p)
  {
    obj_ = LargeObject{p.get<std::string>("some_label")};
    counter_ = 0;
    importantConstant_ = 42;
  }
};
```

To reconfigure or not to reconfigure…

- Consider this code:

```
class MyProducer {
  LargeObject obj_;  // Only const access needed
  unsigned counter_;
  unsigned importantConstant_; // Only const access needed

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```

To boot: ***module reconfiguration is not supported by art***

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```

Use the class's initialization list!

To reconfigure or not to reconfigure…

Using the initialization list

```
class MyProducer {
  LargeObject obj_;
  unsigned counter_;
  unsigned importantConstant_;

public:

  MyProducer(ParameterSet const& pset)
    : obj_{p.get<std::string>("some_label")}
    , counter{0}
    , importantConstant_{42}
  {}
};
```

To reconfigure or not to reconfigure…

Using the initialization list

- `obj_` is constructed once

```
class MyProducer {
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To reconfigure or not to reconfigure…

Using the initialization list

- `obj_` is constructed once
- `obj_` and `importantConstant_` can now be const

```
class MyProducer {
  LargeObject const obj_;
  unsigned counter_;
  unsigned const importantConstant_;

public:

  MyProducer(ParameterSet const& pset)
    : obj_{p.get<std::string>("some_label")}
    , counter{0}
    , importantConstant_{42}
  {}
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Get rid of module reconfigure functions.

Remove inappropriate preprocessor use

There are some places where preprocessor macros are being used when they shouldn't be:

- Header guards are for headers!
  - Do not place header guards in implementation (.cc) files.

- Do not define constants with macros
  - BAD: `#define NUM_BEETHOVEN_SYMPHONIES 9`
  - GOOD: `constexpr unsigned int num_beethoven_symphonies{9};`

- ROOT no longer supports the `__GCCXML__` preprocessor guard. If you absolutely need to hide code from the dictionary generator, use `__ROOTCLING__`.

More simplifications

- Defining *art* modules

```
- namespace something {
-   DEFINE_ART_MODULE(MyModule)
- }
+ DEFINE_ART_MODULE(something::MyModule)
```

- Iterating over `std::map` entries

```
- for (auto const& pr : some_map) {
-   auto const& key = pr.first;
-   auto const& value = pr.second;
-   ...
- }
+ for (auto const& [key, value] : some_map) {
+   ...
+ }
```

More simplifications

- Creating `std::unique_ptrs`

```
- std::unique_ptr<MyType> p(new MyType(arg1, arg2, ...));
- auto p = std::unique_ptr<MyType>(new MyType(arg1, arg2, ...));
+ auto p = std::make_unique<MyType>(arg1, arg2, ...);
```

- Nested namespaces

```
- namespace a {
-   namespace b {
-     ...
-   }
- }
+ namespace a::b {
+   ...
+ }
```

LArSoft's coupling to *art*

- Much of LArSoft has been built on top of *art* and *canvas*
- This makes sense for the components that are meant to interact with a framework
- LArSoft provides facilities that are not intrinsically connected to any framework
  - I encourage you to reduce your reliance on *art*- or *canvas*-provided interface.
  - It is a maintenance burden, and who knows where frameworks will be *n* years from now

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  - I encourage you to reduce your reliance on *art*- or *canvas*-provided interface.
  - It is a maintenance burden, and who knows where frameworks will be *n* years from now
- Practical suggestion: **no `ServiceHandles` outside of *art*-supported plugins**
  - Providers should never create `ServiceHandles`
  - Algorithms in `larreco/RecoAlg` should never create `ServiceHandles`
  - etc.

Takeaways

- Making things simpler takes a lot of effort.
- Ways to get there:
  - Remove unnecessary files
  - Remove unnecessary header dependencies
  - Remove unnecessary link-time dependencies
  - Remove unnecessary functions/classes
  - Use modern C++ facilities to simplify your code
  - Reduce coupling to *art*
- Come talk to the SciSoft team. We're here to help you.