Simplicity
Not Just for Beginners

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When We Teach, We Start Simple

- Omit error checking
- Assume we're given a positive or otherwise reasonable number
- Assume all input is well intentioned
- Show how to move things up but not down, or forward but not back

Why?

- So we can show what we’re trying to teach
- So the learner can concentrate on one thing at a time
- So it fits on a page with a largish font
- To reduce the cognitive burden on those who read it
- Because the sample is artificial and lacks context

So What Happens?

- Real life is complicated
- You can’t omit all that error checking and input sanitizing and handling both directions
- Code grows
- It gets more complicated

What Happens to Developers?

- We reject simple
  - After all, we're not beginners
  - And real life is complicated
- Maybe we even show off a little
  - If it was hard to write, it should be hard to read
  - If it was easy, anyone could do it

What is simple code?

- Expressive
- Readable
- Understandable
- Unsurprising
- Transparent
- Self explanatory
- Reassuring
- Pleasant

Is Simpler Better?

- Better means?
  - Faster to write the first time
  - More correct
  - Runs faster or in less memory or less of some other resource
  - Easier to read and understand the next hundred+ times
  - Easier to modify when the world changes
  - More fun to create and have created

Is it faster to write simple code?

- Definitely not
- Much-misattributed quote about no time for a shorter letter
- New habits required
- New ways of looking
- Reviewing, revisiting, refactoring

Is simpler code more correct?

- Usually, yes
- RAII is less to write, and also less to forget
- Take away opportunities to be inconsistent
  - One function with default parameters instead of two similar functions
  - One function that is called with params instead of blocks of copy-and-paste-and-mostly-edit
  - One template instead of two (or ten) similar functions
- Code that moves complexity to abstractions often has less bugs
  - When you move complexity, can it disappear?
- Library code is already tested and has thought of edge cases

Does simpler code run faster?

- Usually, no
  - `for (auto p : people)`
  - `for (auto& p : people)`
- To get faster code you typically have to know and remember something about the language
- Try not to choose simplicity over performance **if** a real choice exists
- But
  - Library code may be faster than what you would write yourself
  - Compilers and optimizers are often much better than you
    - They’re guaranteed to be better than someone who’s not measuring

What’s in it for you?

- Simpler code is more readable and debuggable
  - Often more correct too
- Unsurprising code is more maintainable code
- Expressive code is fun to work with
- Other people’s code is beautiful

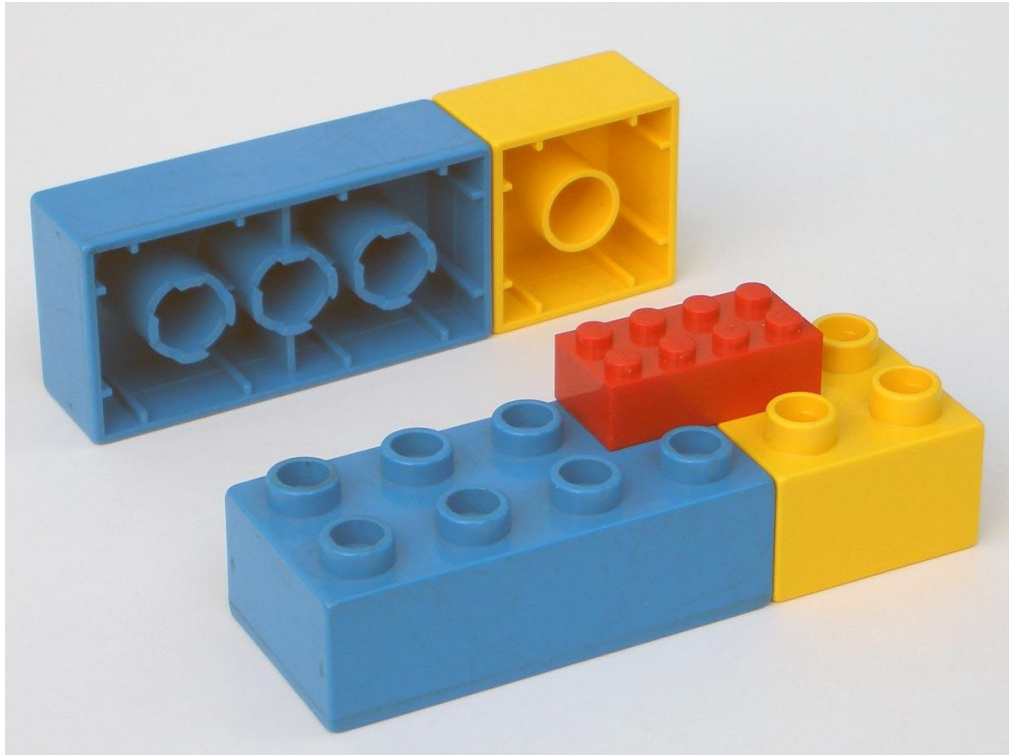
What I Have Learned

- True simplicity is very hard
- You have to know your tools
  - The language
  - The libraries
  - Our idioms
- Simplicity that is complete is utterly different from “I left that out for simplicity”

OK, Give me the Simple Rules to Write Simple Code

The Easiest Step

- Know what simple looks like
- Try to write code simply from the beginning
- As it grows, expands, and twists, recognize when it is too complex
  - Do something to make it simpler
- Prevent opportunities to be inconsistent



Names really help

- Often hiding in comments

```
//total of the numbers in the vector
int i = 0;
for (auto n : v)
{
      i += n;
}
```

- Becomes

```
int total = accumulate(begin(v), end(v), 0);
```

Using names

- Variables (avoid a, x, i, d1, d2, d3, …)
- Functions
  - Especially from <algorithm> et al
- Enums
- Constants

Short Functions

- Not for readability or to print on a single page
- But so they can be named
- If a function does two things, perhaps it's two functions?

- Consider also "emotionally short" functions such as those in <algorithm>
  - Code you didn't write feels very short indeed
  - Code everybody "knows" is also short – no learning and absorbing needed

Avoid really long lists of parameters

- Abstraction is your friend
  - Don’t pass 4 ints, pass a Rectangle or two Points
  - Don’t pass 3 strings and a float, pass an Order or Employee
- Maybe this function needs 10 pieces of information because it’s really 3 functions, that could be called with smaller parameter lists?
- Maybe this should be a member function of something that knows most of this already?

Don’t nest deeply – return early

```
bool Order::Calculate(double x, double y)
{
	if (x < limit)
	{
		if (y >= 0)
		{
			if (shipping)
			{
				//... actual calculation setting some member variable
				return true;
			}
			else
			{
				error = Errors::NotShipping;
				return false;
			}
		}
		else
		{
			error = Errors::YNegative;
			return false;
		}

	}
	else
	{
		error = Errors::XTooLarge;
		return false;
	}

}
```

Don’t nest deeply – return early

```
bool Order::Calculate(double x, double y)
{
	if (x >= limit)
	{
		error = Errors::XTooLarge;
		return false;
	}
	if (y < 0)
	{
		error = Errors::YNegative;
		return false;
	}
	if (!shipping)
	{
		error = Errors::NotShipping;
		return false;
	}
	//... actual calculation setting some member variable
	return true;
}
```

Const all the things

- Beyond just “const correctness”
- Mark everything const that you possibly can
- To lower the cognitive burden of future readers
  - Yes, there are 10 local variables here, but only 2 of them vary
- Also a reason to avoid out params and in/out params in functions
  - Return a struct or std::optional or even a std::tuple
  - Perhaps this should be a member function of the in/out thing
    - Abstraction again

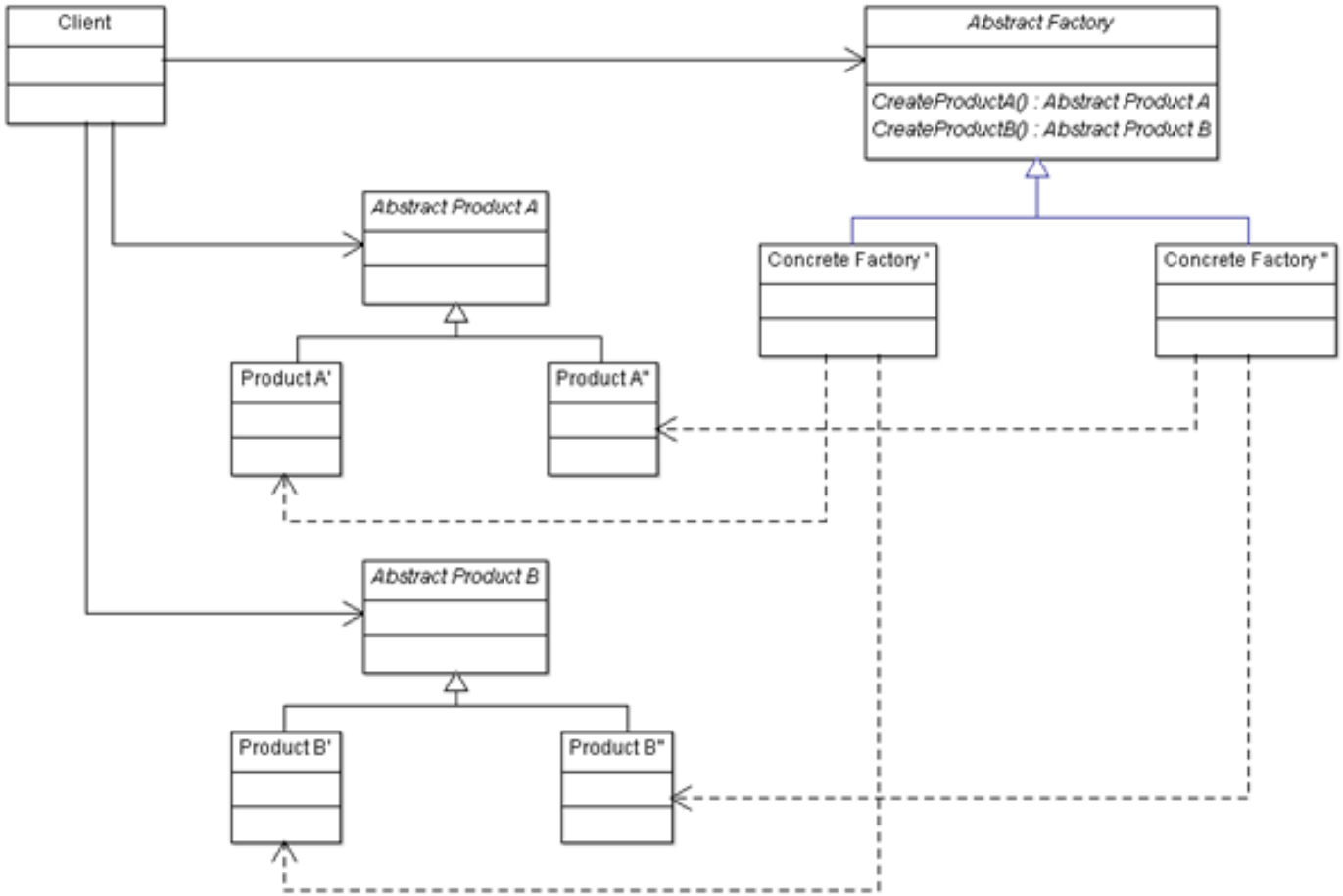
Keep up with the standard

- The *mutable* keyword is 25 years old yet people don’t know it
  - Lets you stay more const correct than you otherwise would be
  - Yes, yes, thread-safe, but…
- Use ranged-for loops if you must use loops
- Instead of making certain constructors private to prevent others creating objects, make them *deleted*
- Use non static member initializers
- Use the library

The pit of success

- We can control a lot of the defaults we leave for the next developer
- Opportunities to be inconsistent are rotten things to leave behind
  - Two versions of a function? They will have to remember to change both
  - One version? No chance to be inconsistent
  - Initialization to defaults with nonstatic member init – ctors can’t get inconsistent
- All cleanup in the destructor?
  - They don’t have to remember to clean up
  - No need for changes when exceptions are added
- Const correct?
  - They don’t need to play chase-the-const later
  - Might also make concurrency less terrifying later
- Good names for everything? Short functions?
  - They will keep the pattern going

Don’t be an architecture astronaut



```
AbstractFactory* factory =
    FactoryMakerSingleton::getInstance()->getFactory();
shared_ptr<Subject> subject = factory->createSubject();
subject->attach(factory->createObserver());
shared_ptr<Command> command =
    factory->createCommand(subject);
command->execute();
```

Simplicity Paradox

- The things you do to make code simple can make it more complex
- It is NOT POSSIBLE to write simple rules for how to write simple code
  - Unless you write vague rules
  - “good”, “short”, “a lot”, “not many”
  - “usually”, “without a good reason”
- This is a law of the universe
  - What speed should you drive at? What lane should you be in? When do you change lanes?
  - The baby is crying. What should you do?

Not all questions have simple answers

- Should you use exceptions?
- How long should a function be?
- What is a good variable name?
- Are default parameters confusing?
- Are overloads confusing?
- Should we really never use raw loops or raw pointers?

Moving to harder steps

- Simple practices like naming and keeping things short are easy enough
  - They require some judgment
- Ideally you write your code like this from the beginning
  - But you can refactor to be simpler
- But that is not the whole story
  - Not by a long shot
- Looking for big gains
  - In performance
  - In understandability, reusability
  - In maintenance pain

Simplifying Polynomials

- At what age did you learn to expand polynomials?
  - (x+1)(x+2)
  - FOIL
  - $x^2 + 2x + 1x + 2$
  - $x^2 + 3x + 2$

- Remember how much harder it is to “simplify” them?
  - $x^2 + 4x + 4$
  - You have to recognize certain combinations
  - (x+2)(x+2)

Idioms, Library Abstractions, Commonality

- These are old friends you can learn to recognize too
- This loop touches every element in the collection; I should use a ranged for instead of a traditional for loop
  - Or something from <algorithm>
- “This is obviously a rotate”
- There is already a stack in the Standard Library
- I bet someone already wrote a pretty good json parser, logger, http-getter, etc
- If I move the initialization of this object to a function or immediately-invoked lambda, I can make it const

Learning patterns and idioms and things with initials isn't **necessarily** just showing off. It can be a powerful technique towards better code.

About that for loop…

```
for(uint8_t i=0; i < GetSize(); i++)
{
 //...
}
```

- Guess what the return type of GetSize() is?
  - uint16_t
  - And it needs to be – won't fit in 8 bits
  - So that means?
- C++ is so complicated with all those darn different types

The Harder Step

- Know what we all should know
  - Is surprising people simple?
  - It is not enough that you know something. The reader must know it
- Replace your complicated things with
  - Familiar idioms and language constructs that express your intent
  - Well known library classes and functions that others will recognize
  - Appropriate abstraction that becomes a thing to learn in your code
    - Moving complexity inside your abstraction
- Without
  - Omitting needed capabilities
  - Hiding core information behind abstractions and indirections
    - Factories, interfaces, InjectorFactoryAdapter
  - Preventing future changes
    - Global mutable state, singletons, hardcoding things because “it’s simpler”

The Hardest Steps

- Knowing that border between “skipping stuff to make it easy” and genuinely elegant simplicity
- Being brave enough to present simple code
  - “Is that all you did?”
  - “I thought you were creative/innovative/an architect?”

The Border

- As simple as possible, but no simpler!
- Simplicity in the larger context
  - Using a magic number is simpler now than setting up a const variable (or an enum for several of them) but will it be simpler to understand later?
  - Adding a global is simpler now than adding a parameter to a long chain of function calls, but later when people don't understand what controls behaviour, was it simpler?
- Remember simpler code isn't always faster or easier to write
  - Take the time to write the shorter letter

The Bravery

- Which side of that border are you on?
  - Is this simple-didn’t-think-it-through or simple-brilliant?
- If you’re relying on knowing your language and library, do others?
- Now your code is expressive and transparent, can you be replaced?
- Does your code reflect you and your abilities?
- How far are you from being a beginner?

Call to Action

- Learn
- Read
- Care
- Test
- Communicate