Renaming any_invocable

**Document**: P2265R0 (2020-12-06)
**Author**: Kevlin Henney <kevlin@curbralan.com>
**Audience**: Library Evolution Working Group
**Project**: ISO/IEC JTC1/SC22/WG21 14882: Programming Language — C++

Express co-ordinate ideas in similar form.

This principle, that of parallel construction, requires that expressions of similar content and function should be outwardly similar. The likeness of form enables the reader to recognize more readily the likeness of content and function.

William Strunk, Jr., and E B White, *The Elements of Style*

1. Abstract

This paper recommends revisiting the proposed name of any_invocable (P0288\(^1\)), recommending that any name chosen follows prior art and user expectation more closely.

2. Overview

P0288 proposes a move-only counterpart to `std::function`. This meets a number of well-defined use cases and makes the function-wrapper functionality offered by the standard more complete, complementing what is already offered by existing `std::function` and what is proposed for `function_ref` (P0792\(^2\)).

This paper makes no attempt to revise the functionality proposed in P0288, which, as it stands, will be a welcome addition to the standard. The functionality for any_invocable is largely defined as a constrained subset of the functionality offered by `std::function`, with the most notable constraint that it is a move-only type. As P0288's abstract states:

> This paper proposes a conservative, move-only equivalent of `std::function`.

What this paper proposes is that the name for the class template should more closely match what a user would expect given knowledge of `std::function` and the description offered in the abstract. While nobody expects the Spanish Inquisition\(^3\), it is also fair to say that no C++ developer would expect any_invocable as the name for a move-only `std::function`.

This paper outlines what we want from a name, how any_invocable measures up, and recommendations for renaming it.

---


3. What we want from a name

It is widely acknowledged that naming is one of the hardest problems in computer science. The process for any_invocable highlights this: straw polls for the name revealed not only a lack of consensus, but also a lack of majority. None of the proposed names even came close: in the final poll of 57, only 10 were cast for any_invocable, which was marginally ahead of four other names out of a total of thirteen. It is not clear that simply repolling without a proper consideration of requirements would be any more meaningful, or that it would not run foul of the Abilene paradox.

Identifiers in the standard are used by a potential audience of over 5 million developers. This user base has a number of needs from any name that are rarely articulated. In no particular order, we can attempt to list some of these practicalities and expectations:

1. **A name should be descriptive.** A reader should be able to read a name and have a reasonable chance at understanding what it represents and the role it plays in code, i.e., the description should be meaningful to the reader.
   
   For example, unordered_set.

2. **A name and its explanation should be as close together as possible.** The distance between what a name represents and a more complete explanation of the named feature or facility should be as small as possible, which implies there should be common terminology between the name and the explanation, and that the principle of least astonishment is respected.
   
   For example, sort is an unsurprising name for a function or template that sorts a container or range of elements, and the term sort is to be found in any explanation of what it does.

3. **A name should be concise.** The danger of descriptive names that fit their explanation is that what they might gain in explicitness, they may lose in convenience. Names are created to appear in code, and they should not require autocompletion or IMAX screens to be considered usable. Names also need to be short, but not so short that they are ambiguous, cryptic, or reminiscent of the Great Vowel Shortage of the 1970s and 1980s.

4. **A name should be complete.** Significant aspects of the feature named should not be omitted. This is, of course, in tension with the desire to be concise. Less significant aspects of a type or function should be omitted in favour of more significant ones when the result would otherwise be a shopping list.

5. **A name should be consistent with existing terminology and experience.** Similarity creates familiarity and recognition. Names already in the reader's

---

4 "There are only two hard things in computer science: cache invalidation and naming things." - Phil Karlton

5 "In the Abilene paradox, a group of people collectively decide on a course of action that is counter to the preferences of many or all of the individuals in the group." - https://en.wikipedia.org/wiki/Abilene_paradox

6 See https://www.daxx.com/blog/development-trends/number-software-developers-world
vocabulary provide a good basis for understanding names for features and facilities that are new. Where two ideas are related, that relationship should be apparent. This is the principle that, all other things being equal, prior art should be followed in preference to invention where a concept is already named and in widespread usage, whether within the C++ standard, the broader C++ community, other programming languages, or other relevant domains.

For example, when function was included into TR1 from Boost it retained its name, which was further preserved with its adoption into C++11.

6. **A name should be well-formed.** Although identifier names are subject to a number of constraints, they should not be awkward on the page or in the mouth. As much as is appropriate, the identifiers in the C++ standard follow the spelling and grammatical conventions of US English.

It would be too much to say these considerations form a set of requirements, as that implies both a rigorous and explicit approach to requirements this paper is not claiming and that it is possible for names, in general, to meet all requirements. In many cases, the most any choice of name can hope to achieve is a fair balance between these sometimes contradictory desires. Naming is more a matter of compromise than perfection.

For example, grammatically the word *any* is an adjective but, as a concrete type, any plays the role of a noun. This can be seen to violate (6). This grammatical quirk, however, is subordinate to (5): C++17’s std::any is named for boost::any, a longstanding Boost library, before which it was written up as any based on implementation experience in previous projects. This in turn took its name in the 1990s from the any type in CORBA’s IDL and the ANY type in ASN.1. Nowadays, any (or Any) is a common name for a universal or top (⊤) type, e.g., TypeScript, Scala, Swift. Prior art and familiarity make a stronger case for the term *any* than violating a part of a speech makes against it — the needs of the any outweigh the needs of the few.

4. How any_invocable measures up to what we want

Reflecting on any_invocable:

1. **A name should be descriptive.** The name has two components: any is a recognised type; as a term, invocable is relatively recent in C++ standardisation, and only became a first class name in C++20 as the std::invocable concept. A reader well versed in C++20 might reasonably expect any_invocable to be a postpositively named version of std::any that was invocable, i.e., supported the function-call operator. (The prepositive name for such a feature would be invocable_any.) In terms of its design and usage, however, any_invocable is related to std::function and not std::any.

---

8 OMG Interface Definition Language, [https://www.omg.org/spec/IDL/](https://www.omg.org/spec/IDL/)
9 ITU-T X.208, Specification of Abstract Syntax Notation One (ASN.1)
10 With apologies to Mr Spock, see *Star Trek II: The Wrath of Khan*. 

3
2. **A name and its explanation should be as close together as possible.** The explanation of any_invocable is "a conservative, move-only equivalent of std::function", which shares no common terminology.

3. **A name should be concise.** any_invocable is easy to type and to read and would not dominate any expression it was a part of.

4. **A name should be complete.** any_invocable has three characteristics of interest: (i) its instances can be used as function objects; (ii) it is a move-only type; (iii) it uses type-erasure. Of these three characteristics, (i) and (ii) are the most important to how the type is considered and used; (iii) is a secondary detail, and is of more interest in implementation (e.g., the use of the External Polymorphism pattern\(^\text{11}\)) than in usage. The name any_invocable is named for (i) and (ii). Its move-only nature (ii), i.e., non-copyability, might be considered one of its most defining features and its distinguishing characteristic when discussed alongside its older sibling std::function, but it is not mentioned.

Although any_invocable takes an invocable rather than a callable, as std::function does, this difference is a relatively trivial variation on the theme of function objects, and is a difference that could be easily removed with a modest future proposal to std::function, a change that would neither justify a name change nor raise an eyebrow.

5. **A name should be consistent with existing terminology and experience.** The name any_invocable shares no familial resemblance with std::function and function_ref. There is little precedent in the standard or elsewhere for the name any_invocable. The recognised name for a polymorphic function wrapper (something that is at least callable and uses type erasure) is function.

LEWG's repurposing of any as a prefix to mean just type erasure rather than a whole value type is not necessarily unreasonable, but it is neither widespread nor often necessary. Such a prefixing convention may have a role when better names cannot be found, and when any is followed by a name that denotes something concrete rather than a partial concept, but that is not the case here.

6. **A name should be well-formed.** It is common and appropriate practice to use an adjective in naming a property or capability of a thing, e.g., invocable and callable, and when expressed in code these are often abstract base classes or concepts, i.e., they express a partial capability rather than a whole type. Naming a concrete type this way is unusual. any_invocable is composed of two adjectives collectively masquerading as a noun. Two wrongs do not often make a right.

---
\(^{11}\) "External Polymorphism" by Chris Cleeland, Douglas C Schmidt, and Tim Harrison, *Pattern Languages of Program Design 3*, Addison-Wesley, 1998
5. Recommendations

This paper recommends revisiting the naming of any_invocable ("a name only an expert committee member could love") and selecting a name that more closely meets the expectations of the C++ user community and that more closely follows prior art. Whether the six considerations listed in this paper are used as a checklist is immaterial.

The specific recommendation of this paper is that whatever name is chosen should include the word function. This matches expectation, prior art, and the function_ref proposal. The name carries most of the weight of invocability and type erasure, which addresses that aspect of completeness. To highlight the move-only nature of the type, the affixes movable, move_only, and move seem to be best suited. My first preference would be for movable_function, with move_only_function a close second and move_function a more distant third. All these names satisfy the principle of least astonishment\(^{13}\), and others may be possible.

The abbreviations m, mo, and mv (mentioned in the name poll in P0288), however, are out of step with current naming trends and may be considered overly terse for the context (likewise fn, fun, and func) and perhaps a little cryptic. The unique prefix has much of the right connotation and builds on a longstanding and widely understood convention, with unique_function being the former and clearly understood name of any_invocable. However, unique tends to refer to a quality of adopted ownership that is not relevant for existing or proposed function.

6. Acknowledgements

My thanks to Jonathan Wakely, Peter Brett, Walter E Brown, James Dennett, and Nevin Liber for comments that have led to, guided, and improved this paper.

---

\(^{12}\) P1737: unique_function vs. any_invokable - Bikeshedding Off the Rails by Nevin Lieber, [http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2019/p1737r0.pdf](http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2019/p1737r0.pdf)