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# 1. Third Party Software Components

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(C) 2006 Douglas Gregor [doug.gregor@gmail.com](mailto:doug.gregor@gmail.com)  
(C) 2001, 2002 Peter Dimov and Multi Media Ltd.

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2. This library would not have happened without:

Christopher Kormanyos' C++ decimal number code.

Paul Bristow for patiently testing, and commenting on the library.

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"The Art Of Computer Programming", Donald E. Knuth, Volume 2: Seminumerical Algorithms, Third Edition (Reading, Massachusetts: Addison-Wesley, 1997), xiv+762pp. ISBN 0-201-89684-2

3. The idea of representing a type as multiple compile-time integers, and passing these integers across function boundaries using `sizeof()`, was taken from Steve Dewhurst's article "A Bitwise `typeof` Operator", CUJ 2002. This article can also be viewed online, at <http://www.semantics.org/localarchive.html>.

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Andrey Beliaikov  
Joel de Guzman  
Daniel James  
Vesa Karvonen  
Andy Little  
Paul Mensonides  
Alexander Nasonov  
Tobias Schwinger  
Martin Wille

4. The comprehensiveness of this library would not be possible without the existence of the indispensable resource that is the Pre-defined C/C++ Compiler Macros Project. It was, and continues to be, the primary source of the definitions that make up this library. Thanks to Bjorn Reese and all the volunteers that make that resource possible.

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6. The mathematical text has been typeset with Nisus Writer. Jens Maurer has helped with portability and standard adherence, and was the Review Manager for this library. More acknowledgements in the History section. Thank you to all who contributed to the discussion about this library.

7. I'd like to thank Agustín Bergé, Eugene Yakubovich, Giovanni Piero Deretta and especially Nat Goodspeed.

8. The author can be contacted at john - at - johnmaddock.co.uk; the home page for this library is at [www.boost.org](http://www.boost.org).

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9. I'd like to thank Alex Hagen-Zanker, Christopher Kormanyos, Conrad Poelman, Eugene Yakubovich, Giovanni Piero Deretta, Hartmut Kaiser, Jeffrey Lee Hellrung, Nat Goodspeed, Robert Stewart, Vicente J. Botet Escriba and Yuriy Krasnoschek.

Especially Eugene Yakubovich, Giovanni Piero Deretta and Vicente J. Botet Escriba contributed many good ideas during the review.

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11. Many thanks to Julian Gonggrijp, Rob Stewart, Andrzej Krzemienski, Matus Chochlik, Jeroen Habraken, Hartmut Kaiser, Joel De Guzman, Thijs (M.A.) van den Berg, Roland Bock, Gavin Lambert, Paul Bristow, Alex Hagen-Zanker, Christopher Kormanyos for taking part in the Boost.Convert review and their valuable input.

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12. Beman Dawes provided the original `config.hpp` and part of this document.

Vesa Karvonen provided a description of the principles (see rationale) and put together an early version of the current configuration setup.

John Maddock put together the configuration current code, the test programs, the configuration script and the reference section of this document.

Matias Capeletto converted the docs to quickbook format.

Numerous boost members, past and present, have contributed fixes to boost's configuration.

13. Fernando Cacciola, Darren Cook, Beman Dawes, Jeremy Maitin-Shepard and Daryle Walker from the Boost mailing list provided useful suggestions for improvement on the first alpha releases of the library. Gang Wang discovered several bugs in the code. Thomas Wenisch brought out the idea of "sequence sets" from which sequenced indices were designed. Giovanni Bajo, Chris Little and Maxim Yegorushkin tested the library on several platforms. Daniel Wallin contributed fixes for MSVC++ 7.0. Ron Liechty and the support staff at Metrowerks provided assistance during the porting of the library to CW 8.3. Porting to VisualAge 6.0 counted on Toon Knapen's help. Markus Schöpflin aided with Compaq C++ 6.5 and GCC for Tru64 UNIX. Rosa Bernárdez proofread the last versions of the tutorial.

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Boost.MultiIndex could not have been written without Aleksey Gurtovoy et al. superb Boost MPL Library. Also, Aleksey's techniques for dealing with ETI-related problems in MSVC++ 6.0 helped solve some internal issues of the library.

The internal implementation of red-black trees is based on that of SGI STL `stl_tree.h` file:

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I would like to dedicate this piece of work to Rosa Bernárdez, my very first C++ teacher, for her unconditional support in many endeavors of which programming is by no means the most important. In memory of my cat López (2001-2003): he lived too fast, died too young.

Boost 1.33 release

Many thanks again to Pavel Vozenílek, who has carefully reviewed the new material and suggested many improvements. The design of hashed indices has benefited from discussions with several Boost members, most notably Howard Hinnant and Daniel James. Daniel has also contributed Boost.Hash to the community: hashed indices depend on this library as their default hash function provider. Robert Ramey's Boost Serialization Library provides the very solid framework upon which Boost.MultiIndex serialization capabilities are built. Toon Knapen helped adjust the library for VisualAge 6.0. Markus Schöpflin provided a Jamfile tweak for GCC under Tru64 UNIX.

#### Boost 1.34 release

Thanks go to Pavel Vozenílek for his useful comments and suggestions during the development of this release, and to Rosa Bernárdez for reviewing the new material in the documentation. Alo Sarv suggested a notational improvement in the specification of partial searches with composite keys. Maxim Yegorushkin proposed a valuable spatial optimization for ordered indices and provided figures of its impact on performance for containers with large numbers of elements. Caleb Epstein performed the tests under MSVC++ 8.0 described in the performance section. The following people have reported bugs and problems with previous versions and prereleases of the library: Alexei Alexandrov, Matías Capeletto, John Eddy, Martin Eigel, Guillaume Lazzara, Felipe Magno de Almeida, Julien Pervillé, Hubert Schmid, Toby Smith.

New member in the family! Thanks to Héctor for his patience during long development sessions and his occasional contributions to the source codebase.

#### Boost 1.35 release

global\_fun was included after a proposal by Markus Werle. Bruno Martínez Aguerre suggested the inclusion of iterator\_to. The rollback versions of modify and modify\_key arose from discussions with Matías Capeletto. Steven Watanabe spotted an include guard bug present from the first release of the library.

#### Boost 1.36 release

Thanks to Amit Jain for reporting a problem with allocator management. Michael Fawcett proposed the addition of an allocator constructor to multi\_index\_container. A report from Zachary Zhou has led to enhancing the behavior of hashed indices update functions so that they meet some intuitive expectations. Grzegorz Jakacki spotted some internal dead code.

#### Boost 1.56 release

Stephen Kelly has contributed the removal of workaround code for old compilers no longer supported.

14. Many, many thanks to the Boost peers, notably Jeff Garland, Beman Dawes, Ed Brey, Gary Powell, Peter Dimov, and Jens Maurer for providing helpful suggestions!

15. The following people have provided valuable feedback and suggestions during the development of the library: Ion Gaztañaga, Janek Kozicki, Tobias Schwinger, Pavel Vozenílek. Simon Atanasyan contributed a workaround for a problem with Sun Studio compilers. Rosa Bernárdez has proofread the documentation from the first drafts up to its present form.

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#### 16. Special thanks to:

Paul Mensonides for his invaluable help while developing the macro expansion engine and his insightful tips. He developed the recursive macro expansion algorithm implemented herein and also contributed most of the small testcases used for testing the correctness of the macro expansion.

Dan Nuffer, who wrote the initial Re2C based C++ lexer and the Slex (Spirit Lex) scanner generator sample.

Martin Wille for helping with the port to Linux, testing on Linux and for contributing the automated test scripts.

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Andrei Alexandrescu for allowing to use his `flex_string` class, a policy based `std::basic_string<>` compatible string implementation.

Reece Dunn, Vesa Karvonen, Faisal Vali, Porter Schermerhorn, Juergen Hunold, Jozsef Mihalicza and Daniel Fontijne for reporting several problems and bugs.

Tarmo Pikaro for reporting several bug while compiling specific headers from the Microsoft Windows SDK.

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and last but not least

Joel de Guzman for nudging me into this adventure and for his work on the Spirit parser framework, without which the Wave library wouldn't have been possible.

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The Wave library uses the following Boost [8] libraries:

Boost Spirit (LL parser framework that represents parsers directly as EBNF grammars in inlined C++)

Boost Iterator Adaptor Library (Adapt a base type into a standard conforming iterator)

Boost Filesystem Library (Portable paths, iteration over directories, and other useful filesystem operations)

Boost Program options and arguments library

and other small parts of different Boost libraries.

17. I'd like to thank Alex Hagen-Zanker, Christopher Kormanyos, Conrad Poelman, Eugene Yakubovich, Giovanni Piero Deretta, Hartmut Kaiser, Jeffrey Lee Hellrung, Nat Goodspeed, Robert Stewart, Vicente J. Botet Escriba and Yuriy Krasnoschek.

Especially Eugene Yakubovich, Giovanni Piero Deretta and Vicente J. Botet Escriba contributed many good ideas during the review.

18. I'd like to thank Agustín Bergé, Eugene Yakubovich, Giovanni Piero Deretta and especially Nat Goodspeed.

19. I'd like to thank Adreas Fett, Artyom Beilis, Daniel Larimer, David Deakins, Evgeny Shapovalov, Fernando Pelliccioni, Giovanni Piero Deretta, Gordon Woodhull, Helge Bahmann, Holger Grund, Jeffrey Lee Hellrung (Jr.), Keith Jeffery, Martin Husemann, Phil Endecott, Robert Stewart, Sergey Cheban, Steven Watanabe, Vicente J. Botet Escriba, Wayne Piekarski.

20. Many, many people in one or another way contributed to the library development. The list below is known to be incomplete and needs updating! We sincerely promise to fix it in the near future.

For bug reports, patches, suggestions and insightful discussions, our thanks go to:

John Bandela  
Fernando Cacciola  
Peter Dimov  
Eric Friedman  
Arnaldur Gylfason  
David B. Held  
Vesa Karvonen  
Mat Marcus  
Hamish Mackenzie  
Paul Mensonides  
Emily Winch

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Vesa Karvonen

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Paul Mensonides

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## 22. Boost Test Team

Boost.Test 3.0 is being developed and maintained by Gennadiy Rozental and Raffi Enficiaud.

New documentation

Raffi Enficiaud and Andrzej Krzemienski efforts were a driving force behind the Boost.Test documentation overhaul.

Second incarnation including the Unit Test Framework

Beman Dawes and Ullrich Koethe started the library. Fernando Cacciola, Jeremy Siek, Beman Dawes, Ullrich Koethe, Dave Abrahams suggested numerous improvements during the Formal Review. Jeremy Siek was the review manager. Beman Dawes was a great help in both final testing and merging library with rest of the boost. Gennadiy Rozental was the developer and maintainer.

Original Test Library

Ed Brey, Kevlin Henney, Ullrich Koethe, and Thomas Matelich provided very helpful comments during development. Dave Abrahams, Ed Brey, William Kempf, Jens Maurer, and Wilka suggested numerous improvements during the Formal Review. Jens Maurer was the review manager. Beman Dawes is the developer and maintainer.

23. I'd like to thank Alex Hagen-Zanker, Christopher Kormanyos, Conrad Poelman, Eugene Yakubovich, Giovanni Piero Deretta, Hartmut Kaiser, Jeffrey Lee Hellrung, Nat Goodspeed, Robert Stewart, Vicente J. Botet Escriba and Yuriy Krasnoschek.

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Vesa Karvonen  
Mat Marcus  
Hamish Mackenzie  
Paul Mensonides  
Emily Winch

28. Thomas Witt in 2002 produced a prototype called cyclic buffer.

The `circular_buffer` has a short history. Its first version was a `std::deque` adaptor. This container was not very effective because of many reallocations when inserting/removing an element. Thomas Wenish did a review of this version and motivated me to create a circular buffer which allocates memory at once when created.

The second version adapted `std::vector` but it has been abandoned soon because of limited control over iterator invalidation. The current version is a full-fledged STL compliant container.

Pavel Vozenilek did a thorough review of this version and came with many good ideas and improvements.

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Also, I would like to thank Howard Hinnant, Nigel Stewart and everyone who participated at the formal review for valuable comments and ideas.

Paul A. Bristow refactored the documentation in 2013 to use the full power of Quickbook, Doxygen and Autoindexing.

29. The first Boost.Process draft was created in 2006. A lot of people have worked on various drafts since then. Especially Merino Vidal, Ilya Sokolov and Felipe Tanus spent a lot of time working on early drafts. They influenced Boost.Process over the years and wrote code which, to various extents, is still around in the library today.

The design of earlier versions of Boost.Process was not always satisfying. In 2011 Jeff Flinn proposed the executor and initializer concepts Boost.Process is based on today. Without Jeff's idea the overall design of Boost.Process would not look like it does today.

A special thank you goes to Intra2net AG (especially Thomas Jarosch) who sponsored a project to support the development of Boost.Process. It was this sponsorship which made it possible to create a new Boost.Process version in 2012.

Great thanks also goes to Boris Schaeling, who despite having boost.process rejected, went on to work on it and maintained it up until this day and participated in the development of the current version.

30. Boost.Accumulators represents the efforts of many individuals. I would like to thank Daniel Egloff of Zürcher Kantonalbank for helping to conceive the library and realize its implementation. I would also like to thank David Abrahams and Matthias Troyer for their key contributions to the design of the library. Many thanks are due to Michael Gauckler and Olivier Gygi, who, along with Daniel Egloff, implemented many of the statistical accumulators.

I would also like to thank Simon West for all his assistance maintaining Boost.Accumulators.

Finally, I would like to thank Zürcher Kantonalbank for sponsoring the work on Boost.Accumulators and graciously donating it to the community.

31. I'd like to thank Adreas Fett, Artyom Beilis, Daniel Larimer, David Deakins, Evgeny Shapovalov, Fernando Pelliccioni, Giovanni Piero Deretta, Gordon Woodhull, Helge Bahmann, Holger Grund, Jeffrey Lee Hellrung (Jr.), Keith Jeffery, Martin Husemann, Phil Endecott, Robert Stewart, Sergey Cheban, Steven Watanabe, Vicente J. Botet Escriba, Wayne Piekarski.

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All the library reviewers, especially Andrey Semashev, for making good notes and proposing improvements to the library.

33. I'd like to thank Alex Hagen-Zanker, Christopher Kormanyos, Conrad Poelman, Eugene Yakubovich, Giovanni Piero Deretta, Hartmut Kaiser, Jeffrey Lee Hellrung, Nat Goodspeed, Robert Stewart, Vicente J. Botet Escriba and Yuriy Krasnoschek.

Especially Eugene Yakubovich, Giovanni Piero Deretta and Vicente J. Botet Escriba contributed many good ideas during the review.

34. Thomas Witt in 2002 produced a prototype called cyclic buffer.

The `circular_buffer` has a short history. Its first version was a `std::deque` adaptor. This container was not very effective because of many reallocations when inserting/removing an element. Thomas Wenish did a review of this version and motivated me to create a circular buffer which allocates memory at once when created.

The second version adapted `std::vector` but it has been abandoned soon because of limited control over iterator invalidation. The current version is a full-fledged STL compliant container.

Pavel Vozenilek did a thorough review of this version and came with many good ideas and improvements.

The idea of the space optimized circular buffer has been introduced by Pavel Vozenilek.

Also, I would like to thank Howard Hinnant, Nigel Stewart and everyone who participated at the formal review for valuable comments and ideas.

Paul A. Bristow refactored the documentation in 2013 to use the full power of Quickbook, Doxygen and Autoindexing.

35. Thanks go to the following people for supporting the development of this library in one or the other way:

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Tom Brinkman  
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Andy Little  
John Maddock  
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Alexander Nasonov  
Richard Smith  
Rob Stewart  
Jonathan Turkanis  
Pavel Vozenilek  
Steven Watanabe  
K. Noel Belcourt

36. `Boost.Accumulators` represents the efforts of many individuals. I would like to thank Daniel Egloff of Zürcher Kantonalbank for helping to conceive the library and realize its implementation. I would also like to thank David Abrahams and Matthias Troyer for their key contributions to the design of the library. Many thanks are due to Michael Gauckler and Olivier Gygi, who, along with Daniel Egloff, implemented many of the statistical accumulators.

I would also like to thank Simon West for all his assistance maintaining `Boost.Accumulators`.

Finally, I would like to thank Zürcher Kantonalbank for sponsoring the work on `Boost.Accumulators` and graciously donating it to the community.

37. Boost.Egg: A very powerful library for function objects in C++98.

Shunsuke Sogame

Boost.Hana: A metaprogramming library with many functional constructs

Louis Dionne

named-operators: A library to create named operators

Konrad Rudolph

Pack/Unpack without Using Tuple

Jamboree

for\_each\_argument

Sean Parent

Suggested Design for Customization Points

Eric Niebler

FC++: Functional Programming in C++

Brian McNamara and Yannis Smaragdakis

Boost.Phoenix

Joel de Guzman, Dan Marsden, Thomas Heller, and John Fletcher

38. This library is based on the design by Peter Dimov. During the initial development Joaquín M López Muñoz made many useful suggestions and contributed fixes.

The formal review was managed by Thorsten Ottosen, and the library reviewed by: David Abrahams, Alberto Barbati, Topher Cooper, Caleb Epstein, Dave Harris, Chris Jefferson, Broniek Kozicki, John Maddock, Tobias Swinger, Jaap Suter, Rob Stewart and Pavel Vozenilek. Since then, further constructive criticism has been made by Daniel Krügler, Alexander Nasonov and ???.

The implementation of the hash function for pointers is based on suggestions made by Alberto Barbati and Dave Harris. Dave Harris also suggested an important improvement to `boost::hash_combine` that was taken up.

Some useful improvements to the floating point hash algorithm were suggested by Daniel Krügler.

The original implementation came from Jeremy B. Maitin-Shepard's hash table library, although this is a complete rewrite.

39. Pre-formal review

Peter Dimov suggested the name 'optional', and was the first to point out the need for aligned storage.

Douglas Gregor developed 'type\_with\_alignment', and later Eric Friedman coded 'aligned\_storage', which are the core of the optional class implementation.

Andrei Alexandrescu and Brian Parker also worked with aligned storage techniques and their work influenced the current implementation.

Gennadiy Rozental made extensive and important comments which shaped the design.

Vesa Karvonen and Douglas Gregor made quite useful comparisons between optional, variant and any; and made other relevant comments.

Douglas Gregor and Peter Dimov commented on comparisons and evaluation in boolean contexts.

Eric Friedman helped understand the issues involved with aligned storage, move/copy operations and exception safety.

Many others have participated with useful comments: Aleksey Gurotov, Kevlin Henney, David Abrahams, and others I can't recall.

Post-formal review

William Kempf carefully considered the originally proposed interface and suggested the new interface which is currently used. He also started and fueled the discussion about the analogy optional<>/smart pointer and about relational operators.

Peter Dimov, Joel de Guzman, David Abrahams, Tanton Gibbs and Ian Hanson focused on the relational semantics of optional (originally undefined); concluding with the fact that the pointer-like interface doesn't make it a pointer so it shall have deep relational operators.

Augustus Saunders also explored the different relational semantics between optional<> and a pointer and developed the OptionalPointee concept as an aid against potential conflicts on generic code.

Joel de Guzman noticed that optional<> can be seen as an API on top of variant<T,nil\_t>.

Dave Gomboc explained the meaning and usage of the Haskell analog to optional<>: the Maybe type constructor (analogy originally pointed out by David Sankel).

Other comments were posted by Vincent Finn, Anthony Williams, Ed Brey, Rob Stewart, and others.

Joel de Guzman made the case for the support of references and helped with the proper semantics.

Mat Marcus shown the virtues of a value-oriented interface, influencing the current design, and contributed the idea of "none".

Vladimir Batov's design of Boost.Convert library motivated the development of value accessors for optional: functions value, value\_or, value\_or\_eval.

40. The format and language of this reference documentation has been greatly influenced by the SGI's Standard Template Library Programmer's Guide.

41. This library would never have been created without inspiration, collaboration and constructive criticism from multiple sources.

David LeBlanc

This library is inspired by David LeBlanc's SafeInt Library . I found this library very well done in every way and useful in my embedded systems work. This motivated me to take it to the "next level".

Andrzej Krzemienski

Andrzej Commented and reviewed the library as it was originally posted on the Boost Library Incubator. The consequent back and forth motivated me to invest more effort in developing documentation and examples to justify the utility, indeed the necessity, for this library. He also noted many errors in code, documentation, and tests. Without his interest and effort, I do not believe the library would have progressed beyond its initial stages.

Boost

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Paul A. Bristow

Steven Watanabe

John Maddock

Antony Polukhin

Barrett Adair

Vicente J. Botet Escriba

John McFarlane

Peter Dimov

42. Alexander Nasonov is the original library author.

Lorenzo Caminiti added variadic macro support, capture of the object `this_`, empty captures using `void`, and `BOOST_SCOPE_EXIT_ALL`.

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Jody Hagins for good comments that helped to significantly improve the documentation;

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Noah Roberts,  
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David Walthall,  
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44. [Boost.Egg](<http://p-stade.sourceforge.net/boost/libs/egg/doc/html/index.html>): A very powerful library for function objects in C++98.

- Shunsuke Sogame

[Boost.Hana](<https://github.com/ldionne/hana>): A metaprogramming library with many functional constructs

- Louis Dionne

[named-operators](<https://github.com/klmr/named-operator>): A library to create named operators

- Konrad Rudolph

[Pack/Unpack without Using Tuple](<http://jamboree.github.io/cout/tricks/2014/07/21/pack-unpack-without-using-tuple.html>)

- Jamboree

[for\_each\_argument](<http://isocpp.org/blog/2015/01/for-each-argument-sean-parent>)

- Sean Parent

[Suggested Design for Customization Points](<http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2015/n4381.html>)

- Ericniebler

[FC++](<https://yanniss.github.io/fc++/>): Functional Programming in C++

- Brian McNamara and Yannis Smaragdakis

[Boost.Phoenix]([http://www.boost.org/doc/libs/1\\_59\\_0/libs/phoenix/doc/html/index.html](http://www.boost.org/doc/libs/1_59_0/libs/phoenix/doc/html/index.html))

- Joel de Guzman, Dan Marsden, Thomas Heller, and John Fletcher

45. Original standard container code comes from SGI STL library, which enhanced the original HP STL code. Code was rewritten for Boost.Interprocess and moved to Boost.Intrusive. Many thanks to Alexander Stepanov, Meng Lee, David Musser, Matt Austern... and all HP and SGI STL developers.

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47. The `__spirit__` repository is the result of the contributions of active members of the Spirit community. We would like to express our thanks to all who directly contributed and to everybody directly or indirectly involved in the discussions, which led to the creation of the parser and generator components.

The following people have directly contributed code to this repository:

[\*Aaron Graham] wrote the `__qi_advance__` parser component, which allows the parser to skip (advance) through a specified number of iterations without performing unnecessary work.

[\*Chris Hoeppler] submitted the `__qi_confix__` parser directive allowing to embed a parser (the subject) inside an opening (the prefix) and a closing sequence (the suffix).

[\*Francois Barel] contributed the `__qi_subrule__` parser and `__karma_subrule__` generator components, allowing to create a named parser or generator, and to refer to it by name. These components are in fact fully static versions of the corresponding ``rule`` component.

[\*Thomas Bernard] contributed the `__qi_keywords__` and `__qi_keywords_list__` parser components, allowing to define keyword parsers.

48. This library was developed in the context of the Google SoC 2006. I first want to thank my mentor, Joaquin, for his friendship during this project. Not only did he help me go through the process of creating this library, but he also did his best so we could have a great time doing it. Also, Boost.Bimap would not exist had Boost.MultiIndex, Joaquin's masterpiece, not existed. Thanks a lot!

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49. Earlier efforts that have influenced the library design:

\* The [[@http://staff.cs.utu.fi/BL/](http://staff.cs.utu.fi/BL/) Binder Library] by Jaakko J\u00E4rvi;

\* The [[@boost:/libs/lambda/index.html](http://boost/libs/lambda/index.html) Lambda Library] (now part of Boost) by Jaakko J\u00E4rvi and Gary Powell (the successor to the Binder Library);

\* [[@http://more.sourceforge.net/](http://more.sourceforge.net/) Extensions to the STL] by Petter Urkedal.

Doug Gregor suggested that a visitor mechanism would allow `bind` to interoperate with a signal/slot library.

John Maddock fixed a MSVC-specific conflict between `bind` and the [[@boost:/libs/type\\_traits/index.html](http://boost/libs/type_traits/index.html) type traits library].

Numerous improvements were suggested during the formal review period by Ross Smith, Richard Crossley, Jens Maurer, Ed Brey, and others. Review manager was Darin Adler.

The precise semantics of `bind` were refined in discussions with Jaakko J\u00E4rvi.

Dave Abrahams fixed a MSVC-specific conflict between `bind` and the [[@boost:/libs/utility/iterator\\_adaptors.htm](http://boost/libs/utility/iterator_adaptors.htm) iterator adaptors library].

Dave Abrahams modified `bind` and `mem\_fn` to support `void` returns on deficient compilers.

Mac Murrett contributed the "pascal" support enabled by `BOOST\_BIND\_ENABLE\_PASCAL`.

The alternative `bind(type<R>(), f, ...)` syntax was inspired by a discussion with Dave Abrahams and Joel de Guzman.

This documentation was ported to Quickbook by Agustín Bergé.

50. \* Rene Jager's initial suggestion of using traits classes to make `mem\_fn` adapt to user-defined smart pointers inspired the `get\_pointer`-based design.

\* Numerous improvements were suggested during the formal review period by Richard Crossley, Jens Maurer, Ed Brey, and others. Review manager was Darin Adler.

\* Steve Anichini pointed out that COM interfaces use ``__stdcall``.

\* Dave Abrahams modified ``bind`` and ``mem_fn`` to support ``void`` returns on deficient compilers.

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This documentation was ported to Quickbook by Agustín Bergé.

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52. I'd like to thank Adreas Fett, Artyom Beilis, Daniel Larimer, David Deakins, Evgeny Shapovalov, Fernando Pelliccioni, Giovanni Piero Deretta, Gordon Woodhull, Helge Bahmann, Holger Grund, Jeffrey Lee Hellrung (Jr.), Keith Jeffery, Martin Husemann, Phil Endecott, Robert Stewart, Sergey Cheban, Steven Watanabe, Vicente J. Botet Escriba, Wayne Piekarski.

53. I'd like to thank Alex Hagen-Zanker, Christopher Kormanyos, Conrad Poelman, Eugene Yakubovich, Giovanni Piero Deretta, Hartmut Kaiser, Jeffrey Lee Hellrung, [\*Nat Goodspeed], Robert Stewart, Vicente J. Botet Escriba and Yuriy Krasnoschek.

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56. The author can be contacted at john - at - johnmaddock.co.uk; the home page for this library is at [<http://www.boost.org> [www.boost.org](http://www.boost.org)].

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John Maddock put together the configuration current code, the test programs, the configuration script and the reference section of this document.

Matias Capeletto converted the docs to quickbook format.

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58. The first Boost.Process draft was created in 2006. A lot of people have worked on various drafts since then. Especially Merino Vidal, Ilya Sokolov and Felipe Tanus spent a lot of time working on early drafts. They influenced Boost.Process over the years and wrote code which, to various extents, is still around in the library today.

The design of earlier versions of Boost.Process was not always satisfying. In 2011 Jeff Flinn proposed the executor and initializer concepts Boost.Process is based on today. Without Jeff's idea the overall design of Boost.Process would not look like it does today.

A special thank you goes to [[@http://www.intra2net.com/](http://www.intra2net.com/) Intra2net AG] (especially Thomas Jarosch) who sponsored a project to support the development of Boost.Process. It was this sponsorship which made it possible to create a new Boost.Process version in 2012.

Great thanks also goes to Boris Schaeling, who despite having boost.process rejected, went on to work on it and maintained it up until this day and participated in the development of the current version.

59. I'd like to thank Alex Hagen-Zanker, Christopher Kormanyos, Conrad Poelman, Eugene Yakubovich, Giovanni Piero Deretta, Hartmut Kaiser, Jeffrey Lee Hellrung, [\*Nat Goodspeed], Robert Stewart, Vicente J. Botet Escriba and Yuriy Krasnoschek.

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61. I am indebted to [[@http://boost.org/people/joel\\_de\\_guzman.htm](http://boost.org/people/joel_de_guzman.htm) Joel de Guzman] and [[@http://boost.org/people/hartmut\\_kaiser.htm](http://boost.org/people/hartmut_kaiser.htm) Hartmut Kaiser] for their expert advice during the early states of `xpressive`'s development. Much of static `xpressive`'s syntax is owes a large debt to `_spirit_`, including the syntax for `xpressive`'s semantic actions. I am thankful for [[@http://boost.org/people/john\\_maddock.htm](http://boost.org/people/john_maddock.htm) John Maddock]'s excellent work on his proposal to add regular expressions to the standard library, and for various ideas borrowed liberally from his `regex` implementation. I'd also like to thank [[@http://moderncppdesign.com/](http://moderncppdesign.com/) Andrei Alexandrescu] for his input regarding the behavior of nested `regex` objects, and [[@http://boost.org/people/dave\\_abrahams.htm](http://boost.org/people/dave_abrahams.htm) Dave Abrahams] for his suggestions regarding the `regex` domain-specific embedded language. Noel Belcourt helped porting `xpressive` to the Metrowerks CodeWarrior compiler. Markus Sch"ö"pflin helped to track down a bug on HP Tru64, and Steven Watanabe suggested the fix.

Special thanks are due to David Jenkins who contributed both ideas, code and documentation for `xpressive`'s semantic actions, symbol tables and attributes. `Xpressive`'s ternary search trie implementation is David's, as is the number parser example in [`^libs/xpressive/example/numbers.cpp`] and the documentation for symbol tables and attributes.

Thanks to John Fletcher for helping track down a runtime assertion when using `xpressive` with Howard Hinnant's most excellent `libc++`.

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62. The original implementation of `__boost_thread__` was written by William Kempf, with contributions from numerous others. This new version initially grew out of an attempt to rewrite `__boost_thread__` to William Kempf's design with fresh code that could be released under the Boost Software License. However, as the C++ Standards committee have been actively discussing standardizing a thread library for C++, this library has evolved to reflect the proposals, whilst retaining as much backwards-compatibility as possible.

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Antony Polukhin  
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John McFarlane  
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John Maddock  
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Charles Brockman  
Jonathan Wakely

67. Hartmut Kaiser implemented the original lazy casts and constructors based on his original work on Spirit SE "semantic expressions" (the precursor to Phoenix), and guided Phoenix from the initial review of V2 to the release of V3.

Eric Niebler did a 2.0 pre-release review and wrote some range related code that Phoenix stole and used in the algorithms. Additionally he played the leading role in inventing the extension mechanism as well as providing early prototypes and helping with Boost.Proto code. DA Proto MAN!

Angus Leeming implemented the container functions on Phoenix-1 which I then ported to Phoenix-2.

Daniel Wallin helped with the scope module, local variables, let and lambda and the algorithms. I frequently discuss design issues with Daniel on Yahoo Messenger.

Jaakko Jarvi. DA Lambda MAN!

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Jeremy Siek, even prior to Thorsten, in 2001, started the "container\_algo".

Vladimir Prus wrote the mutating algorithms code from the Boost Wiki.

Daryle Walker did a 2.0 pre-release review.

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The implementation of stream\_buffer is indebted to work of Angelika Langer and Klaus Kreft ([Langer], pp. 228-43).

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The concepts InputFilter and OutputFilter were inspired by James Kanze's extractors and inserters. In addition, the names of the components filtering\_stream and filtering\_streambuf are borrowed from Kanze, as are several of the Filters from the Tutorial. See [Kanze].

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71. Hartmut Kaiser implemented the original lazy casts and constructors based on his original work on Spirit SE "semantic expressions" (the precursor to Phoenix), and guided Phoenix from the initial review of V2 to the release of V3.

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72. I am indebted to Joel de Guzman and Hartmut Kaiser for their expert advice during the early states of xpressive's development. Much of static xpressive's syntax is owes a large debt to Spirit, including the syntax for xpressive's semantic actions. I am thankful for John Maddock's excellent work on his proposal to add regular expressions to the standard library, and for various ideas borrowed liberally from his regex implementation. I'd also like to thank Andrei Alexandrescu for his input regarding the behavior of nested regex objects, and Dave Abrahams for his suggestions regarding the regex domain-specific embedded language. Noel Belcourt helped porting xpressive to the Metrowerks CodeWarrior compiler. Markus Schöpflin helped to track down a bug on HP Tru64, and Steven Watanabe suggested the fix.

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Peder Holt for his porting work on Phoenix, Fusion and Spirit to VC6.

To Joel's wife Mariel who did the graphics in this document.

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John Maddock, our review manager, Aleksey Gurtovoy, Andre Hentz, Beman Dawes, Carl Daniel, Christopher Currie, Dan Gohman, Dan Nuffer, Daryle Walker, David Abrahams, David B. Held, Dirk Gerrits, Douglas Gregor, Hartmut Kaiser, Iain K.Hanson, Juan Carlos Arevalo-Baeza, Larry Evans, Martin Wille, Mattias Flodin, Noah Stein, Nuno Lucas, Peter Dimov, Peter Simons, Petr Kocmid, Ross Smith, Scott Kirkwood, Steve Cleary, Thorsten Ottosen, Tom Wenisch, Vladimir Prus

Finally thanks to SourceForge for hosting the Spirit project and Boost: a C++ community comprised of extremely talented library authors who participate in the discussion and peer review of well crafted C++ libraries.

77. This section aims to recognize the contributions of all the different people that participated directly or indirectly to the design and development of this library.

Many thanks to Steven Watanabe and Vicente Botet for suggesting to me to use Boost.ScopeExit binding to emulate local functions. Many thanks to Alexander Nasonov for clarifying how Boost.ScopeExit binding could be used to implement local functions and for some early work in this direction.

Many thanks to Gregory Crosswhite for using an early version of this library in one of his projects.

Thanks to David Abrahams, Vicente Botet, et al. for suggesting to provide the variadic macro syntax on compilers that support variadic macros.

Thanks to Pierre Morcello for sharing some code that experimented with implementing local functions using Boost.ScopeExit binding (even if this library is not based on such a code).

Thanks to John Bytheway for checking the authors' virtual functor technique that originally allowed this library to pass local functions as template parameters.

Thanks to Jeffrey Lee Hellrung for suggesting the use of the "keyword" bind to bind variables in scope and for suggesting to use bind(type) to optionally specify the bound variable type. Thanks to Vicente Botet for suggesting to provide a macro to expose the bound variable type to the public API.

Thanks to Steven Watanabe, Vicente Botet, Michael Caisse, Yechezkel Mett, Joel de Guzman, Thomas Heller, et al. for helping with the Alternatives section and with the profiling of the different alternatives.

Many thanks to Jeffrey Lee Hellrung for managing the Boost review of this library. Thanks also to all the people that submitted a Boost review: Andrzej Krzemienski, Edward Diener, Gregory Crosswhite, John Bytheway, Hartmut Kaiser, Krzysztof Czainski, Nat Lindon, Pierre Morcello, Thomas Heller, and Vicente J. Botet. Thanks to everyone that commented on the library during its Boost review.

Finally, many thanks to the entire Boost community and mailing list for providing valuable comments about this library and great insights on the C++ programming language.

78. Many thanks to Mathias Gaunard for suggesting to implement `boost::overloaded_function` and for some sample code.

Thanks to John Bytheway for suggesting to implement `boost::make_overloaded_function`.

Thanks to Nathan Ridge for suggestions on how to implement `boost::make_overloaded_function`.

Thanks to Robert Stewart for commenting on the library name.

Many thanks to the entire Boost community and mailing list for providing valuable comments about this library and great insights on the C++ programming language.

79. The Spirit repository is the result of the contributions of active members of the Spirit community. We would like to express our thanks to all who directly contributed and to everybody directly or indirectly involved in the discussions, which led to the creation of the parser and generator components.

The following people have directly contributed code to this repository:

Aaron Graham wrote the advance parser component, which allows the parser to skip (advance) through a specified number of iterations without performing unnecessary work.

Chris Hoeppler submitted the confix parser directive allowing to embed a parser (the subject) inside an opening (the prefix) and a closing sequence (the suffix).

Francois Barel contributed the subrule parser and subrule generator components, allowing to create a named parser or generator, and to refer to it by name. These components are in fact fully static versions of the corresponding rule component.

Thomas Bernard contributed the `keyword_list` and `kwd()[]` parser components, allowing to define keyword parsers.

80. Dan Nuffer for his work on lexers, parse trees, ASTs, XML parsers, the multi-pass iterator as well as administering Spirit's site, editing, maintaining the CVS and doing the releases plus a zillion of other chores that were almost taken for granted.

Hartmut Kaiser for his work on the C parser, the work on the C/C++ preprocessor, utility parsers, the original port to Intel 5.0, various work on Phoenix, porting to v1.5, the meta-parsers, the grouping-parsers, extensive testing and painstaking attention to details.

Martin Wille who improved grammar multi thread safety, contributed the `eol_p` parser, the dynamic parsers, documentation and for taking an active role in almost every aspect from brainstorming and design to coding. And, as always, helps keep the regression tests for g++ on Linux as green as ever :-).

Martijn W. Van Der Lee our Web site administrator and for contributing the RFC821 parser.

Giovanni Bajo for last minute tweaks of Spirit 1.8.0 for CodeWarrior 8.3. Actually, I'm ashamed Giovanni was not in this list already. He's done a lot since Spirit 1.5, the first Boost.Spirit release. He's instrumental in the porting of the Spirit iterators stuff to the new Boost Iterators Library (version 2). He also did various bug fixes and wrote some tests here and there.

Juan Carlos Arevalo-Baeza (JCAB) for his work on the C++ parser, the position iterator, ports to v1.5 and keeping the mailing list discussions alive and kicking.

Vaclav Vesely, lots of stuff, the `no_actions` directive, various patches fixes, the distinct parsers, the lazy parser, some phoenix tweaks and add-ons (e.g. `new_`). Also, Stefan Slapeta and wife for editing Vaclav's distinct parser doc.

Raghavendra Satish for doing the original v1.3 port to VC++ and his work on Phoenix.

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81. The library uses Peter Dimov's implementation of `std::make_index_sequence`. Manu Sánchez aided immensely with CI setup and performance testing. Sehe contributed performance results for GCC 5.2, and Francisco José Tapia for Clang 3.9.

The Boost acceptance review took place between the 3rd and 17th of May, 2017. Thank you to Ion Gaztañaga for smoothly managing the process. The following people participated with full reviews or valuable comments: Pete Bartlett, Hans Dembinski, Dominique Devienne, Edward Diener, Vinnie Falco, Ion Gaztañaga, Andrzej Krzemiński, Brook Milligan, Thorsten Ottosen, Steven Watanabe, Adam Wulkiewicz. Many thanks to all of them. Steven Watanabe gave crucial help in solving some hard problems related to the usage of Boost.TypeErase.

Boost.PolyCollection was designed and written between rainy Viavélez, noisy Madrid and beautiful Cáceres, August-November, 2016. Most of the after-review work in preparation for the official Boost release was done in the quiet town of Oropesa during the spring of 2017.

In memory of Joaquín López Borrella (1939-2015), in memory of Héctor (2004-2017): may your ghosts keep us company.

82. I would like to thank CEO Hermann Steppe and Chief Developer Peter Wuttke of Cortex Software GmbH for their friendly support of my work on the Icl and their permission to release the library as open source. For her genuine interest in my work and many creative and uplifting talks I want to thank my colleague Axinja Ott who contributed a lot to the success of the project.

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For sending in bug reports, code patches and suggestions for improvements after the review thanks to Denis and Marvin Sielenkemper.

83. We like to thank all the people who helped to develop this library.

First of all we are grateful to Hartmut Kaiser for managing the formal review of this library. Hartmut is an excellent review manager, who intervened when necessary and produced the review report quickly.

We thank the 14 reviewers of our library, reviewed from November 5, 2009 to November 22, 2009. Reviews have been written by: Brandon Kohn, Christophe Henry, Fabio Fracassi, Gordon Woodhull, Joachim Faulhaber, Jonathan Franklin, Jose, Lucanus Simonson, Michael Caisse, Michael Fawcett, Paul Bristow, Phil Endecott, Thomas Klimpel, Tom Brinkman.

We also thank all people who discussed on the mailing lists (either at boost, or at osgeo) about Boost.Geometry, in preview stage, or in review stage, or after that.

Furthermore we are thankful to people supplying patches: Arnold Metselaar, Aleksey Tulinov, Christophe Henry

Finally I (Barend) would like to thank my former employer, Geodan. They allowed me to start a geographic library in 1995, which after a number of incarnations, redesigns, refactorings, previews, a review and even more refactorings have led to the now released Boost.Geometry. And with them I want to thank the team initially involved in developing the library, Valik Solorzano Barboza, Maarten Hilferink, Anne Blankert, and later Sjoerd Schreuder, Steven Fruijtier, Paul den Dulk, and Joris Sierman.

84. This section tries to recognize the contributions of all the different people that participated directly or indirectly to the design and development of this library.

Sincere thanks to my parents for their support with my education and my studies in computer science.

Many thanks to Andrzej Krzemienski for reviewing early versions of this library providing valuable insights and exchanging early ideas on assertion requirements.

Many thanks to Vicente J. Botet Escriba for reviewing earlier versions of this library providing valuable insights and for suggesting to use a dedicated trait to copy old values.

Thanks to Steven Watanabe for providing valuable insights on C++, SFINAE, and introspection.

Thanks to Dave Abrahams for moderating the Boost review of this library.

Thanks to Daniel James for his help with incorporating this library files into the Boost Git repository.

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Many thanks to Bertrand Meyer for his pioneering and thorough work on contract programming in `__Meyer97__`.

Finally, many thanks to the entire Boost community and [[@http://lists.boost.org](http://lists.boost.org) mailing list] for providing valuable comments on this library and great insights on the C++ programming language.

85. [h4 Boost Test Team]

Boost.Test 3.0 is being developed and maintained by Gennadiy Rozental and Raffi Enficiaud.

[h4 New documentation]

Raffi Enficiaud and Andrzej Krzemienski efforts were a driving force behind the Boost.Test documentation overhaul.

[h4 Second incarnation including the Unit Test Framework]

Beman Dawes and Ullrich Koethe started the library. Fernando Cacciola, Jeremy Siek, Beman Dawes, Ullrich Koethe, Dave Abrahams suggested numerous improvements during the Formal Review. Jeremy Siek was the review manager. Beman Dawes was a great help in both final testing and merging library with rest of the boost. Gennadiy Rozental was the developer and maintainer.

[h4 Original Test Library]

Ed Brey, Kevlin Henney, Ullrich Koethe, and Thomas Matelich provided very helpful comments during development. Dave Abrahams, Ed Brey, William Kempf, Jens Maurer, and Wilka suggested numerous improvements during the Formal Review. Jens Maurer was the review manager. Beman Dawes is the developer and maintainer.

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87. This version of Spirit is a complete rewrite of the /classic/ Spirit many people have been contributing to (see below). But there are a couple of people who already managed to help significantly during this rewrite. We would like to express our special acknowledgement to (in no particular order):

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[\*Ben Hanson] for providing us with an early version of his `__lexertl__` library, which is proposed to be included into Boost (as Boost.Lexer). At the time of this writing the Boost review for this library is still pending.

[\*Francois Barel] for his silent but steady work on making and keeping Spirit compatible with all versions of gcc, older and newest ones. He not only contributed subrules to Spirit V2.1, but always keeps an eye on the small details which are so important to make a difference.

[\*Andreas Haberstroh] for proof reading the documentation and fixing those non-native-speaker-quirks we managed to introduce into the first versions of the documentation.

[\*Chris Hoeppler] for taking up the editorial tasks for the initial version of this documentation together with Andreas Haberstroh. Chris did a lot especially at the last minute when we are about to release.

[\*Michael Caisse] (a.k.a mjcaisse) for being Spirit's benevolent evangelist on freenode's #boost IRC . No Spirit question asked there stays without an answer because of his active involvement. Also, we would like to thank him for last minute editing work on the 2.1 release documentation.

[\*Tobias Schwinger] for proposing expectation points and GCC port of an early version.

[\*Dave Abrahams] as always, for countless advice and help on C++, library development, interfaces, usability and ease of use, for reviewing the code and providing valuable feedback and for always keeping us on our toes.

[\*OvermindDL] for his creative ideas on the mailing list helping to resolve even more difficult user problems.

[\*Carl Barron] for his early adoption and valuable feedback on the Lexer library forcing us to design a proper API covering all of his use cases. He also contributed an early version of the variadic attribute API for Qi.

[\*Daniel James] for improving and maintaining Quickbook, the tool we use for this documentation. Also, for bits and pieces here and there such documentation suggestions and editorial patches.

[\*Stephan Menzel] for his early adoption of Qi and Karma and his willingness to invest time to spot bugs which were hard to isolate. Also, for his feedback on the documentation.

[\*Ray Burkholder] and [\*Dainis Polis] for last minute feedback on the documentation.

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[\*Bryce Leylback] (a.k.a. wash) for contributing the components ``qi::`__qi_as__` and ``karma::`__karma_as__`, for working on `__utree__` and its integration with Qi and Karma, for adding numeric parser literals, for contributing the related documentation, and for being a big help in the everyday maintenance of the library's (and our) sanity.

[\*Mathias Gaunard] for his bug reports, suggestions and regression test contributions to the Lexer helping to find subtle bugs and to improve its overall usability.

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such as helping with support, bug tracking, benchmarking and testing, etc. The list include: [\*Larry Evans], [\*Richard Webb], [\*Martin Wille], [\*Dan Marsden], [\*Cedric Venet], [\*Allan Odgaard], [\*Matthias

Vallentin], [\*Justinas V.D.], [\*Darid Tromer], [\*Brian O'Kennedy], [\*Aaron Graham], [\*Joerg Becker].

[\*Joao Abecasis] for his early support and involvement in Spirit2 development and for disturbing my peace every once in a while for a couple of jokes.

The list goes on and on... if you've been mentioned thank Joel and Hartmut, if not, kick Joao :-)

[heading Acknowledgements from the Spirit V1 /classic/ Documentation]

Special thanks for working on Spirit /classic/ to:

[\*Dan Nuffer] for his work on lexers, parse trees, ASTs, XML parsers, the multi-pass iterator as well as administering Spirit's site, editing, maintaining the CVS and doing the releases plus a zillion of other chores that were almost taken for granted.

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from the Boost community who supported the development of the Interval Template Library by numerous hints and feedbacks on the boost mailing list. Also helpful have been conversations, hints and contributions

at the BoostCon 2009 by Jeff Garland, David Jenkins, Tobias Loew, Barend Gehrels, Luke Simonson and Hartmut Kaiser.

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88. Many thanks to Julian Gonggrijp, Rob Stewart, Andrzej Krzemienski, Matus Chochlik, Jeroen Habraken, Hartmut Kaiser, Joel De Guzman, Thijs (M.A.) van den Berg, Roland Bock, Gavin Lambert, Paul Bristow, Alex Hagen-Zanker, Christopher Kormanyos for taking part in the [Boost.Convert] review and their valuable input.

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\*\*\*\*\* UTF8 Validation logic (utf8\_validation.hpp) \*\*\*\*\*  
utf8\_validation.hpp is adapted from code originally written by Bjoern Hoehrmann  
<bjoern@hoehrmann.de>. See <http://bjoern.hoehrmann.de/utf-8/decoder/dfa/> for  
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