A WYSIWYG Framework

by

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Abstract

Browsers do not offer native elements that allow for rich-text editing. There are third-party libraries that emulate these elements by utilizing the `contenteditable`-attribute. However, the API enabled by `contenteditable` is very limited and unstable. Bugs and unwanted behavior make it hard to use and can only be worked around, not fixed. By reviewing the APIs history, it can be argued that its design has never been revisited only to ensure compatibility to current browsers. This thesis explains the APIs downsides and demonstrates that rich-text editing can be achieved without requiring the `contenteditable`-attribute with library "Type", thus solving many problems that can be found contemporary third-party rich-text editors.

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Title: Associate Professor

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Chapter 1

Introduction

1.1 Motivation

Rich-text editors are commonly used by many on a daily basis. Often, this happens knowingly, for instance in an office suite, when users wilfully format text. But often, rich-text editors are being used without notice. For instance when writing e-mails, entering a URL inserts a link automatically in many popular e-mail-applications. Also, many applications, like note-taking apps, offer rich-text capabilites that go unnoticed. Many users do not know the difference between rich-text and plain-text writing. Rich-text editing has become a de-facto standard, that to many users is *just there*. Even many developers do not realise that formatting text is a feature that needs special implementation, much more complex than plain-text editing.

While there are APIs for creating rich-text input controls in many desktop programming environments, web-browsers do not offer native rich-text inputs. However, third-party JavaScript libraries fill the gap and enable developers to include rich-text editors in web-based projects.

The libraries available still have downsides. Most importantly, only a few of them work. As a web-developer, the best choices are either to use CKEditor or TinyMCE. Most other editors are prone to bugs and unwanted behaviour. Piotrek Koszuliński, core developer of CKEditor comments this on StackOverflow as follows:

"Don't write wysiwyg editor[sic] - use one that exists. It's going to consume all your time and still your editor will be buggy. We and guys from other... two main editors (guess why only three exist) are working on this for years and we still have full bugs lists ;)."[1]

A lot of the bugs CKEditor and other editors are facing are due to the fact that they rely on so-called "HTML Editing APIs" that have been implemented in browsers for years, but only been standardized with HTML5. Still, to this present day, the implementations are prone to noumerous bugs and behave inconsitently across different browsers. And even though these APIs are the de-facto standard for implementing rich-text editing, with their introduction in Internet Explorer 5.5, it has never been stated they have been created to be used as such.

It's a fact, that especially on older browsers, rich-text editors have to cope with bugs and inconsistencies, that can only be worked around, but not fixed, as they are native to the browser. On the upside, these APIs offer a high-level API to call so-called "commands" to format the current text-selection.

However, calling commands will only manipulate the document's DOM tree, in order to format the text. This can also be achieved without using editing APIs, effectively avoiding unfixable bugs and enabling a consistend behaviour across all browsers.

Furthermore CKEditor, TinyMCE and most other libraries are shipped as user interface components. While being customizable, they tend to be invasive to web-projects.

This thesis demonstrates a way to enable rich-text editing in the browser without requiring HTML Editing APIs, provided as a GUI-less software library. This enables web-developers to implement rich-text editors specific to the requirements of their web-projects.

Rich-text editing on the web is a particularly overlooked topic. Most libraries use contenteditable without questioning its benefits. The literature on this topic is thin. It

[1] http://stackoverflow.com/questions/11240602/paste-as-plain-text-contenteditable-div-textarea-word-excel/11290082112900082, last checked on 07/13/2015

is rarely written about in books and papers and noone really examines alternative ways for implementation. ACE and CodeMirror show techniques how to do it. However looking at its history, it seems very questionable. People who implement editors using it often rant about its disadvantages. <- der letzte Satz sollte einer der kernpunkte der introduction sein. ÃIJberahupt, das questioning sollte im kern stehen.

1.2 Terminilogy

rich-text, WYSIWYG, word-processing, WYSIWYM

1.3 Structure

The first part of this thesis explains rich-text editing on desktop PCs. The second part explains how rich-text editors are currently being implemented in a browser-environment and the major technical differences to the desktop. Part three will cover the downsides and the problems that arise with the current techniques used. Part four will explain how rich-text editing can be implemented on the web bypassing these problems. Part five dives into the possibilities of web-based rich-text editing in particular when using the techniques explained in this thesis.

Chapter 2

Text editing in desktop environments

2.1 Basics of plain-text editing

caret selection input

2.2 Basics of rich-text editing

document tree formatting algorithms

2.3 Libraries for desktop environments

It is no longer needed to implement basic rich-text editing components from the ground up. Rich-text editing has become a standard and most modern Frameworks, system APIs or GUI libraries come with built-in capabilites. Table 2.1 lists rich-text text components for popular languages and frameworks.

Environment	Component
Java (Swing)	JTextPane / JEditorPane
MFC	CRichEditCtrl
Windows Forms / .NET	RichTextBox
Cocoa	NSTextView
Python	Tkinter Text
Qt	QTextDocument

Table 2.1: Rich-text components in desktop environments

Chapter 3

Text editing in browser environments

3.1 Plain-text inputs

Text input components for browsers have been introduced with the specification of HTML 2.0[1]. The components proposed include inputs for single line (written as `<input type=''text'' />`) and multiline texts (written as `<textarea></textarea>`). These inputs allow writing plain-text only.

3.2 Rich-text editing

Major browsers, i.e. any browser with a market share above 0.5%[2], do not offer native input fields that allow rich-text editing. Neither the W3C's HTML5 and HTML5.1 specifications nor the WHATWG HTML specification recommend such elements. However, by being able to display HTML, browsers effectively are rich-text viewers. By the early 2000s, the first JavaScript libraries emerged, that allowed users to interactively change (parts of) the HTML of a website, to enable rich-text editing in the browser. The techniques used will be discussed in section 3.3 through section 3.8.

[1] https://tools.ietf.org/html/rfc1866, last checked on 07/15/2015

[2] http://gs.statcounter.com/all-browser-ww-monthly-201406-201506-bar, last checked on 07/15/2015

Attribute	Type	Can be set to	Possible values
designMode	IDL attribute	Document	"on", "off"
contentEditable	IDL attribute	Specific HTMLElements	boolean, "true", "false", "inherit"
contenteditable	content attribute	Specific HTMLElements	empty string, "true", "false"

Table 3.1: Editing API attributes

3.3 HTML Editing APIs

In July 2000, with the release of Internet Explorer 5.5, Microsoft introduced the IDL attributes `contentEditable` and `designMode` along with the content attribute `contenteditable`[3][4]. These attributes were not part of the W3C's HTML 4.01 specifications[5] or the ISO/IEC 15445:2000[6], the defining standards of that time. Table 3.1 lists these attributes and possible values.

```
1 <div contenteditable="true">
2   This text can be edited by the user.
3 </div>
```

Listing 3.1: An element set to editing mode

By setting `contenteditable` or `contentEditable` to "true" or `designMode` to "on", Internet Explorer 5.5 switches the affected elements and their children to an editing mode. The `designMode` can only be applied to the entire document and the `contentEditable` and `contenteditable` attributes can be applied to specific HTML elements as described on Microsoft's Developer Network (MSDN) online documentation[7]. These elements include "divs", "paragraphs" and the docuement's "body" element amongst others. In editing mode

1. Users can interactively click on and type inside texts

2. An API is enabled that can be accessed via JScript and JavaScript

[3]https://msdn.microsoft.com/en-us/library/ms533720(v=vs.85).aspx, last checked on 07/10/2015

[4]https://msdn.microsoft.com/en-us/library/ms537837(VS.85).aspx, last checked on 07/10/2015

[5]http://www.w3.org/TR/html401/, last checked on 07/14/2015

[6]http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=27688, last checked on 07/14/2015

[7]https://msdn.microsoft.com/en-us/library/ms537837(VS.85).aspx, last checked on 07/10/2015

Setting the caret by clicking on elements, accepting keyboard input and modifying text nodes is handled entirely by the browser. No further scripting is necessary.

The API enabled can be called globally on the `document` object, but will only execute when the user's selection or caret is focussed inside an element in editing mode. Table A.1 lists the full HTML editing API. To format text, the method `document.execCommand` can be used. Calling

```
1 document.execCommand('italic', false, null);
```

Listing 3.2: Emphasizing text using the HTML editing API

will wrap the currently selected text inside an element in editing mode with `<i>` tags. The method accepts three parameters. The first paramter is the "Command Identifier", that determines which command to execute. For instance, this can be `italic` to italicize the current selection or `createLink` to create a link with the currently selected text as label.

```
1 document.execCommand('createLink', false, 'http://google.de/');
```

Listing 3.3: Creating a link using the HTML editing API

The *third* parameter will be passed on to the internal command given as first parameter. In the case of a `createLink` command, the third parameter is the URL to be used for the link to create. The *second* paramter determines if executing a command should display a user interface specific to the command. For instance, using the `createLink` command with the second parameter set to `true` and not passing a third parameter, the user will be prompted with a system dialog to enter a URL. A full list of possible command identifiers can be found on MSDN[8].

[8]https://msdn.microsoft.com/en-us/library/ms533049(v=vs.85).aspx, last checked on 07/10/2015

3.4 Discussion of HTML Editing APIs

HTML editing APIs have been poorly designed. Sections V to W discuss the origins and the reasons why HTML editing APIs have been standardized and are supported by all major browser. It can be seen, that they did not came to be cos of their good design. In sections X and Y will discuss the design of these APIs.

3.5 Browser support

With the release of Internet Explorer 5.5 and the introduction of editing capabilities, Microsoft released a short documentation[9], containing the attributes' possible values and element restrictions along with two code examples. Although a clear purpose has not been stated, the code examples demonstrated how to implement rich-text input fields with it. Mark Pilgrim, author of the "Dive into" book series and contributor to the the Web Hypertext Application Technology Working Group (WHATWG), also states that the API's first use case has been for rich-text editing[10].

In March 2003, the Mozilla Foundation introduced an implementation of Microsoft's designMode, named Midas, for their release of Mozilla 1.3. Mozilla already named this "rich-text editing support" on the Mozilla Developer Network (MDN)[11]. In June 2008, Mozilla added support for contentEditable IDL and contenteditable content attributes with Firefox 3.

Mozilla's editing API mostly resembles the API implemented for Internet Explorer, however, to this present day, there are still differences (compare[12][13]). This includes the available command identifiers [14][15] as well as the markup generated by

[9] https://msdn.microsoft.com/en-us/library/ms537837(VS.85).aspx, last checked on 07/10/2015
[10] https://blog.whatwg.org/the-road-to-html-5-contenteditable, last checked on 07/10/2015
[11] https://developer.mozilla.org/en/docs/Rich-Text_Editing_in_Mozilla, last checked on 07/10/2015
[12] https://msdn.microsoft.com/en-us/library/hh772123(v=vs.85).aspx, last checked on 07/10/2015
[13] https://developer.mozilla.org/en-US/docs/Midas, last checked on 07/10/2015
[14] https://developer.mozilla.org/en-US/docs/Midas, last checked on 07/10/2015
[15] https://msdn.microsoft.com/en-us/library/ms533049(v=vs.85).aspx, last checked on 07/10/2015

invoking commands[16].

In June 2006, Opera Software releases Opera 9[17], providing full support for contentEditable and designMode[18], followed by Apple in March 2008[19] providing full support Safari 3.1[20]. MDN lists full support in Google Chrome since version 4[21], released in January 2010[22].

Starting in November 2004, WHATWG members have started actively discussing to incorporate these editing APIs in the HTML5 standard. Through reverse engineering, the WHATWG developed a specification based on Microsoft's implementation[23] and finally decided to include it in HTML5. With W3C's coorporation and the split in 2011, similar editing APIs based on this work are now included in W3C's HTML5 Standard[24] and WHATWG's HTML Standard[25].

3.6 Emergence of HTML editing JavaScript libraries

Around the year 2003[26] the first JavaScript libraries emerged that made use of Microsoft's and Mozilla's editing mode to offer rich-text editing in the browser. Usually these libraries were released as user interface components (text fields) with inherent rich-text functionality and were only partly customizable.

In May 2003 and March 2004 versions 1.0 of "FCKEditor"[27] and "TinyMCE" have been released as open source projects. These projects are still being maintained and remain among the most used rich-text editors. TinyMCE is the default editor for

[16]https://developer.mozilla.org/en/docs/Rich-Text_Editing_in_MozillaInternet_Explorer_Differences, last checked on 07/10/2015

[17]http://www.opera.com/docs/changelogs/windows/, last checked on 07/10/2015

[18]http://www.opera.com/docs/changelogs/windows/900/, last checked on 07/10/2015

[19]https://www.apple.com/pr/library/2008/03/18Apple-Releases-Safari-3-1.html, last checked on 07/10/2015

[20]http://caniuse.com/feat=contenteditable, last checked on 07/10/2015

[21]https://developer.mozilla.org/en-US/docs/Web/Guide/HTML/Content_Editable, last checked on 07/10/2015

[22]http://googlechromereleases.blogspot.de/2010/01/stable-channel-update_25.html, last checked on 07/10/2015

[23]https://blog.whatwg.org/the-road-to-html-5-contenteditable, last checked on 07/15/2015

[24]http://www.w3.org/TR/html5/editing.html, last checked on 07/15/2015

[25]https://html.spec.whatwg.org/multipage/interaction.htmlediting-2, last checked on 07/15/2015

[26]compare *Meine Tabelle aller Editoren*

[27]Now distributed as "CKEditor"

Wordpress and CKEditor is listed as the most popular rich-text editor for Drupal[28].

Since the introduction of Microsoft's HTML editing APIs, a large number of rich-text editors have been implemented. While many have been abandoned, GitHub lists about 600 JavaScript projects related to rich-text editing[29]. However, it should be noted, that some projects only use other projects' editors and some projects are stubs. Popular choices on GitHub include "MediumEditor", "wysihtml", "Summernote" and others.

3.7 Standardization of HTML Editing APIs

It makes sense to use HTML editing APIs for rich-text editing. Microsoft's demos published with the release of these API suggest to do so. Mozilla picked up on it and called their implementation "rich-text editing API". Other browsers followed with APIs based on Microsoft's idea of editable elements. However, it would have been imaginable for browsers to offer a native user interface component, a dedicated rich-text input field.

The HTML editing APIs have only been standardized with HTML5, which itself introduces 13 new types of input fields[30], but none with rich-text capabilites. The WHATWG discussed various ways to specify rich-text editing for the upcoming HTML5 standard, including dedicated input fields. The issues that have been faced with that idea are

1. Finding a way to tell the browser which language the rich-text input should generate. E.g. should it output (the then popular) "bb" code, (X)HTML, Textile or something else?

2. How can browser support for a rich-text input be achieved?

[28] https://www.drupal.org/project/project_module, last checked on 07/16/2015

[29] https://github.com/search?o=desc&q=wysiwyg&s=stars&type=Repositories&utf8=%E2%9C%93, last checked on 07/16/2015

[30] https://developer.mozilla.org/en/docs/Web/HTML/Element/Input, last checked on 07/16/2015

Ian Hickson, editor of WHATWG and author of the HTML5 specification adresses these main issues in a message from November 2004[31]. He states

> *Realistically, I just can't see something of this scoped[sic] [the ability to specify a input 'language' for a text-area and possibly to specify a subset of language elements allowed] getting implemented and shipped in the default install of browsers.*

and agrees with Ryan Johnson, who states

> *Anyway, I think that it might be quite a jump for manufacturers. I also see that a standard language would need to be decided upon just to describe the structure of the programming languages. Is it worth the time to come up with suggestions and examples of a programming language definition markup, or is my head in the clouds?*

Ian Hickson finally concludes

> *Having considered all the suggestions, the only thing I could really see as being realistic would be to do something similar to (and ideally compatible with) IE's "contentEditable" and "designMode" attributes.*

Mark Pilgrim lists this as milestone of the decision to integrate Microsoft's HTML editing APIs in the HTML5 standard.[32].

3.8 Usage of HTML Editing APIs for rich-text editors

Most rich-text editors use HTLM editing APIs as their basis. CKEditor and TinyMCE dynamically create an `iframe` on instantiation and set its `body` to editing mode using

[31] https://lists.w3.org/Archives/Public/public-whatwg-archive/2004Nov/0014.html, last checked on 07/16/2015

[32] https://blog.whatwg.org/the-road-to-html-5-contenteditable, last checked on 07/16/2015

`contenteditable`. Doing so, users can type inside the `iframe` so it effectively acts as text input field. Both libraries wrap the `iframe` in a user interface with buttons to format the `iframe`'s contents. When a user clicks on a button in the interface `document.execCommand` will be called on the `iframe`'s `document` and the selected text will be formatted. While using an `iframe` is still in practice, many newer editors use a `div` instead. The advantages and disadvatanges of this technique will be discussed in Sections XY.

3.9 HTML Editing APIs are questionable

Understanding the history of the HTML editing APIs, the reasons for their wide browser support and their final standardization are questionable. It can be doubted if they fit their purpose secifically well. In fact, all major browsers mimicked the API as implemented in Internet Explorer 5.5, even though there was no specification on it. It had to be reverse-engineered. The reasons for this have not been publically discussed. A reason may have been to be able to compete with the other browsers. Both, Microsoft's original implementation as well as Mozilla's adoption have been released in the main years of the so-called "browser wars". However Mozilla adopted Microsoft's API applying practically no change to it. It can be argued that this has been part of the browser wars. At this time, it was essential for any browser to be able to be compatible with as many websites as possible. Many websites were only optimized for a specific browser. To gain market share, it was essential to support methods that other browsers already offered and that have been used by the web developers. Being able to display websites just as good as their competitor may have been a key factor for Mozilla's decision to implement Microsoft's HTML editing APIs and not alter them in any way. Creating another standard would have been a disadvantage over the then stronger Internet Explorer.

As described in section ABC, other now popular browsers, i.e. Chrome, Safari and Opera, implemented these APIs only years later, when JavaScript libraries based on them have already been popular and widely used, which can be seen as a reason

for these decisions. As described in section YZ, it has clearly been stated (see section 3.7), that the reason for standardizing these APIs for rich-text editing has been to ensure browser support.

The API itself stems from the time when the usage of the web was different from today, its future was still unknown and web applications like Google Docs have not even been thought of. It should be discussed if this API really is the answer to all problem and if it still fits (or ever fit) modern requirements for content management systems or web application. The advantantages, disadvantages and practical issues will be discussed in sections x y z.

3.10 Advantages of HTML Editing APIs

HTML Editing APIs have some notable advantages which will be discussed in this section.

Browser support A fair reason for using HTML editing APIs is its wide browser support. caniuse.com lists browser support for 92.78% of all used web browsers[33]. I.e. 92.78% of all people using the web use browsers that have full support for HTML editing APIs.

High-level API HTML editing APIs offer high-level commands for formatting text. It requires little setup to implement basic rich-text editing. The browser takes care of generating the required markup.

HTML output HTML editing APIs modify and generate HTML. In the context of web development, user input in this format is likely to be useful for further processing.

No need for language definitions The WHATWG discussed dedicated rich-text inputs, for instance as an extension of the `textarea` component. Offering a native input for general rich-text input brings up the question which use-cases this input

[33]http://caniuse.com/search=contenteditable, last checked on 07/17/2015

conforms. For a forum software, it might be useful to generate ”BB” code, while for other purposes other languages might be needed. Offering HTML editing APIs offers a semantically distinct solution, while still enabling a way to implement rich-text editing.

Possbile third-party solutions for other languages While HTML editing APIs can be used to generate HTML only, third-party libraries can build on top of that by implementing editors that write ”BB” code (for instance) and use HTML only for displaying it as rich-text.

3.11 Disadvantages of HTML Editing APIs

No specification on the generated output The specifications on the HTML editing APIs do not state what markup should be generated by specific commands. There are vast differences in the implememtations of all major browsers. Calling the `italic` command, this is the output of Internet Explorer, Firefox and Chrome:

```
1 <i>Lorem ipsum</i>
```

Listing 3.4: Markup of italic command in Internet Explorer

```
1 <span style="font-style: italic;">Lorem ipsum</span>
```

Listing 3.5: Markup of italic command in Firefox

```
1 <em>Lorem ipsum</em>
```

Listing 3.6: Markup of italic command in Chrome

This is a *major* problem for web development, because it makes processing input very difficult. Given the number of possible edge cases, it is very hard to normalize the input. Apart from that Internet Explorer’s output is semantically incorrect for most

use cases[34] while Firefox's output is breaking sementics entirely and considered a bad style regarding the principle of the separation of concerns[35]. Different browsers will not only generate differnent markup when executing commands. When a user enters a line break (by pressing enter), Firefox will insert a `<br>` tag, Chrome and Safari will insert a `<div>` tag and Internet Explorer will insert a `<p>` tag.

Flawed API The original and mostly unaltered API is limited and not very effective. MDN lists 44 commands available for their `execCommand` implementation[36]. While other browsers do not match these commands exactly, their command lists are mostly similar. 17 of those commands format the text (for instance to italicize or make text bold) by wrapping the current selection with tags like `<em>` or `<strong>`. The only difference between any of these commands is which tag will be used. At the same time there is no command to wrap the selected text in an arbitrary tag, for instance to apply a custom class to it (`<span class="highlight">Lorem ipsum</span>`). All 17 commands could be summarized by a single command that allows to pass custom tags or markup and wraps the selected text with it. This would not only simplify the API, but would also give it enormously more possibilities. The same goes for inserting elements. 7 commands insert different kinds of HTML elements, this could be simplified and extended by allowing to insert any kind of (valid) markup or elements with a single command.

Both alternatives would also give developers more control of what to insert. As previously described, browsers handle formatting differently. Allowing to format with specific HTML would generate consistent markup (in the scope of a website) and allow developers generate the markup fitting their needs.

Not extendable Google points out that implementing an editor using HTML editing APIs comes with the restriction that such an editor can only offer the least com-

[34]https://developer.mozilla.org/en-US/docs/Web/HTML/Element/i#Notes, last checked on 07/17/2015

[35]https://en.wikipedia.org/wiki/Separation_of_concerns#HTML.2C_CSS.2C_JavaScript, last checked on 07/17/2015

[36]https://developer.mozilla.org/en-US/docs/Web/API/document/execCommand#Commands, last checked on 07/17/2015

mon denominator of functions supported by all browsers. They argue, if one browser does not support a specific feature or its implementation is buggy, it cannot be supported by the editor[37]. This is mostly true, although it is to be noted, that editors like CKEditor show, that some bugs can be worked around as well as some functionality be added through JavaScript. These workaround still have limitations and not everything can be fixed. In particular there can be cases where the editing mode is not able to handle content inserted or altered by workarounds.

Clipboard When dealing with user input, usually some sort of filtering is required. It is possibly harmful to accept any kind of input. This must be checked on the server side since attackers can send any data, regardless of the front end a system offers. However, in a cleanly designed system, the designated front end should not accept and send "bad" data to the back end. This applies to harmful content as well as to content that is simply *unwanted*. For example, for asthetical reasons, a comment form can be designed to allow bold and italic font formatting, but not headlines or colored text.

Implementing a rich-text editor with HTML editing APIs, unwanted formatting can be prevented by simply not offering input controls for these formattings (assuming no malicious behavior by the user). However any content, containing any formatting, can be pasted into elements in editing mode from the clipboard. There is no option to define filtering of some sort.

Recent browser versions allow listening to paste events. Chrome, Safari, Firefox and Opera grant full read access to the clipboard contents from paste events, which can then be stopped and the contents processed as desired. Internet Explorer allows access to plain-text and URL contents only. Android Browser, Chrome for Android and IOS Safari allow reading the clipboard contents on paste events as well. Other browsers and some older versions of desktop and mobile browsers do not support clipboard access or listening to paste events. 82.78% of internet users support listening

[37] http://googledrive.blogspot.fr/2010/05/whats-different-about-new-google-docs.html, last checked on 07/18/2015

to and reading from clipboard events[38].

When dealing with the clipboard, especially older browsers show an unexpected behavior. Older WebKit-based browsers insert so-called "Apple style spans"[39] on copy and paste commands. "Apple style spans" are pieces of markup that have no visible effect, but clutter up the underlying contents of an editor. When pasting formatted text from Microsoft Word, Internet Explorer inserts underlying XML, that Word uses to control its document flow into the editor.

Bugs HTML editing APIs are prone to numerous bugs. Especially older browser versions are problematic. Piotrek Koszuliński states:

> *"First of all... Don't try to make your own WYSIWYG editor if you're thinking about commercial use. [...] I've seen recently some really cool looking new editors, but they really doesn't[sic] work. Really. And that's not because their developers suck - it's because browsers suck."*[40]

Mozilla lists 1060 active issues related to its "Editor" component[41]. Google lists 420 active issues related to "Cr-Blink-Editing"[42]. The WebKit project lists 641 active issues related to "HTML Editing"[43]. Microsoft and Opera Software allow public access to their bug trackers. Some rich-text editors like CKEditor have been developed for over 10 years and still need to fix bugs related to the editing API[44][45]. Some bugs have caused big websites to block particular browsers entirely[46].

[38] http://caniuse.com/#feat=clipboard, last checked on 07/18/2015

[39] https://www.webkit.org/blog/1737/apple-style-span-is-gone/, last checked on 07/18/2015

[40] http://stackoverflow.com/questions/10162540/contenteditable-div-vs-iframe-in-making-a-rich-text-wysiwyg-editor/11479435#11479435, last checked on 07/18/2015

[41] https://bugzilla.mozilla.org/buglist.cgi?bug_status=__open__&component=Editor&product=Core&query_forma last checked on 07/18/2015

[42] https://code.google.com/p/chromium/issues/list?q=label:Cr-Blink-Editing, last checked on 07/18/2015

[43] https://bugs.webkit.org/buglist.cgi?query_format=advanced&bug_status=UNCONFIRMED&bug_status=NEW& last checked on 07/18/2015

[44] http://dev.ckeditor.com/report/2, last checked on 07/18/2015

[45] http://stackoverflow.com/questions/11240602/paste-as-plain-text-contenteditable-div-textarea-word-excel/11290082112900082, last checked on 07/18/2015

[46] https://medium.com/medium-eng/the-bug-that-blocked-the-browser-e28b64a3c0cc, last checked on 07/18/2015. Medium however has contacted Microsoft and lead them to fix this bug.

Given the argument that editing APIs provide easy to use and high-level methods to format text, in practice, the number of bugs and work-arounds required, renders a ”easy and quick” implementation impossible. Also, browser bugs cannot be fixed by web developers. At best they can be worked around, enforcing particular software design on developers and possibly spawning more bugs.

3.12 Treating HTML editing API related issues

The issues arising with HTML editing APIs cannot be fixed. Many libraries find workarounds to treat them. CKEditor, TinyMCE, that framework. Google Docs finds another way and does not use HTML editing APIs.

huge editor libraries, developed for 10 years trying to fix stuff libraries, not editors targeting inconstiencies they all can never know what's gonna happen medium

Clipboard CKEditor ”fixes” paste problems by implementing a custom fake context menu and opening a modal with some instruction that the user should press ctrl+v. This is a UX nightmare. Other editors like retractor (oder so) sanitize any change to the editors contents for the case of input by paste events.

3.13 Rich-text editing without editing APIs

Manipulating the DOM, e.g. changing the contents of a website—or particular parts of a website—has been possible since the first implementations of JavaScript and JScript and has been standardised in 1998 with the W3C's ”Document Object Model (DOM) Level 1 Specification”[47]. Any DOM manipulation that can be achieved with HTML editing APIs can also be achieved using this API.

To implement formatting commands, the currently selected text can be wrapped in newly created tags, depending on what formatting shall be achieved. For instance, to implement the `bold` commmand of `execCommand`, the selected text can be read

[47] http://www.w3.org/TR/REC-DOM-Level-1/level-one-core.html, last checked on 07/10/2015

with the browser's selection API[48][49] and wrapped in `strong` tags using basic DOM Level 1 methods. Insertion commands can be implemented with basic DOM Level 1 methods to create and append elements. Table ABC lists commands that can be invoked with execCommand and possible equivilents with DOM Level 1 methods. Specific cross-browser implementations will be discussed in section XY.

Google completely rewrote their document editor in 2010 abandoning HTML editing APIs entirely. In a blog post[50], they stated some of the reasons discussed in section XYZ. They state, using the editing mode, if a browser has a bug in a particular function, Google won't be able to fix it. In the end, they could only implement "least common denominator of features". Furthermore, abanding HTML editing APIs, enables features not possible before, for example tab stops for layouting.

With their implementation, Google demonstrates it is possible to implement a fully featured rich-text editor using only JavaScript and not HTML editing APIs. However, fetching input and modifying text will not suffice to implement a text editor or even a simple text field. There is many more things, that need to be considered.

Caret The most obvious part is probably the text caret. Even if a user types on his or her keyboard, a caret must be seen on the screen to know where the input will be inserted. The caret also needs to be responsive to the user's interaction. In particular, the user must be able to click anywhere in the editable text and use the arrow keys to move it (possibly using modifier keys, which's behaviour even depends on the operating system used).

Selection Just like the caret, the user must be able to draw a text selection using his or her mouse and change the selection using shift and the arrow keys. Most systems allow double clicks to select words and sometimes tripple clicks to select entire paragraphs. Other systems, for example OS X, allow holding the option key

[48]https://developer.mozilla.org/en-US/docs/Web/API/Selection, last checked on 07/18/2015

[49]Internet Explorer prior version 9 uses a non-standard API https://msdn.microsoft.com/en-us/library/ms535869(v=VS.85).aspx, last checked on 07/18/2015

[50]http://googledrive.blogspot.fr/2010/05/whats-different-about-new-google-docs.html, last checked on 07/18/2015

to draw are rectengular text selection, independent of line breaks.

Context menu The context menu is different in text inputs from other elements on a website. Most importantly, it offers an option to paste text, that is only available in native text inputs.

Keyboard shortcuts Text inputs usually allow keyboard shortcuts to format the text and to perform clipboard operations. Formatting the text is possible through DOM manipulation, pasting text however is a challenge, since browsers do not offer arbitrary access to the clipboard for security reasons.

Undo / Redo Undo and redo are common functions of text processing and it may be frustrating to users if they were missing.

Behaviour Rich-text editors (usually) share a certain behaviour on user input. When writing a bulleted list, pressing the enter key usually creates another bulleting point instead of inserting a new line. Hitting enter in a heading will insert a new line. However pressing enter when the caret is at the end of a heading commonly creates a new text paragraph just after that heading. Other rules that need to be considered will be discussed in section [implementation].

Switching an element to editing mode enables these components natively. The user can click in a text and move a caret with the keyboard's arrow keys. He or she can copy and paste text with no further scripting. The browser offers the same native context menu as for text inputs. All major browsers implement the common behaviour that is common for rich-text editing as described.

When not using editing APIs, all of this must be implemented with JavaScript. This requires a lot of trickery and many components must be *faked* to make it *seem* there is an input field, where there is none. The user must be convinced he or she is using a native input and must not notice he or she isn't. Many of the techniques to mimick a native text input like this can be found in web-based code editors like "ACE" or "CodeMirror".

Using tricks and *faking* elements or behavior is common in web front end development. This applies to JavaScript as well as to CSS. For instance, long before CSS3 has been developed, techniques (often called "hacks") have been discussed on how to implement rounded corners without actual browser support. Only years later, this has become a standard. This not only enables features long before the creators of browsers implement them, this *feedback* by the community of web developers also influences future standards. Encorporating feedback is a core philisophy of the WHATWG, the creators of HTML5.

3.14 Advantages of rich-text editing without Editing APIs

With a pure JavaScript implementation, many of the problems that editing APIs have, can be solved.

Generated output and flawed API The generated markup can be chosen with the implementation of the editor. Furthermore, an editor can be implemented to allow developers using the editor to *choose* the output. Section AX describes the inconsistent output across various browsers as well as the problems of the API design of `execCommand`. Both issues can be adressed by offering a method to wrap the current selection in arbitrary markup. jQuery's `htmlString` implementation[51] demonstrates a simple and stable way to define markup in a string and pass it as an argument to JavaScript methods. A sample call could read as

```
1 // Mimicking document.execCommand('italic', false, null);
2 editor.format('<em />');
3
4 // Added functionality
5 editor.format('<span class="highlight" />');
```

Listing 3.7: Example calls to format text

[51] http://api.jquery.com/Types/#htmlString, last checked on 07/19/2015

With an implementation like this, developers using the editor can choose which markup should be generated for italicising text. The markup will be consistent in the scope of their project unless chosen otherwise. Since the DOM manipulation is implemented in JavaScript and not by high-level browser methods, this will also ensure the same output on all systems and solve cross-browser issues. The second example function call in listing 3.7 demonstrates that custom formatting, fitting the needs of a specific project, can be achieved with the same API.

As described in section AB, many components native to text editing have to be implemented in JavaScript. This requires some effort but also enables full control and direct over it. Ultimately, these components can be exposed in an API to other developers, enabling options for developing editors, not offered by HTML editing APIs. An example API will be discussed in sectionXImplementationn.

Not extendable When implementing and editor in pure JavaScripts, the limitations aufgedrÃijck by the editing mode, do not apply. Anything that can be implemented in a browser environment can also be implemented as part of a (rich-)text editor. The Google docuement editor demonstrates rich functionality incliding layouting tools or floating images. Both of which are features that are hardly possible in an editing mode enabled environment[52]. SectionABC discusses some use cases exploring the possibilites of rich-text editing implemented this way.

Clipboard In a pure JavaScript environment, clipboard functionality seems to be harder to implement than with the use of editing mode. Apart from filtering the input, pasting is natively available—via keyboard shortcuts as well as the context menu. However, as demonstrated in section IMPLEMENTATION, it is possible to enable native pasting—via keyboard and context menu—even without editing mode. Furthermore, it is possible to filter the pasted contents before inserting them in the editor.

[52]http://googledrive.blogspot.fr/2010/05/whats-different-about-new-google-docs.html, last checked on 07/19/2015

Bugs No software can be guaranteed to be bug free. However, refraining from using HTML editing APIs will render developing an editor independent from all of these APIs' bugs. Going a step further, the implementation can be aimed to minimize interaction with browser APIs, especially unstable ones. DOM manipulation APIs have been standardized for more than 15 years and tend to be well-proven and stable. This will minimize the number of "unfixable" bugs and ultimately free development from being dependent on browser development, update cycles and user adoption. Bugs can be fixed quicker and rolled out to websites. This means that, other than with HTML editing APIs, bugs that occur are part of the library can be fixed and not only worked around. Furthermore, with minimizing browser interaction, bugs probably occur indeopendently of the browser used, which makes finding and fixing bugs easier.

3.15 Disadvantages of rich-text editing without Editing APIs

Formatting Editing APIs' formatting methods take away a crucial part of rich-text editing. Especially on the web, where a text may have many sources, formatting must account for many edge cases. Nick Santos, author of Medium's rich-text editor states in regeards of their editor implementation:

> *"Our editor should be a good citizen in [the ecosystem of rich-text editors]. That means we ought to produce HTML that's easy to read and understand. And on the flip side, we need to be aware that our editor has to deal with pasted content that can't possibly be created in our editor."*[53]

An editor implemented *without* HTML editing APIs does not only need to account for content (HTML) that will be pasted into the editor[54] (in fact, content should be sanitized before it gets insterted in the editor, see sections A and b, paragraphs

[53] http://stackoverflow.com/questions/11240602/paste-as-plain-text-contenteditable-div-textarea-word-excel/11290082112900082, last checked on 07/13/2015

[54] Medium uses HTML editing APIs

"clipboard"), but also for content that will be loaded on instantiation. It cannot be assumed that the content that the editor will be loaded with (for example integrated in a CMS), is *well-formatted* markup or even valid markup. "Well-formatted" means, the markup of a text is *simple* in the sense that it expresses semantics with as few tags as possible (and it conforms the standards of the W3C). The same visual representation of a text, can have many different—and valid—underlying DOM forms. Nick Santos gives the exaple of the following text[55]:

The hobbit was a very well-to-do hobbit, and his name was ***Baggins***.

The word "Baggins" can be written in any of the following forms:

```
1 <strong><em>Baggins</em></strong>
2 <em><strong>Baggins</strong></em>
3 <em><strong>Bagg</strong><strong>ins</strong></em>
4 <em><strong>Bagg</strong></em><strong><em>ins</em></strong>
```

Listing 3.8: Different DOM representations of an equally formatted text

A rich-text editor must be able to edit any of these representations (and more). Furthermore, the same edit operation, performed on any of these representations must provide the same *expected* behavior, i.e. generate the same visual representation and produce predictive markup. Above that, being a "good citizen" it should produce simple and semantically appropriate HTML even in cases when the given markup is not. It may even improve the markup it affects.

Mimicking native functionality As described in section XY, rich-text editing consists of many components like the caret or the ability to paste text via a context menu. These basic components require complex implementations. HTML editing APIs offer these components natively without further scripting.

[55] http://stackoverflow.com/questions/11240602/paste-as-plain-text-contenteditable-div-textarea-word-excel/11290082112900082, last checked on 07/13/2015

Possible performance disadvantages Modifying the text on a website means manipulating the DOM. DOM operations can be costly in terms of performance as they can trigger a browser reflow[56]. The same goes for mimicking some elements like the caret. To display a caret a DOM element like a `div` is needed and it needs to be moved by changing its style attribute. While it should be a goal to keep browser interactions to a minimum, there is no way to avoid DOM interaction with any visual text change.

File size While bandwidth capacities have vastly improved, there may still be situations where a JavaScript libraries' file sizes matter. This may be for mobile applications or for parts of the world with less developed connections. When not using HTML editing APIs a lot of code must be written and transmitted just to enable basic text editing, which would not be needed otherwise.

3.16 Disadvantages of offering user interface components

Most rich-text editors are implemented and distributed as user interface components. That means instead of only providing a library that offers methods to format the selected text and leaving the implementation of the user interface to the respective developer, most libraries are shipped as input fields with a default editor interface that is, at best, customizable.

This can be unfitting for many situations. The user interface of an editor highly depends on the software it will be integrated in. Within the software the interface may even vary depending on the specific purpose within it. For instance, a content management system may require an edtitor with a menubar offering many controls while a comment form on a blog requires only very little controls. Medium.com uses an interface that only shows controls when the user selects text and has no menubar at all. Assuming there are many implementations of editors, it seems, choosing between

[56] https://developers.google.com/speed/articles/reflow, last checked on 07/19/2015

editors is often just a choice of the desired ui. Customizing a ui can be just as complex as writing a ui from scratch. The latter affords to add HTML elememts and call JavaScript methods. In a worst case styling the elements can be just as much effort.

It can be much more fitting for developers to include a library that handles all text-input and -formatting operations while only providing a powerful API, leaving the ui to the developer. The API must be *well-designed*. That means it must be simple, effective and fit the developers' needs. The methods it offers should be simple in the sense that they conceal possibly complex tasks with understandable high-level concepts. They should be effective and fit the developers' needs in the sense that the API should be designed so that any requirements should be matched with as little effort as possible. The API should create a workflow for developers that allows them to do what they want to do and is as easy to use as possible. jQuery is an example of encorporating an API conforming these principles.

Chapter 4

Concept

4.1 Conformity with HTML Editing APIs

Wie sehr passt meine library zu dein HTML Editing APIs Was definieren die? Was muss ich conformen, welche Freiheiten habe ich? https://dvcs.w3.org/hg/editing/raw-file/tip/editing.html

4.2 Leave as much implementation to the browser as possible

"Easy to make it fast – The browser (not the app) handles the most computationally intensive task: text layout. Since layout is a core component of browser functionality, you can trust that layout performance has already been heavily optimized." http://googledrive.blogspot.fr/2010/05/whats-different-about-new-google-docs.html

4.3 Markup

Our editor should be a good citizen in this ecosystem. That means we ought to produce HTML thatâĂŹs easy to read and understand. And on the flip side, we need to be aware that our editor has to deal with pasted content that canâĂŹt possibly

be created in our editor. https://medium.com/medium-eng/why-contenteditable-is-terrible-122d8a40e480

4.4 Partially using HTML editing APIs

That would be one way **note: try to show all the options for implementation for WeWu**

4.5 MVC

Document model -> no

4.6 Stability and performance

Cache For traversing the text, for example when the caret moves, the text will need to be measured. All measurements can be stored to a cache to only perform the same measurement operations once. On the other hand, the library should be a "good citizen" on a website, which means it should be as unobtrusive and leave the developers as much freedom as possible. The library will essentially modify parts of the DOM that act as the editor's contents. It should be agnostic to the editor's contents at all times to give other developers the freedom to change the contents in any way needed without breaking the editor. A cache must account for external changes. The DOM3 Events specification[1] offers `MutationObserver`s to check for DOM changes. This feature is not supported by Internet Explorer version 10 or less[2]. Internet Explorer 9 and 10 offer an implementation for `MutationEvents`[3]. The W3C states that "The MutationEvent interface [...] has not yet been completely and interoperably implemented across user agents. In addition, there have been critiques that the interface, as designed, introduces a performance and implementation

[1] http://www.w3.org/TR/DOM-Level-3-Events/, last checked on 07/21/2015
[2] http://caniuse.com/#search=mutation, last checked on 07/21/2015
[3] http://help.dottoro.com/ljfvvdnm.php#additionalEvents , last checked on 07/21/2015

challenge."[4]. Apart from that, the benefits of a cache may not signifcantly increase the library's performance. The actions that can be supported by a cache, most importantly moving the caret in the text, are not very complex and do not noticably afflict the CPU. Implementing an editor that is stateless in regards of its contents can also improve stability.

Minimze interaction with the DOM DOM operations are slow and should be avoided. DOM operations can be "collected" and only executed when necessary etc pp like React.

Minimze interaction with unstable APIs Some APIs like the `Range` or `Selection` are prone to numerous bugs. To maximize stability, these APIs should be avoided when possible unless doing so has any downsides (like lower performance).

[4]http://www.w3.org/TR/DOM-Level-3-Events/#legacy-mutationevent-events, last checked on 07/21/2015

Chapter 5

Implementation

5.1 JavaScript library development

No IDEs, tools, not even conventions.

Not for building: Big JS libraries all do it differently. Top 3 client side JavaScript repositories (stars) on github https://github.com/search?l=JavaScript&q=stars%3A%3E1&s=stars&ty Angular.js: Grunt d3 Makefile, also ein custom build script welche node packages aufruft jQuery custom scripts, mit grunt und regex und so

Not for Architecture Angular custom module system with own conventions d3 mit nested objects (assoc arrays) und funktionen jQuery mit .fn ACE mit Klassen, daraus habe ich gelernt

5.2 Ich habe verwendet

Gulp requireJs AMDClean Uglify

JSLint - Douglas Crockford coding dogmatas / conventions JSCS - JavaScript style guide checker

Livereload PhantomJs Mocha Chai

Durch Require und AMDClean schÃűne arbeitsweise (am ende Ãijber bord geworfen) und kleine DateigrÃűÃ§e, wenig overhead.

Automatisierte Client side Tests mit PhantomJs und Mocha/Chai

5.3 Coding conventions

Habe mich grÃűÃ§tenteils an Crockfordstyle orientiert, aber die Klassen anders geschrieben. Habe den Stil von ACE editor verwendet, denn der ist gut lesbar. Lesbarkeit war mir wichtiger als Crockford style. FÃijr private Eigenschaften und Methoden habe ich die prefix convention verwedendet. https://developer.mozilla.org/en-US/Add-ons/SDK/Guides/Contributor_s_Guide/Private_Properties Sie bewirkt keine echte accessibility restriction, aber es ist eine allgemein anerkannten convention und ist auch viel besser lesbar.

5.4 Coding Klassen

Ich habe mich fÃijr Klassen entschieden. Das hat folgende Vorteile:

* Klassen sind ein bewÃďhrtes Konzept um Code zu kapseln, logisch zu strukturieren und lesbar zu verwalten * Durch prototypische Vererbung existiert die funktionalitÃďt von Klassen nur 1x im Browser 7 RAM * Zudem gibt es Instanzvariablen, die fÃijr jede Type Instanz extra existieren und so mehrere Instanzen erlauben * Die instanzvariablem sind meistens nur Pointer auf Instanzen anderer Klassen * Das ganze ist dadurch sehr schlank

5.5 Programmstruktur

Es gibt ein Basisobjekt, das ist die Type "Klasse". Darin werden dann die anderen Klassen geschrieben "Type.Caret", "Type.Selection", "Type.Range", ... Das hat den Vorteil dass das ganze ge-name-spaced ist, so dass ich keine Konflikte mit Systemnamen habe (Range) (und auch nicht mit anderen Bibliotheken) Effektiv gibt es eine (flache) Baumstruktur und so mit Ordnung. FÃijr bestimmte Klassen, "Type.Event.Input", "Type.Input.Filter.X" geht es tiefer. Der zweite Grund ist, dass ich somit alle Klassen die ich geschrieben habe fÃijr Entwickler sichtbar bereit stelle und nicht implizit und versteckt Ãijber irgend nen Quatsch.

UrsprÃijnglich ein MVC konzept geplant mit einem Document Model und verschiedenen Renderern, aber Ãijber den haufen geworfen.

Ich werde jetzt die einzelnen Module erlÃd'ren

5.6 Type

Die Type

5.7 Caret

caret

5.8 Range

range

5.9 Input

There are many devices (hardware and virtual) a user can interact with native inputs:

1. Keyboard (as hardware and as virtual keyboard)
2. Mouse
3. Touch
4. Game controller (on browsers imlpemented in game consoles)
5. Remote control (on Smart TV einvironments)

When simulating a native input, in a best-case scenario, all these input methods should be accounted for. Fetching input needs to account for two scenarios: The user clicks / touches / or selects the input in any way and does so at any position inside the input. If the user touches / clicks / etc in the middle of the text, the caret should

move to that position and typing must be enabled. In environments without hardware keyboards, the libarary must ensure that a virutal keyboards, possible native to the system, show up. Once the input is selected, text input must be fetched and written to the editor. There are various options to fetch user input, which will be discussed in the following paragraphs:

Events One way to fetch user input is by listening to events. Text input can be read through `KeyboardEvent`s. Keyboard events will be triggered for virtual keyboards just as for hardware keyboards. When the user presses a key, the event can be stopped and the according characters can be inserted at the position of the caret. As a downside, listeners for keyboard events cannot be bound to a specific element that is not a native text input, that means keyboard events must be listened to on the `document` level. This not only has (minor) performance downsides but als requires more logic to decide whether a keyboard input should be processed and ultimatively stopped or ignored and allowed to bubble to other event listeners of a website. Furthermore, there can be edge cases, where even though a keyboard event should write contents to the editor, the event itself is supposed to trigger other methods that are not part of the editor. Keyboard events are supported by all major browsers across all devices.

To support clicking or touching inside the editor's contents `MouseEvent`s and `TouchEvent`s can be used. Mouse events are supported on all major desktop browsers and all mobile browsers support touch events. Both event types support reading the coordinates indicating where the click or touch has been performed.

Although some smart TVs offer keyboards, mice, pointers similar to Nintendo's Wii remote or input via smartphone apps, button-based remote controls are offered with almost any smart TV and remain a edge case for interacting with a text editor. In such an enviroment, users commonly switch between elements by selecting focusable elements with a directional pad. Using only events would not account for this case since there would be no focusable element representing the editor. Recent browsers

on Samsung's and LG's smart TVs are based on WebKit[1] while Sony's TVs use Opera. Before 2012 Samsung's browser was based on Gecko. All of these browsers and browser engines supprt keyboard events to fetch input.

Clipboard

Hidden native input fields

5.10 Selection

5.11 Selection Overlay

overlay

5.12 Formatting

formatting

5.13 Change Listener

change

5.14 Contents

contents

5.15 Development

developmnent

[1] http://www.samsungdforum.com/Devtools/Sdkdownload, last checked on 07/22/2015

5.16 Dom Utilities

dom util

5.17 Dom Walker

dom walker. Used SO OFTEN in the project. Goal is to have a really simple api new DomWalker('text') by having lots of pre-defined magick in it.

5.18 Environment

env

5.19 Core Api

core api

5.20 Event Api

ev api

5.21 Events

Input input event only event required so far

5.22 Input Pipeline

pipeline idea rules for behaviours (lists, headlines, enter, spaces...)

Caret caret

Command command

Headlines head lines

Line Breaks line breaks

Lists lists

Remove remove

Spaces spaces

5.23 Plugin Api

plugin api

5.24 Settings

settings

5.25 Text Walker

text walker

5.26 Utilities

util

5.27 Extensions

Collaboration with etherpad, Markdown wohl eher als Ausblick.

Appendix A

Tables

Method	Description
execCommand	Executes a command.
queryCommandEnabled	Returns whether or not a given command can currently be executed.
queryCommandIndeterm	Returns whether or not a given command is in the indeterminate state.
queryCommandState	Returns the current state of a given command.
queryCommandSupported	Returns whether or not a given command is supported by the current document's range.
queryCommandValue	Returns the value for the given command.

Table A.1: HTML Editing API

Appendix B

Figures

Bibliography