

Unplagged Developers Manual

Building the Plagiarism Detection Cockpit

Term paper for the master project I

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Introduction

After Minister Guttenberg had to resign, because of the plagiarisms found in his doctoral thesis, the big media coverage and interest in plagiarism in Germany has very much subsided ([Google, 2012](#)). However, the initial idea for the creation of the “Unplagged” project, whose development approach will be described here, can be found in this very case of plagiarism. Related to it were the formation of the [GuttenPlag](#) and its descendent [VroniPlag](#). Both are Wiki-based communities that are collaboratively discovering and collecting plagiarism in their respective cases and are kind of the role models for the way the Unplagged system is developed.

The project idea and context were provided by our professor Dr. Debora Weber-Wulff and the two-term master project, every media informatics student at the [HTW-Berlin](#) has to take. Professor Weber-Wulff is a well known expert in Germany on the topic of plagiarism. As she has also done research in this field for over ten years and is actively involved in the VroniPlag community under her synonym “WiseWoman”([Spiegel-Online, 2011](#)), she came up with the idea to build a dedicated system — a “Plagiarism Detection Cockpit”([Weber-Wulff, 2011](#)) — that is modeled after the experiences that were made with the workflow used in VroniPlag and GuttenPlag.

So, to put it in a catchy marketing phrase, here is what Unplagged aims to become:

Unplagged is a simple, web-based, collaborative system to help discover, collect and document plagiarism in scientific papers.

To make things a bit more conceivable, we also often refer to it as a mixture of a very specialised text editor, with a focus on comparing texts and marking passages and a modern project management tool like [Redmine](#) or [JIRA](#), to manage the collaborative

aspects of the system. The big distinction we make to other plagiarism software on the market is, that the approach is not to autodetect plagiarism, but focused on aiding the workflow of the users while searching for plagiarized fragments inside a scientific paper, a homework assignment or any other kind of probable textual plagiarism.

This present document will be the handbook that gets you started if you are interested in helping us with the development of this open source project, which is licensed under the [GNU GPLv3](#).

Chapter Overview

One of the biggest problems we faced at the start was, that none of the team members had written a longer scientific text than a bachelors thesis and therefore the experience we got with actual scientific writing was very limited and very specific to the field of computer science. We understand the ethical problems, that come with the betrayal of good scientific practice of plagiarists, but we simply can not relate easily to the amount of work that has to be put into a PhD., or be as passionate about plagiarism as Prof. Weber-Wulff always is, because we never experienced it ourselves.

That is why we had a lot of catching up to do on the most important history behind VroniPlag, the different types of plagiarism, different citation styles and the research Prof. Weber-Wulff and others had already done on systems that try to help finding plagiarism. Chapter 1, [A Plagiarism Primer](#), will give a brief overview of the most important topics to get you up to speed with the domain of the software, if you are not already familiar with it.

Chapter 2, [Project Workflow and Requirements](#), will be the place, where the development process is described and a collection and description of the parts of the system, that already exist or that we identified as necessary parts of Unplagged will be given. As the system is developed with an agile project management style, this will be done primarily based on the product backlog.

If you know all those things already and simply want to get started working and coding,

you should probably jump to [3, Developing Unplugged](#). This chapter will give the technical insights into the system, the basic installation steps and all necessary tools for you as a developer.

And if this still isn't enough reading material for you, the appendices show you..

Conventions

To markup important words in the text, the following typographical conventions are used:

Italic

First used technical terms

Constant Width

Programm code, file names, paths

Bold Constant Width

Variables that have to be changed by the user

1. A Plagiarism Primer

1.1. Basic Classification of Plagiarisms

1.1.1. Copy&paste

1.1.2. Copy, shake&paste

1.1.3. Patchwriting (rewriting)

1.1.4. Structural plagiarism

1.1.5. Translations

1.2. How to detect plagiarism

1.2.1. Software systems

1.2.2. Human approach

1.3. Vroni Plag

2. Project Workflow and Requirements

First of all, we've got a confession to make: Unplagged is like a big playground of new workflows and technologies for us, as we are aiming to incorporate "best-practices" wherever possible, or at least what we currently consider to be best-practices.

We believe this approach is necessary, because of the fact, that we are essentially trying to incubate Unplagged as a real open source project and this will only work if it is well crafted and if cutting-edge workflows and technologies are used. Nearly all of the team members are also working in some kind of web related side job, so we all got enough experiences with the problems that can occur during the maintenance of badly designed software.

Most of the times this works pretty well, but sometimes we are still trying to figure out how to get everyone up to speed with every technology and part of the system or how to divide the responsibilities carefully.

To start this project, we opted to use *Scrum*¹ as our agile development approach. If you are familiar with this methodology, you may notice, that there could be a few problems when considering, that the team is working mostly distributed without a common office and with very different time tables for each of the members.

We struggled a bit to tweak the workflow that is required by Scrum to fit the situation we faced, but you will see in the following what we came up with.

¹A nice introduction into Scrum is "The Scrum Primer" of the Scrum Alliance: <http://www.scrumalliance.org/resources/339>

2.1. The Workflow

To make it possible to work efficiently together in this kind of environment, we chose to use [Redmine](#) as our project management tool, which you can access under:

- <http://tickets.unplagged.com>

If you register there, an administrator should grant you access to the tickets and the wiki, so that you can participate in solving the problems at hand.

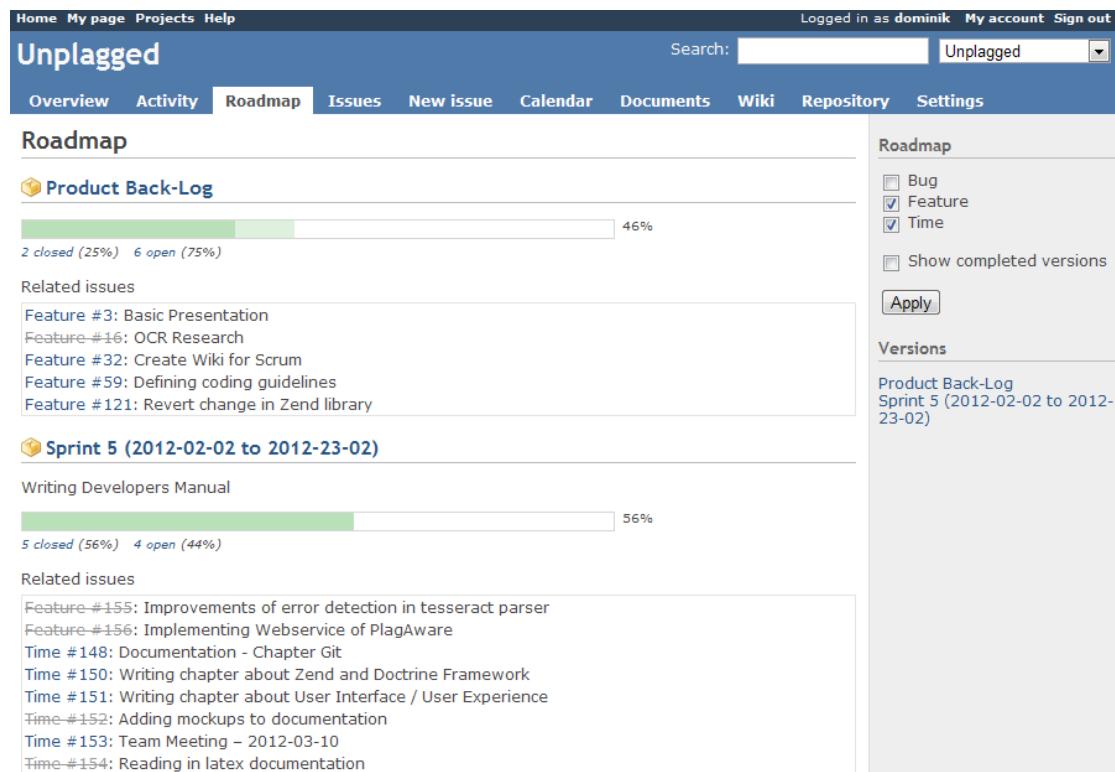


Figure 2.1.: Redmine Roadmap

What we are doing there is to map every *Sprint* and the *Product Backlog* to Redmine's notion of "Version" and every identified *User Story* to an "Issue".

You can see in figure 2.1 the view of the roadmap, with the current sprint 5 designated to create this very document at the bottom and a not very well filled product backlog at

the top.

Normally every identified user story that is not part of the current sprint should be in the product backlog (and we got plenty), but as we were still working in our small group at this point, the hassle of filling in all the tickets seemed unnecessary. This is something that will be fixed in the near future, so that you are able to see where the development is going.

Currently we are working mostly with four week long sprints, to overcome the problem that we are not working fulltime on the tickets, which is something that scrum normally assumes.

To have a nice statistical overview and more planning security for the “scrums”, it is required to log the time that was spent on an issue within redmine.

2.1.1. Product Owner — “The Debbie Meetings”



Figure 2.2.: Scrum Meeting

To figure out the user stories we mostly rely on what we internally call “Debbie Meetings”. Normally at the end of every sprint, the members of the team meet with Prof. Weber-Wulff, who we state to be our *Product Owner*. We simply sit down there and talk about

what should be implemented in the next sprint and collect it on cards as you can see in figure 2.3.

We consider this to be just a temporary way of handling this, because we hope that when we eventually have a prototype that we consider to have enough “business value” to be shown to more people, the focus will shift away from Prof. Weber-Wulff to a more broader understanding of the product owner.

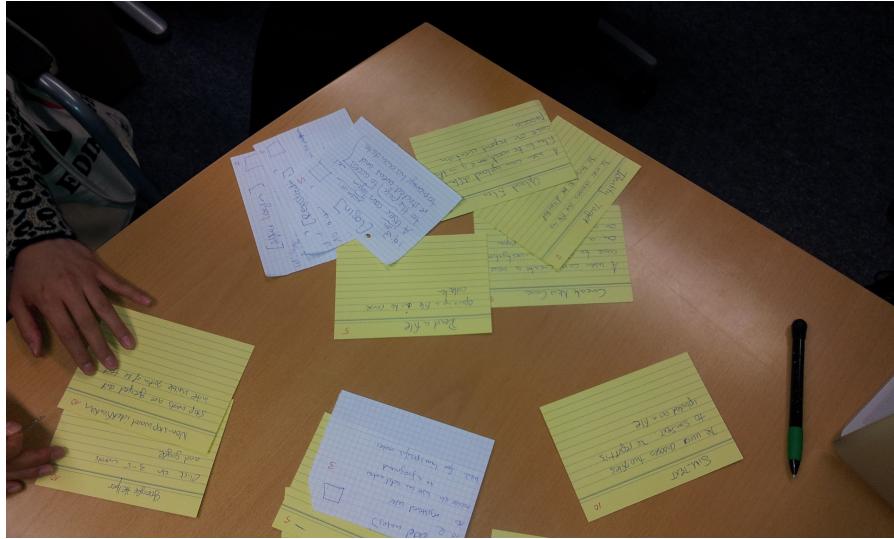


Figure 2.3.: User Stories

This means, that we want to open up our ticket system to directly collect new user stories and gather feedback for example from the VroniPlag group, which can be reached through their IRC channel #VroniPlag on:

- <http://webchat.freenode.net/>

2.1.2. Team Meetings

The Unplugged version of the *Daily Scrum* is currently a weekly meeting. Even our meetings weren't daily, it was still a meeting which was respecting the other characteristics of a *Daily Scrum*. Each team member used to say what he did for the last week and

what he attends to do for the next week. These meetings were good occasions to verify the evolution of the project and determine the possible bottlenecks as soon as possible.

Our projectteam was doing the meetings every monday for at least one hour. Most of the times we met at the same place, if due to appointment collisions we couldn't manage to meet in persons, we met in Skype. So we never used to skip the weekly meeting.

For each meeting that we held someone was responsible for writing the protocol about the meeting. For each protocol a new wiki-page was created to our [Redmine](#). To put the protocols to our [Redmine](#) was really helpful for the teamwork. So everybody had access to it and could if necessary have a look on the decisions which were made in the past.

During the meetings at least these following points have been discussed:

- What was done last week.
- What will be done for the next week.
- Organisation issues.
- External dependencies issues.
- Problems encountered last week.
- Further questions.

All the protocols which were made during the phase one are available on the appendix [A](#) (page number [31](#)).

2.2. Target Group

The main goal of the application is to support the detection of plagiarism. So the target group is composed of people who want to correct documents and be sure that this does not contain any plagiarism.

The following list is showing people who could be interested in using this application:

- Professors
- Teachers
- Academics
- Instructors
- Tutors
- ...

This people are mostly not it-specialists, so it is important to focus on it during the development of the application. This has an influence on the way they will use the application: it must be easy and naturally to use, the results must be easy to understand and reliable.

2.3. User roles

As the Unplagged system will provide a permission based user system, our goal is to make it possible, to create custom user roles from an administration area and make it possible for users to have multiple user roles in one case and also different roles for different cases. The standard roles which will be provided by the system are:

Guest A user without a valid login can only see the parts of cases that are set to be public.

Registered Registered users can get “promoted” to higher roles and contribute to publicly editable cases.

Collaborator Collaborators are registered users who were granted access to a specific case. Collaborators can access and edit these projects.

Case-Manager Case-Managers can set up new cases and manage collaborators for their cases and project versions. They may have the permission to add or remove project members.

Admin An admin owns all permissions, such as user administration or project administration. They also have the ability to block/unblock an existing case.

2.4. Basic functionalities

2.4.1. Register

2.4.2. Sign up

2.4.3. Files overview

Set target

Parse

Download

Delete

2.4.4. Parsed files overview

2.4.5. Edit profile

2.5. Document Parser

2.6. Detection Modes

2.7. Plugin Architecture

2.8. Use Cases

3. Developing Unplagged

Coming from the [Project Workflow and Requirements](#) here we have yet another set of requirements, before we can start with the actual description of the way you can help us develop the system. This time it's about what we believe will be helpful or sometimes even necessary prerequisites.

First of all, the programming languages mostly used in Unplagged are PHP and JavaScript, both of which in conjunction with a framework. Teaching programming languages is, as you probably can imagine, well beyond the scope of this document, but we will at least try to cover the most important concepts of the frameworks as they occur.

The used frameworks are [jQuery](#) for Javascript and [ZEND](#) for PHP respectively. jQuery is kind of the industry standard for unobtrusive scripting with about 50% of the Top 10.000 websites using it according to [Built With Trends \(2012\)](#) and the Zend framework is also well established and brings a lot of features, that are useful to this project.

For most of the other topics, we will give you some (hopefully) helpful resources on the way, if it isn't covered thoroughly by us. But just to let you know, here is a list of the buzzwords, er technologies that will be mentioned:

- Scrum
- HTML5 and CSS3
- Continuous Integration
- Responsive Webdesign

- Progressive Enhancement
- Git, Netbeans, Redmine
- Tesseract, Imagemagick
- Simtext

As said in section ??, the system is developed, so that it should work on multiple platforms. This makes it sometimes difficult to describe certain installation processes in a way that would work for everybody. As it's often most problematic, to get some Linux software running on Windows, we will mostly concentrate on the way those things are done on this platform and give the instructions for other operating systems as an aside if necessary.

3.1. Development Environment

The following parts will mostly focus on the way you can get a development version of unplagged up and running on your system.

3.1.1. Git

The source code and files of all parts of the Unplagged project are managed through Git, with the repository hosted at [Github](#). Git is a distributed version control system, that exists since 2005 and gained more and more track in recent years. Many developers prefer it over other version control systems, because it is much easier to create different branches and merge them again or simply initialize local repositories. This made it also interesting for us to use it for Unplagged.

However, none of the team members had ever used Git before in a bigger context so it was a challenge to get it running on all the systems. But we took it, to explore all the features Git offers. .

Installing Git Bash

First of all let's find out, how to install the Git console application, called Git Bash. Unfortunately all the GUIs we were evaluating didn't work consistently, so we decided to use it from the command line only. A very good instruction on how to install the Git Bash can be found on the website of the github project:

Windows: <http://help.github.com/win-set-up-git/>

Linux: <http://help.github.com/linux-set-up-git/>

Mac OS X: <http://help.github.com/mac-set-up-git/>

Getting the source code of the unplagged project

Now it is time to get the project source code on your machine. As said before, the whole unplagged project is hosted on github, so if you want to be able to contribute source code later on, you first need to create an account there:

- <https://github.com>

This isn't necessary, if you simply want to look into the source code, which can be accessed via the repository URL:

- <https://github.com/benoertel/unplagged>

If you haven't been granted write access to the above mentioned repository by a project member (which is very likely when you are reading this document for the first time), you will need to do a fork of the Unplagged project right at github, like described in:

- <http://help.github.com/fork-a-repo/>

After this, the following steps are mostly the same for everybody, with the distinction of the project URIs, which should be the one of your newly created fork.

Open up the Git Bash and switch to the directory where you want the project to be located and clone the repository as you can see in listing 3.1.

Listing 3.1: Cloning a repository

```
1 cd Sites/unplagged.local  
2 git clone  
    https://<username>@github.com/benoertel/unplagged.git
```

After this you should have a local copy of all the repository data in the specified directory.

The most important git commands

You are now ready to use Git! Here are some more instructions on the most important commands and how to properly use it. However, if the given instructions in this manual are not enough, feel free to checkout the whole Git manual on:

- <http://schacon.github.com/git/user-manual.html>

The unplagged project consists of several branches, which are used to develop and store code independently of the other developers. Once a new feature is done, it is merged into the master branch. The master branch usually includes only fully tested and deployable source code.

As a new developer, it is important to create an own branch before doing anything else and switch to it.

Listing 3.2: Creating branches

```
1 git branch mynewfeature  
2 git checkout mynewfeature
```

Now anything in the repository can be changed. At any point changes can be versioned in the repository by using the `git commit` command. If new files were created, `git add` has to be executed as well.

Listing 3.3: Committing

```
1 git add .
2 git commit -m "A message that describes the changes."
```

When the feature is fully working and approved, it has to be merged back to the master branch, in order to get deployed to the staging environment. To do this, the master branch has to be checked out, updated with `git pull` and then all changes have to be merged from the new feature into the master branch. The feature branch can then be removed.

Listing 3.4: Merging branches

```
1 git checkout master
2 git pull
3 git merge mynewfeature
4 git branch -d mynewfeature
```

In comparison to Subversion for example, Git has one more step to really write back to the remote source repository. After a `git commit`, a `git push` has to be executed, each push can include multiple commits.

Listing 3.5: Pushing to the server

```
1 git push origin master
```

This is nearly it, the changes to the repository have been pushed to the master branch. The only thing, that probably has to be done now, is to open up a pull request on github, if you developed on your own fork of the project. This means, that you are asking the project members who have access to the “real” Unplugged github account, to integrate your changes into the actual project sources. A nice description of how this process is done can be found at github again:

- <http://help.github.com/send-pull-requests/>

Handling conflicts in merging process

It is possible, if two developers were working on the same part of file, that a conflict is found during the merge. Such a conflict could look like this:

Listing 3.6: Merge conflict

```

1 CONFLICT (content): Merge conflict in readme.txt
2
3 To https://github.com/benoertel/unplagged.git
4 ! [rejected]          master -> master (non-fast-forward)
5 error: failed to push some refs to 'https://github.com/
       benoertel/unplagged.git'
6 To prevent you from losing history, non-fast-forward updates
   were rejected
7 Merge the remote changes (e.g. 'git pull') before pushing
   again. See the
8 'Note about fast-forwards' section of 'git push --help' for
   details.
9
10 # Unmerged paths:
11 #   (use "git add/rm <file>..." as appropriate to mark
12 #     resolution)
13 #   both modified:      readme.txt
14 #

```

To resolve the issues, open the files listed in the error message, in this case *readme.txt* and decide how the correct version should look like, by removing all the “<<<<< << HEAD” and “>>>>>> b478801d68267ef479acc5ca54544634c52c545c” parts accordingly or using a dedicated merge tool, that is able to show you the changes that were made

Here is an example of how this process would work:

Listing 3.7: Conflicted file

```
1 <<<<< HEAD
2 The goal of this project is the creation of an easy-to-use,
   web-based
3 system to document and detect plagiarism in scientific papers.
4
5 hello world
6 =====
7
8 The goal of this project is the creation of an easy-to-use,
   web-based
9 system to document and detect plagiarism in scientific papers.
10
11 >>>>> b478801d68267ef479acc5ca54544634c52c545c
12 Just a change for educational purposes.
```

Could look like this after merging:

Listing 3.8: Fixed conflict after merging

```
1 The goal of this project is the creation of an easy-to-use,
   web-based
2 system to document and detect plagiarism in scientific papers.
3
4 hello world
5
6 Just a change for educational purposes.
```

3.1.2. Local Deployment

This subsection will describe how to configure a virtual host properly. A virtual host is a domain that is mapped to the local web server. It is assumed that Apache, MySQL and PHP are already running on the machine. If not, here are some tutorial to get them all running:

Windows:

<http://www.apachefriends.org/de/xampp-windows.html#1098>

Mac OS:

<http://www.djangoproject.com/blog/2011/07/24/installation-of-mysql-server-on-mac-os-x-lion/>

<http://www.quarkstar.at/index.php/2009/05/18/webserver-aktivieren-und-konfigurieren-in-mac-os-x/>

Most Linux distribution should already have this kind of server stack installed.

The main goal is to create a local domain and add the virtual host from listing 3.12 to the vhost config.

In Max OS X and Linux this can be done via the command line:

Listing 3.9: Mac OS X: Creating virtual host

```
1 sudo vi /private/etc/hosts
2 #add the following line:
3 "127.0.0.1 unplagged.local"
4
5 sudo vi /private/etc/apache2/extr/httpd-vhosts.conf
```

On Windows you need to open up your *hosts* file, which is mostly located in *C:\WINDOWS\system32\drivers\etc\hosts*, and add the following line on the bottom:

Listing 3.10: New host declaration

```
1 127.0.0.1 unplagged.local
```

Now you need to open your apache configuration file *C:\xampp\apache\conf\httpd.conf* and remove the hash symbol(uncomment) from the following line

Listing 3.11: httpd.conf

```
1 #Include conf/extr/httpd-vhosts.conf
```

Add the following configuration to the httpd-vhosts.conf file you just included:

Listing 3.12: Apache configuration

```
1 <VirtualHost *:80>
2   ServerName unplagged.local
3   DocumentRoot "/Users/me/Sites/unplagged.local/public"
4   SetEnv APPLICATION_ENV "development"
5
6   <Directory "/Users/benjamin/Sites/unplagged.local/public">
7     Options +Indexes +FollowSymLinks +ExecCGI
8     DirectoryIndex index.php
9     AllowOverride All
10    Order allow,deny
11    Allow from all
12  </Directory>
13 </VirtualHost>
```

You can tryout your new configuration by entering *unplagged.local* in your browser.

3.1.3. Netbeans

Configuring Tests

Documentation

Unplagged uses [Apgen \(2012\)](#) for the generation of a HTML page of all the source code documentation comments, because of it's superior and much more beautiful user interface in comparison to the older [PHPDocumentor \(2012\)](#).

Sadly the automatic generation is not yet supported by Netbeans, but as it will be soon([Heise, 2012](#)), we are currently only generating this server-side as described in section [??](#).

This section will be enhanced, when the Netbeans user interface becomes available. If you are interested, you could install the software for yourself and use it over the command

line.

3.1.4. Additional Software

As we currently have no installer or script that checks for installed software, you still have to install some additional dependencies to make some parts of the system work. Those are mainly command line tools that we use for the optical character recognition or text comparison.

Most of the times the software wouldn't break completely if those dependencies were not installed, but some parts would silently fail, which is of course one of the more annoying problems to debug.

Tesseract

Tesseract is an open source OCR¹ software, that is used to

Simtext

Imagemagick

3.1.5. Continuous Integration

To always have a running version of the latest code, we use an automated workflow, that always deploys everything that has been pushed to the Github repository on the Unplagged staging server. The machine this is done with, is a simple Ubuntu web server, that is also used for hosting our collaboration tools and the webpage.

¹Optical character recognition

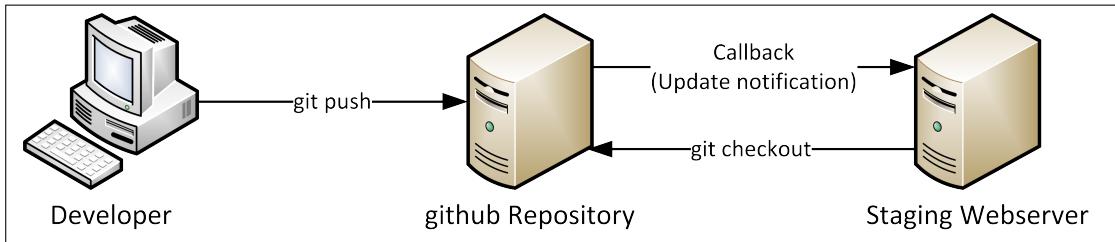


Figure 3.1.: Deployment workflow

As you can see in figure 3.1 the mechanism used for this is a callback, the *post-receive hook* of git, which github employs to let it's users enter a *post-receive URL* to call a URL after someone has pushed to the repository. The URL that gets called is located on our staging server and gets answered by a Redmine plugin called “redmine_github_hook”, that would normally only call a checkout on the server-side repository, so that the newest sources can be seen via the Redmine web frontend.

Listing 3.13: Changes to redmine_github_hook.rb

```

1 # Fetches updates from the remote repository
2 def update_repository(repository)
3   command = git_command('fetch origin', repository)
4   if exec(command)
5     command = git_command("fetch origin '+refs/heads/*:refs/
6       heads/*'", repository)
7     exec(command)
8   #custom checkout to preview area
9   system('sh /usr/local/etc/scripts/buildUnpluggedPreview.sh
10      ')
11 end
12 end

```

However, we tweaked the source code of this plugin slightly, as you can see on line 9 in listing 3.13 so that it also calls the below bash script(listing 3.14) to initiate the deployment process.

Listing 3.14: Deployment script

```
1 #!/bin/bash
```

```

2
3 cd /var/git/unplagged.git/
4 GIT_WORK_TREE=/var/www/preview.unplagged.com git checkout -f
5
6 cd /var/www/preview.unplagged.com
7 #generate phpdoc
8 apigen -s application/ -s library/Unplagged/ -d docs/phpdoc --
      title "Unplagged Documentation" --todo yes
9
10 #run database build scripts
11 cd scripts/build
12 php initdirectories.php
13 php doctrine_staging.php
14
15 cd /var/www
16 chown www-data:www-data preview.unplagged.com

```

The bash script is then used to do a “clean checkout”(without hidden .git folders) of the repository and to run “Apigen”, an engine to process the PHPDoc comments inside the project. Those two things can be accessed by the already prepared vHosts on the server:

- <http://preview.unplagged.com/>
- <http://phpdoc.unplagged.com/>

If you would like to get access to the preview areas, you need to obtain the password and username from a team member.

Possible Improvements

The above described workflow is, as we believe, already on a good way, but it still has a lot of room for improvement. First of all, it would be nice to only let the deployment go through, if the unit tests ran successfully on the server and to have some sort of email

notification mechanism if this wasn't the case.

Another improvement would also be to have a separation into a staging environment with the newest commits and an actual preview environment, that can be deployed to a known stable state/commit of the system in a simple manner.

3.2. User Interface / User Experience

This chapter will explain the progress and development of the user interface of our project. As we tried to follow the typical project workflow, we first drew a lot of mockups in the beginning, which represented the main features of Unplagged. At first the wireframes, or also called mockups were drawn by hand, before we digitalized them. As an example the mockups of the 'new case' page are shown below. All the other mockups can be found in the appendix.

After we had a basic idea how the main interface should be structured, we created a first screen in Photoshop. Therefore we got several helpful suggestions from the website PremiumPixels: <http://www.premiumpixels.com/>.

The next step, before the HTML template got created, we defined the key features, our user interface should take care of:

- Responsive Layout – optimized layouts for different devices
- Cross-Browser-Compatibility
- Light-weight and w3c-conform XML Markup
- Progressive enhancement with CSS3 – CSS instead of images where possible

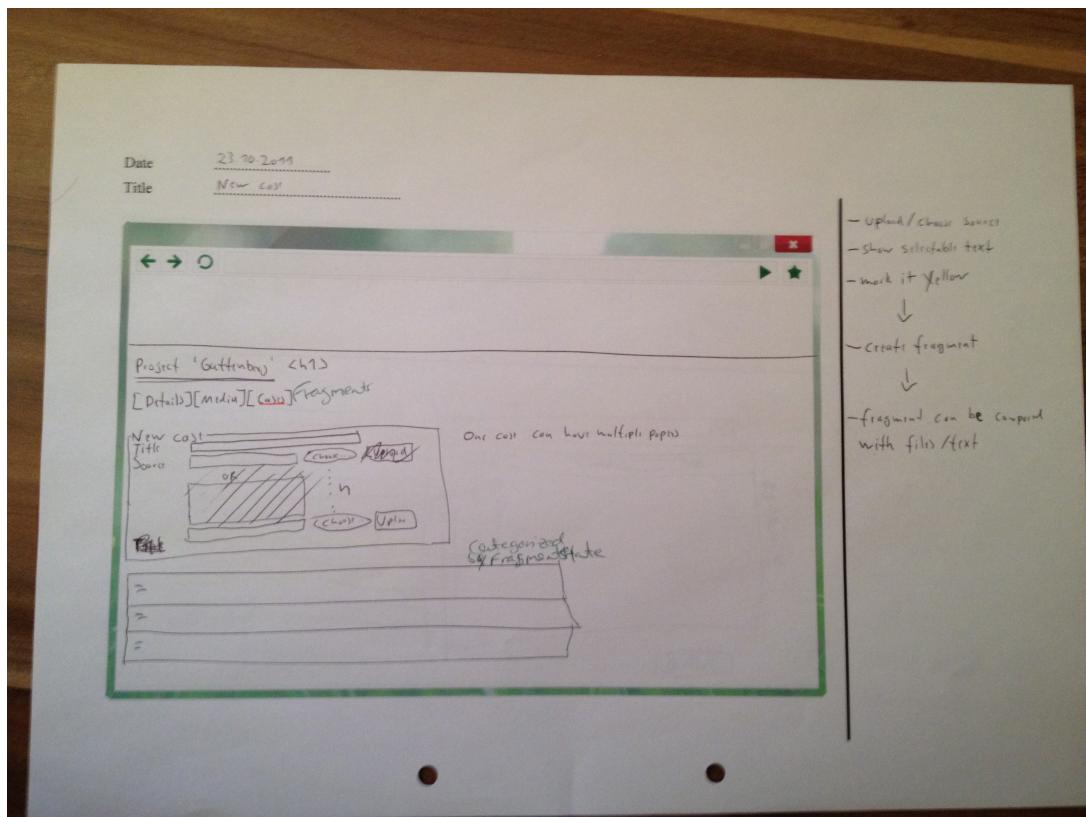


Figure 3.2.: Mockup – New case – hand-drawn

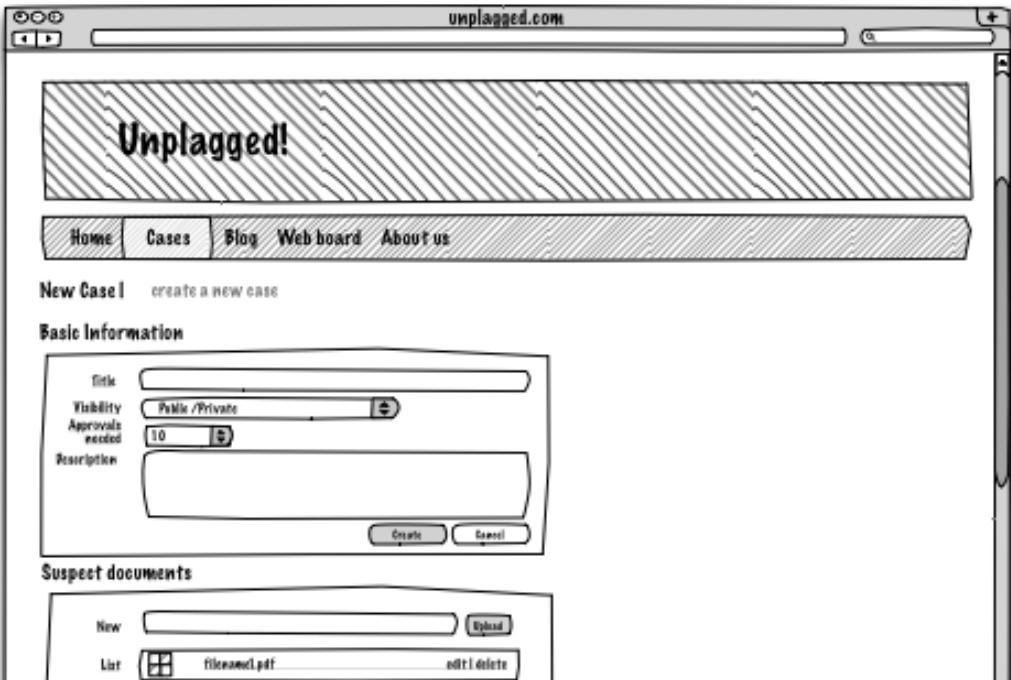


Figure 3.3.: Mockup – New case – digitalized

3.2.1. Responsive Layout using CSS3 Media Queries

Since the worldwide amount of smartphones and tablets is growing very fast, website developers should optimize for these devices as well. And so do we. Some functionality as uploading a file, doesn't work on iOS at all, but at least all functions that are working on mobile devices, should work. So the goal is creating a user interface that uses the same markup, but displays differently on different devices. Therefore CSS media queries can be used, these are basically conditions that execute a part of CSS only if the condition is true. The most prominent conditions are the following:

Listing 3.15: CSS Media Queries

```

1 max-width: 600px # max browser width 600px
2 min-width: 300px # min browser width 300px
3 orientation:landscape # current orientation landscape mode
4 orientation:portrait # current orientation portrait mode
5 -webkit-min-device-pixel-ratio: 2 # min pixel ration (iPhone
   4, Retina)

```

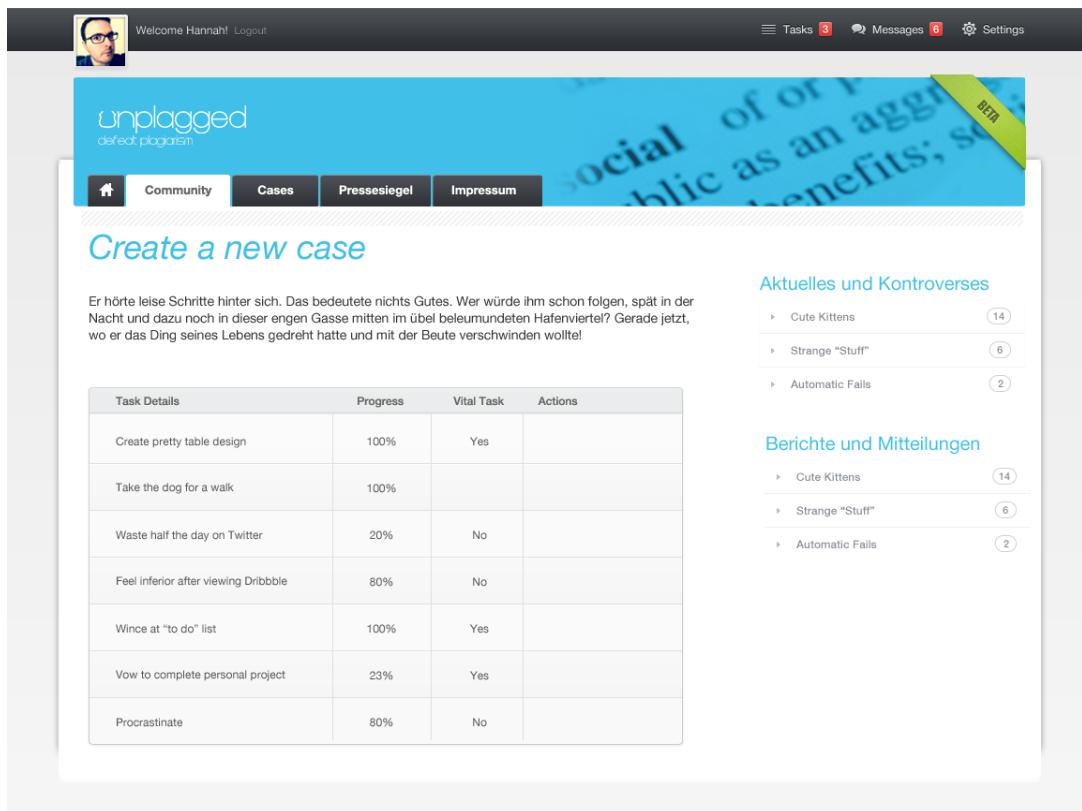


Figure 3.4.: Initial Screen PSD

These media queries can be combined in any order to display an optimized page for each device. Since only the CSS changes, the HTML does not have to be touched. An example query looks like this:

Das entsprechende CSS Media Query sieht wie folgt aus:

Listing 3.16: CSS Media Query

```
1 @media only screen and (max-width: 600px) { }
```

Media queries are a new feature of modern browsers, except IE9. Though, this isn't a problem, because browsers that don't support them, just display the default css for desktop browsers.

3.2.2. Javascript and fallbacks

Even though many websites require Javascript as mandatory for using the whole functionality range of the page, it is important to provide as much functionality as possible, when Javascript is turned off. A short example will show how to implement a pagination with and without Javascript.

Usually when Javascript is disabled, the whole page will be reloaded, when the user changes to another page of the paginated content. The URL in this case will look something like this: <http://unplugged.local/document/list/page/2>. When Javascript is enabled, it is much faster to only refresh the area of the page, that really needs to reload, in this case the table with the content of the next page. It is only possible to change the hash of an URL, the part after the hash key (#), using Javascript, the changed URL will be: <http://unplugged.local/document/list/#page/2>. An event called 'hashchange' can trigger a change of this part of the url and then reload the content through an AJAX request.

The pagination has the same HTML markup with and without Javascript, but with Javascript enabled it is much more convenient.

Listing 3.17: Javascript Pagination

```

1 $(".pagination a").live("click", function() {
2     var href = $(this).attr("href");
3     if(href) {
4         var substr = href.split('/');
5         var hash = substr.substr.length-2] + "/" + substr[
6             substr.length-1];
7         window.location.hash = hash;
8     }
9     return false;
10 });
11
12 $(window).bind('hashchange', function(){
13     var newHash = window.location.hash.substring(1);
14
15     if (newHash) {
16         var substr = newHash.split('/');
17         var hash = substr.substr.length-2] + "/" + substr[
18             substr.length-1];
19         var url = window.location.pathname;
20         if(url.charAt(url.length-1) != '/') {
21             url += '/';
22         }
23         url += hash;
24         $("#main-wrapper").load(url + " #main");
25     };
26
27 });

```

3.3. Frameworks

When we first discussed which programming language and frameworks, the Unplagged project should be built on, we figured out, that everyone was familiar with PHP. Since programming in a group requires a much better structure, than programming on your own, we needed a framework that requires a comfortable Model-View-Controller structure,

we decided to use the Zend Framework. And to get rid of all the database issues as well as getting a flexibility in the used database system, we decided to use an Object-Relational-Mapping framework, called Doctrine. What an ORM is, will be discussed later on.

3.3.1. Zend Framework

The Zend Framework is a typical PHP Framework using the Model-View-Controller pattern. Due to it's pre-defined directory structure, it is easy to get well seperated code.

The directories and their meaning:

- application — includes controller, models and view
- data — currently only includes i18n stuff (language stuff)
- docs — PHP Documentation and Developers Manual
- library — extrnal and internal frameworks and extension to the Zend framework
- public — files that are accessible directly through the browser
- scripts — build scripts, deploying scripts
- temp — data that is overridden at any deployment
- tests — PHP Unit tests

The Zend framework offers REST-ful URLs that follow a fixed pattern: [unplagged.local/controller/action/key/value/key2/value2](#). Each controller is defined as ControllerName-Controller.php in the application/controllers directory and includes all possible actions. For example a file controller will look like this:

Listing 3.18: Persisting an object to the database in Doctrine

```
1 class FileController extends Zend_Controller_Action{
2     public function init() {
3     }
4
5     public function indexAction() {
6     }
7
8     public function uploadAction() {
9     }
10
11    public function listAction() {
12    }
13
14    public function downloadAction() {
15    }
16 }
```

By default, if no action is defined, the indexAction is called. For each action the appropriate view is by default rendered in the application/views/scripts/controllerName/actionName.phtml file.

The models directory includes all the objects, this will be discussed in more detail in the following chapter about Doctrine.

3.3.2. Doctrine

The whole database connection management of Unplugged is implemented using the Doctrine Framework in version 2. It consists of two layers, a database abstraction layer (DBAL) and an object relational mapping framework (ORM). The DBAL uses PDO, a PHP framework for encapsulating database statements. The DBAL manages the communication with any kind of SQL database and offers an own query syntax. This has the advantage, that the database behind the framework can be changed from MySQL, to OracleSQL, PostgreSQL or SQLite at any time. The DBAL is the agent between PDO

and the ORM. The ORM is the connection between PHP objects and the DBAL.

Before the use of Doctrine is described, it will be explained, how the database on a new machine can be created and how the database structure can be updated, whenever something changed in the structure. Actually this is very easy, it is required to have a local my sql database at this point having 'root' as a username, no password and a database called 'unplagged'. It is also possible to create a new configuration in the application/configs/application.ini file, although this step will not be described in this chapter. If the database is created, the build script can be executed:

Listing 3.19: Updating database structure

```
1 php unplagged.local/scripts/build/doctrine.php
```

Now, the database is created or updated. If the database already existed, the data in it will not be removed! As described below, the big advantage of ORM is, that the programmer can stay in the PHP object context at any time. The only thing that has to be done additionally, is adding comments to the member variables of a class, that define the fields in the database:

Listing 3.20: Defining a class in Doctrine

```
1 /** @Entity */
2 class UserClass
3 {
4 /** @Column(type="integer") */
5 private $id;
6 /** @Column(length=30) */
7 private $username;
8 }
```

The whole syntax documentation of doctrine can be found here: <http://docs.doctrine-project.org/projects/doctrine-orm/en/latest/index.html>

To persist a new object to the database, the persist method on this object has to be called, this writes the object into the doctrine cache. It stays in the cache, until the flush

method is called, which actually executes all the previous operation since the last flush. These can be deleting, updating, or editing an object.

Listing 3.21: Persisting an object to the database in Doctrine

```
1 $user = new User();
2 $user->setUsername('Max');
3 $em->persist($user);
4 $em->flush();
```

As the previous examples show, no database programming is necessary to create or persist a new object to the database, everything can be done in the PHP object context.

3.4. Architectural Goals

3.4.1. Progressive Enhancement

3.4.2. Test Driven Development

A. Minutes

B. Logged Time As Of March 11, 2012

The following tables are some example reports generated from the logged time in Redmine. To find the most recent version of these reports or to generate custom data analysis you can use the “Report” tool found in Redmine on the “Overview” page.

Table B.1.: Overview By Member and Month

Member	2011-10	2011-11	2011-12	2012-1	2012-2	2012-3	Total
Dominik Horb	27.30	10.00	55.75	51.00	28.00	16.80	188.85
Benjamin Oertel	34.00	29.00	19.00	57.50	4.50	29.00	173.00
Elsa Mahari	9.50	10.00	23.50	14.50	7.00		64.50
Tien Nguyen	1.00	24.00	13.00	12.00			50.00
Heiko Stammel	16.00	28.00	13.50	11.00			68.50
Total	91.30	101.00	124.75	146.00	39.50	45.80	548.35

Table B.2.: Overview By Member and Issue

Issue	Member	Total
none		18.30
Feature #1: Trac aufsetzen	Dominik Horb	2.00
Feature #5: Create Wiki List of Interesting Plagiarism Papers	Dominik Horb	1.00
Feature #6: Logo	Dominik Horb	1.00
Feature #8: Configure Email Notification in Trac	Benjamin Oertel Elsa Mähari	8.00
Feature #9: Github in Trac integrieren	Dominik Horb	1.50
Bug #11: Umstellung von Trac auf Redmine	Dominik Horb	1.00
Bug #12: Zeitmanagement in Trac integrieren	Dominik Horb	3.50
Bug #13: Initialize basics in wiki and issues	Dominik Horb	4.80
Bug #14: Setup Github in Redmine	Dominik Horb	1.00
	Dominik Horb	2.50
	Dominik Horb	2.50

Table B.2.: Overview By Member and Issue

Issue	Member	Total
Bug #15: Fremde Federn finden	Dominik Horb	3.00
Feature #16: OCR Research	Dominik Horb	3.50
Feature #20: Create Wiki Page for UserRoles	Dominik Horb	3.50
Time #21: Meeting 24.10.11	Tien Nguyen	1.00
	Dominik Horb	12.50
	Benjamin Oertel	2.50
	Elsa Mahari	2.50
	Tien Nguyen	2.50
	Heiko Stammel	2.50
Time #22: Meeting 17.10.11		10.00
	Dominik Horb	2.00
	Benjamin Oertel	2.00
	Elsa Mahari	2.00
	Tien Nguyen	2.00
	Heiko Stammel	2.00
Time #23: Meeting 10.10.11		10.00
	Dominik Horb	2.00
	Benjamin Oertel	2.00
	Elsa Mahari	2.00

Table B.2.: Overview By Member and Issue

Issue	Member	Total
Time #24: Debbie-Meeting 18.10.11	Tien Nguyen Heiko Stammel	2.00 2.00
	Dominik Horb	7.00
	Benjamin Oertel	1.00
	Elsa Mahari	2.00
	Tien Nguyen	1.00
	Heiko Stammel	2.00
Feature #28: Resume: Projectmeeting with HTW-Plag-Team		4.00
Feature #29: Projectmanagement Research	Heiko Stammel	4.00
Feature #30: Scrum Research	Heiko Stammel	7.00
Feature #31: Create Wiki for Project Management Steps	Heiko Stammel	7.00
Feature #32: Create Wiki for Scrum	Heiko Stammel	6.00
Bug #33: Mockup hand-drawing	Heiko Stammel	2.00
Bug #34: Mockup digital version	Benjamin Oertel	1.00
	Benjamin Oertel	6.00
	Benjamin Oertel	11.00
	Benjamin Oertel	11.00

Table B.2.: Overview By Member and Issue

Issue	Member	Total
Bug #35: Textvergleich-Algorithmen rechechieren	Tien Nguyen	1.00
Time #39: Meeting 31.10.11		12.50
	Dominik Horb	2.50
	Benjamin Oertel	2.50
	Elsa Mahari	2.50
	Tien Nguyen	2.50
	Heiko Stammel	2.50
Time #43: Meeting 2011-11-04 (Martin Heidingsfelder)		8.00
	Benjamin Oertel	2.00
	Elsa Mahari	2.00
	Tien Nguyen	2.00
	Heiko Stammel	2.00
Feature #44: Setting up initial Zend Framework + Doctrine environment		2.00
Feature #45: User Stories	Benjamin Oertel	2.00
Time #47: Meeting 07.11.11	Tien Nguyen	1.00
		10.00
	Dominik Horb	2.00
	Benjamin Oertel	2.00
	Elsa Mahari	2.00
	Tien Nguyen	2.00

Table B.2.: Overview By Member and Issue

Issue	Member	Total
Time #48: Meeting 14.11.11	Heiko Stammel	2.00
	Dominik Horb	2.00
	Benjamin Oertel	2.00
	Elsa Mahari	2.00
	Tien Nguyen	2.00
	Heiko Stammel	2.00
Time #49: Wiki Editing	Dominik Horb	2.00
Bug #50: Meeting Plagiatssteam HTW 3.11.11	Dominik Horb	6.00
	Benjamin Oertel	1.50
	Heiko Stammel	1.50
Time #53: Debbie Meeting 15.11.11	Dominik Horb	3.00
	Benjamin Oertel	1.50
	Elsa Mahari	1.50
	Tien Nguyen	1.50
	Heiko Stammel	1.50
Feature #56: User registration	Benjamin Oertel	6.50
Feature #57: Profile information update		3.00

Table B.2.: Overview By Member and Issue

Issue	Member	Total
Time #58: Meeting 28.11.11	Benjamin Oertel Dominik Horb	3.00 2.50
	Benjamin Oertel Elsa Mahari	2.50 2.50
	Tien Nguyen Heiko Stammel	2.50 2.50
Feature #59: Defining coding guidelines	Benjamin Oertel	0.50
Feature #61: Meeting 24.11.11 - Setting up developing environment	Benjamin Oertel Dominik Horb	0.50 12.00
	Benjamin Oertel Elsa Mahari	3.00 3.00
	Tien Nguyen	3.00
Feature #62: Identify target	Benjamin Oertel	0.50
Feature #63: Read a file	Benjamin Oertel	1.00
Feature #64: Upload files	Elsa Mahari	8.00
Feature #65: User Login	Benjamin Oertel	6.50
		1.00

Table B.2.: Overview By Member and Issue

Issue	Member	Total
Feature #66: Create a new case	Tien Nguyen	5.50
	Dominik Horb	2.00
Feature #67: Setting up PHPUnit	Dominik Horb	7.50
	Benjamin Oertel	2.00
	Elsa Mahari	2.00
Time #68: Meeting 05.12.11		4.00
	Dominik Horb	2.00
	Elsa Mahari	2.00
Time #69: Reading DocBook-XML	Dominik Horb	4.00
	Benjamin Oertel	1.00
Feature #70: Writing git tutorial		1.00
Time #71: Meeting Online 07.12.11	Benjamin Oertel	1.00
	Dominik Horb	16.00
	Benjamin Oertel	4.00
	Elsa Mahari	4.00
	Tien Nguyen	4.00
Time #72: Meeting preparation PHPDoc		2.00
Feature #73: Layout design	Dominik Horb	2.00
		10.50

Table B.2.: Overview By Member and Issue

Issue	Member	Total
Bug #74: protocoll meeting minuts 05.12.2011	Benjamin Oertel	10.50
	Elsa Mahari	0.50
Time #75: Creation of Preview area on server		3.00
Time #76: Meeting 12.12.2011	Dominik Horb	3.00
	Dominik Horb	7.50
	Benjamin Oertel	1.50
	Elsa Mahari	1.50
	Tien Nguyen	1.50
	Heiko Stammel	1.50
Time #77: create Wiki page for MeetingMinutes 15.11.2011		0.50
	Tien Nguyen	0.50
Feature #78: Setting up the unplagged-blog		17.00
Feature #79: Google Helper	Heiko Stammel	17.00
Feature #80: SIM-Text	Elsa Mahari	10.00
		10.00
Feature #81: Correct/edit OCR-scanned Text	Dominik Horb	3.00
	Tien Nguyen	10.00
	Benjamin Oertel	4.00

Table B.2.: Overview By Member and Issue

Issue	Member	Total
Feature #82: De-hyphenator	Benjamin Oertel	8.00
Feature #83: Non-stop word identification	Dominik Horb	8.00
Feature #84: Display text	Heiko Stammel	2.00
Feature #85: Standard OCR	Dominik Horb	6.00
Feature #86: Change file list view columns	Benjamin Oertel	3.50
Feature #87: Decrease line-height in tables.	Dominik Horb	1.00
Time #89: create Wiki page for MeetingMinutes 13.12.2011	Benjamin Oertel	2.50
Time #90: Prepare automatic preview area	Tien Nguyen	18.00
Time #101: Preparation of Database Mocks	Dominik Horb	12.00
Feature #102: Basics for responsive layout	Benjamin Oertel	6.00
	Benjamin Oertel	0.50
	Benjamin Oertel	0.50
	Benjamin Oertel	0.50
	Tien Nguyen	0.50
	Dominik Horb	11.25
	Dominik Horb	3.50
	Dominik Horb	3.50
		9.00

Table B.2.: Overview By Member and Issue

Issue	Member	Total
Time #103: Meeting 10.01.12	Dominik Horb	9.00
		3.00
	Dominik Horb	1.50
	Elsa Mahari	1.50
Bug #104: Skype Meeting 4.01.12	Elsa Mahari	1.00
		3.00
Bug #105: Switching Menu to Zend_Navigation	Dominik Horb	3.00
		10.00
Feature #106: Add Imagick to convert to different formats	Dominik Horb	6.00
	Benjamin Oertel	4.00
Bug #107: Meeting 2012-01-09		1.50
	Tien Nguyen	4.00
Time #108: Skype Meeting 12.01.12	Dominik Horb	2.00
	Elsa Mahari	2.00
		2.50
Time #109: Cleaning up directory structure	Dominik Horb	2.50
		13.50
Feature #110: Implementing Zend_Acl for user access control	Dominik Horb	11.50
	Benjamin Oertel	2.00
Feature #111: Improving interface workflow		8.00

Table B.2.: Overview By Member and Issue

Issue	Member	Total
Time #115: Debbie Meeting 18.01.12	Benjamin Oertel	8.00
	Dominik Horb	6.00
	Elsa Mahari	3.00
Feature #116: Logger	Benjamin Oertel	3.00
	Dominik Horb	4.00
Feature #117: Create Paging mechanism	Benjamin Oertel	2.00
Bug #118: create Wiki page for MeetingMinutes 18.01.2012	Benjamin Oertel	2.00
Bug #119: Fixing several css issues	Tien Nguyen	6.00
Feature #120: Beautifying forms, tables and buttons	Benjamin Oertel	0.50
Time #122: 23.01.12 Meeting	Benjamin Oertel	5.00
	Dominik Horb	5.00
	Elsa Mahari	5.00
Time #123: 30.01.12 Meeting	Benjamin Oertel	6.00
	Dominik Horb	2.00
	Benjamin Oertel	2.00

Table B.2.: Overview By Member and Issue

Issue	Member	Total
Time #128: LaTeX preparation	Elsa Mahari	2.00
Time #142: License research and inclusion	Dominik Horb	2.00
Bug #143: Fixing tests after last refactorings	Dominik Horb	6.00
Time #144: Reading Zend Doku for Bootstrap Plugins	Dominik Horb	1.50
Time #145: Meeting 06.02.12	Dominik Horb	4.00
Time #146: Basic TOC and split up of LaTeX document	Dominik Horb	2.00
Feature #147: Preface Developers Manual	Dominik Horb	1.50
Time #148: Documentation - Chapter Git	Dominik Horb	7.00
Time #149: Meeting 04.03.12	Benjamin Oertel	4.50
Time #150: Writing chapter about Zend and Doctrine Framework	Benjamin Oertel	5.00
	Benjamin Oertel	5.00

Table B.2.: Overview By Member and Issue

Issue	Member	Total
Time #151: Writing chapter about User Interface / User Experience	Benjamin Oertel	6.00
Time #152: Adding mockups to documentation	Benjamin Oertel	2.00
Time #153: Team Meeting – 2012-03-10	Benjamin Oertel	2.00
Time #154: Reading in latex documentation	Benjamin Oertel	1.50
Feature #155: Improvements of error detection in tesseract parser	Benjamin Oertel	3.00
Feature #156: Implementing Webservice of PlagAware	Benjamin Oertel	2.00
Bug #157: Zend Acl – allowing/denying access to actions, not only controllers	Benjamin Oertel	1.00
Total		548.35

Table B.3.: Overview By Sprints

Version	2011-10	2011-11	2011-12	2012-1	2012-2	2012-3	Total
none	7.00		28.75	47.00	33.00	19.30	135.05
Sprint 1 (2011-10-01 - 2011-11-14)	81.80	67.50					149.30
Product Back-Log	2.50	0.50	3.00				6.00
Sprint 2 (2011-11-15 to 2011-12-13)		33.00	72.00				105.00
Sprint 3 (2011-12-14 to 2012-01-17)			21.00	63.00			84.00
Sprint 4 (2012-01-18 to 2012-02-01)				36.00	2.00		38.00
Sprint 5 (2012-02-02 to 2012-23-02)					4.50	26.50	31.00
Total	91.30	101.00	124.75	146.00	39.50	45.80	548.35

C. Mockups

C.1. Hand-Drawn

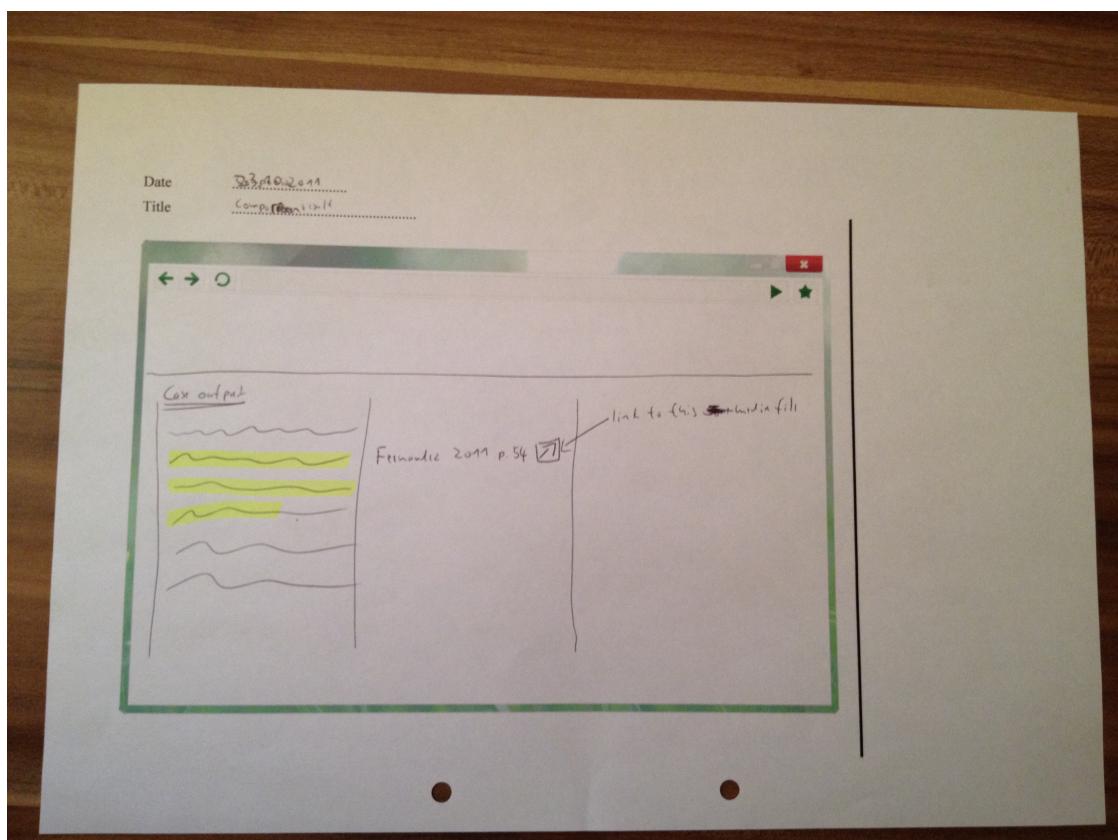


Figure C.1.: Mockup – Compare results – digitalized

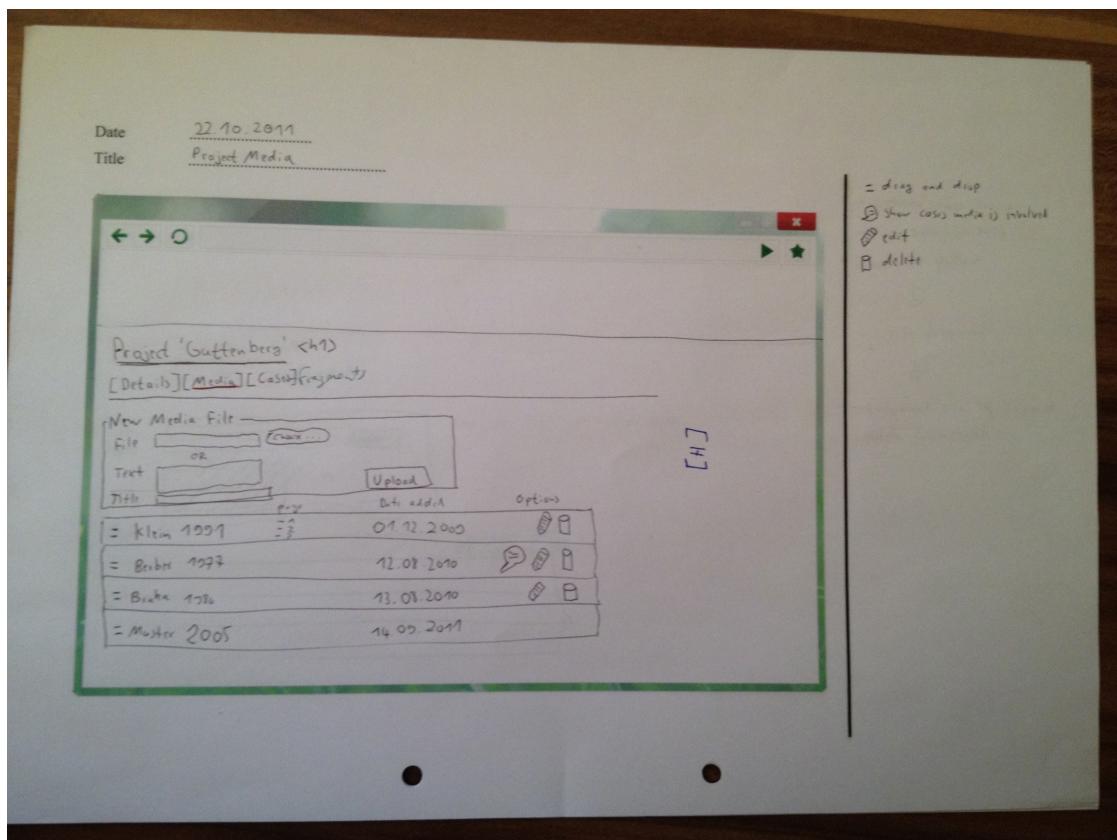


Figure C.2.: Mockup – Media list – digitalized

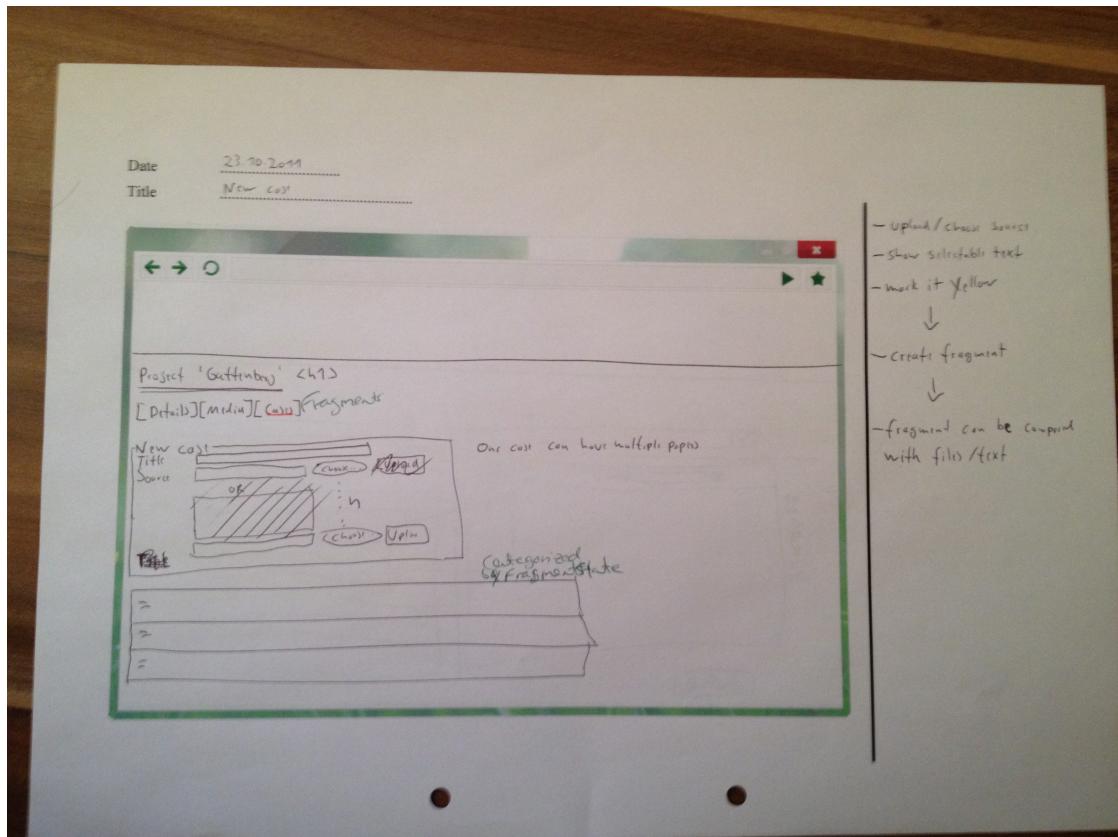


Figure C.3.: Mockup – New case – digitalized

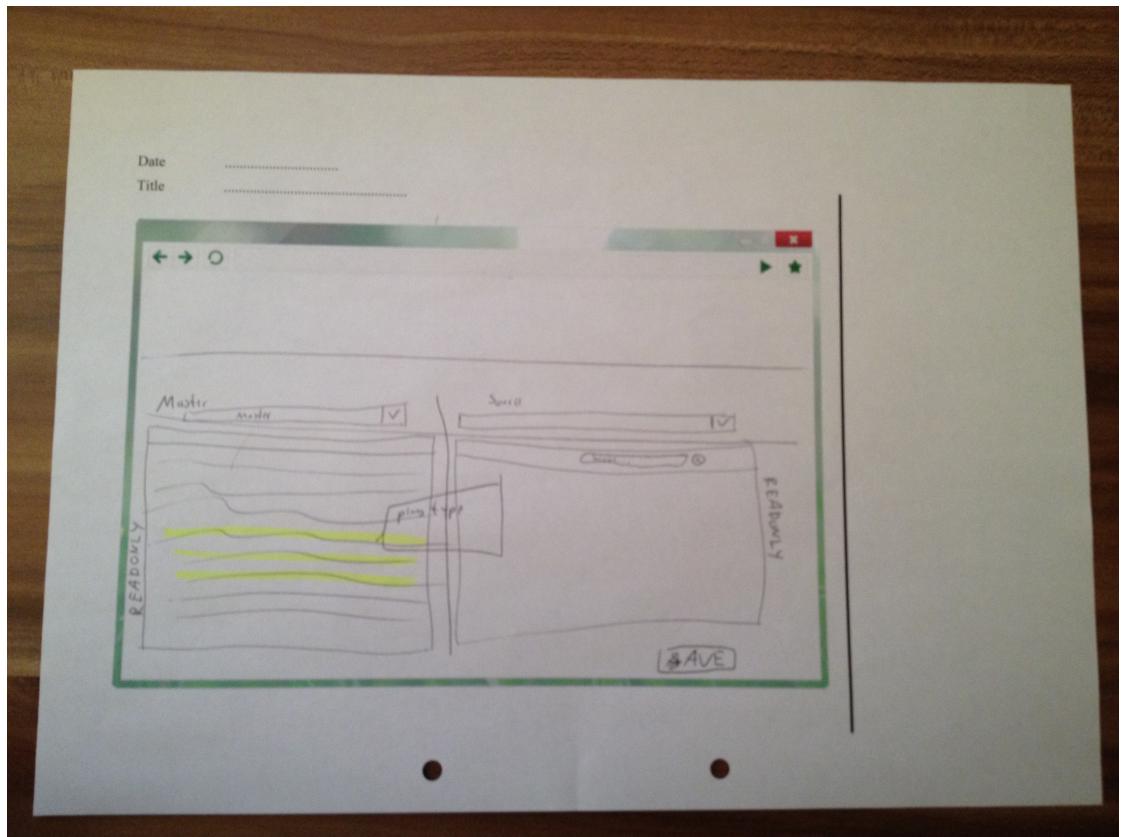


Figure C.4.: Mockup – New fragment – digitalized

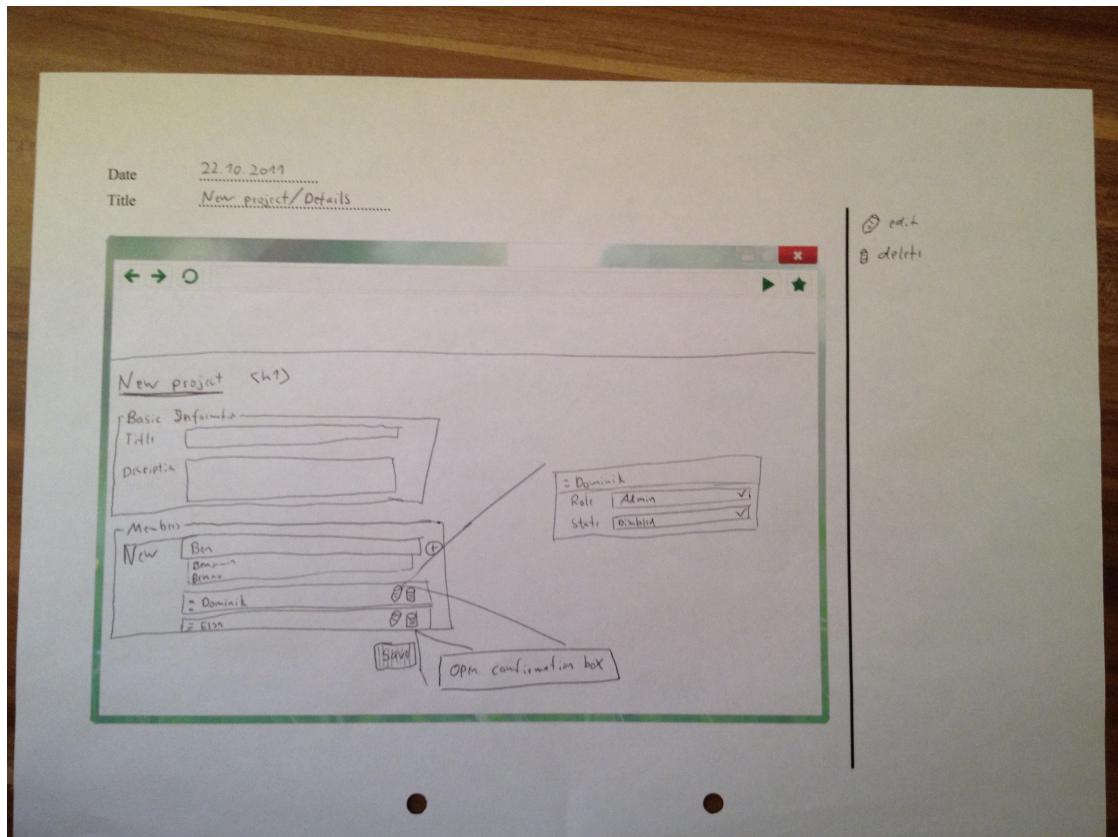


Figure C.5.: Mockup – New project – digitalized

C.2. Digitalized

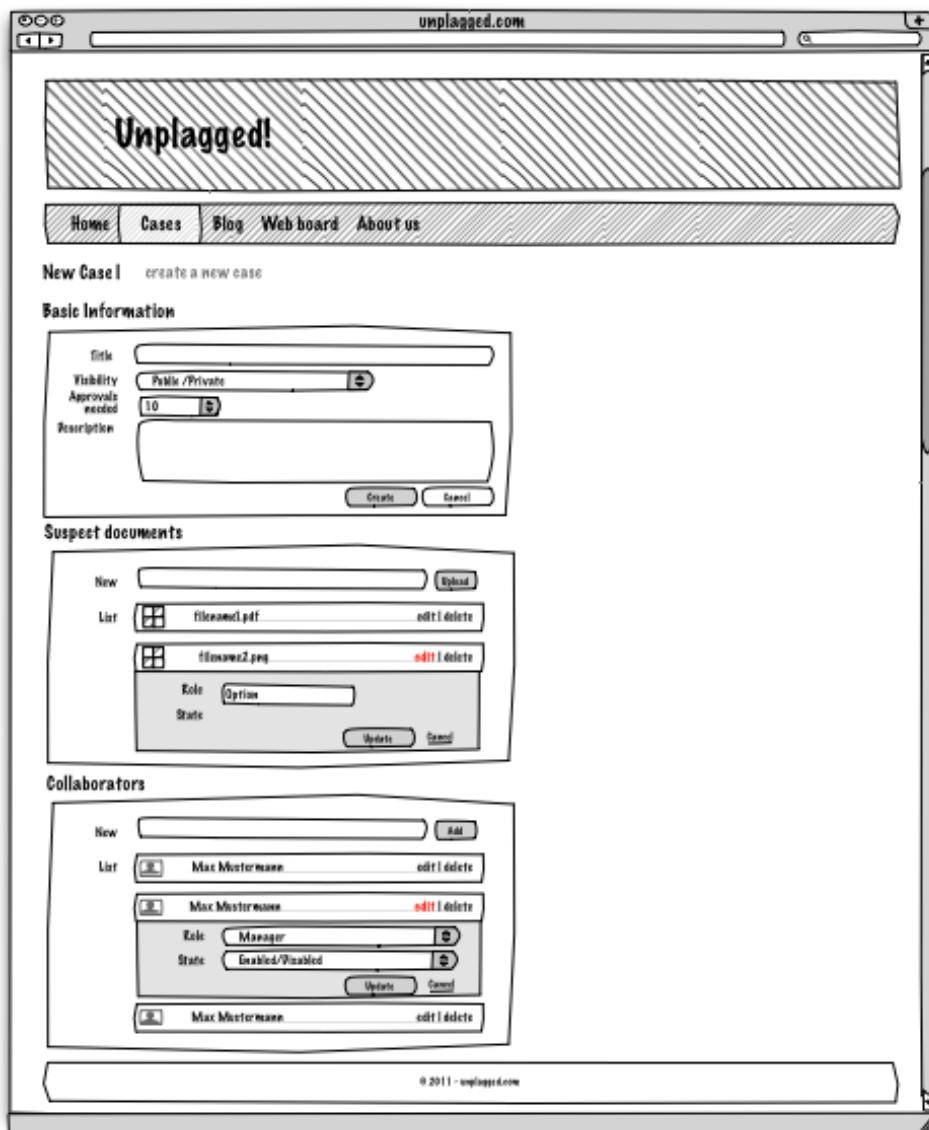


Figure C.6.: Mockup – New case – digitalized

unplugged.com

Unplugged!

Home **Cases** **Blog** **Web board** **About us**

Fragments | all fragments in case 'Gutenberg'

New Fragment

Suspect document: Gutenberg.pdf
Suspected source: Kafka

Create **Cancel**

clicking creates opens a new page with suspect document and source pre-selected

Fragments by page

Document: Gutenberg.pdf
Filter: -----

Page Category	Fragments edit approve awaiting approval	Latest activity	Options
(+) Page 1	021715	2011-10-25	
(+) Page 2	021715	2011-10-25	
(+) Page 3	011120	2011-10-25	
(+) 19-55 Kompletthylist	approved	2011-10-25	edit show approve
(+) 29-94 Kompletthylist	awaiting approval	2011-10-25	edit show approve
(+) 55-55 Kompletthylist	awaiting approval	2011-10-25	edit show approve
(+) Page 5	021715	2011-10-25	
(+) Page 6	021715	2011-10-25	

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Figure C.7.: Mockup – List fragments – digitalized

The mockup displays the Unplagged! website interface with the following sections:

- Header:** Shows the Unplagged! logo and navigation links: Home, Cases, Blog, Web-board, About us.
- Suspect document:** A text editor window showing a document page from "Ostenberg.pdf" (Page 1). The text discusses Josef K. being questioned about his actions after being hit by a dog. A callout bubble highlights the word "mark as plagiarism" and notes "type: lorem ipsum".
- Supposed source:** A text editor window showing a document page from "Kafka" (Page 8). The text discusses a dog hitting Josef K. and his subsequent behavior. A callout bubble highlights "comments possible on each line, different colors per user" and "text colors different per plagiarism type". Another callout bubble says "commenter show comment".
- Comment:** A form for creating a comment. It includes fields for "Note" (with a large text area), "Visibility" (set to "Private/Public/Group"), and buttons for "Create", "Save", "Revert", and "Cancel". A callout bubble lists comment status options: "new (created but not ready for verification)", "in progress (can be edited)", "resolved", "feedback", "closed (5 approvals)", and "rejected (5 declined)".
- Footer:** Shows the copyright notice "© 2011 - unplagged.com".

Figure C.8.: Mockup – New fragment – digitalized

unplugged.com

Unplugged!

Home Cases Blog Web board About us

Show Fragment 1 fragment in case "Gutenberg"

Suspect document

File: document1.pdf
Page: 1
Line: 34-40

...Als Gregor Samza eines Morgens aus unruhigen Träumen erwachte, fand er sich in seinem Bett zu einem ungeheueren Ungeziefer verwandelt. Und es war ihnen wie eine Bestätigung ihrer neuen Träume und guten Absichten, ...
2 words below and 2 above ...

Supposed source

File: document1.pdf
Page: 1
Line: 34-40

emand musste Josef K. verleumdet haben, denn ohne dass er etwas Böses getan hätte, würde er eines Morgens verhaftet. »Wie ein Handl« sagte er, es war, als sollte die Scham ihn überleben. Als Gregor Samza eines Morgens aus unruhigen Träumen erwachte, fand er sich in seinem Bett zu einem ungeheueren Ungeziefer verwandelt. Und es war ihnen wie eine Bestätigung ihrer neuen Träume und guten Absichten, als am Ziele ihrer Fahrt die Tochter als erste sich erhob und ihren jungen Körper dehnte. »Es ist ein eigenmächtiger Apparat«, sagte der Offizier zu dem Fassungsverlustenden und überblieb mit einem prahlsmäßigen bewundernden Blick den ihm doch wohlbekannten Apparat.

(+) expand whole page (-) collapse whole page

commenter show facebook-like list with all selected users, comment and date

Ratings

appreciate : 1 rejects : 1

State: Approve

comment ratings that are not the most recent ones of a user are shown greyed out

Comment	User	Date	Rating
guten Absichten, als am Ziele ihrer Fahrt die Tochter als erste sich erhob und ihren jungen Körper dehnte. »Es ist ein eigenmächtiger Apparat«, sagte der Offizier zu dem Fassungsverlustenden und überblieb mit einem prahlsmäßigen bewundernden Blick den ihm doch wohlbekannten Apparat.	Max Mustermann	2011-11-05	no
Re: guten Absichten, als am Ziele ihrer Fahrt die Tochter als erste sich erhob und ihren jungen Körper dehnte. »Es ist ein eigenmächtiger Apparat«, sagte der Offizier zu dem Fassungsverlustenden und überblieb mit einem prahlsmäßigen bewundernden Blick den ihm doch wohlbekannten Apparat.	Emmy Watson	2011-11-06	no
Re: guten Absichten, als am Ziele ihrer Fahrt die Tochter als erste sich erhob und ihren jungen Körper dehnte. »Es ist ein eigenmächtiger Apparat«, sagte der Offizier zu dem Fassungsverlustenden und überblieb mit einem prahlsmäßigen bewundernden Blick den ihm doch wohlbekannten Apparat.	Max Mustermann	2011-11-07	no
guten Absichten, als am Ziele ihrer Fahrt die Tochter als erste sich erhob und ihren jungen Körper dehnte. »Es ist ein eigenmächtiger Apparat«, sagte der Offizier zu dem Fassungsverlustenden und überblieb mit einem prahlsmäßigen bewundernden Blick den ihm doch wohlbekannten Apparat.	Emmy Watson	2011-11-08	no
guten Absichten, als am Ziele ihrer Fahrt die Tochter als erste sich erhob und ihren jungen Körper dehnte. »Es ist ein eigenmächtiger Apparat«, sagte der Offizier zu dem Fassungsverlustenden und überblieb mit einem prahlsmäßigen bewundernden Blick den ihm doch wohlbekannten Apparat.	Max Mustermann	2011-10-27	yes

Figure C.9.: Mockup – Show fragment for approval – digitalized

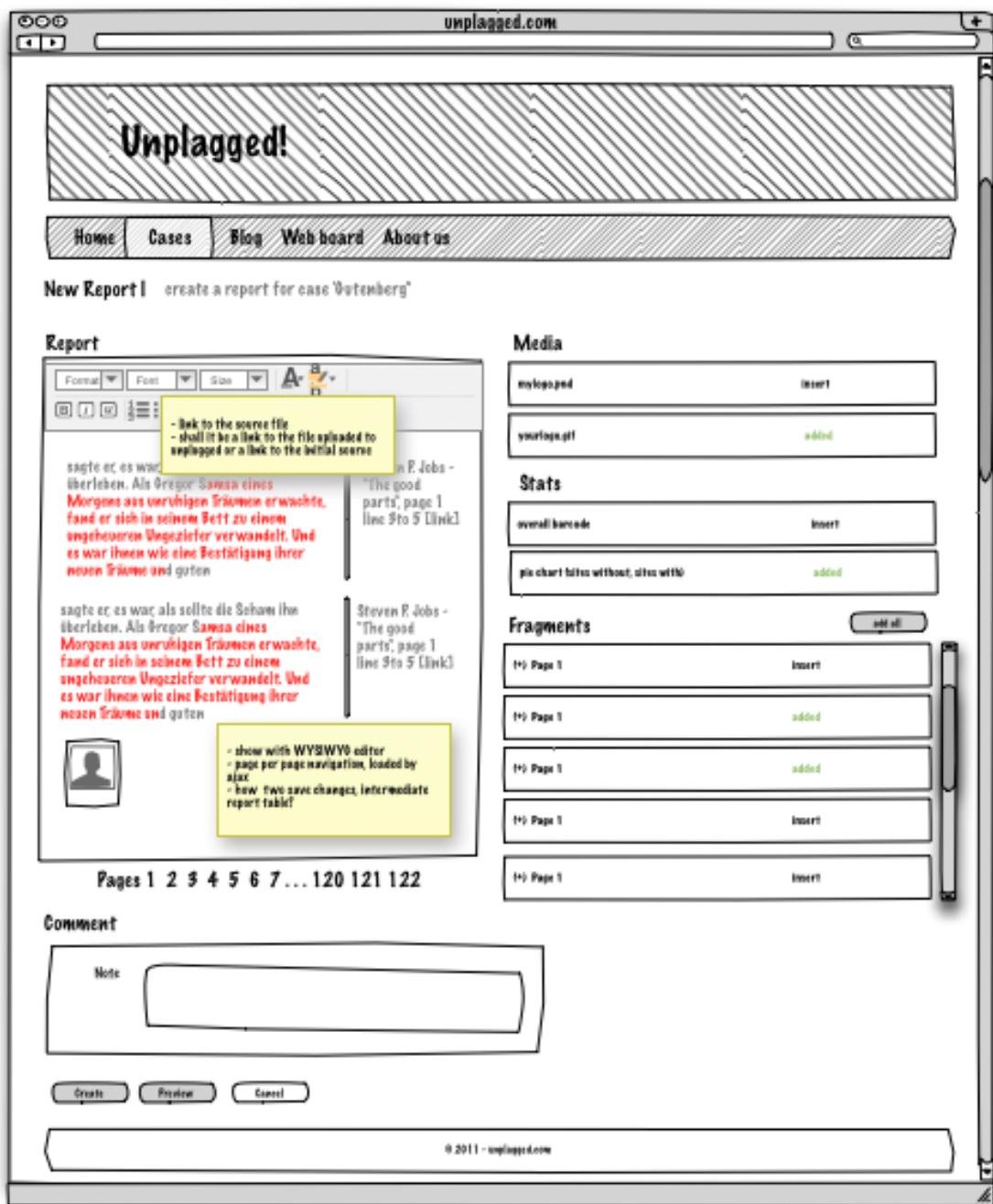


Figure C.10.: Mockup – New report – digitalized

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