

# Semantic wiki for business companies: a return of experiment

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October 24, 2014

*Abstract:*

*The technical data is one of the company's assets. In a context where more and more organizations are globalized, it is urgent to equip companies with computer systems for managing and disseminating data to the teams. He was selected in this business to use a wiki and involve the principles of the semantic web. After 18 months of use and created 1,400 pages, the interest of such a system is no longer any doubt. Users enjoy web technology to access information and hyperlinks to navigate and find information easily. The structuring of information also allowed to make data analysis and create automated dashboards. Now we need the wiki better integrate WYSIWYG editors for wider deployment writing pages in the company.*

Keywords: data management, web semantic, wiki, knowledge management, RDFa, Microdata

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## INTRODUCTION

The objective of this contribution is to present a feedback on the use of a semantic wiki to organize the technical information within a company. This is a concrete and real box could in place in February 2013. We will detail throughout the pages of this article the chosen solution to manage the technical information of this company and we will analyze the successes and failures of this experiment after 18 months of use .

The background of this article is based on the observation following: increasingly, to develop a product, companies need to manage an increasing amount of information, and they are more and more versatile. This is the result of the direct increase in object technicality that are around us and the car is a good example. [1]

Take the example of protection contre theft of cars. Previously, to secure his vehicle, there was only a key and a lock. The company, who designed and manufactured these elements, manipulated only mechanical data, ie dimensions and associated tolerances. In engineering drawing with all dimensions and tolerances was sufficient to fully describe the product. With the arrival of infrared or radio frequency key remote controls, these companies learned how to manipulate data in the field of electronics (power supply voltage, power consumption of equipment) and signal processing (cryptography to secure the communication between the electronic key and the vehicle ). An engineering drawing of the hand is no longer sufficient to describe the product completely. Call, also it requires the electrical diagram of the key, the software and the cryptography study and technically to fully describe this object. This example shows clearly the increase in the quantity and the diversity of increased technical information.

Business companies also face a new challenge: the globalization of the economy. Companies must react by deploying globalized organisms [5]. Teams are scattered on all continents, close to customers (car manufacturers) and most often factories are located in countries with low labor costs. To be effective, the company must have his technical information up to date and available anywhere in the world.

In this enterprise, it was decided to solve the problem of information management with the support of a semantic wiki. This principle is not really new and has already been explained by [10].

A semantic wiki is a web technology so available anywhere in the world from a secure access to Internet. [12] The wiki is a collaborative tool to facilitate the maintenance of a wide amount of information. Adding to the wiki the principles of the semantic web, it becomes easier to manage the diversity of information and information becomes readable by a machine [6].

In summary:

- wiki = Collaborative → Solution to Numerous data
- Wiki + semantic wiki → Solution to various data
- wiki = web → Solution to data accessibility

## CONTEXT AND THEORY

### **Context: The company**

The company is a French company specialized in the design, production and sale of equipment involved in motor vehicle manufacturing. The specific kind of equipment does not really matter in this article but it will nevertheless be useful to keep in mind that these equipments are made from the processing of primary components or raw materials.

Like most automotive companies, this company works in project mode with a matrix organization. [13] The main departments of the company directly involved in the project life are: Project, R&D, Purchasing, Sales, Industrialization and Production (including Logistics and Quality). Added to these operational departments, we find the following support departments: general management,

management of human resources and finance & accounting management. The departments are then required to staff projects with the resources needed to ensure the QCD objectives (quality, cost and delay) of each project.

This company has also an worldwide dimension. Design teams, sales or production are not necessarily grouped together on one site. Product may be designed in France, the sales team can be Italian if the manufacturer is located in Italy and the production can be located in a country with low labor cost.

### **Data**

To understand the importance of the management of technical information, spend some time to clarify what is meant by "technical information". In an industrial company whose role is to manufacture a product, a (non-exhaustive) information list to structure (to be better controlled) could be:

- a product definition drawing
- a list of product features, some of them may be critical
- Bill of material listing the components needed for product manufacturing
- a flowchart for manufacturing describing the manufacturing operations and their sequence
- a component list to buy
- Components cost and suppliers chosen for their supply

To ensure that the proposed product meets perfectly customer requirements, we must be able to measure its technical characteristics; so we can add to the list and for each characteristic:

- the validation plan listing all the tests and all measures to prove that the product fulfills all customer requirements
- reference to the test method describing how to measure the characteristic
- test report recording the measurement results

- the list of tools and measuring instruments as well as the date of last calibration to ensure that the quantity measured by the device is reliable.

But you also need to know if the product design timing is consistent with the development schedule of the vehicle; so add to the project data list:

- the started date of the study
- end date of the study of the product
- the date to launch the tools which will enable factories to manufacture the product
- the date of delivery for first parts
- production start date

It is a list, largely non-exhaustive, and everyone reading it will surely have in mind a missing information.

#### **What is the problem with a large and varied number of data?**

In a global company, matrix organized and working in project mode, the technical data management is critical. In order to work efficiency, information must be available everywhere and constantly updated. In some companies, a considerable time is spent by the teams to collect information and to ensure that it is up to date.

This information is sometimes not shared, not well known by all team members and poorly maintained. They are in the best case stored precariously on a network drive and in the worst case on locally hard drives. The sharing is done through emails and then it is common to see the same information stored on multiple local hard drives.

Another problem is organization of data itself inside the document. If we take, for example, a characteristic dimension of a component of the product. This dimension is created in a 3D CAD software. It is available in the 2D drawing of the part in PDF or TIF picture. It is also end up in the validation plan at the test checking this feature and in the corresponding test report. Normally these four documents must

refer to the same feature. If this characteristic changes during the study, it has to evolve in the first three documents. We see also that a document can contain one or more technical information and, each time, in different format (precisely a computer electronic format). Now imagine a system that would contain the technical information in only one unique place, and it would be the document that needs this information to get it at this unique place. Changing the information in this unique location would automatically update all of the documentation that references it. More if this system is a web-based system, we are at the key point of our paper main idea: information always updated and available. It remains only to give sense of the information by giving a type and then we achieve the 'semantic web' and the 'web of data'.

We also see that all this information are interconnected or linked together. This example illustrates that the more important for a company is data (and the links between them) rather than the application (software) that create them. The company becomes centered on their data and not on its applications.

Nowadays, the data become true virtual company assets [2] and data-centric business financially successful than others [3]. Similarly, an insecure technical data management causes financial losses. [4]

### **Semantic Web, Web of Data**

To deploy and share information, web technology is a good solution [16]. All computers have a browser and Internet connections are easily available worldwide (see free wifi in hotels or coffee shops). The structuring of data raises since a long time ago the interest of the W3C (World Wide Web Consortium <http://www.w3.org/>). Indeed, the switch from the "web of documents" to "web of data" is the subject of a separate working group and one of the first standards of the "web of data", the RDF (Resource Description Framework), was released in 1999.

We will focus on one of the standards of the semantic web, which is the closest of the solution that was selected by the company and that will better understand the web of data articulation.

RDFa is a syntax for structuring data in RDF inside an HTML page [7]. This principle is really interesting because it is not necessary to have an RDF file associated with the wiki, structuring data outside the page. RDFa is a bit complicated, we will study the Microdata rather, the principle is essentially the same but understanding and reading are much easier.

We approach the Microdata language through a simple example. The plain text, or to be more precise the HTML text, is of the form:

```
<div itemscope itemtype = "http://data-vocabulary.org/Person">
  My name is <span itemprop = "name"> Jacques Dupont </ span>. I live in
<span itemprop = "address_city"> Paris </ span>. Here is my homepage:
<a href="http://www.mapage.com" itemprop="url"> www.mypage.com.
</a> My position is: <span itemprop = "title"> Accounting </ span> in
company <span itemprop = "affiliate"> ABC </ span>.
</ div>
```

The different tags DIV and SPAN of HTML language include special properties: *itemscope*, *itemtype*, *itemprop*. The tag that integrates itemscope property defines the beginning and end of what might be called a record from a database. The ItemType tag defines the type, or the table name of a database in which is stored the recording. The tags that contain the itemprop property define the fields and values associated with each field in the concerned record.

Viewing in a browser gives:

```
My name is Jacques Dupont. I live in paris. Here is my homepage:
http://www.mapage.com. My position is: Accounting in company ABC.
```

And hereafter, how a search engine could retrieve the information if it is programmed to understand the structure of language Microdata.

```
itemscope (type: person)
```

*name: Jacques Dupont*  
*address\_city: Paris*  
*url: http://www.mapage.com*  
*title: Accounting*  
*affiliation: ABC*

In concept database, we could see things as following:

**Table 1:** Example of a standard table view of a database

table: **PERSON**

<b>name</b>	<b>address_city</b>	<b>url</b>	<b>title</b>	<b>affiliate</b>
...				
Jacques Dupont	Paris	http://www.mapage.com	accounting	ABC
...				

We see very clearly that web technologies evolution allows to associate directly into plain text database concepts. No need to have databases on one side and text documents to publish information. Web technology allows to combine the two functions in a single language.

## **Wikis**

The wiki term defines a web site whose pages can be modified by all users [8]. The first wiki was created in 1995 by Ward Cunningham. One of the most famous is the collaborative encyclopaedia called Wikipedia that is ranked sixth most visited sites in France in July 2014. The wiki is only a concept for a website. Technically it is based on a web server that contains software that integrate the principles and functions of wiki, this server and software is called: a wiki engine. There are several wiki engines. For example, the Wikipedia encyclopedia is based on wiki engine Wikimedia. The wiki was created initially to allow everyone to write web



pages with simplified format features. The wiki word comes from the Hawaiian word "wikiwiki" meaning fast.

Wiki basic principles are:

- The content is editable by everyone
- The link between pages is done by simply adding the name of the page inside the page and automatically creates a hyperlink to page
- The text input syntax is easy (no need to know HTML language)
- a plugin will list all the pages that mention the current page (ie backlinks)

Soon other features have emerged:

- the history of all the changes
- right page management for each user

To format the text of a wiki, we have to use a WikiML language [9]. This language allows to easily integrate formatting commands directly into the edit page. For example, in the TWiki wiki engine, bold character uses asterisks, italic setting *underscore* (see table #2 below).

**Table 2:** Example WikiML language for TWIKI

Language WikiML TWiki	rendering in the browser
* bold *test	<b>boldtest</b>
_essai of italique_	<i>italics trial</i>

Some wiki engines have natively integrated the principles of the Semantic Web for semantic wikis .

## MATERIAL AND METHOD

Previously to set up an information management system which follows the principles of the semantic web, we had to answer two questions:

- What web technology IT tool choose?
- What method of structured data choose?

For the first question, it was decided to respond by installing a wiki. The wiki principle has been retained for the following reasons:

- web technology: for the user only web browser is enough. No need to deploy a special software
- Collaborative: all employees can and must help to live the wiki data by producing them, filling the correcting or at least by reading and using them.
- revision management: all versions are stored and automatically signed. This guarantees against vandalism (conscious or not) [11].

Most wikis also now has features that are not part of the founding principles of wikis but are essential in most multi-user situations

- Fine management of read and write access permissions on the pages.

To support this semantic wiki, we used the wiki engine *TWiki* developed by Peter Thoeny [15]. Originally, this engine was chosen only because IT had installed on the secure intranet web server. We will see how the use confirmed this choice.

For the second question concerning the method of structuring information, we chose to use specific techniques of wiki engine *TWiki*. Two complementary methods were used.

1) The wiki engine *TWiki* natively integrates information structuring functions. Indeed, *TWiki* offers the ability to easily add fields to a formatted page. These structured fields associated with a page, let you to add features *database* to the wiki. The wiki is not only a set of linked web page together by hyperlinks but also a huge *database*. Therefore, *TWiki* has a search function that accepts the *language SQL* (<http://twiki.org/cgi-bin/view/TWiki/QuerySearch>).

2) The other way to structure and therefore semantize information within a wiki page was used a trick described by Peter Thoeny [<http://twiki.org/cgi-bin/view/Sandbox/EditActionItems>]. This solution is based on the use of an array whose first cell of each row contains a information marker label. This marker identifies the row of the table as a set of structured information. This marker is surrounded html codes "<! -" and "->" that hide all the characters between the two tags. Visually, when reading the pages we see nothing but the source code of the page actually contains this marker. The machine can then read and research from this marker. Here we find the same principle that has been the source of data description languages "RDFa" and "Microdata" that structure the information directly into a web page.

Now let us take an example to illustrate this concept by describing in detail how is structured a technical characteristic in this wiki.

The source code of an array of technical characteristic:

```
| * <NOP> * | Symbol * * | * Name * | *Name. Value * | * Unit * | * * Min
| * Max * | * * Test Method | | | | | | |
| <- FEATURE -> | I | Current Elec | 10 | mA | -0.5 | +0.5 | IECxxx-4 |
| <- FEATURE -> | W | Weight | 145 | g | -2 | 10 | ISOzzz $ 3.2 |
```

And now render in a browser:

**Table 3:** Example of structuring data in a page

	Symbol	Name	Nominal Value	Unit	Min	Max	Test Method
	I	Elec Current		10mA	-0.5	+0.5	IECxxx-4
	W	Weight	145	g	-2	10	\$ 3.2ISOzzz

This table is included inside a component page, the features described in this table thus corresponds to the component described by the page. Each line represents a data (here a technical characteristic) and each column a property of this data.

Page looks like:

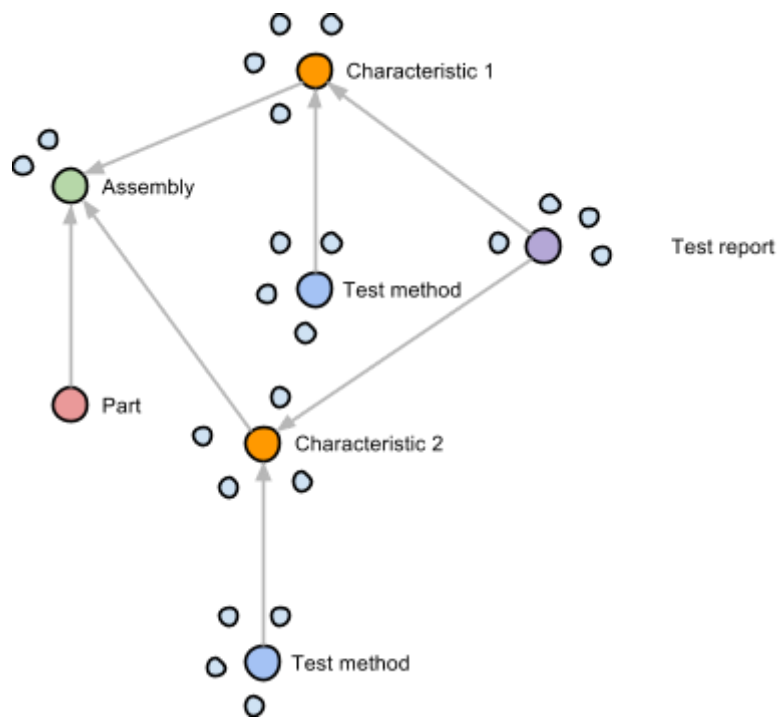
*Figure 1: Website page picture*

Nom de la page :	PartOring6022																						
<b>1. Overview</b>																							
This page describes an O-Ring component.																							
<b>2. Product Characteristics</b>																							
<table border="1"><thead><tr><th>Name</th><th>Nom. Value</th><th>Unit</th><th>Min</th><th>Max</th><th>Test Method</th></tr></thead><tbody><tr><td>ID</td><td>7.67</td><td>mm</td><td>-0.02</td><td>+0.05</td><td>ISOxyyz</td></tr><tr><td>Tore</td><td>2</td><td>mm</td><td>-0.01</td><td>+0.01</td><td>ISOxyyz</td></tr></tbody></table>	Name	Nom. Value	Unit	Min	Max	Test Method	ID	7.67	mm	-0.02	+0.05	ISOxyyz	Tore	2	mm	-0.01	+0.01	ISOxyyz					
Name	Nom. Value	Unit	Min	Max	Test Method																		
ID	7.67	mm	-0.02	+0.05	ISOxyyz																		
Tore	2	mm	-0.01	+0.01	ISOxyyz																		
<b>3. Design and Operations</b>																							
This o-ring is used for all fluids except fuel. It could be used with oil only for temperature below 125 degC.																							
Form:	<input type="text" value="PartForm"/>																						
P/N:	<input type="text" value="HR64789"/>																						
Date:	<input type="text" value="25/07/2014"/>																						

We then see a wiki page with text (*unstructured information*) and formatted text, inside table or inside form tied to the page (*structured information*). If hyperlink connects two structured pages, so we have a relationship between two structured data.

We can also better understand the nesting of structured data together with the network graph below which highlights the data, their type by the colors and the link between them.

**Figure 2: Network graph**



Legend for nodes:

- Big circle = a data
- Little circle = property of data

Legend for links:

- Line = link between two nodes

## **Ontology**

A big task is to list all the data that the company wants to structure. This set of terms and concepts is the ontology of the company. Ontology can simply be defined as a set of terms used to describe a domain (ont 2014). For each data, you have to choose his method of structuring: page (with forms) or table (with columns), and list the properties necessary to describe the data.

In the specific case of the company that interests us, just fifty data types was sufficient to describe how to work the company.

**Table 4: Structured data example**

<b>Data</b>	Test
<b>Keyword</b>	Test
<b>Structure</b>	Labeled table
<b>Definition</b>	
<p>A test can be considered as technical operation or procedure that consists of determination of one or more characteristics of a given product according to a specified procedure (see test method). Often a test is part of an experiment or validation plan. The test result can be qualitative (yes/no), categorical, or quantitative (a measured value). It can be a personal observation or the output of a precision measuring instrument.</p>	

<b>Properties</b>			
#	Name	Type	Definition
1	DVPnR (1)	page	Link (hypertext) to DVP&R web page
2	Customer requirement	text	Reference of customer requirement
3	Start	date	Start date of test
4	End	date	End date of test
5	Completion	number	
6	Laboratory	page	Link to organization which makes test
7	Status	text	Pass, fail or other comment
8	Test Report	page	Link (hypertext) to Test Report page

(1) Design Validation Plan and Report



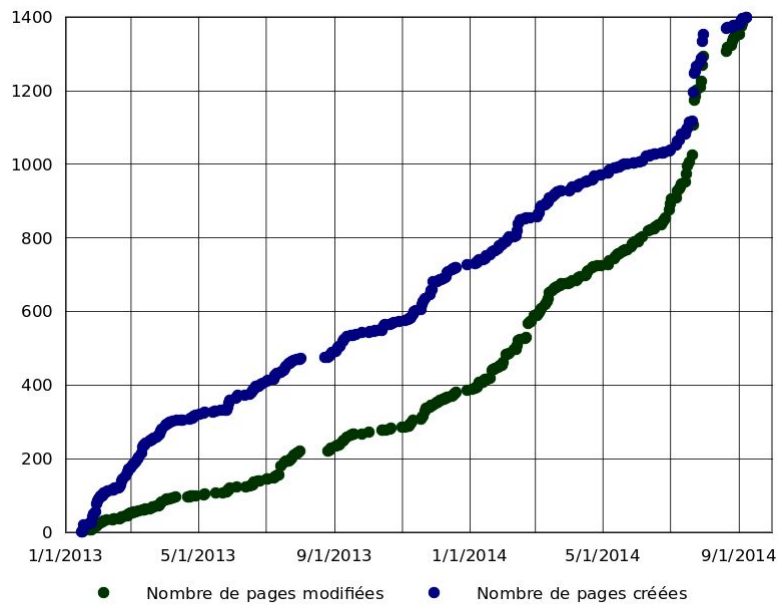
## RESULTS

We will now analyze how this semantic wiki is used. What is the attendance, the number of pages created, the number of modified pages and some other metric.

This wiki has been set up in one of the R&D sub-department of the company. This technical service is predominantly made up of 4 people, the oldest been forty. The wiki was commissioned in February 2013. In September 2014, 1 400 pages were created.

The blue curve of graph (Figure 3) shows the cumulative evolution of the number of pages created versus time. We can observe two accelerations: one at the beginning of the installation is the initial effort required to start using the wiki. The second acceleration in July 2014 simply due to the hiring of a temporary employee for a month to update a few pages. We can observe the effect of his work.

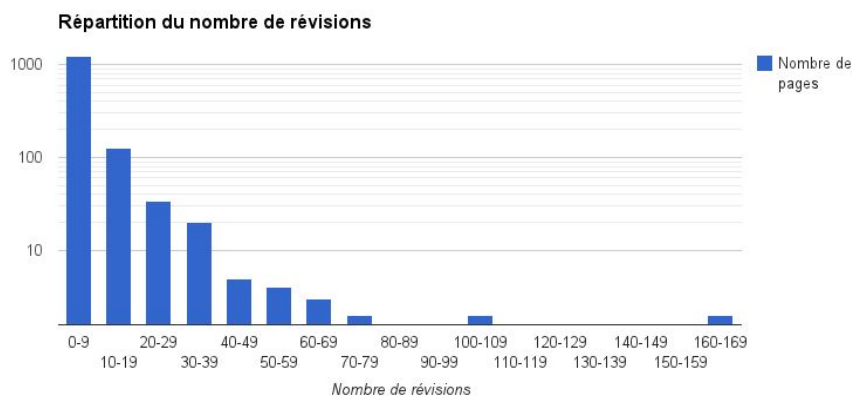
*Figure 3: Cumulative number of created pages and pages modified vs time*



The green curve (Figure 3) shows the same pattern as the blue one but each page is not placed at the moment of its creation, but at the date of modification. More the steeper the slope of the green curve is steep, more the changes during the period is numerous. It is interesting that the steepest part of the green line is the last part, this means that the wiki is alive: users use it and modify pages. The greater the gap between the green curve (changes) and the blue curve (creations), the greater the wiki is used.

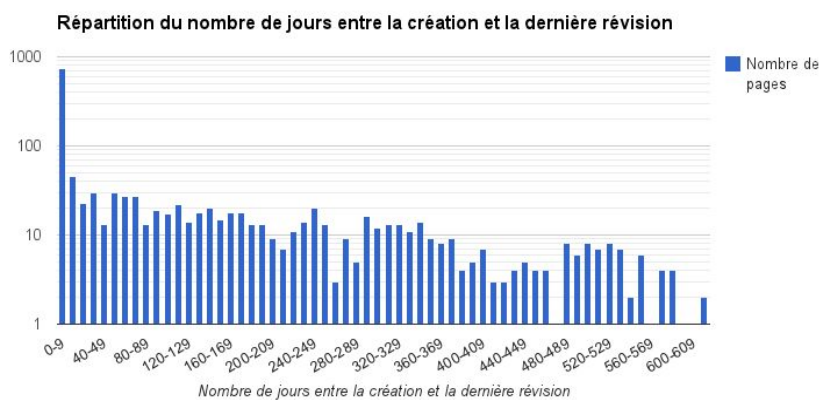
We now concern ourselves with the number of amendments or revisions of each page. It is indeed interesting to know if the pages are changed regularly or, conversely, if the wiki is static. Unsurprisingly, the maximum number of pages (35%) have never been changed and 51% of the pages has not been more than 10 changes. The graph below (Figure 4) shows the distribution of the number of modifications.

**Figure 4: Distribution of the number of revisions**



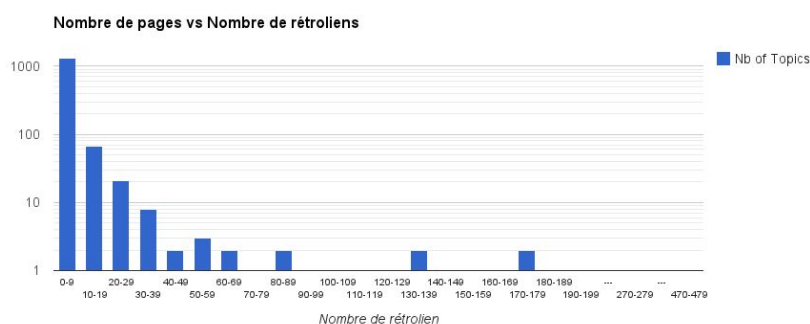
Now let's observe the time that exists between creation and last modification. 51% of the pages are changed in the 10 days after their creation. Then the distribution follows a slight downward trend (Figure 5).

**Figure 5: Distribution of the number of days between the creation and the latest revision**



One way to make sense in the wiki data is also to link the pages each others by hyperlinks. More there are links between the data, more the data are meaningful. It is therefore interesting to see if a page created is used in another page. For this we will study the distribution of the number of backlinks: number of pages that have a link to the study page (Figure 6).

**Figure 6:** Breakdown of the number of trackbacks



63% of the pages are only used once and 30% of pages are used between 2 and 10 times. The table below provides a zoom on the number of smallest link number. More than 1,000 pages were at most 4 links. It will be in the future one of the areas for improvement for this semantic wiki: how to force the page editor has put a meaningful number of connections? Ideally, the maximum is within the range from 10 to 20 links.

**Table 4:** Number of pages versus number of backlink

Backlink Number	Number of pages
0-4	1158
5-9	141
10-14	46
15-19	21

The reader will get noticed that some pages have a large number of links (greater than 50). This is actually the pages that define the types created in the ontology. (user, technical, business, test method, project, test report, validation plan, ...). These pages are to be seen as more categories as useful information to store and share. It is therefore normal that this page has many links.

## DISCUSSION

### **What does an ontology to the business?**

The drafting of the ontology of the business was a relevant work. This ontology has created a common business vocabulary to the company. Each term of the ontology was the subject of a definition. This work has clarified the ways of working of the company, to clarify *who does what*. We also noticed that, in defining who was responsible for the data, we defined the corporate way of work. The next job is to create a workflow between the data to fully define the company's work processes.

### **Implementation wiki**

Once integrated wikiML language, the implementation is easy. In TWiki motor, function `%SEARCH { "text" ...}%` recovers information on tabular or point list format. The function `%SEARCH {}%` can also be nested to do research on several criteria. All information inclusions in a page that use semantic links are built from this function.

If at the beginning of the construction of the wiki, information to structure should be essentially technical, we realized quickly that this was not enough and had to add other kinds of information. Information related to the project task, ie dates, hours spent on projects entered, logistics data on deliveries of parts received in phase prototyping parts.

### **What is the acceptance of the wiki by the company (users)?**

Everyone agrees that this is the right way of work. In reading mode, users state the use is really simple even if some users are difficulties to jump over pages. Usually they do not know what they want, you need a strong starting point. In writing mode, the brakes are numerous. The reluctance comes from WikiML language and this even if *TWiki* has a WYSIWYG<sup>2</sup> editor. The commercial tools (ie word processing or spreadsheet) is so ingrained in the habits that the transition to a logical *Markup Language* seems insurmountable. Here we find the true limiting of the penetration of wikis in the company [14].

One of the most mentioned concern was fear that contributors register anything in the pages or even sabotage the content of others. Here the answer is simple: the history of all changes is kept. Which is for the user to sign all his contributions as an email is signed and sent by only one person.

### **The surprises of the installation of a semantic wiki**

A function allows to export page to PDF file. The company logo, the page title, the name of the author of the page, the revision number and date are automatically added. There are no more possible error on the date entry or revision number. The dissemination of information to people that do not have access to the wiki is how quickly and safety.

Here is a list of features that have been added to the wiki but that was not originally planned.

- Automatic Organizational
- Multiple Indicator Dashboard
- Tracking time spent on different projects

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<sup>2</sup> What You See Is What You Get

The flexibility of the wiki and structuring of data allows complex analysis and automatic dashboard creation.

## CONCLUSION

After describing the context of the company and what we meant by "data" we saw how it was possible to implement a solution of semantic wiki with wiki engine called *TWiki*. These principles can be easily applied to other wiki engine. It is now clear to the company that semantic web technologies are a good response to the global distribution and management of technical data. However, web technologies, even if they enter more privacy area (particularly with social networks), are far from the business habits, word processors or commercial spreadsheets. It is therefore necessary to carry out a real training work to break the brakes of the users towards these technologies. It is at this price that the company can take full advantage of all the strength of the web and the semantic data. One of the unsuspected fruits of this work of data semantization is the ontology contribution on the descriptions of the processes of the company. Procedures and processes can easily be deduced from this semantization by introducing a notion of workflow between structured data.

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