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# **Optimisation of CERN tools & methods for e-learning: the case of short online tutorials**



**Master's Thesis submitted for the Master of Science HES  
in Information Sciences**

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## Declaration

This Master thesis is submitted as part of the final examination requirements of the Haute école de gestion de Genève for obtaining the title of Master of Science in Information Sciences.

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Geneva, 15<sup>th</sup> August 2016

Alexandre Racine



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<sup>1</sup> It has to be noted that this work has been entirely completed by myself. Nevertheless, the pronoun “we” has been chosen throughout this thesis in order to include all those who have helped me to achieve my aim.

## Abstract

The term “*e-learning*” is directly related to the practice of distance education, which started about one hundred and fifty years ago. At this time, it was possible for lecturers to teach using means such as mail, phone, radio or television. With the progress made in the field of telecommunications, the Internet and the web allowed people to drastically extend their ability to learn through various means, avoiding the constraints of location and time.

It is often difficult to know exactly what is covered by the word “*e-learning*”. The concepts of MOOC or blended learning are very popular nowadays, whereas fewer people know precisely what rapid e-learning is. This particular type of distance education is often used for quickly teaching procedures to people, using, for example, short online video tutorials. This form of education will be the one focused on for this thesis.

We collaborated for six months with the European Organisation for Nuclear Research (CERN), to provide an analysis and recommendations regarding the creation of short online video tutorials. Our primary aims were: assessing the technologies already available on the web, i.e. free, open-source and cross-platform screen recording tools. Also providing recommendations concerning the best practices and pedagogical recommendations to take into consideration for the creation of content. Taking user-related variables into account can ensure the success of an e-learning project, despite the technological features which seem, often, more important to people than the pedagogical principles.

To achieve these goals, we gathered all necessary information to define which tools and content would be the most appropriate for our project. We assessed eight potentially relevant screen recording packages and compared them according to a selection of criteria. We also found that dealing with open-source and free packages was more demanding than with proprietary and profit-oriented ones.

In this context, we concluded with recommendations for the use of three easy to use screen recording tools for the lecturers, depending on their preferred Operating System (OS). Also, a terminal recording tool for processes achieved in a shell. We also provided a set of pedagogical recommendations to create a good short online tutorial. We also discussed future work regarding rapid e-learning at CERN.

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# 1. Introduction

In the context of our studies to obtain a Master's degree in the field of Information Sciences, we chose to provide an analysis and recommendations about e-learning at the European Organisation for Nuclear Research (CERN). The aim of this study is to focus on the creation of short online tutorials, i.e. the concept of rapid e-learning which we will develop in the last section of the literature review.

CERN, based in Switzerland (Geneva) and France, is one of the largest and most prestigious scientific laboratories in the world and aims at understanding the fundamental constituents of matter, i.e. the core components of our universe (CERN 2016a). To achieve this goal, scientists at CERN use, for example, the Large Hadron Collider (LHC) which is the world's biggest and most powerful particle accelerator (CERN 2016b). To process the data collected by the LHC, physicists rely particularly on several collaborator profiles, such as Information Technology (IT) collaborators, who are providing a large number of IT services. These IT services can sometimes be complex to understand and some are changed frequently. It is in this context that rapid e-learning offers many benefits to the organisation by improving employee autonomy, understanding and usage of these services.

This thesis will introduce the history, definitions and general concept of e-learning, focusing on its advantages and limits. It will also approach the different forms of e-learning (e.g. MOOCs, blended learning, etc.) with particular attention paid to rapid e-learning which is considered to be the most relevant concerning the subject treated in this work.

The Methodology chapter will address the way in which information about e-learning at CERN was acquired and used. It should be noted that other CERN courses contain e-learning components although they are outside the scope of this project (CERN HR department 2015). Various screen capture products available on the web were studied, based on various criteria to consider for those packages.

The last parts of this thesis will present the results obtained, as well as educational and technical elements to consider when one wishes to implement e-learning projects. The conclusions drawn at the end of this work are outlined including a general discussion about positive aspects and limits of e-learning, along with future work which CERN could pursue concerning e-learning projects.

## 2. Literature review

In this chapter, the history and definitions of e-learning will be explained. This will be followed by its general concepts and its different types, trying to identify why this particular way of learning became so popular during the last few years. Finally, there will be more focus on a specific type of e-learning, rapid e-learning, which is considered the most appropriate in the context of this thesis.

### 2.1 History of e-learning

In order to get acquainted with the general concept of e-learning, the following gives a brief historical overview. According to several authors ([Hügi 2014, p. 7](#); [Benraouane 2011, pp. 10–11](#); [Bourban 2010, p. 3](#)), e-learning is considered, on one hand, related to the practice of distance education which offered the possibility to teach using tools such as radio, television or mail. On the other hand, it should be noted that this form of learning is more closely related to the field of computer-based training (CBT), also known as computer-assisted instruction (CAI) ([University of Geneva 2016a](#)). Then, with the advent of the Internet in the 1990s, universities which were already specialised in the field of distance education used the opportunity to transform their courses into online training sessions. Indeed, it should be noted that the success of the e-learning programs adopted by the first online universities in the USA is mainly because these institutions had already established distance learning programs that were providing correspondence courses ([Benraouane 2011, p. 10](#)). The following will explain how distance learning has evolved over the last 150 years.

#### 2.1.1 General timeline of distance education

According to Sherron and Boettcher (1997), quoted in [Benraouane \(2011, pp. 11–13\)](#) and [Botturi and Tagliatesta \(2001, p. 2\)](#), distance education has evolved through 5 major steps:

- **From 1850 to 1960:** during this period the primary tools used were mail, radio and television and the communication between teachers and learners was asynchronous, i.e. mostly dependent on the constraints of distance and time.
- **From 1960 to 1985:** during this period, other tools such as audiotapes, videotapes and phones were introduced. Distance education was evolving, however the communication was still asynchronous.
- **From 1985 to 1995:** CD-ROM and personal computers arrived on the market as well as the first web-based technologies and e-mails. It became possible for learners to communicate in real time with teachers. However, the weakness of telecommunication infrastructures during this period made the communication difficult.

- **From 1995 to 2005:** This period is characteristic of the transformation from distance education to online learning. E-learning became popular, and most of the universities which had already developed distance learning transposed their content to e-learning. In addition, there was an evolution in the Internet access technologies, with broadband access allowing institutions and people rapid access to the Internet.
- **From 2005 to nowadays:** the advent of web 2.0. with the evolution from static to dynamic content allowing users to create, share and collaborate in real time. Social sites such as Facebook, Twitter or LinkedIn were established, as well as collaborative sites to create and enrich content, such as Wikipedia.

This transition from distance education to e-learning leads naturally to the various definitions of this concept in the following section.

## 2.2 E-learning definitions

There are several definitions of e-learning. As presented by [Sener \(2015\)](#), e-learning has evolved to a point where it is now difficult to have a shared set of meanings for this concept. However, there is at least one common point which is the use of new technologies to foster learning. For example, as defined by [Benraouane](#), e-learning is the process to:

*“Learn through electronic means and it refers to the use of the web and new technology applications [...] to improve the process of acquiring new knowledge or update [...] knowledge. National education programs, higher education programs, corporate training programs, and continuing education programs use e-learning.”*<sup>2</sup> ([Benraouane 2011, p. 4](#))

In their article, [Lee, Hsieh and Chen](#) resume the most important points of this definition, but they add some other interesting elements. For example, they define it as such:

*“Electronic learning (e-learning), a new approach in education, highlights **learner oriented life-long teaching-learning processes**. E-learning generally refers to the use of computer network technology, primarily **over an Intranet** or through the Internet, to deliver information and instruction to individuals.”* ([Lee, Hsieh, Chen 2013, p. 173](#))

The concept of “*life-long teaching-learning process*” is crucial here as it assumes that learning is no longer a task one does only at school or during studies, but in almost every dimension of our lives, irrespective of age or social level. As [Botturi and Tagliatesta \(2001, p. 2\)](#) define, “*learning is the most suitable source of adaptation to the environment [and] learn to learn is the law of the knowledge society jungle [...]*”. The authors point out that “*learn to learn*” is not only knowing how to learn but also knowing why to learn as well, i.e. having the motivation to learn.

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<sup>2</sup> Translation from the passage of the book of this French author.

Furthermore, as Daniel K. Schneider, associate professor in the faculty of psychology and education at the University of Geneva, writes *“it takes time. Count 7 +/- 2 years to learn something right”* (Schneider 2015). Thus, it is fully understandable why we need more than traditional education courses to master all the elements needed in our professional and personal lives.

One other thing which is also important to note when one focuses on the meaning of e-learning is the following. An “e-” is being written before every task which is done with a computer. This generally implies that *“an e-something is always better than its old-fashioned non-e equivalent”* (Botturi, Tagliatesta 2001, p. 1).

Although illustrated in the two primary definitions above that e-learning is generally accepted as involving new technologies, web technologies and new media, it would be wrong to think this way of learning always includes the Internet and excludes face to face educational activity. Furthermore, we should not forget to use traditional media such as books or blackboard too (Botturi, Tagliatesta 2001, p. 1). Learning should be seen as a relationship between people as:

*“A teacher is the element that can start the communication flow in the right way. In the beginning, he/she may even embody the dialogical pole the student has to come in touch with, by representing the subject matter in itself, by being directly (or through a medium) in dialogue with students.”* (Botturi 2002, p. 6).

Modern technologies can not replace everything, and it seems not to be by chance that education has a strong connection with social sciences and various theories such as behaviourism, cognitivism and constructivism for example.

With these general definitions of e-learning and what they imply, the typology of different types of e-learning can now be introduced.

### **2.3 A typology of e-learning lessons**

According to Allen and Seaman (2008), quoted in (Hügi 2014, p. 8; Benraouane 2011, pp. 4–5), there are several types of e-learning lessons which can be classified related to their percentage of online content. Group<sup>3</sup> lessons with no on line content. Web-based lessons with a low percentage of online content and use of web technologies to foster learning.

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<sup>3</sup> Translation from French.

Blended learning which is a solution with a vast percentage of online content mixed with group lessons, and finally entire online lessons, e.g. MOOCs<sup>4</sup>, with no face to face meeting. Table 1 illustrates these various types of e-learning lessons.

Table 1: Typology of lessons

| Percentage of online content | Types of lessons               | Description  |
|------------------------------|--------------------------------|--|
| 0%                           | Group lessons                  | No on line content   |
| 1 to 29%                     | Web-based lessons              | Low percentage of on line content & use of web technologies to foster learning |
| 30 to 79%                    | Mix lessons (blended learning) | Vast percentage of on line content mixed with group lessons                    |
| +80%                         | Entire on line lessons         | Entire on line lessons with no meeting face to face                            |

(Adapted from Hügi 2014, p. 8)

## 2.4 E-learning advantages

As Benraouane (2011, p. 5) defines, the success of e-learning during the last years is mainly due to the multiple advantages it offers. Those benefits can be classified in more or less four categories:

- Flexibility
- Deployment
- Accessibility
- Cost containment

Indeed e-learning fosters access to knowledge and educational software which are available on the Internet. It offers the possibility to learners to choose when and where they want to learn. It allows the quick deployment of learning strategies within organisations and helps to contain the costs of learning. Finally, it also allows employees to improve their employability by giving them the opportunity to acquire life-long knowledge as we have illustrated before.

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<sup>4</sup> The definition of MOOCs (Massive Open Online Course) is generally accepted as: *"[online courses] with the option of free and open registration [...] and open-ended outcomes. [They] integrate [...] accessible online resources, and are facilitated by leading practitioners in the field of study. [...] MOOCs build on the engagement of learners who self-organize their participation according to learning goals, prior knowledge and skills, and common interests."* (Luján Mora 2013)

In her Master's thesis, Hügi (2014, pp. 9–11) organises e-learning advantages into three main categories which are:

- pedagogical
- organisational
- economical

#### **2.4.1 Pedagogical advantages**

Concerning pedagogical advantages, she insists, supported by AWT (2008), on the point that the diversification of educational and learning methods offered by this way of acquiring knowledge allows consideration of the several cognitive styles of the learners. For example, certain students prefer to read a text while others prefer listening to a podcast or watching a video. An online course can thus use and mix those various mediums, i.e. text, sound or video, etc. and thereby help to influence the student's motivation positively.

#### **2.4.2 Organisational advantages**

Concerning organisational advantages, as illustrated in the introduction of this point, e-learning offers the possibility to learners to be more flexible regarding the time when, and the place where, they want to learn. Another interesting point to be stressed is the fact that the student can himself<sup>5</sup>decide how he intends to progress in the formation, regardless of the progress of the other students, and regardless of the constraints of face to face courses.

#### **2.4.3 Economical advantages**

Finally, concerning the economical advantages, several sources (Hügi 2014, p. 11; AWT 2008; Benraouane 2011, p. 5) indicate that e-learning enables reduction of the cost of learning which can be relatively high. On one hand, the costs can be reduced for example by avoiding the need for participants to have to move to the learning venue. On the other hand, Benraouane (2011, p. 5) points out that this cost-effective paradigm facilitates bringing education to people for whom it would be difficult in other circumstances, mainly because they live in areas relatively far from urban centres. This is why they are often excluded from national education programs.

While e-learning is often considered to have many benefits, there are also some negative (or less positive) aspects to be taken into account when determining which characteristics are predominant concerning the success or the failure of an e-learning approach. These “*negative*” points are introduced below.

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<sup>5</sup> The use of the pronouns, e.g. “*he*”, “*himself*”, etc. throughout the text refers to either males or females..

## 2.5 E-learning challenges

According to the literature review and, again, to Hügi (2014, pp. 11–12), the disadvantages related to e-learning projects can be classified into three broad categories:

- Pedagogical
- Learners' preconditions
- Economical

### 2.5.1 Pedagogical challenges

As defined by Favre (2006, p. 6), current knowledge concerning learning refers to two central points: the cognitive and the social aspects. The one of most interest at this point is the social one:

*“Learning is seen as a modification of a state of knowledge by assimilating information. [And] this modification can be foster through contact (confrontation) with a partner (generally the teacher or other participants). E-learning introduces [thus] a “pedagogical distance” which is necessary to take into consideration”<sup>6</sup> (Favre 2006, p. 6).*

In the most extreme cases, this lack of contact can even lead the learner to feel isolated and lonely. Students attending an online course are obliged to provide much more effort regarding motivation than those participating in a face to face lecture. This may result in a high number of them abandoning due to the complete lack of interaction involved (Hügi 2014, p. 12).

Moreover, as Govindasamy presents, and even if this reference is outdated, e-learning is generally supported by LMS<sup>7</sup> but the problem is that:

*“Most LMS vendors deliberately distance themselves from pedagogical issues [...] [as they] perceive themselves as mere providers of technology” (Govindasamy 2001, p. 288).*

This may result, “in a worse case scenario”, in a situation where:

*[...] the tools may end up being used in a manner entirely opposed to pedagogical principles, and in turn, will hamper learning” (Govindasamy 2001, p. 289).*

In addition, the selection and implementation processes of the LMS can totally fail if institutions lack pedagogical support (Wright et al. 2014).

### 2.5.2 Learners' preconditions

One other significant disadvantage concerns the preconditions which a learner has to fulfill before attending any of e-learning lectures. The learner should possess basic

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<sup>6</sup> Translation from French.

<sup>7</sup> Learning Management Systems



technological skills such as use of a computer and Internet navigation (Hügi 2014, p. 12). In addition to these technological skills, and according to Botturi and Tagliatesta (2001, p. 2) mentioned earlier in this work, a metacognition skill is indispensable, i.e. knowing how to learn and identifying which method offers the most relevant results to the learner with respect to retaining knowledge. Finally, he should be able to organize his planning to have time to learn. A lot of self-discipline is required and if this is not the case, it could lead to a lack of motivation and procrastination. (Hügi 2014, p. 12). It is therefore critical for the learner to know himself well in terms of his ability to learn.

Furthermore, in terms of technological aspects, Lee, Hsieh and Chen (2013) refer to the TAM, i.e. the Technology Acceptance Model, which they have studied among employees of Taiwanese companies. In summary:

*“The TAM is a specific model developed to explain and predict users’ computer usage behaviour [...] [and] asserts that two salient beliefs—PU [i.e. Perceived Usefulness<sup>8</sup>] and PEU [i.e. Perceived Ease of Use<sup>9</sup>]—determine technology acceptance and are the key antecedents of BIs [i.e. Behavioural Intentions] to use information technology” (Lee, Hsieh, Chen 2013, pp. 174–175).*

The TAM includes other user-related variables as well, such as PE, i.e. Prior Experience, which is the user’s prior experience in using computer related technologies. The authors demonstrated that PE influences the PEU which will affect the PU. Finally, the PU influences the BIs. Figure 1 illustrates the results of the various influences concerning the TAM.

It supports the necessity for the learner to feel comfortable with basic technological skills. In addition, it underlines another interesting fact; the need for institutions to be aware of the technical skills level of their employees. As all staff do not have the same skills and levels, in this context it could be difficult to deploy a strategy which is in line with the technological capabilities of all of them. Even if the context is slightly different because the study addressed students’ usage of e-learning, this matter of technical skills has been identified in the article written by Zinn (2009, p. 164).

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<sup>8</sup>“[...] [It] is the degree to which an individual believes that a particular system would enhance job performance within an organisational context” (Davis et al. 1989 quoted in Lee, Hsieh, Chen 2013, p.175)

<sup>9</sup>“[...] [It] is the degree to which an individual believes that using a particular system would be free of effort (Davis 1989 quoted in Lee, Hsieh, Chen 2013, p.175)

Figure 1: The TAM various influences

Table 7. Hypothesis testing results.

| Hypotheses | Path      | Path coefficient | Results       |
|------------|-----------|------------------|---------------|
| H1         | PU → BI   | 0.708**          | Supported     |
| H2         | PEU → PU  | 0.304**          | Supported     |
| H3         | PU → AT   | 0.137            | Not supported |
| H4         | PEU → AT  | -0.238**         | Supported     |
| H5         | AT → BI   | -0.165**         | Supported     |
| H6         | OS → PU   | 0.438**          | Supported     |
| H7         | OS → PEU  | 0.341**          | Supported     |
| H8         | PE → PU   | 0.291**          | Supported     |
| H9         | PE → PEU  | 0.149**          | Supported     |
| H10        | CSE → PU  | -0.071           | Not supported |
| H11        | CSE → PEU | 0.413**          | Supported     |
| H12        | TE → PU   | 0.161*           | Supported     |
| H13        | TE → PEU  | -0.049           | Not supported |

Note: \* $p < 0.05$ ; \*\* $p < 0.01$ .

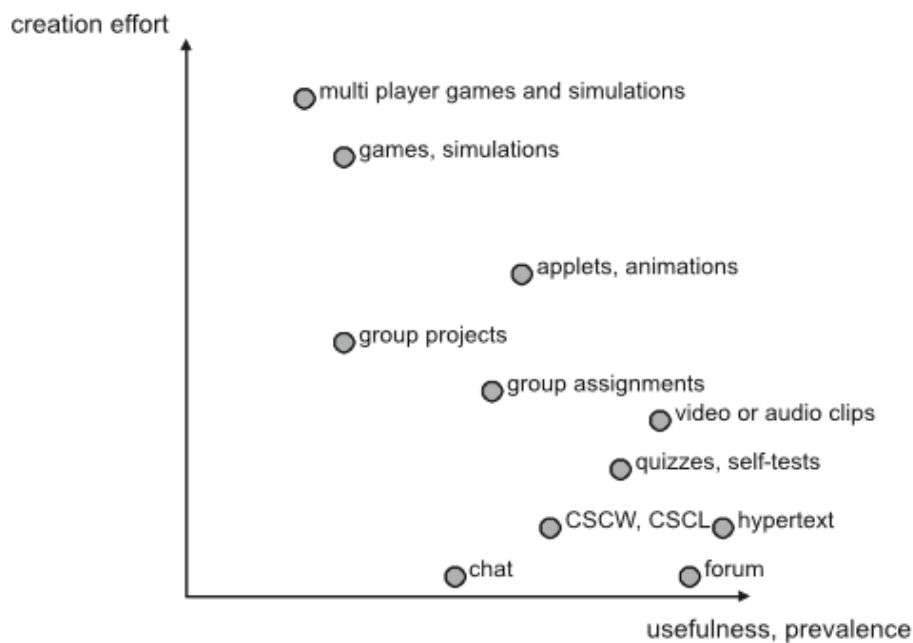
(Adapted from Lee, Hsieh, Chen 2013, p. 183)

### 2.5.3 Economical challenges

Focusing on economical disadvantages, the cost reduction benefit seen above is not sufficient in all cases. Indeed, the initial expenses incurred by creating material for e-learning can be relatively high. The production of relevant material to achieve the pedagogical goals is time-consuming and, hence, quite expensive (Hügi 2014, p. 11). The same problem exists concerning development of the necessary technological environment if the organisation has not yet acquired the relevant infrastructure. In addition, the maintenance required also adds to the cost.

Furthermore, another interesting point to be taken into consideration is the ratio between creation effort and usefulness & prevalence. As Figure 2 presented by Henrich and Sieber shows, this ratio may be significantly different for the variety of selected scenarios.

Figure 2: Cost–benefit ratio of different techniques for interaction



([Henrich, Sieber 2009, p. 128](#))

In this context, whoever wants to develop content using educational technologies should clearly identify in advance which content is the most appropriate given its targeted audience, organisation and budget.

## 2.6 Best practices and key success factors

According, mainly, to [Alberts et al. \(2007\)](#) and [Henrich and Sieber \(2009\)](#), the best practices and critical success factors in terms of e-learning are described hereafter. Firstly, it should be noted that the advantages of e-learning seen above are named by [Alberts et al. \(2007, pp. 55–56\)](#) in other words: the four P's which are presented as such:

- Place
- Pace
- Peace
- Process

Meaning, in this order, that learners have the possibility to learn at the venue of their choice (Place), at their own speed (Pace), at the moment of their own choosing (moment of peace) as well as the means by which they want to learn (Process). For this last point and to give a simple example, it means that the learners may be able to skip a part of the course that they already know to better concentrate on topics they

master less.

### 2.6.1 Introduction to the best practices

Alberts et al. (2007) define the primary challenge of creating an e-learning lecture as:

*“to make [its] environment sufficiently engaging in order to promote the advantages of the ‘four Ps’, thereby promoting independent learning amongst students” (Alberts et al. 2007, p. 56).*

To achieve this goal they propose a set of ten recommendations based on previous studies as well as the famous Jakob Nielsen’s “*Top Ten Mistakes in Web Design*”. They also mention their awareness that “*studying for a degree in higher education*”, or in our case as organisations’ employees who want to perfect their knowledge:

*“is different from gathering information by surfing the Internet, which was the focus of Nielsen’s work. [that is why] additional considerations for the use of the web technology in formal learning contexts are included” (Alberts et al. 2007, p. 57).*

Regarding those best practices, and in order not to overload the reader with information, the details are not included, but it is possible at any time to refer to the original article presented by Alberts et al. (2007).

Only the list of those ten relevant recommendations has been included followed by a short explanatory definition.

### 2.6.2 The list of ten best practices regarding e-learning

These best practices are paraphrased and are also all extracted from the article from Alberts et al. (2007, pp. 57–62) or inspired by EDUCAUSE (2016).

1. **Specify your learning outcomes and design your assessment strategies with them in mind.** Learning outcomes make content more relevant and allow learners to understand precisely what they should achieve in their learning.
2. **Keep in mind that the lecturer is not physically present to explain the learning environment.** The descriptions should be self-explanatory. A good practice is to use “*user-testing*” with a sample of learners.
3. **Make use of multimedia:** the impact of the course can be made more forceful by the use of multimedia elements. Presenting information through various ways increases the interest of the learners.
4. Compared to, for example, chapters and sub-chapters in a book, it is imperative to **structure the content to more than one level**. It is better to avoid the learners scrolling down a single very long web page.

5. **Give enough navigational information to the learners.** Especially where they come from and where they go. As for web-design, good practice is to use breadcrumbs.
6. **Allow a good balance between freedom of navigation and necessary constraints.** The learners should have the possibility to navigate relatively freely to explore content, but where this opportunity is offered, a risk exists that he will be lost in the complex structure of the learning environment.
7. **Make use of the hyperlinks only for supplementary information.** Hyperlinks can be very useful to provide more context but can also really disorientate.
8. **Provide a feedback to the learner.** Feedback should be constructive and encouraging and can be delivered through various media.
9. **Make use of interactions in the electronic environment and vary those interactions.** The level of interactivity provided will determine how the learners will stay interested and focused on the lesson. Besides, as presented by Bourban (2010):
 

*“an interactive multimedia means that the learner can have control over the presentation and this personally involves him or her, thereby allowing to produce a beneficial effect on the formation”<sup>10</sup> (Bourban 2010, p. 6).*
10. **Encourage the learners to practice their learning.** Because *“an effective learning situation is to provide the opportunity for the student to interact extensively with the content”*.

### 2.6.3 Key success factors

Although differences can exist between various organisational contexts, as well as the different targeted audience, Henrich and Sieber (2009, pp. 144–145) approach a series of *“critical success factors”* which they consider *“as essential aspects for successful blended learning and pure e-learning courses”*. First of all, the concept. It has to be clear, in words of addressed content and targeted audience.

As illustrated in point 2.5.3 about economical challenges, one other point to take into account is the ratio between the effort provided to create the content (the cost) and the benefit. It is worthy to note that the creation of the content itself is critical and will depend on the subject, the organisational context and the targeted audience. Whatever the choice, it has to ensure a good cost-benefit ratio, as well as a relevant content presentation.

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<sup>10</sup>Translation of the passage of the Bachelor's thesis of this French author.

In the context of content creation, the maintenance effort must be mentioned as many presentations or other multimedia productions in the context of an e-learning course become obsolete quickly and need to be updated. It is important not to neglect this point when taking into consideration the above-mentioned cost-benefit ratio.

Furthermore, monitoring the component usage of e-learning systems can offer relevant information about how useful (or not) a tool is. If there is monitoring evidence that certain elements are not used, this could be an opportunity to rethink the structure of the lesson, the content or to identify if there are problems with the approach, i.e. if something appears to be unclear to the participants.

Finally some words about participation. The lecturer and the tutors play a significant role in the learning environment as they need to promote involvement and participate. For example by using the courses' forum.

As illustrated in [Figure 2](#) and in accordance with Henrich and Sieber, it is interesting to note that asynchronous communication, i.e. forums, are indispensable as they are:

*“[...] an established form of communication, and are available in abundant supply with desired features and maturity. The creation of own solutions is therefore not necessary” (Henrich, Sieber 2009, p.128).*

In addition *“The existence of possibilities for including formulae, graphs and other appendices in posts [...] generally fosters the use of forums” (Henrich, Sieber 2009, p.128).*

Finally, supporting their relevant point concerning above-mentioned participation, Henrich and Sieber state that:

*“[...] even more important [...], in order to encourage the usage among all participants, the participation of lecturers and tutors is very important. A short response time also has very positive effects on the use of forums” (Henrich, Sieber 2009, p. 128).*

Although these best practices and key success factors have been largely addressed in terms of content types, content creation and technologies, there are also some other factors which are worthy of mention. According to [Hügi \(2014, pp. 13–15\)](#), important points related to management, organisational and, pedagogical levels should also be considered. The management level concerns directly the prescriber, i.e. those who have initiated the e-learning project. Their duty is to communicate the objectives and the expected outcomes efficiently. They should also clearly define the roles of all those involved in the project and ensure that the organisation grants the necessary financial resources to the project.

If this is not the case, the objectives must be revised. This point implies full support from the top level management.

The notions regarding the organisational level are widely related to the theory of project management. In other words, e-learning must be deployed as an iterative process, such as with the Agile<sup>11</sup> methodology, thereby avoiding initiation of multiple complex tasks while the previous ones are still not finished. As an example, Lungu (2011, p. 21) can be quoted when he says he is “*convinced that the success of an LMS implementation depends on a project management approach*”. Moreover, in a situation where the organisation is embarking on the establishment of e-learning projects, it is advisable to begin with a not too ambitious learning project and then improve it at a later stage.

Finally, in terms of the pedagogical level, Govindasamy (2001, p. 296) warns about the impact of not adhering to the educational principles previously mentioned. Neglect of those aspects will “*undermine the implementation process*” and lead the learners away from the learning environment. Moreover, as mentioned in point 2.5.1 about the pedagogical challenges, it is critical to develop Learning Management Systems with “*fully integrated pedagogy*”. She even stresses that:

*“Often LMS are compared and evaluated on the basis of feature richness. The more the features of an LMS, the more likely it is to be chosen. This form of uninformed decision-making on the part of LMS customers positively reinforces vendors’ inclusion of every technologically possible feature in an LMS” (Govindasamy 2001, p. 296).*

To assess these hypotheses, research was conducted to find more recent information about LMS. Lungu (2011) approaches the pedagogical principles concerning LMS, but does not really address the necessity to include those principles in the development of a “*fully integrated pedagogy*” Learning Management System.

## 2.7 E-learning in organisations

To achieve the goal of this study, which is to analyse methods and provide recommendations concerning e-learning at CERN, it was felt appropriate to compare the e-learning practices in other organisations with relevant scope. Most of the books and articles found cover e-learning practices in academic environments. Various studies conducted in this field focus on learners pursuing studies with a slightly different aim than for workers in a profit-oriented organisation. Some books and articles

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<sup>11</sup> “*The Agile movement seeks alternatives to traditional project management. Agile approaches help teams respond to unpredictability through incremental, iterative work cadences and empirical feedback*” (*The Agile Movement 2008*)

specifically mention the research domain under question, described in more detail hereafter. Primary, [Derouin, Fritzsche and Salas \(2005, p. 922\)](#) mention a benchmarking survey, conducted in 2001 in both U.S. and Canadian companies, which indicates that participants used e-learning mostly for training on IT subjects. Furthermore, an increasing number of organisations have used it to teach business and soft skills, although soft skills' development is subject to discussion as it implies verbal and non-verbal processes, traditionally learned face to face.

In terms of which e-learning types are mostly used within organisations, [Derouin, Fritzsche and Salas \(2005, p. 925\)](#) state that blended learning, (please refer to [Table 1](#)), appears to be the most suitable form of education in their context. According to a survey conducted by Sparrow (2004) quoted in [Derouin, Fritzsche and Salas \(2005, p. 925\)](#), “77% of all U.S. companies currently rely on blended learning to meet their training objectives”. A study managed among 200 employees from companies such as Lockheed-Martin and the Executive Service Corps of Chicago even demonstrated that:

*“participants in [...] three blended-learning environments performed real-world tasks with between 27% and 32% better accuracy than the e-learning-only group. [...] they completed these tasks in between 41% to 51% less time [...] It appears, therefore, that blended learning does offer organizations some benefits over stand-alone e-learning programs, particularly with respect to transfer of training outcomes” (Derouin, Fritzsche, Salas 2005, pp. 931–932).*

The authors suggest nonetheless to take those results with caution as this study has not been peer-reviewed. Another point which is interesting to note is that a single e-learning type may not be sufficient depending on regional characteristics. Another study conducted by HP demonstrated that:

*“[...] in Asia, employees prefer instructor-presented or blended learning options, [whereas] in the United States and Europe, employees prefer self-paced and instructor-presented learning approaches” (O’Leonard 2004 quoted in Derouin, Fritzsche, Salas 2005, p. 926).*

In the context of this work, it is a point for consideration as CERN is composed of collaborators from various countries and cultures.

On the subject of organisations, the concept of Informal learning should be considered.

What is Informal learning ? As Hoyle describes:

*“In 21st-century organizations, learning is not an optional extra but a process that is embedded in the everyday. [...] We all learn pretty much all the time [...]. Organizations are under a peculiar pressure to somehow manage this day-to-day learning [...] that we have come to describe as informal.” (Hoyle 2015, p. 1)*



Therefore despite numerous employers' belief that *“learning happens only in classrooms or at the end of online modules”* (Hoyle 2015, p. 1) informal learning exists. For example, a discussion next to the water fountain or a friendly explanation by a colleague on how to use a particular application are forms of informal learning. Furthermore, the author (Hoyle 2015, p. 2) quotes a new mantra arguing that 90% of all learning would be informal. 70% would be acquired on the job, 20% through networking and sharing with peers the remaining 10% would be the formal learning component. Based on these assumptions, informal learning is a significant challenge organisations have to face considering a management belief about informal learning is:

*“If all [the] money [engaged in formal training programs] only delivers 10 per cent of the learning we need, let’s not bother. Let’s save the cash and rely on the initiative [...] and enthusiasm for the job in our employees to undertake the 90 per cent which will keep us as a competent [and] capable [...] organization.”*  
(Hoyle 2015, p. 2)

The balanced approach of this situation leads to recognition that formal learning is needed as much as informal learning. Hoyle (2015, p. 3) even sustains *“that effective formal trainers encourage, harness and enable informal learning to happen”*.

### **2.7.1 E-learning in organisations similar to CERN**

As described in the introduction the work for this thesis was conducted in collaboration with CERN. As CERN is an international organisation focusing on research in the field of High Energy Physics (HEP), to enhance understanding of the environment related to the subject, information about e-learning practices in similar organisations was gathered.

A short survey was compiled and sent to about 200 institutions, international organisations, research institutes, universities and polytechnic schools. Of the 50 replies received, only 10 were complete. Despite the low response rate, the answers highlight some interesting aspects of the e-learning subject. The full survey answers are available in [Appendix 1](#). Hereafter a subset of them, with comments.

With respect to the types of organisations, the distribution among the respondents is quite balanced: 30% from international organisations, 30% from universities and polytechnic schools and finally 50% from research institutes.<sup>12</sup>

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<sup>12</sup>The charts proposed are not referenced with an author in the bibliography as their construction is based upon data collected in the survey, not part of a published paper.

Figure 3: Types of organisations

Organisations' types

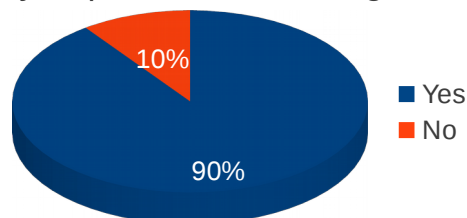


We can consider this distribution relevant to our needs as CERN is both an international organisation and a research institute.

Participants were asked if there were e-learning programs in their organisations, i.e. if they had implemented e-learning.

Figure 4: The amount of organisations interviewed who practice e-learning

Do you practice e-learning ?



As illustrated, nine of the ten have e-learning programs. The organisation who answered “No” indicated the reason: “**[because we have] no budget and lack of manpower to maintain a system like that**”. This result is compatible with an observation mentioned in point 2.5.3 about the economical challenges of e-learning related to the cost of content creation and maintenance.

To the questions “*which types of e-learning do you practice?*” and “*For which purposes?*” the results collected showed:

Figure 5: E-learning types practiced by those organisations

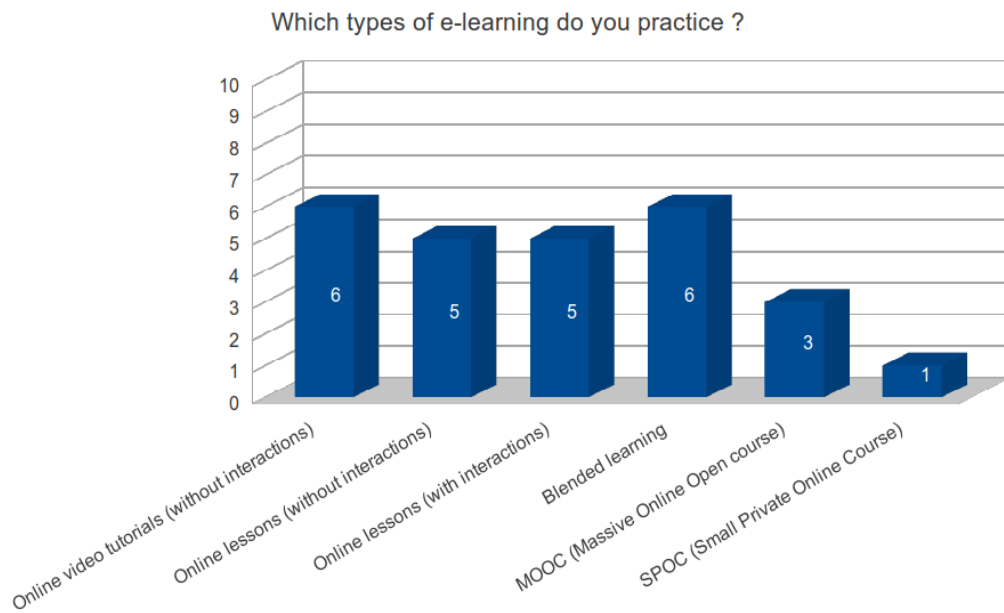


Figure 6: For which purposes those organisations practice e-learning



Blended learning and simple online video tutorials are the most common types of e-learning used while “*Productivity gain*”, “*Employees' autonomy*” and “*Other*” are the most common answers given to the question about the purposes. For more details about “*Other*”, the respondents included the following comments:

*“How to use new systems”; “Dissemination activities connected with EU projects”; “Required training for specialized job categories”; “training of government officials on the agreements of the organization”; “Improve on-campus pedagogy; Support French speaking Africa”. (Extracted from the original comments of the survey)*

Moreover, 78% (7/9) have a team dedicated to e-learning projects. These teams are composed of 2 to 12 people, 0 to 10 of which are full-time equivalents (FTE). The largest team is in one of the organisations who manages MOOCs. It is also worthy to note that all nine respondents who said they were practising e-learning stated that it brought several benefits to their organisation. Some of the benefits expressed include:

*“Solidarity, time gain, collaboration”; “Better visibility and reputation [...]”; “Just-in-time training, manage time more effectively, cost effectiveness and access to learning for all staff member”. (Extracted from the original comments of the survey)*

## **2.8 Focus on rapid e-learning**

In the previous sections of this thesis, the history and the definitions of e-learning in general were explored. Then, the different types of training were outlined. According to the activities at CERN and the scope of the mandate, rapid e-learning, which is a form of training online, also used in industry to familiarise people with procedures will now be addressed.

According to [Derouin, Fritzsche and Salas \(2005, p. 925\)](#) *“Rapid e-learning refers to e-learning that can be created and administered quickly and requires a limited amount of effort in its development and delivery.”* Typically, it is developed in less than three weeks and mainly consists of Powerpoint slides available on the web. It may include *“video-based instructions”*, i.e. narrated videos, as well ([Epignosis 2014, p. 80](#)) which corresponds precisely to the type of content which we are looking to create. [Derouin, Fritzsche and Salas \(2005, p. 925\)](#) give an example of the company Cisco Systems' e-learning program which involves this type of learning content.

This section about rapid e-learning falls naturally after the [2.7 “e-learning in organisations”](#) section for the following reason developed by De Vries:

*“For decades, technology-based training has promised to give corporations, universities, [...] the power to increase the scale and reach of training. As companies have rushed into e-learning [...] many have found that the time and cost to build excellent content sometimes overcomes these advantages”.*  
([De Vries 2004, p. 1](#))

Moreover, she found in her research that training problems in companies are often related to critical development timelines and outdated contents. In this context, rapid

e-learning *“changes the development model, leverages new tools, and dramatically changes the economics of content development”*, whereas the greatest challenges perceived by e-learning developers in companies are resources, speed and time (De Vries 2004, p. 2). Rapid e-learning, sometimes called *“micro-learning”*, can also benefit the learners in terms of *“absorbing information quickly [...] on the go or even at work”* (Epignosis 2014, p. 81). However, the success of a rapid online lesson depends on its ability to enable learners' engagement as *“this will raise the likelihood of knowledge absorption and ensure that one gets the most out of the experience”* (Epignosis 2014, p. 81). Following this literature review, it is now time to outline the methodology which enabled the creation of short online tutorials, i.e. evaluate and establish rapid e-learning methods and tools.

### 3. Methodology

Working at the Haute Ecole de Gestion de Genève of the University of Applied Sciences Western Switzerland, in the Department of Information Sciences, we were employed as teaching assistant three days a week and student two days a week. In addition, the two days studies were often dedicated to supplementary lectures we had to follow at the University. For this reason, it was only possible for us to be at CERN a few days a month until the end of June. From the first of July, we were then present at CERN two entire days a week.

We will outline the two methodologies followed: one when we were physically present at CERN, interviewing key people and gathering relevant information for our thesis. The other was pursued independently, looking for relevant information on the web and in specialised databases accessed via the University resources.

This chapter will also describe these methodologies in terms of collecting information about technological, as well as pedagogical, principles and best practices.

#### 3.1 Research for the literature review

Initially, relevant information in the literature about the field of interest was researched. The sources used were mainly web search engines, specialised databases as well as the 2.7.1 short survey conducted about e-learning in organisations similar to CERN. Relevant websites such as [University of Geneva \(\[no date\]\)](#) and the personal site of Pr. [Schneider \(2015\)](#) were also identified which helped to improve understanding of educational technology.

Concerning information retrieval on the web and in the specialised databases, here is a short list of the keywords used to obtain results:

- E-learning AND / OR Electronic learning AND / OR Rapid e-learning
- MOOC
- E-learning AND education
- E-learning AND / OR organisations
- Blended learning
- Informal learning

Some of these keywords were inspired by articles and books consulted.

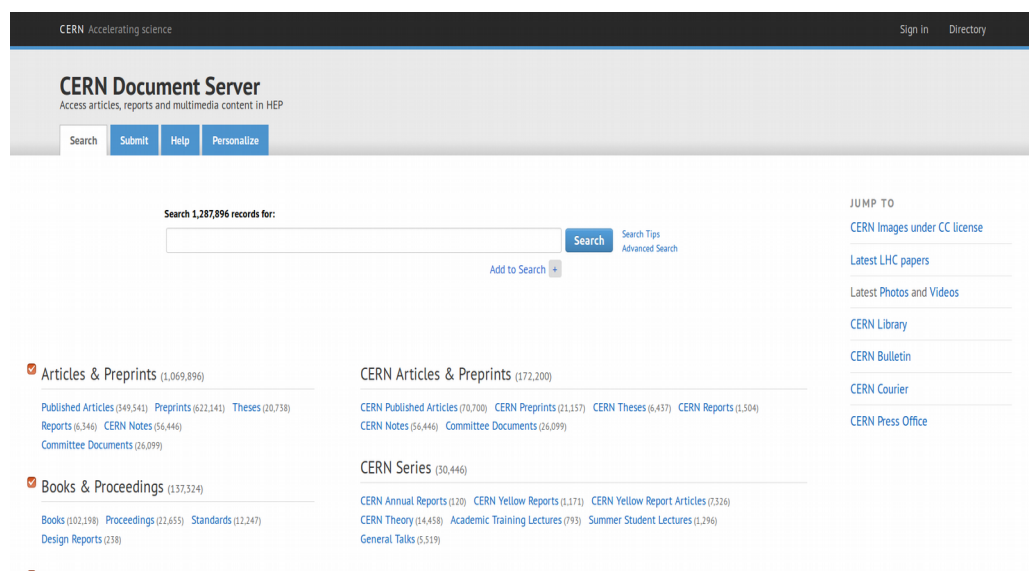
## 3.2 Collecting information and meetings with key people

It was necessary to gather information about the organisational structure of CERN. About 2,500 people are working for CERN, and the organisation provides infrastructures for about 11,000 scientists of 100 different nationalities around the world (CERN [no date]). It is therefore quite difficult to appreciate the organisational complexity and its implications. In order to enhance understanding of the structure, we interviewed our supervisor who defined the key elements. Then, in order to identify the organisation's needs with respect to the thesis' topic, key people were contacted such as people involved in learning at CERN, and those related to the audiovisual services.

### 3.2.1 Meeting with the audiovisual services team

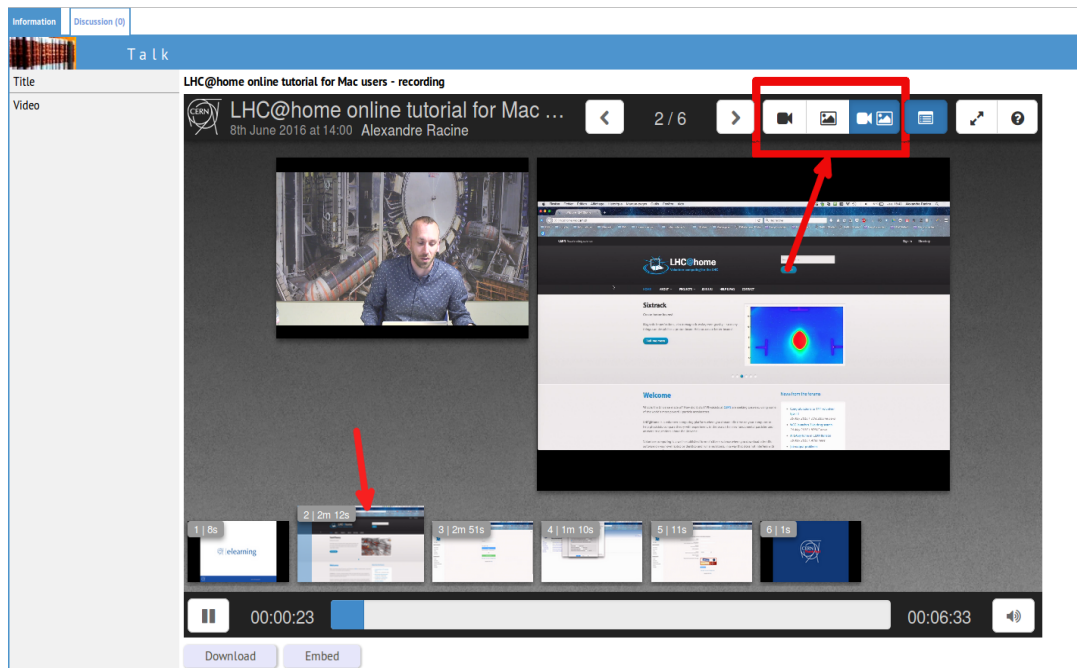
The audiovisual team is responsible for the support of recording lectures, colloquia, seminars, conferences and other events at CERN. They were, therefore, able to provide information on the technical features concerning the recording of short online tutorials. They expressed interest in research on screen recording products as well as video player software available on the market and demonstrated their current tool to stream videos recorded at CERN which is known as the CERN Document Server (CDS) (CERN 2016c). In addition to streaming videos, CDS gives access to several different materials such as articles, photographic archives and other multimedia elements related to the life of the laboratory.

Figure 7: An overview of the CERN Document Server (CDS): the homepage



(CERN 2016c)

Figure 8: An overview of the CERN Document Server (CDS): the video player



(adapted from CERN 2016c)

Studying the CDS video player helped to highlight very useful elements in accordance with the information identified in the literature review. For example, as can be seen in the red rectangle in Figure 8 CDS enables users to choose whether they want to see the speaker, the slides / computer screen, or both. This functionality is linked with Derouin, Fritzsche and Salas (2005, p. 922) and Bourban (2010, p. 6) as they point out that giving control to the learners fosters their ability to focus on the tasks to be achieved. In addition, concerning this notion of control, at the bottom of the player the video is cropped into multiple visible parts, allowing users to jump to the part which is most interesting for them.

It is worthy to note that enabling users to see the speaker is also related to an important point identified in the literature review. What Clark and Mayer (2003) quoted in Derouin, Fritzsche, Salas (2005, p. 933) called “*The personalization principle*” and implies, among other things, that “*learners are given access to onscreen virtual learning coaches (i.e., characters that provide guidance and direction to learners)*”. As a consequence:

*“The purpose of using [...] onscreen coaches is to encourage the learner to see the computer as a conversational partner rather than as an information delivery agent. In doing so, learners are likely to exert more effort toward learning the material presented to them” (Derouin, Fritzsche, Salas 2005, p. 933).*



### 3.2.2 Meetings with the content owners

Those who are referred to as the content owners are the people responsible for a use case to be addressed via a short tutorial, e.g. the person who knows best the functionalities of a given piece of software and is responsible for it. In order to prepare efficiently for the numerous meetings, the following template for the interviews was established:

Figure 9: Template to describe a use case

#### Template to describe a Use Case

Title:

Duration:

Public: (CERN users, public?)

Material: (For example: slides, documentation files attached, screen capture, terminal recording,...)

Preferred recording method: (CERN audiovisual services or screen capture at the service manager's desktop)

Description: (ideally the exact text of the whole tutorial for the teleprompter or, at least, the chapters/sections' titles)

CERN video content owner:

Other information:

(Dimou 2016)

The template contains the relevant information associated with the use case such as the duration, e.g. 5 minutes, the material or the preferred recording method. It was decided that such short videos should not exceed 5 minutes to maintain the focus of the learners and to prevent them from skipping over relevant information in the video. Moreover, the material and the preferred recording method are tightly connected as they can be used to highlight different information for the learners. For example, referring to the personalization principle, if it is relevant for a given use case to see the speaker and give a more human dimension to the lesson, the CERN audiovisual services will be chosen. In other cases, if simple screencasting with audio is sufficient, screen capture at the service manager's desktop can be chosen.

In terms of “*Material*”, if the learning aim is to demonstrate a workflow such as navigating the Web and / or the usage of software, a simple screen recording with audio could be enough while a “*terminal recording*” is preferable to demonstrate commands typed, and processes performed in a shell environment. The various options in terms of tools are detailed in [chapter 4 Results](#). It is crucial to determine in advance which kind of material and methods are the most relevant according to what needs to be explained.

### 3.2.3 Participation in tutorials

To identify the most relevant methods and material, participation in some tutorials and lessons took place. One of these tutorials was the “*Agile Infrastructure & Puppet for Service Managers*” course which aims at creating and managing virtual machines (VMs) through the CERN cloud infrastructure called OpenStack. The configurations of the VMs are reproduced and stored in an environment called “*Puppet*” to help the launch of future VMs with the same settings. In other words, if a machine is configured as a server, it will be possible for all the future servers to call the same configuration in the “*Puppet*” environment to easily reproduce the machine.

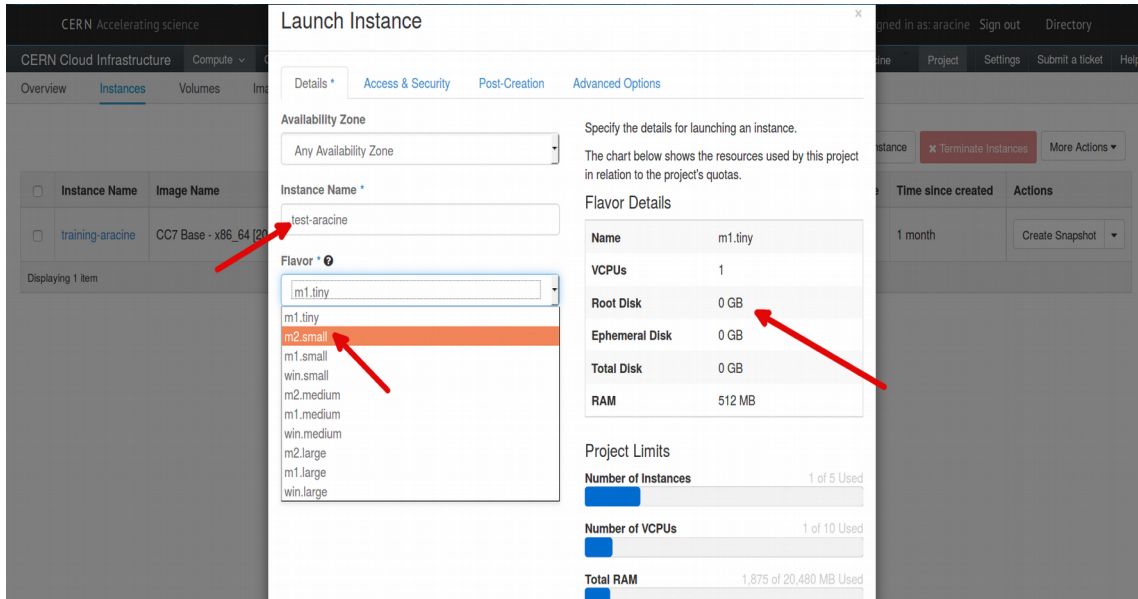
In this example, there are several steps to perform which can be potentially handled by different use cases. The tutorial was therefore divided into three major parts:

- Create a simple VM through the web-based interface and explore its simple configuration
- Manage the more advanced configuration of the VM in a shell through command lines
- Monitor the usage of the VM and create notification alerts: this process involves both a web-based user interface, and command lines in a shell

These different parts may imply different “*material*” and “*preferred recording methods*” as illustrated in the use case template. This links conveniently to the literature review, point [2.7.1 e-learning in organisations](#), which states that a single e-learning type may not be sufficient depending on learners' preferences and cultures. In this case, it also depends on the content itself. This example is based on the blended learning type (face to face lecture and e-learning with online resources). Moreover, attending this course enabled the material and preferred recording method relevant for each type of task to be defined according to the learners aim. Concerning understanding of the content of this course, Prior Experience (PE) ([Lee, Hsieh, Chen 2013](#)) using computing technologies, i.e. programming, had a significant impact on our ability to fulfill the tasks. Consequently, this implied an influence on our Perceived Ease of Use (PEU) ([Lee, Hsieh, Chen 2013](#)). These aspects will be developed further later in the discussion of this work.

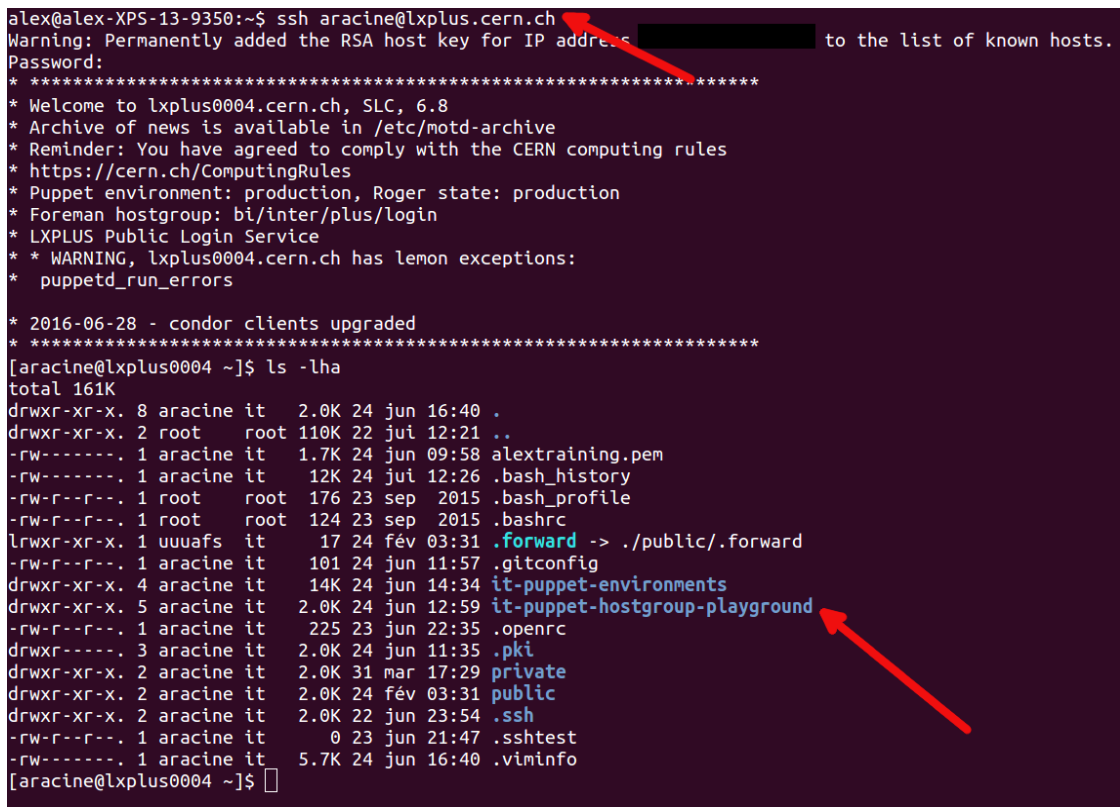
Hereafter some visual examples describing two of the three tasks mentioned above.

Figure 10: VM creation through the Openstack web-based interface



(Adapted from CERN 2016d)

Figure 11: Managing VM in Openstack through the shell environment



(Adapted from our own shell environment connected to lxplus)

As illustrated in [Figure 10](#), a VM (instance) is launched through the web-based interface. It is identified and its flavor is selected. Selecting a flavor is the process which will define the resources allocated to the VM e.g. disc size and RAM<sup>13</sup>. In the “*Access and Security tab*”, it is necessary to authenticate via an ssh key pair<sup>14</sup> to start the VM.

[Figure 11](#) shows the first steps of the process of managing the VM through the shell environment with command lines. First it is necessary to log into the CERN lxplus service which is “*the interactive logon service to Linux for all CERN users*” ([CERN IT Department 2016a](#)). Then, after completing other primary tasks during the tutorial e.g. copied gitlab repositories, it is possible to see the different folders related to “*Puppet*” for working on the VM.

### 3.2.4 Meeting with the Human Resources (HR) department

As introduced in the first chapter, CERN HR department, “*Learning and Development Group*”, (HR L&D) already coordinates learning programs which contain components of e-learning ([CERN HR department 2015](#)). Hereafter, an overview of the main learning areas proposed by HR L&D.

Figure 12: Training programs proposed by HR L&D

|                   |   | Technical competencies     |                             | Behavioural competencies |   |                                   |  |
|-------------------|---|----------------------------|-----------------------------|--------------------------|---|-----------------------------------|--|
| <b>Induction</b>  | <b>Languages</b>                              | <b>Technical</b>           | <b>Technical management</b> | <b>Leadership</b>        | <b>Communication and Personal Development</b> | <b>Career transition measures</b> |  |
| contact           | contact                                       | contact                    | contact                     | contact                  | contact                                       | contact                           |  |
| Staff and fellows | Members of Personnel (MoP) + spouses/partners | Members of Personnel (MoP) |                             |                          |   | Staff on LD contracts             |  |

(Adapted from CERN HR department 2015)

<sup>13</sup>Random Access Memory

<sup>14</sup> “SSH uses public-key cryptography to authenticate the remote computer and allow it to authenticate the user, if necessary. There are several ways to use SSH. [one of them] is to use a manually generated public-private key pair to perform the authentication, allowing users or programs to log in without having to specify a password” ([Secure Shell 2016](#)).

These programs contain full courses, some lasting a number of days. The mandate of the “rapid e-learning project”, clarified the scope of these parallel activities by explicitly focusing on short online tutorials' on specific use cases. In a meeting with people responsible for training within HR, the tools and methods were explained. In this discussion, based on the literature sources mentioned, we agreed that a single type of e-learning is often not sufficient depending on learners' profiles and skills. Especially as, according to people we spoke with, their own videos last about 45 minutes and are rather courses than short tutorials. Consequently, our specific activities are entirely complementary to the technical training activities. HR L&D proposed to link relevant short videos from the CERN technical training web pages, clarifying that maintenance of the content should remain the responsibility of the content owner.

As HR L&D will soon adopt a new LMS, additional information was requested. It will offer additional functionalities to the service catalogue<sup>15</sup> which is currently only accessible with a CERN account. An overview of this tool is presented below.

Figure 13: The actual LMS used by CERN HR department

The screenshot shows the CERN Training Catalogue interface. At the top, there is a navigation bar with tabs for Career Transition, Language, Leadership, Personal Dev & Comm, Safety, Technical, Tech Mgmt, and Your career at CERN. Below the navigation bar, there is a search area with a dropdown menu for 'Course or Competency' set to 'programming'. A search button and a 'Racine's Courses' button are also visible. Below the search area, there is a table of courses with columns for Course Name, Language, Duration, Availability, and Competencies. The 'Technical' category is highlighted in the dropdown menu.

| Course Name                                      | Language          | Duration               | Availability         | Competencies   |
|--|-------------------|------------------------|----------------------|--|
| FESA Hands-on                                    | English           | 4 days                 | 5 places available   | Control system design  |
| JCOP Framework and WinCC-OA                      | English           | 4 days 3 hours         | 8 places available   | Control software and hardware configuration, Control theory        |
| LabVIEW Real Time and FPGA                       | English or French | to be scheduled        | 4 more people needed | Control software and hardware configuration                        |
| LabVIEW Structures                               | English           | 17-Oct-16 to 18-Oct-16 | 9 places available   | Control software and hardware configuration                        |
| LabVIEW for Experts                              | English or French | to be scheduled        | 3 more people needed | Control software and hardware configuration                        |
| LabVIEW for beginners                            | English           | 10-Oct-16 to 12-Oct-16 | 5 places available   | Control software and hardware configuration                        |
| MATLAB - Simulink                                | English           | to be scheduled        | 8 more people needed | Control software and hardware configuration                        |
| Schneider: Automate Modicon Premium UNPP2 Expert | English           | to be scheduled        | 6 more people needed | Control software and hardware configuration, Control system design |
| ...  | English or ...    | ...                    | One more person      | Control software and hardware configuration                        |

(CERN Administrative Information Services 2016)

The future LMS is called NetDimensions.<sup>16</sup> This tool enables the support of SCORM files<sup>17</sup> which are not supported by the current catalogue. It allows the creation of

<sup>15</sup> <https://cta.cern.ch/cta2/f?p=110:9:202058755813984> only accessible with a CERN account

<sup>16</sup> <http://www.netdimensions.com/talent-management-suite/learning-management-system-lms.php>

<sup>17</sup> “Sharable Content Object Reference Model (SCORM) is a collection of standards and specifications for web-based electronic educational technology [...] It defines communications between client side content and a host system (called “the run-time environment”), which is commonly supported by a learning management system (Sharable Content Object Reference Model 2016).”

learning objects' repositories and gives management access to trainers. It also allows features addition and configuration without needing programming skills. The last interesting point of this discussion confirms the emphasis of technical features in the chosen LMS versus pedagogical aspects, as observed in the literature reviewed earlier in this paper.

To conclude this part about the interviews of several key people, we also had two or three meetings with our both supervisors (from CERN and HEG) to validate our methodology and define which would be the next steps related to our work.

### **3.3 Research about screen recording tools**

The main objectives of this work were the following:

- Identify a list of screen recording tools available on the web to give the possibility to CERN users to record a short tutorial on their own computer
- Provide a list of speakers' preparation points advising about how to create a relevant tutorial

Regarding the screen recording tools, progress followed the following set of criteria recommended by the CERN supervisor. If possible the tools should be:

- Free
- Open source
- cross-platform

This will be touched on later in this thesis, needless to say it was a difficult challenge to face. The information retrieval process started specifically focused on the tools, i.e. about the technological variable of this work. In accordance with the criteria set, an online and collaborative comparison of multiple screen recording tools according to various characteristics was found ([Comparatif d'outils pour réaliser des screencasts 2016](#)). Not all the criteria were relevant at this stage of the work however the principle ones such as price, platforms or distribution, i.e. proprietary, open source or online services, helped to eliminate those tools which did not fulfill the recommended criteria. The most relevant ones were selected and tested in order to define which one(s) would be the most appropriate. An overview of the comparison table is shown in Figures [14](#) and [15](#).

Figure 14: The online collaborative website about tools comparison (1)

|                              | Site web  | Dernière version | Date de sortie | Distribution          | Prix  | Langues  | Tutoriel  | Mis à jour            | Plateformes | Windows | Mac OS | Linux | Fonctionnalités |
|------------------------------|---|------------------|----------------|-----------------------|---|--|---|-----------------------|-------------|---------|--------|-------|-----------------|
| <b>FastStone Capture</b>     | <a href="http://faststone.org">faststone.org</a>              | 7.9              | 23 déc. 2004   | Logiciel propriétaire | 19,95 \$US one month test old version free but no video | English  | <a href="http://ordi-netfr.com/">ordi-netfr.com/...</a>                             | 15 oct. 2014 09:21:40 |             | ✓       |        |       |                 |
| <b>Screenr</b>               | <a href="http://screenr.com">screenr.com</a>                  |                  |                | Service en ligne      | 0,00 \$US, \$19/mo, \$49/mo, \$99/mo, \$289/mo          | English  | <a href="http://screenr.com/">screenr.com/...</a>                                   | 5 févr. 2015 12:06:10 |             | ✓       |        |       |                 |
| <b>TipCam</b>                | <a href="http://utipu.com">utipu.com</a>                      |                  |                | Logiciel propriétaire | 0,00 \$US - \$99  |  |   | 7 août 2012 21:54:08  |             |         |        |       |                 |
| <b>Windows Media Encoder</b> | <a href="http://microsoft.com/">microsoft.com/...</a>         |                  |                |                       |   |  |   | 7 août 2012 21:57:12  |             |         |        |       |                 |
| <b>Adobe Captivate</b>       | <a href="http://adobe.com/">adobe.com/...</a>                 | 8.0.1            | 15 juin 2012   | Logiciel propriétaire | 799,00 \$US - 1165,20 €                                 | Deutsch English Español Français Portuguais (Brasil) |   | 20 mars 2015 14:23:17 |             | ✓       | ✓      | ✗     |                 |
| <b>Camtasia Studio</b>       | <a href="http://techsmith.fr/">techsmith.fr/...</a>           | 8.0.2            | 24 juil. 2012  | Logiciel propriétaire | 299,00 \$US   | English, Français, Deutsch, Korean, Japanese         |  | 15 nov. 2013 19:26:06 |             | ✓       | ✓      | ✗     |                 |
| <b>iShowU HD Pro</b>         | <a href="http://shinywhitebox.com/">shinywhitebox.com/...</a> | 2.2.9            | 14 mars 2012   | Logiciel propriétaire | 29,95 \$US (and \$59,95 PRO)                            | English  | <a href="http://shinywhitebox.com/">shinywhitebox.com/...</a>                       | 25 août 2015 14:25:37 |             | ✗       | ✓      | ✗     |                 |

(Adapted from Comparatif d'outils pour réaliser des screencasts 2016)

Figure 15: The online collaborative website about tools comparison (2)

|                                       | Fonctionnalités       |                                |                     |                               |   | Autres             |              |              |                    |                |                   |
|---------------------------------------|-----------------------|--------------------------------|---------------------|-------------------------------|---|--------------------|--------------|--------------|--------------------|----------------|-------------------|
|                                       | Enregistrement webcam | Enregistrement du son du micro | Record system audio | Edition de la vidéo           | Type de fichiers générés  | Screen annotations | Pause/Resume | Follow Mouse | Mouse highlighting | Custom presets | Custom background |
| <a href="#">FastStone Capture</a>     | ✗                     | ✓                              |                     | ✓                             | saves images in BMP, GIF, JPEG, PCX, PNG, TGA, TIFF and PDF formats. Built-in screen recorder saves videos in WMV (Windows Media Video) format. | ✓                  |              | ✓            | ✓                  | ✓              |                   |
| <a href="#">Screenr</a>               |                       | ✓                              |                     |                               |   |                    |              |              |                    |                |                   |
| <a href="#">TipCam</a>                |                       |                                |                     |                               |   |                    |              |              |                    |                |                   |
| <a href="#">Windows Media Encoder</a> |                       |                                |                     |                               |   |                    |              |              |                    |                |                   |
| <a href="#">Adobe Captivate</a>       | ✓                     | ✓                              |                     | ✓                             | HTML5, MP4, EXE, SWF, PDF   | ✓                  | ✓            |              |                    |                |                   |
| <a href="#">Camtasia Studio</a>       | ✓ With PC             | ✓                              | ✓                   | ✓ For pros, lots of features. | H.264, Windows Media, AVI, SWF, FLV   |                    | ✓            |              |                    |                |                   |
| <a href="#">10kand1 Win D...</a>      | ✓                     | ✓                              | ✓                   | ✗                             |   | ✓                  |              | ✓            |                    | ✓              | ✓                 |

(Adapted from Comparatif d'outils pour réaliser des screencasts 2016)



### 3.3.1 Testing the tools

To evaluate the selected tools, it was necessary to work on the three Operating Systems (OS) required, i.e. Linux, Mac OS X and Windows. Our personal laptop was a Mac OS X with virtualization software installed. We attempted to install Linux and Windows machines through the virtualization technology. It is worth noting that this process was quite useful for simple tasks, e.g. word processing, however the performances of the machines were weak concerning more advanced functions on our host computer, rendering the tool testing slow and painful.

As a second step, there was an attempt to use OpenStack (see [Figure 10](#)) to create VMs running the different OS's needed. Although the process of building VMs on a personal laptop had already been experienced, it was difficult with OpenStack. Running a VM through the CERN infrastructure requires knowledge about configuration information, e.g. domain name, etc. making it difficult to run the VMs therefore the process was stopped.

In the meantime, a new GNU/Linux Ubuntu laptop was acquired offering two functional OS's: Linux and Mac OS X for the tests and for testing on Windows, the OS was installed on a CERN spare laptop. This therefore offered three environments for the testing of the tools. The results of the tests are explained in section [4.2. Analysis of the selected recording tools](#). Concerning the process, it should be stated that many bugs were encountered during the tests necessitating extensive web research to find solutions which led to an iterative process:

Figure 16: The iterative process of testing the tools



After testing the different tools several times and getting an understanding of their operation, documentation for some of those tools was written to provide instructional material for users. The documentation is available in Appendices 2 and 3 of this thesis.

### 3.4 Creating the tutorials

At this stage of the process, many projects had been launched and it was decided to record videos for one of them: LHC@home (CERN 2016e). LHC@home is a volunteer computing project. In essence CERN asks many people around the world to provide the extra power of their computer to help to process the data collected by the Large Hadron Collider. To do this, the volunteers use a software named BOINC developed by the Berkeley University of California (2015). When a computer is idle, the power of the CPU can be used by CERN to add to its computing resources. In the project timeline the tools were still being tested and although understanding of their operation grew quickly, it was premature to use them for the video recordings. In addition, as the targeted audience was the general public, it was decided to use the CERN audiovisual facilities, due to their support for many advanced features and help from the audiovisual team. In addition, the audiovisual rooms are equipped with a large

background picture of the LHC which can help enhance the promotion of CERN activities for the public. The main objective was to present the BOINC software, from its installation to its configuration, and encourage the public to participate by donating their unused CPU power.

Therefore it was necessary to master the software on the three different platforms presented above i.e. Windows, Linux and Mac OS X. With the help of a student working in the IT department at CERN, we learned to use and configure BOINC to prepare for the tutorials. The scripts and scenarios were written to ensure fluency while speaking and simultaneously performing tasks on the computer. Our role was to record the tutorial for Mac OS X while the IT student had to record it for Windows and Linux.

The audiovisual facilities room was used several times to rehearse as much as possible and to gain confidence. It is an iterative process to identify all the elements which could cause problems and there is always room for improvement. Several rehearsals are not only useful but also necessary to identify the several points of failure and to understand why we fail. There are many important variables to take into consideration such as the body language and words of the speaker, as well as its workflow on the computer. It should be stressed that the audiovisual facilities record both the screen computer and the speaker.

To help with this challenging task, colleagues at CERN gave us advice. Firstly our supervisor who was physically present in the room with us and other people through Vidyo. Vidyo is a tool which *“allows users to make point-to-point calls or multipoint videoconference meetings from their desktop machines, tablets and smartphones [...]”* (CERN IT Department 2016b). They therefore connected through Vidyo, followed the rehearsals, and offered advice when they identified something to improve, e.g. when something we showed on the screen or something we said was unclear. This high quality and precious feedback helped to not have to waste valuable time in numerous supplementary rehearsals.

Following the rehearsals, audiovisual support uploaded the files on CERNBox<sup>18</sup> which is a cloud solution available at CERN to share documents and resources. These files were then downloaded and analysed to improve the next rehearsals. An overview of the tutorials can be found in Figure 8 as well as in Figures 17 and 18 below.

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<sup>18</sup><https://cernbox.cern.ch/cernbox/doc/index.html>

Figure 17: An overview of the BOINC installation for Linux

The video player interface shows the following details:

- Title:** LHC@home online tutorial for Linux users - recording
- Video:** LHC@home online tutorial, 8th March 2016 at 10:00, Karolina Mari...
- Author(s):** Bozek, Karolina Maria (speaker) (Jagiellonian University (PL))
- Corporate author(s):** CERN, Geneva
- Imprint:** 2016-03-08. - Streaming video.

The video content includes a presenter and a terminal window with the following text:

### 1. Installing the boinc-client and boinc-manager on Linux

**Debian/Ubuntu**

- \$ sudo apt-get install boinc

**Fedora/CentOS/Scientific Linux**

- \$ sudo yum install boinc-client boinc-manager

**Others distribution (stable)**

- Download shell script from <https://boinc.berkeley.edu/download.php>
- \$ cd Directory where boinc was installed (e.g. \$ cd /home/Download - not recommended, move it to e.g. /home/boinc/linux)
- \$ chmod +x boinc\_version\_pc\_linux\_gnu.sh (e.g. boinc\_7.2.42\_x86\_64\_pc\_linux\_gnu.sh)
- \$ ./boinc\_version\_pc\_linux\_gnu.sh

**Linux testing distributions**

- Download boinc from source
- More information and source you will find here [http://boinc.berkeley.edu/wiki/install\\_BOINC\\_Linux](http://boinc.berkeley.edu/wiki/install_BOINC_Linux)

(CERN 2016c)

Figure 18: An overview of the BOINC installation for Windows

The video player interface shows the following details:

- Title:** LHC@home online tutorial for Windows users - recording
- Video:** LHC@home online tutorial for Windows users, 8th June 2016 at 14:00, Karolina Maria Bozek
- Author(s):** Bozek, Karolina Maria (speaker) (Jagiellonian University (PL))

The video content includes a presenter and a Windows desktop with the BOINC 'Create an account' window open.

(CERN 2016c)

### 3.5 Archiving and dissemination of tutorials

Before our arrival, at the beginning of the project, our supervisor created an “*e-learning category*” in CDS to make all recorded tutorials available from the same place. The videos presented in Figures 8, 17 and 18 above are all indexed under this “*e-learning category*”. CERN has many web pages presenting different information to different communities. For example, the videos recorded for the LHC@home project are also both available on the LHC@home website. To avoid users having to browse numerous pages searching for the tutorials it was decided to store them in CDS and link to them from all other relevant pages.

To archive all relevant information related to the e-learning project, two CERN TWikis<sup>19</sup> (Thoeny 2016; Dimou 2016; Dimou, Jones 2016) were also created. Our supervisor established the first TWiki before our arrival, and its purpose was to disseminate all news concerning e.g. the use cases, templates, tools discovered and points for speakers identified, i.e. best practices and elements to take into consideration while recording.

As the project progressed it was decided to create the second TWiki to complement the information in the first TWiki and to avoid users scrolling down a single very long web page. The tutorials were made available as well as the demonstration of, and documentation about, the tools. It contains one page per video recorded, based on the template described in Figure 9. It should be noted that University of Geneva (2016b) inspired the second TWiki.

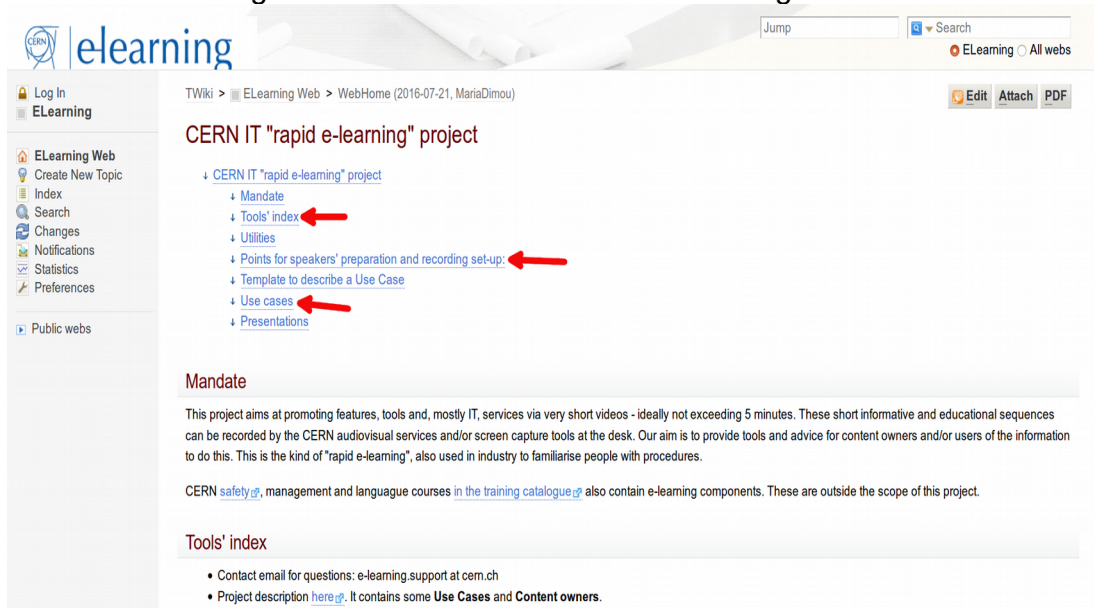
Another important reason why the tutorials and their documentation were made available on the TWiki was the following: it allowed those people interested in the project, as well as the content owners, to act as the targeted public to provide feedback about format issues, tutorials' quality and clarity of the content (see point 4.5.2.1.1.). It offered the ability to enhance the material and take into consideration other interesting points which had not been considered.

An overview of the two TWikis created for the project is available in figures 19 and 20.

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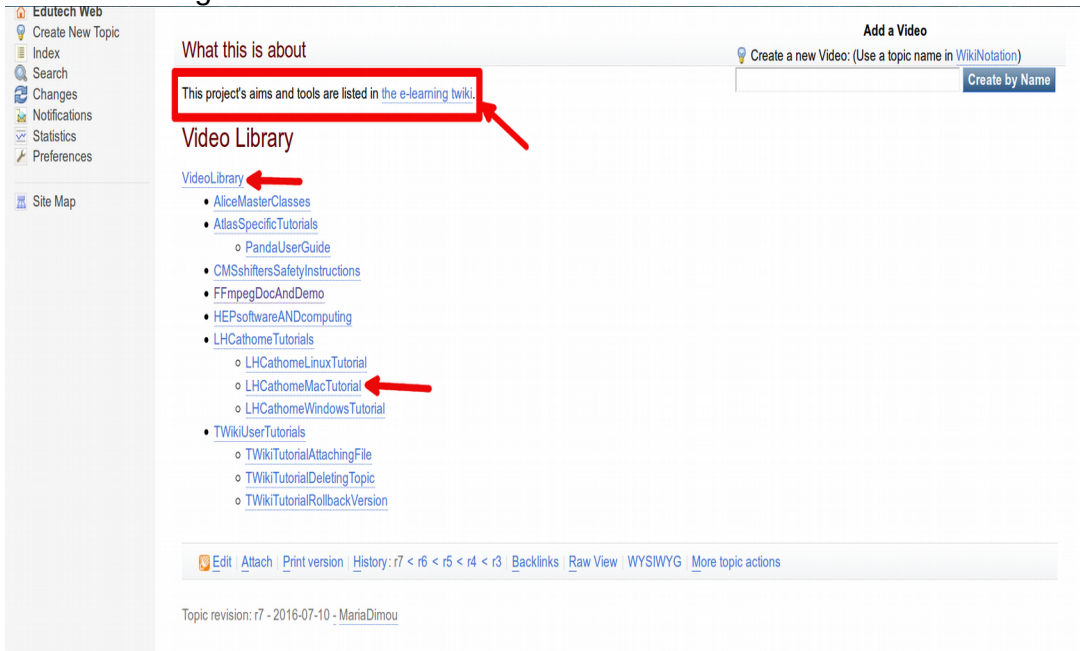
<sup>19</sup> “TWiki is a flexible, powerful, and easy to use enterprise wiki, enterprise collaboration platform, and web application platform. It is a Structured Wiki, typically used to run a project development space, a document management system, a knowledge base, or any other groupware tool, on an intranet, extranet or the Internet.” (Thoeny 2016)

Figure 19: The first TWiki: the e-learning TWiki



(Adapted from Dimou 2016)

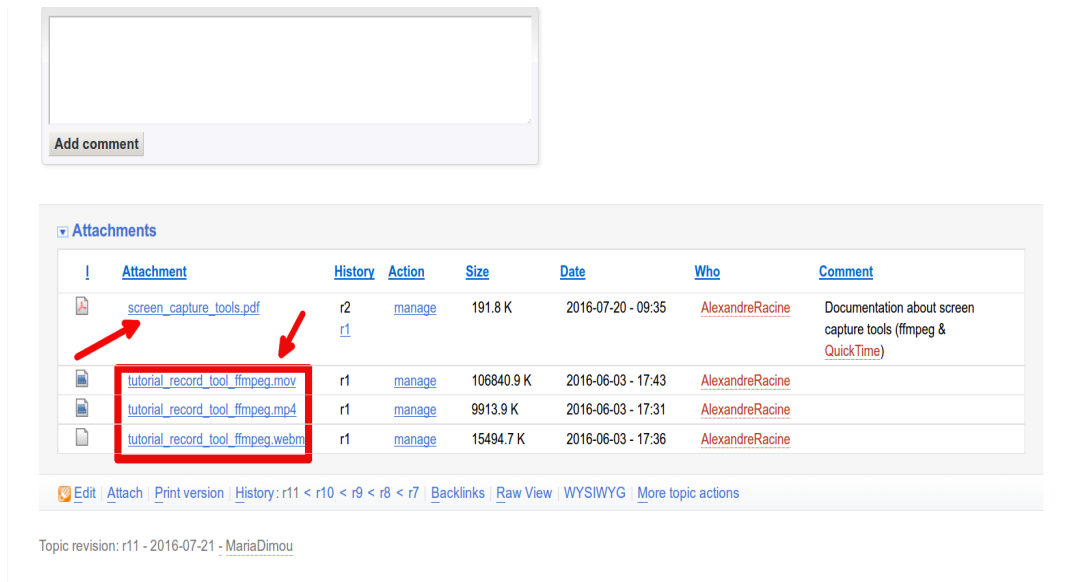
Figure 20: The second TWiki: the Edutech web TWiki



(Adapted from Dimou, Jones 2016)

As already mentioned, the videos are available in the “*Edutech web*” TWiki (see figure 20). However, according to the pedagogical principles identified in the literature review, it was also judged necessary to use the functionality of this tool and to attach all the documentation about the videos. See figure 21.

Figure 21: Documentation and multiple video sources attached to the TWiki



(Adapted from Dimou, Jones 2016)

It is therefore possible for users to choose whether they want to acquire information (knowledge) with the tutorial, the text (documentation) or both.

Furthermore, the arrow pointing to the red rectangle in Figure 21 shows three file formats attached to the TWiki as sources for the video. This is due to issues concerning file formats and compatibilities with browsers which were identified during the tests. Sometimes, depending on which browser was used, the video did not play correctly, and for example the user had sound only and no image.

Following some research on the web, and precious advice of a colleague, two resources (kentuckyfriedtakahe 2016; w3schools 2016) were identified which helped to understand that providing multiple sources with different file formats could help the browser itself to determine which video it was able to play thereby reducing the probabilities of failure while playing a tutorial on any browser.

As a follow-up to this chapter devoted to applied methodology, the results obtained, the discussion about, and the conclusion of the work will be described hereafter.

## 4. Results

In this chapter dedicated to the results, there is a brief summary of the outcomes we obtained to date. These outcomes will be analysed in terms of what was produced, and a list of recommendations concerning technical and pedagogical aspects to be taken into consideration. The tools used will also be analysed, and compared according to criteria relevant to this work.

### 4.1 Results produced

As already mentioned before in this thesis, numerous tutorials were recorded. An overview of these tutorials is shown in Figures 8, 17 and 18. In addition, there is an “*e-learning category*” in the CERN Document Server (CDS), to collect all project-related material. Two TWikis were also created to disseminate information to those interested in e-learning at CERN and an “*e-learning interest group*” was created to enable all people interested in the activity to follow progress.

With respect to the tools, eight products were found of relevance to the mandate which are presented and described in terms of their functionalities below. A list of best practices / recommendations in terms of technological and pedagogical considerations were also identified and provided. A presentation was made for all the CERN members involved in the “*e-learning interest group*” and it was also recorded to include it in the CDS' e-learning category.

### 4.2 Analysis of the selected recording tools

This section could have been included in the methodology chapter however, it is felt to be more relevant to describe it here mainly because a principal aim of the mandate was to evaluate screen capture products available on the web. Therefore, the different steps completed to address a list of useful tools are tightly bound with the recommendations about the tools themselves. The list of the tools found are presented below.

#### 4.2.1 FFmpeg for all platforms

FFmpeg is a powerful command line tool enabling users to record their computer screen and their voice. This tool is “*a complete, cross-platform solution to record, convert and stream audio and video*” (Bellard 2016a).

It is “*able to decode, encode, transcode, [...] play pretty much anything that humans and machines have created*” (Bellard 2016b). The tool can be quite complex to learn



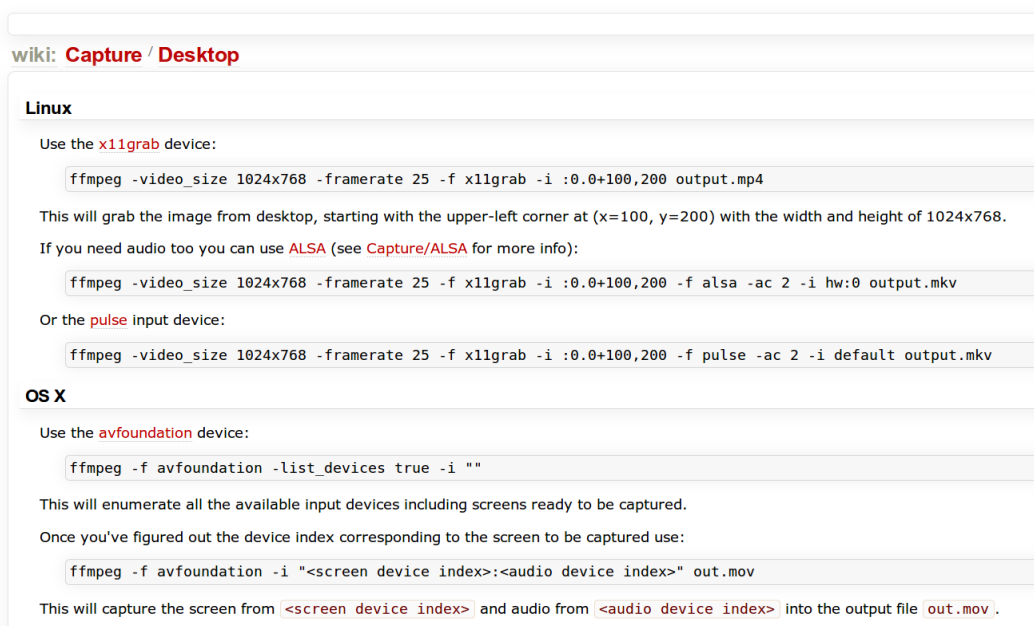
but with basic commands high performances can be achieved with multimedia files. To use FFmpeg, some experience with command lines in a shell is necessary. The following shows an example of the syntax:

```
“ffmpeg -i input.mp4 output.avi”
```

This specific command is to convert files. As can be seen in this example, each command begins with the word “ffmpeg”. In this case of conversion, it is followed by “-i” which indicates that the user will give an input file to the software. Then come the name and the format of the entry file followed by the name and the format of the output file. With this simple command, the file is now converted from a .mp4 file to a .avi file.

FFmpeg enables numerous other very useful features e.g. crop a video, record and add an audio track and accelerate a video, i.e. edit a file. The list of the functionalities covered by FFmpeg is vast therefore not relevant to detail here. More details can be found by referring to the complete official documentation (Bellard 2016c), the official ffmpeg wiki (Edgewall Software 2016a) or the specific documentation (Appendix 2) created for the use of the software. Figure 22 shows an overview of the simple commands available to record audio and video on Mac OS X and Linux.

Figure 22: Capture audio and video on Mac OS X and Linux with ffmpeg



The screenshot shows a wiki page with the following content:

wiki: **Capture / Desktop**

**Linux**

Use the **x11grab** device:

```
ffmpeg -video_size 1024x768 -framerate 25 -f x11grab -i :0.0+100,200 output.mp4
```

This will grab the image from desktop, starting with the upper-left corner at (x=100, y=200) with the width and height of 1024x768.

If you need audio too you can use **ALSA** (see [Capture/ALSA](#) for more info):

```
ffmpeg -video_size 1024x768 -framerate 25 -f x11grab -i :0.0+100,200 -f alsa -ac 2 -i hw:0 output.mkv
```

Or the **pulse** input device:

```
ffmpeg -video_size 1024x768 -framerate 25 -f x11grab -i :0.0+100,200 -f pulse -ac 2 -i default output.mkv
```

**OS X**

Use the **avfoundation** device:

```
ffmpeg -f avfoundation -list_devices true -i ""
```

This will enumerate all the available input devices including screens ready to be captured.

Once you've figured out the device index corresponding to the screen to be captured use:

```
ffmpeg -f avfoundation -i "<screen device index>:<audio device index>" out.mov
```

This will capture the screen from **<screen device index>** and audio from **<audio device index>** into the output file **out.mov**.

(Edgewall Software 2016b)

Although FFmpeg is complete and robust, there are different considerations to be aware of in order to use the tool. As illustrated in Figure 22, the devices used to grab audio and video are not the same depending on the Operating Systems. There are also

parameters (e.g. screen resolution, audio or video device input) which are different. Moreover, the parameters used to record and / or encode a video and / or an audio file vary depending on which output format has been specified. This can lead to bugs and errors while managing a project and increases the complexity to understand the software. This complexity led to the creation of some basic shell scripts to reduce such difficulties for users. Figure 23 shows an overview of the scripts. It should be noted that they were developed due to personal interest in the subject despite a lack of advanced programming knowledge therefore completeness of the work cannot be guaranteed.

Figure 23: Scripts to record with FFmpeg

```
#!/bin/bash
# [CC licence Attribution - no commercial usage - Share alike 4.0 International http://creativecommons.org/licenses/by-nc-sa/4.0/] [07.07.2016]
# Contributors: [Alexandre Racine] <alexandre.racine1@gmail.com> | [Igor Mlhit] <igor@mlhit.ch>

# This analyses your system to check your OS
os=$(uname -s)

# If your OS is Linux then...
if [ "$os" == "Linux" ]
then
# Look for your screen resolution (e.g. 1920x1080) and enter it when asked for.
echo "Enter your screen resolution as this example (e.g. 1920x1080) and press ENTER : "
read reslinux
# Capt the display value number in a variable. Apparently this number can change sometimes. Hopefully it is possible to have it with an envtr. variable.
disp=$DISPLAY

# Look for your screen device number (e.g. 1 or 0 or other number) and enter it when asked for. The script will adapt the command accorded to your system.
# To find the number related to your preferred device please type "arecord -l" in another terminal prompt.
echo "Enter you screen device number (e.g. 1 or 0 or other number) and press ENTER. You can find this number by writing [arecord -l] in your shell : "
read lnscreen

# Look for your audio device number (e.g. 1 or 0 or other number) and enter it when asked for. The script will adapt the command accorded to your system.
# To find the number related to your preferred device please type "arecord -l" in another terminal prompt.
echo "Choose the audio device you want to record (e.g. 1 or 0 or other number) and press ENTER. You can look which number it is according to your system writing [arecord -l] in your shell : "
read lndevic

# If your OS is OS X then...
elif [ "$os" == "Darwin" ]

```

If your os is Linux then ask the appropriate parameters to users... else if your OS is Darwin (Mac OS X) then do the same...

The parameters are asked to users depending on the OS identified and then the video is recorded for the appropriate OS

1,1 Haut

(An overview of the scripts developed)

The scripts store the user input into variables. The variables are used to record with the correct parameters depending on the OS identified. In case the users do not know which parameters to type, the scripts prompt a helpful comment offering them the ability to obtain the appropriate parameters. This recording method may be quite complicated especially according to the literature review, regarding the necessity to have easy to use processes for users. This explains why more accessible alternatives were researched.

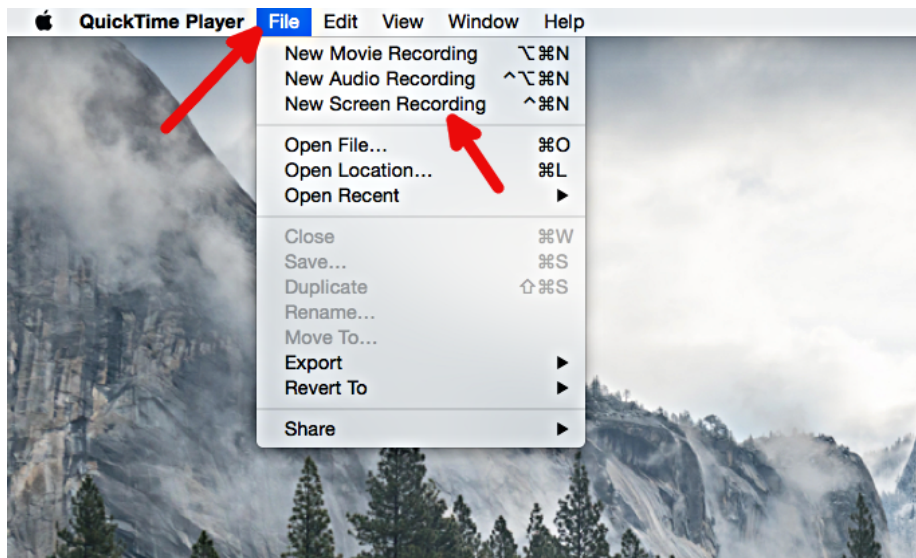
#### 4.2.2 Quicktime Player for Mac OS X

Quicktime Player is installed natively on Mac OS X computers. It is also available for Windows, however it was not tried on this platform.

To record a screencast with this software, Quicktime Player has to be launched from

the application folder and once opened, “File → New screen recording” needs to be selected as presented in Figure 24

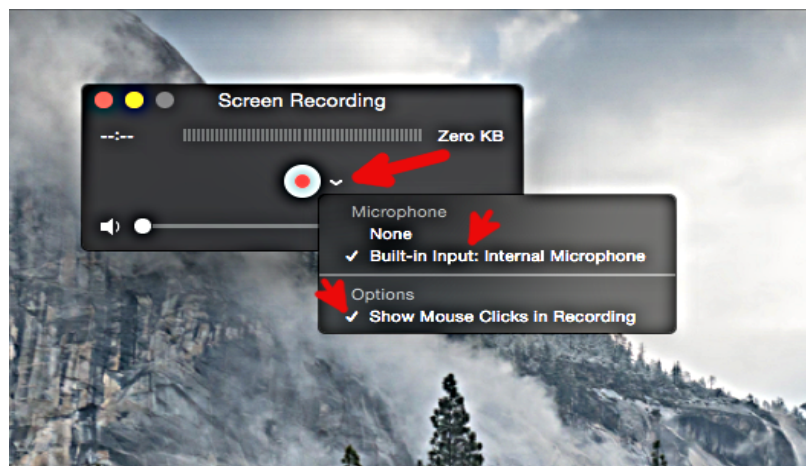
Figure 24: Recording with QuickTime Player



(Adapted from Apple Inc. 2007)

Once selected a new pop-up window will open offering choices for the microphone input to record audio and, whether the mouse clicks should be shown during the video or not. Once the recording button is activated by clicking, the recording begins.

Figure 25: Choosing the audio device and mouse clicks with QuickTime Player



(Adapted from Apple Inc. 2007)

To stop the recording, the small square in the menu bar can be clicked on. The process will end, and the system will ask where the video should be saved. Quicktime saves the file in .mov format only.

Figure 26: QuickTime Player: Stopping the recording

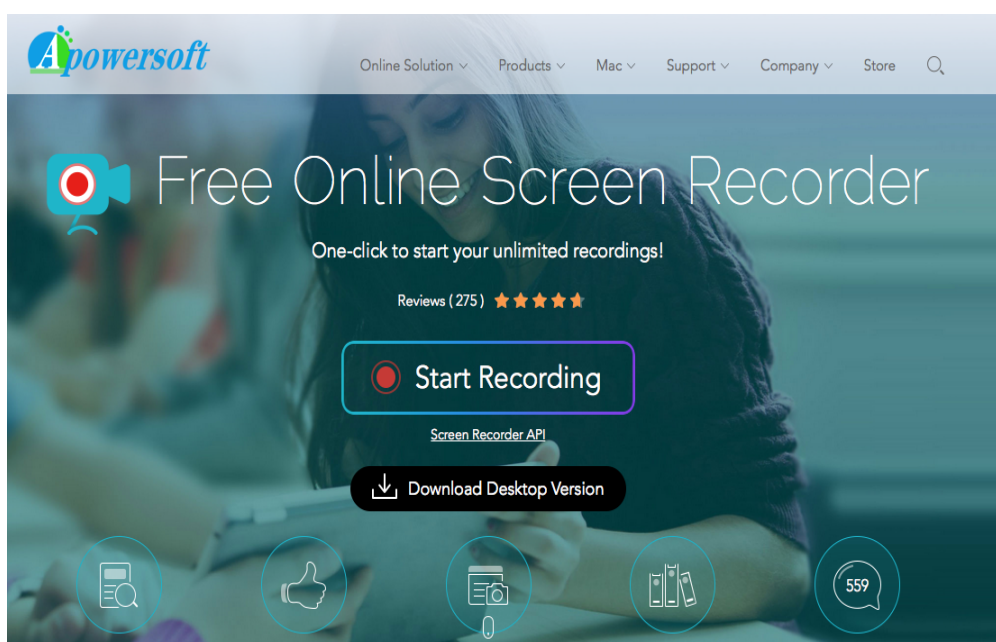


(Adapted from Apple Inc. 2007)

### 4.2.3 Apowersoft free online screen recorder (Mac OS X & Windows)

Apowersoft (Apowersoft Ltd. 2016) is a free online recorder which is available for Windows and Mac OS X. With this tool, the web page presented in Figure 27 needs to be navigated before clicking on “Start Recording” in the middle of the page. It will download the necessary application to launch the process of recording.

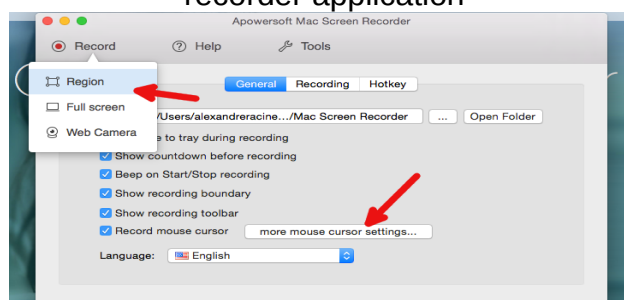
Figure 27: Apowersoft free online recorder



(Apowersoft Ltd. 2016)

Once the application has been installed, return to the web page and click on the “start recording” button to launch the previously installed application as presented in Figure 28

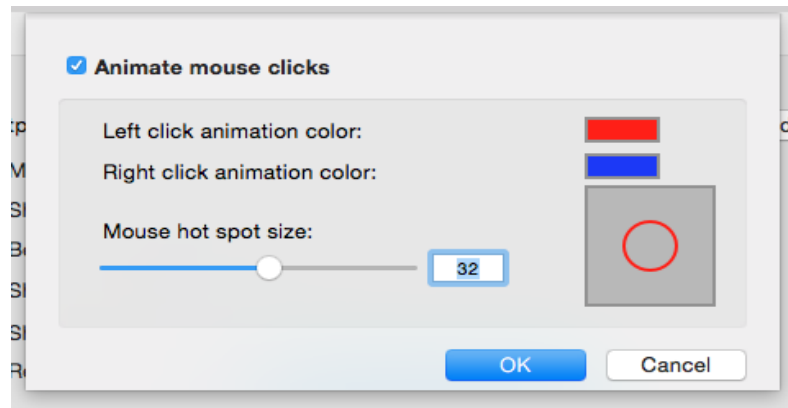
Figure 28: The Apowersoft free online recorder application



(Adapted from Apowersoft Ltd. 2016)

There are choices between recording the full screen, a region or even the webcam. It is also possible to select more advanced mouse settings, such as different animations for right or left clicks as presented in Figure 29.

Figure 29: Selection of different animations for left or right clicks



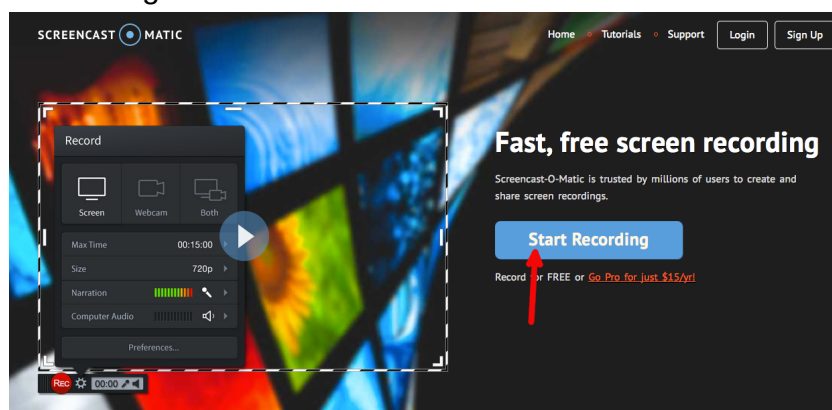
(Apowersoft Ltd. 2016)

During the recording, it is also possible to choose to add the webcam showing the speaker in a corner of the screen. Once the process of recording is finished, the video file is stored in the folder specified. Tests with Mac OS X showed the output file format was .mov. It should be noted that this software also enables the audio recording.

#### 4.2.4 Screencast-O-matic (Mac OS X & Windows)

Screencast-O-Matic is available for Windows and Mac OS X in free and premium versions. The free version is limited to 15 minutes recording. To get this software navigate to its homepage and click on “*Start recording*” in the middle of the screen to be redirected to a web page to download the application.

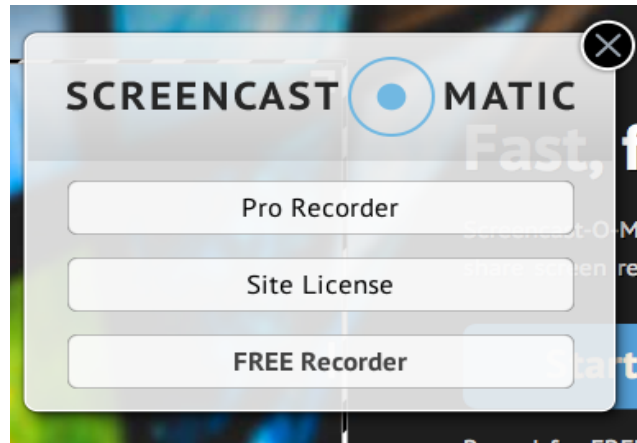
Figure 30: The screencast-O-Matic software



(Adapted from Screencast-O-Matic [ca. 2014])

Once the application is open, a pop-up window will ask to choose between the free and premium versions.

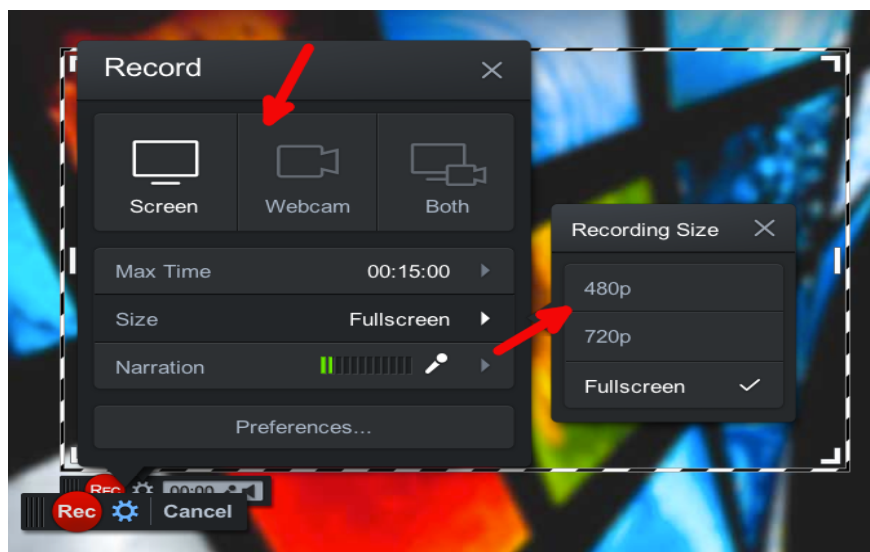
Figure 31: Free or Premium Screencast-O-Matic



(Screencast-O-Matic [ca. 2014])

Once the free version is chosen, a new pop-up window opens offering the selection to record the full screen, the webcam or both. It is also possible to record in two other dimensions. It is not possible to set up a defined area of the screen.

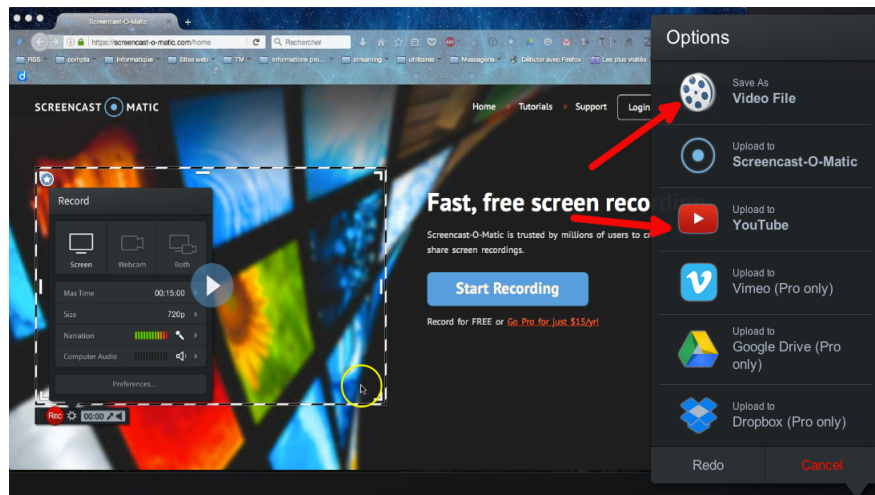
Figure 32: Screencast-O-Matic: set up the recording



(Adapted from Screencast-O-Matic [ca. 2014])

Finally, once the video has been recorded, it is possible to choose to export it as a file in .mp4, .avi or .flv format, or to upload it directly to the Screencast-O-Matic website or to Youtube. The premium version offers more advanced features.

Figure 33: Screencast-O-Matic: the final output

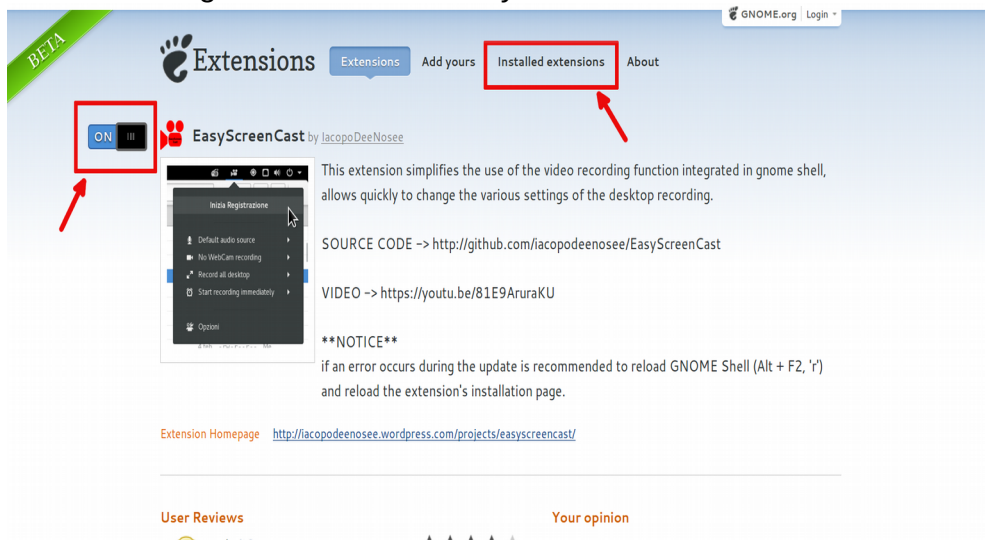


(Adapted from Screencast-O-Matic [ca. 2014])

#### 4.2.5 EasyScreenCast for the Linux Ubuntu Gnome Shell Environment

EasyScreenCast is available as a simple extension for the Linux Ubuntu Gnome Shell Environment (GSE). To install it, go to the official page of the extension ([The GNOME Project 2013](#)) and turn the button in the upper left corner on. It should then be visible in the “installed extensions” tab.

Figure 34: Activate EasyScreenCast extension

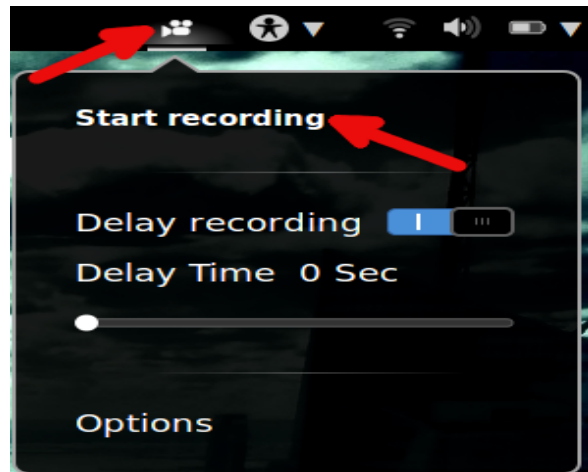


(Adapted from The GNOME Project 2013)

Once it is activated, a small camera icon in the menu bar will be visible as presented in [Figure 35](#). Once clicked, it will open a pop-up window which enables “Start Recording” to be selected, and the process begins. When the video is recording if “Stop Recording” is selected the process will end, and the file will be saved in the home video folder. It should be noted that EasyScreenCast can be started with simple keyboard

shortcuts: CTRL+ALT+SHIFT+R and repeated to stop the recording. To test EasyScreenCast on the Linux Ubuntu host, without having to install again all the system from scratch, we integrated the GSE with a PPA<sup>20</sup> which probably led to the lack of available advanced settings such as recording audio, etc. and implied the poor scores obtained. (see section 4.3. Comparative table of the selected recording tools).

Figure 35: The usage of EasyScreenCast extension

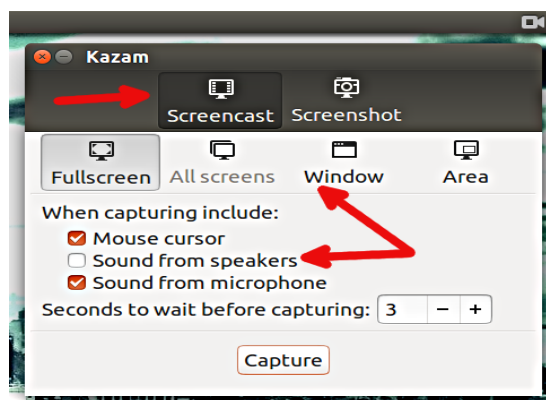


(Adapted from The GNOME Project 2013)

#### 4.2.6 Kazam for Linux Ubuntu

“Kazam provides a well designed and easy to use interface for capturing screencasts and screenshots” (Canonical Ltd 2012). To install download it from the Ubuntu apps official directory, or type “`sudo apt-get install kazam`” in a shell. Then Kazam can be launched from the applications folder to obtain a display such as the one presented in Figure 36.

Figure 36: Kazam application interface



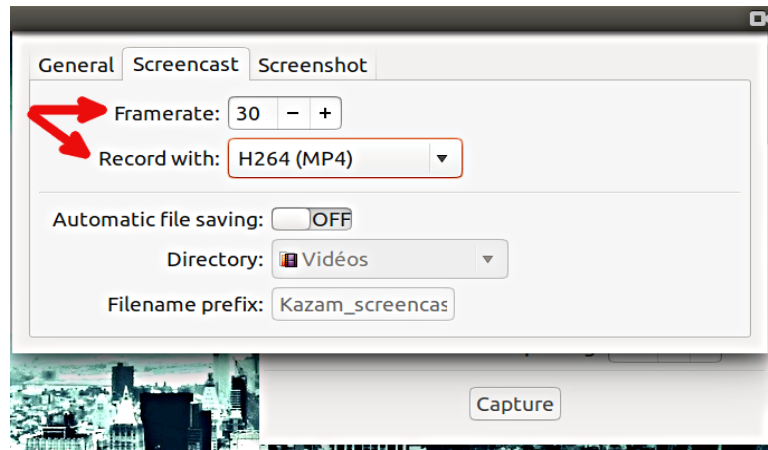
(Adapted from Canonical Ltd 2012)

<sup>20</sup>See the definition of PPA in section 4.2.8



It is possible to select a screencast or a screenshot as well as full screen, window, area or even multiple screen recordings. [Figure 37](#) shows the preferences available by clicking “*File* → *Preferences*”.

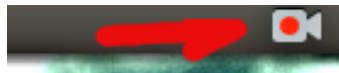
Figure 37: Kazam's preferences



(Adapted from Canonical Ltd 2012)

It is possible to choose the numbers of images per second and the format between .mp4, .avi or .webm. Once “*Capture*” is clicked on, the process begins. Once it starts recording, a small camera icon with a red point appears in the menu bar as presented in [Figure 38](#).

Figure 38: Kazam's icon in the menu bar



(Adapted from Canonical Ltd 2012)

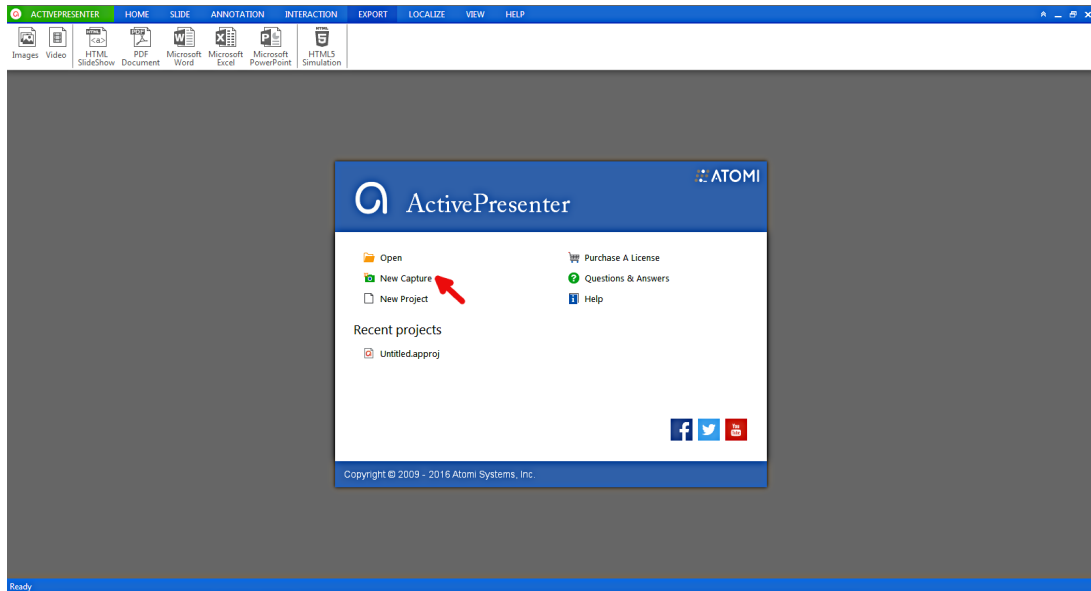
The camera icon needs to be re-clicked on to stop the recording. It is also possible to “*pause*” and restart from the point stopped. When stopping the recording, the software asks either to save the file or edit it directly. Once the location of the saved file is selected and the process is complete, the video is recorded.

#### 4.2.7 ActivePresenter for Windows

Following advice from a CERN colleague, the ActivePresenter software ([Atomi Systems Inc. 2016](#)), was assessed. It is a powerful software however only available for Windows in both free and premium versions. The free version is limited in terms of functionality and it is not open source, but it already has some interesting features. In addition, it is probably the only one in this list which is properly dedicated to the needs of “*real*” e-learning, whereas the other tools approached are more for

screencasting. This product enables the annotation of content and allows a video to be recorded as multiple separated slides. Then, the software exports the various, annotated, slides in one video. An overview of the tool follows.

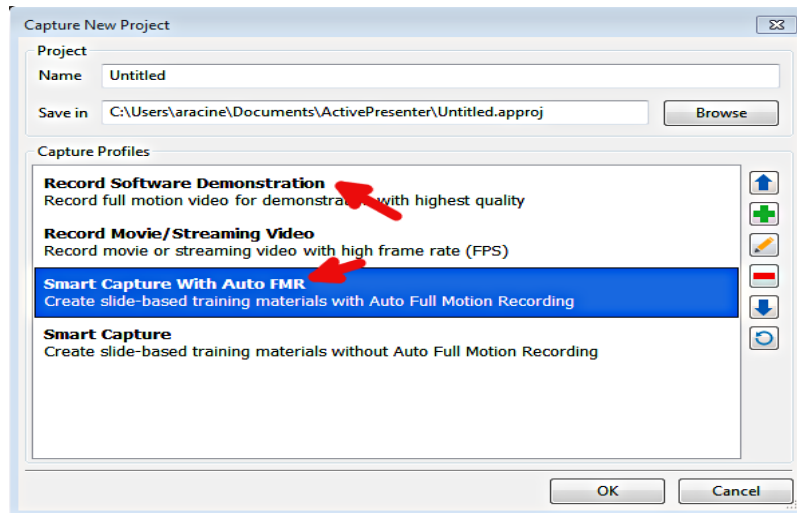
Figure 39: The start page of ActivePresenter



(Adapted from Atomi Systems Inc. 2016)

To start, “*New Capture*” is selected to create a new video. This opens a pop-up window and allows a choice between different types of recordings. For example, the “*Software Demonstration*” is just a video, e.g. simple tutorial, while the “*Smart Capture With Auto FMR*” is more advanced, cropped into multiple slides. The slides can be annotated and smart paths created for navigation on the web. It therefore allows the learners to see the different relations between the actions accomplished while browsing.

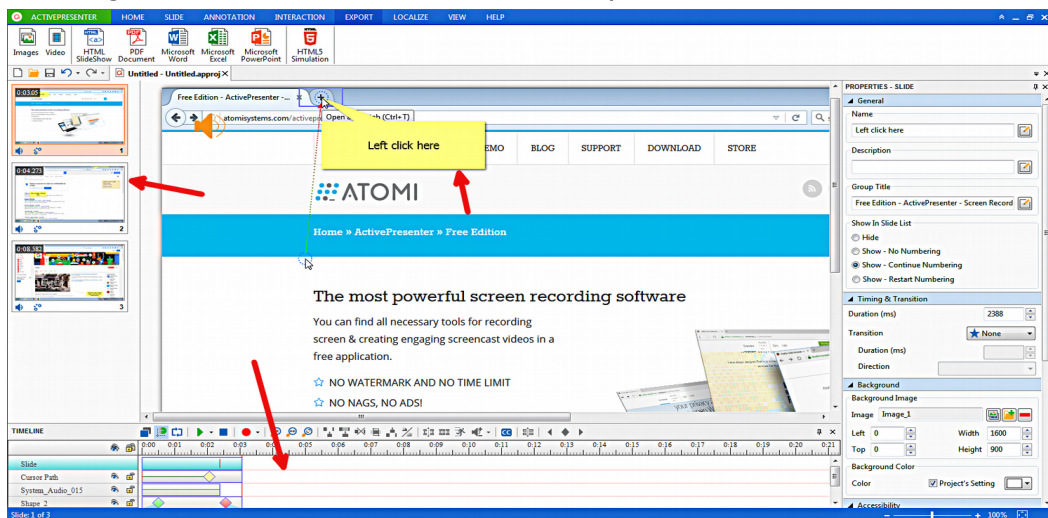
Figure 40: Different types of recordings with ActivePresenter



(Adapted from Atomi Systems Inc. 2016)

It is possible to select whether to record the entire screen or a defined area, as well as the audio devices. Finally, when the recording is finished, via the menu bar, click on the application's icon, and resume, stop or discard the recording. Figure 41 shows an overview of the output provided in “*Smart Capture With Auto FMR*” mode.

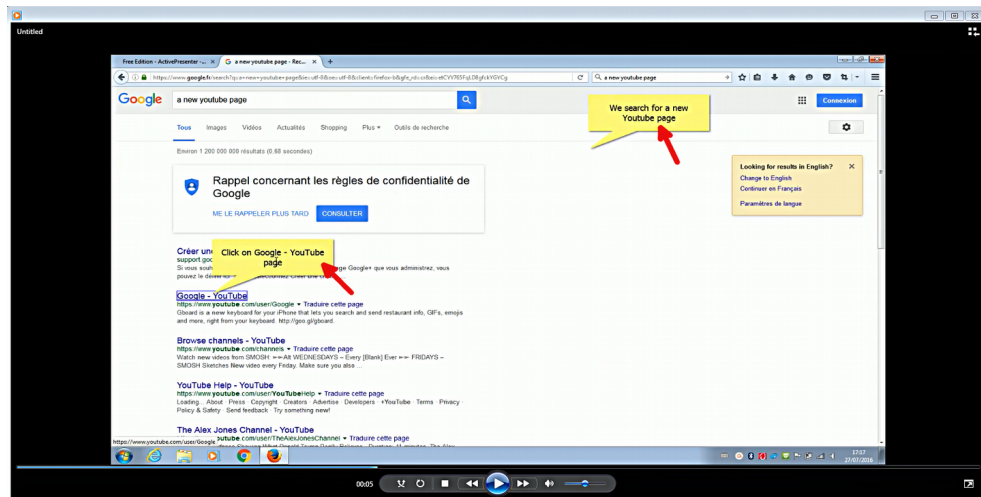
Figure 41: ActivePresenter: Smart Capture With Auto FMR mode



(Adapted from Atomi Systems Inc. 2016)

As illustrated in Figure 41, the video is separated in three slides allowing management of the tutorial slide by slide by annotating it. It is possible to edit the tutorial directly before publishing by, for example, adding an audio track. As a result, the export provides one video composed of several edited slides as presented in Figure 42.

Figure 42: ActivePresenter: tutorial composed with edited slides



(Adapted from Atomi Systems Inc. 2016)

#### 4.2.8 asciinema terminal recording tool (Mac OS X, Linux & BSD)

"asciinema is a free and open source solution for recording terminal sessions and sharing them on the web" (Kulik 2013a). It is supported on Linux, Mac OS X and BSD (Kulik 2013b) and quite easy to use. The focus here is on the process for Linux Ubuntu Trusty 14.04 LTS but, for any further information about its installation for Mac OS X or complementary documentation about its usage, the official documentation (Kulik 2013c) or the one prepared in Appendix 3 can be consulted. This tool was discovered thanks to advice of a CERN colleague and it corresponds well to the needs of the project as it addresses another type of content. It therefore provides another class of information, for a different targeted audience and other use cases than those seen so far. e.g. the "Agile Infrastructure & Puppet for Service Managers" course described in point 3.2.3.

To obtain asciinema, a Personal Package Archives (PPA) (Canonical Ltd 2016) needs to be installed. PPA's are a way for developers to provide Ubuntu software which is not in the official application centre mainly due to the development cycle of the platform. A new version of the platform is developed every six months, however Long Time Support (LTS) versions of Ubuntu exist. If the preferred application is not up-to-date due to an "old" LTS version, it is possible to get a more recent version by adding a PPA provided by the developers. We tried to avoid PPA's as it may contain security risks but it is the only way to install it on Ubuntu. Packages are available in the official repositories for other Linux distributions such as Debian. Regarding asciinema, the process to install it is as follows:

Go to the terminal and type:

- `sudo apt-add-repository ppa:zanchey/asciinema`
- `sudo apt-get update`
- `sudo apt-get install asciinema`

Asciinema is now installed. Once it is installed, already being in the terminal means by typing “*asciinema rec*” the process starts.

Figure 43: asciinema: recording a terminal session

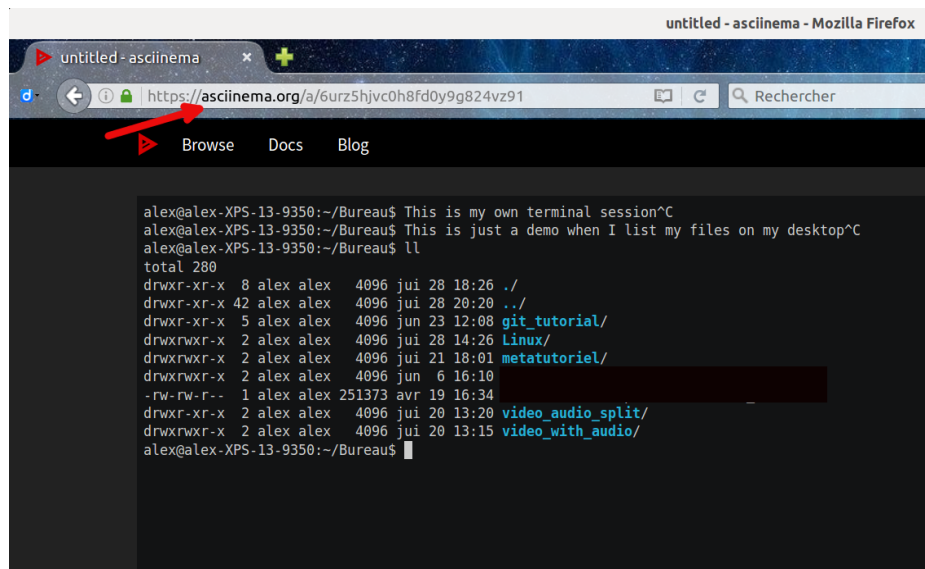
```
alex@alex-XPS-13-9350:~$ asciinema rec
~ Ascicast recording started.
~ Hit Ctrl-D or type "exit" to finish.
alex@alex-XPS-13-9350:~$ exit
~ Ascicast recording finished.
~ Press <Enter> to upload, <Ctrl-C> to cancel.

https://asciinema.org/a/8kfyzlnvme71726et1rvno10y
alex@alex-XPS-13-9350:~$
```

(A terminal session overview)

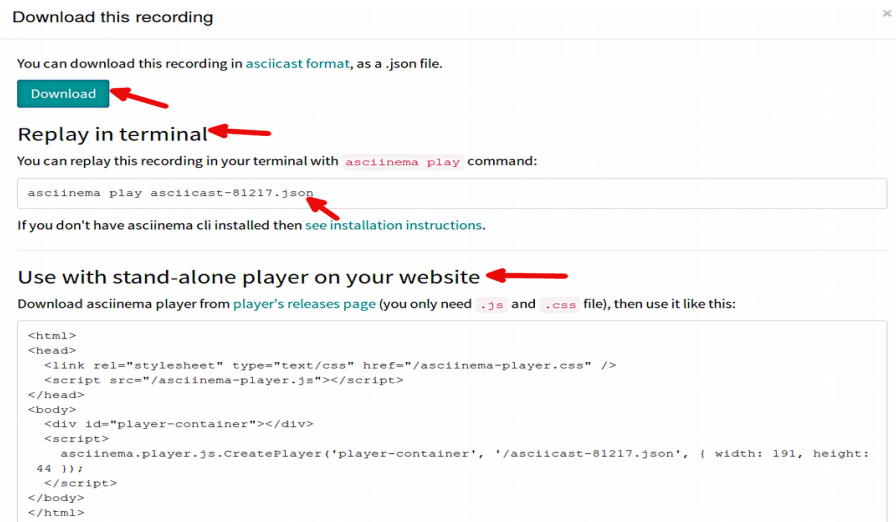
As shown in Figure 43, at the end of recording the file is uploaded on the official asciinema website, which provides a URL to access it. This URL allows to share / embed (Kulik 2013d) the video in any website / social media or download the necessary files for upload to a server.

Figure 44: An overview of our own asciinema recording



(Adapted from Kulik 2013b: private online asciinema environment)

Figure 45: Providing asciinema recording through our own website



(Adapted from Kulik 2013b: private online asciinema environment)

Figure 45 shows multiple ways of sharing the asciinema recording besides embedding it. For this work, the choice was made to provide it through our own website. The main reason being that it is not yet clear how to access the file in future if asciinema closes its services.

As illustrated in Figure 45, it should be noted that the downloaded file is in a .json format, i.e. structured text. That means it is not a “real” video but rather a text file, which can be played as a video with a javascript player. It therefore allows users to copy / paste the commands inside the playing video. Unfortunately, for the moment it is not possible to record audio, but discussions are currently in progress about this point (Playback hooks for audio syncing · Issue #12 2016).

### 4.3 Comparative table of the selected recording tools

Having discovered these eight primary tools for the creation of short online tutorials described above, the next step was to analyse them and compare their features. This was done with a table listing the characteristics considered useful or necessary for the project and including the important pre-defined criteria i.e. free, open source and cross-platform. Other characteristics studied regarding their usefulness for e-learning were, for example, their ability to capture just an area or a window, to record audio, to edit / annotate the video or to create advanced mouse click animations. This is mainly based on the belief that a simple video does not improve the learners' ability to acquire knowledge much. The above-mentioned criteria allow for the creation of a more attractive and interactive content for viewers.

In addition, it was necessary to address the types of formats supported to avoid problems for people to play the videos as well as the “Ease of Use” (Lee, Hsieh, Chen 2013), therefore making the creation of content as easy as possible for users. Finally, it was decided to take into consideration the “Issues” criteria, i.e. if the software might create bugs or failures with the devices used. The criteria were weighted to stress the ones which seemed more or less important.<sup>21</sup>

Table 2: Comparative table for tools according to several criteria relevant to our project

|                                | Score per criteria | ffmpeg                | Quicktime Player | Apowersoft       | ScreenCast-O-Matic | EasyScreen Cast | Kazam               | Active Presenter | asciinema          |
|--------------------------------|--------------------|-----------------------|------------------|------------------|--------------------|-----------------|---------------------|------------------|--------------------|
| Free                           | 5                  | 5                     | 5                | 5                | 3                  | 5               | 5                   | 3                | 5                  |
| Open Source                    | 5                  | 5                     | 0                | 0                | 0                  | 5               | 5                   | 0                | 5                  |
| Cross platforms                | 5                  | 5                     | 0                | 3                | 3                  | 1               | 1                   | 1                | 3                  |
| Supported OS                   | -                  | Windows / Linux / Mac | Mac              | Windows / Mac    | Windows / Mac      | Linux (GSE)     | Linux               | Windows          | Linux / Mac / BSD  |
| Capture area / window / webcam | 5                  | 3                     | 5                | 5                | 4                  | 0               | 5                   | 5                | 0                  |
| Audio                          | 5                  | 5                     | 5                | 5                | 4                  | 0               | 5                   | 5                | 0                  |
| Output formats (1)             | 4                  | 4                     | 1                | 2                | 2                  | 1               | 3                   | 4                | 2                  |
| Output formats (2)             | -                  | Too many              | .mov             | Only .mov on Mac | .mov / .avi / .flv | .webm           | .mp4 / .avi / .webm | Too many         | .json + javascript |
| Annotate / Edit videos         | 4                  | 0                     | 0                | 4                | 2                  | 0               | 1                   | 4                | 1                  |
| Ease of Use                    | 5                  | 1                     | 5                | 5                | 5                  | 5               | 5                   | 5                | 5                  |
| Completeness                   | 3                  | 3                     | 1                | 2                | 2                  | 0               | 2                   | 3                | 1                  |
| Advanced mouse clicks          | 4                  | 2                     | 2                | 4                | 2                  | 0               | 0                   | 4                | 0                  |
| Issues                         | 5                  | 1                     | 5                | 5                | 5                  | 2               | 5                   | 5                | 5                  |
| <b>Total</b>                   | <b>50</b>          | <b>34</b>             | <b>29</b>        | <b>40</b>        | <b>32</b>          | <b>19</b>       | <b>37</b>           | <b>39</b>        | <b>27</b>          |

(Concluded from our own evaluation of the tools on different Operating Systems)

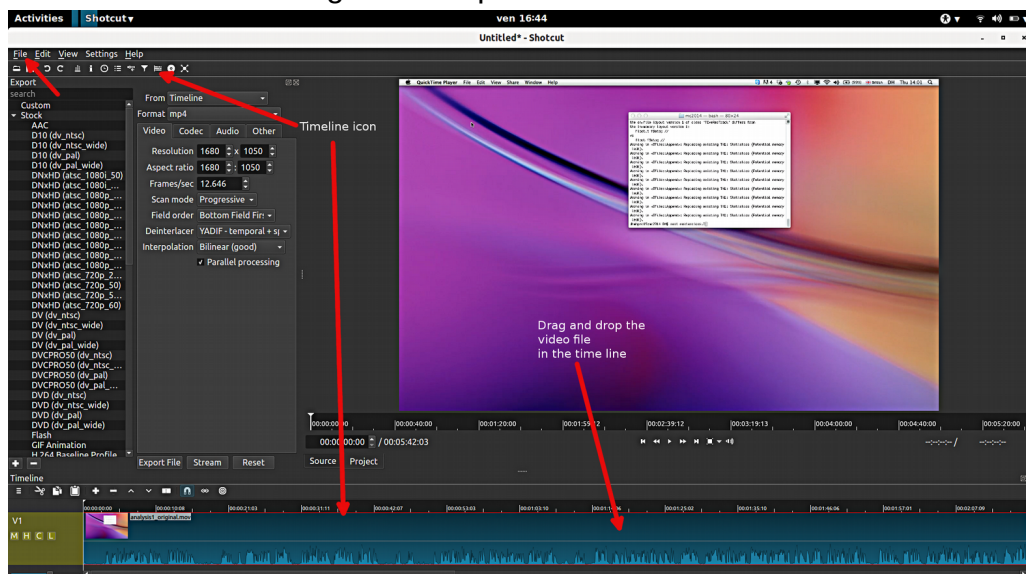
<sup>21</sup>Key for the weight of the criteria presented in table 2: a score of 5 is assigned to those considered indispensable. A score of 4 are those considered as really important to have but not discriminant. Completeness has a score of 3 as it is difficult to get a single free package which covers all needs regarding the creation of content.

Each package offers distinct possibilities therefore these recommendations are largely dependent on the objectives, content and / or targeted audience of a given e-learning project. This result should not be considered as static recommendations however, this will be explored in the proposals specifically concerning this project and the discussion of this work.

#### 4.4 Shotcut: a brief introduction to a free, open source and cross-platform video editor

As mentioned above, a simple video is not sufficient to disseminate knowledge, when referring to e-learning content. Moreover, in the context of an organisation like CERN, a raw video should at least contain additional information, such as a logo for example. Also the beginning and the end of a recording must often be cropped to remove its launch or end. As it was considered essential to perform some basic editing before publishing a video editor was researched. Shotcut (Mellytech LLC 2016a) was found, it is available for Windows, Linux and Mac OS X, is free, and it supports multiple file formats as well as various interesting features. As this software is quite complete, full details cannot be covered however the main points of interest are shown in the screen shots below. Shotcut can be downloaded from its official website download page (Mellytech LLC 2016b). Once Shotcut is downloaded and opened, the layout is as such:

Figure 46: Open a file in Shotcut

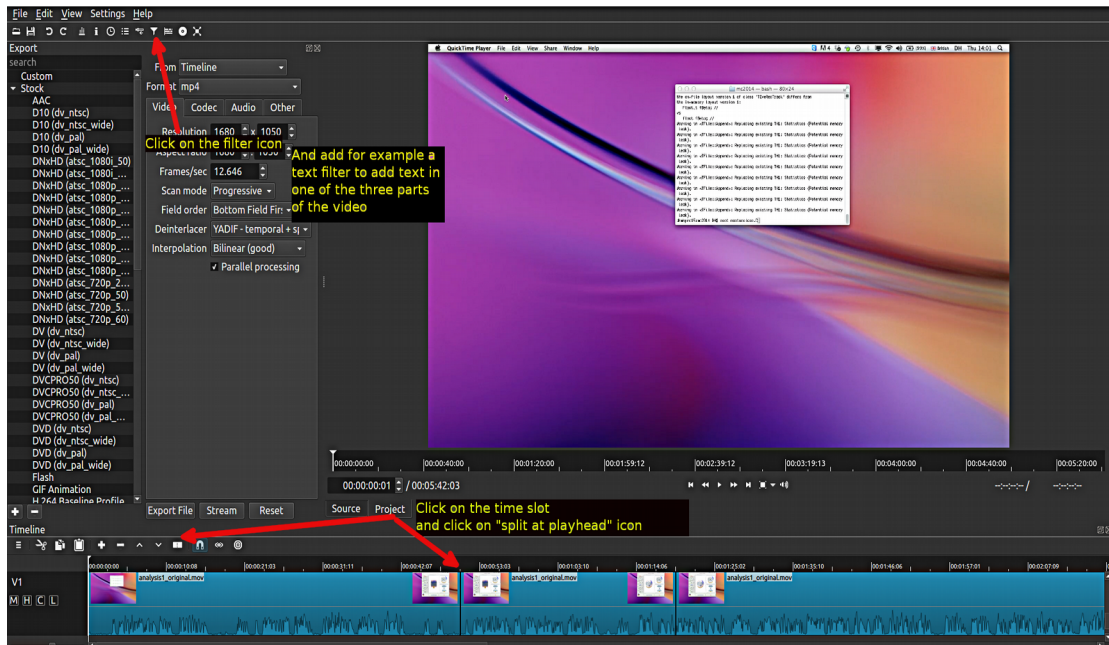


(Adapted from Meltytech LLC 2016a)



By clicking “File → Open” the video file to edit can be selected. Clicking on the “Timeline” icon opens the timeline. The file from the centre area can be dragged and dropped to the timeline and the file is ready to be edited.

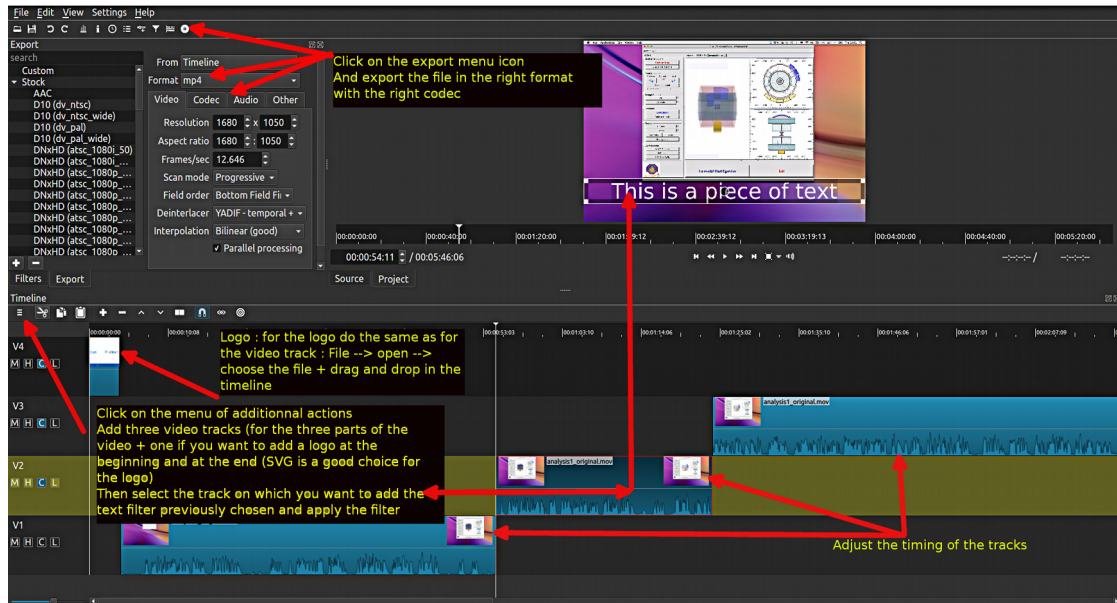
Figure 47: Cropping the file in multiple parts



(Adapted from Meltlytech LLC 2016a)

To remove the unnecessary seconds at the beginning or end of the recording, e.g. when launching or stopping the screen recording tool, the track is cropped by selecting the time slot in the timeline, clicking on the “Split at playhead” icon, selecting the necessary part and entering BACKSPACE or DELETE. More information about e.g. adding text filter, exporting or adding a logo can be found as text comments area in Figures 47 and 48.

Figure 48: Advanced edition with Shotcut



(Adapted from Melytech LLC 2016a)

## 4.5 Recommendations to create a good tutorial

In this section, the various recommendations regarding which tools to choose for our e-learning project at CERN, as well as the most important pedagogical principles to take into consideration in order to create a good and useful tutorial will be covered.

Although in point 4.3; Table 2 the case of the tools with a comparative study regarding various criteria was already addressed, it is important to stress that the results obtained might cause surprise as the criteria used deal with a particular context. For example, ActivePresenter, which is a powerful software, even in its free version, obtained a slightly lower score than Apowersoft, which is also free software however, less complete than ActivePresenter, at least the version tested. This is mainly because the support for various Operating Systems (OS) was considered as an essential criterion (see Table 2). This highlights the point already stressed: a set of criteria chosen for a context like the one at CERN may imply that the performance of a given software is lower than its effective performance. The recommendations of this work are for the particular context at CERN.

### 4.5.1 The recording software

The content owners at CERN use mostly Mac OS X and Windows computers. In this context, Windows users are recommended to try ActivePresenter, as it is complete, robust and enables the creation of content considered as “*authentic*” e-learning. Even in the free version. Regarding the Mac OS X users, Apple already provides a built-in

solution which allows good quality recordings to be created with QuickTime Player. This is therefore a very good compromise, and it enables anyone already familiar with the Apple environment to create content without too much effort. The Ubuntu users are recommended to use Kazam. As seen in the analysis, this tool could have more features however, the solution provided so far already enables advanced screencasts to be created by allowing an area, a window or even multiple input screens to be selected. In each of these three cases, the solutions recommended give the opportunity to people to create content without too much effort. Please refer to the graph presented in [Figure 2](#).

The choice of a tutorial recording tool also depends on the nature of the content itself and what the lecturers would like to show and teach. For example in the “*Agile infrastructure and Puppet for service managers*”, one of the three parts of this lesson, i.e. the configuration part, was exclusively made through command lines in a shell. For this reason and for such content, using asciinema which provides a useful .json (text) output is recommended as this file can be played as a video through a JavaScript player established by the developer. It provides an interactive video in which the commands typed can be copy / pasted. This way of providing instructional content is the most suitable regarding processes within a shell. As already mentioned, asciinema can not yet record sound as it is complex to synchronise structured text and audio, however discussions are in progress concerning this ([see 4.2.8](#)).

As seen above, a basic editing process is considered necessary in any case before publishing a video. Apple, for example, provides its built-in solution with iMovie ([Apple Inc. 2016](#)). Shotcut provides a solution that works well for all platforms and complies with the primary criteria, i.e. non-proprietary.

#### **4.5.2 List of pedagogical principles**

This section will describe our recommendations about pedagogical principles regarding the creation of rapid e-learning content, i.e. short online tutorials. Some of these points are more general recommendations while others are “*real*” pedagogical principles. All the elements below are considered useful towards achieving the primary objectives of the project, i.e. deliver knowledge to viewers for their day to day work, by offering quality content and recording.

According to the numerous elements identified, it was decided to separate the information into three sub-parts:

- How to create a good tutorial, i.e. best practices and general points for speakers
- Pedagogical recommendations inspired by the literature review
- Technology as a service to pedagogy

#### 4.5.2.1 How to create a good tutorial: best practices and general points for speakers<sup>22</sup>

In this list, most of the points are intended to keep the viewers' attention until the end of the video. However, there are also some points which aim at helping the lecturer to save time while creating a short online tutorial. Although those last points do not concern the educational path of the learner, it was considered useful to mention them here, because they are also part of *"How to create a good tutorial"*. They constitute the *"points to improve speakers' experience"* part while the others will be presented under the *"points to improve learners' experience"* part.

##### 4.5.2.1.1 Points to improve learners' experience

- **Writing a script and giving it structure.** In other words we should tell the audience exactly where we are and where we will go, e.g. *"This tutorial is about this cool feature... I'll explain what it does, how to install, how to configure, how to start, stop, monitor..."*. Of course, it seems basic, but it will help the viewers to understand what the subject of the tutorial is in order not to be lost.
- **Using a teleprompter if the recording includes both the screencast and the speaker.** Teleprompters exist free-of-charge on the web such as this reference ([MirrorScript free teleprompter software \[no date\]](#)) which allows very easy upload of a plain text file, as well as managing the speed and size of the text. Nevertheless, the teleprompter should be placed at the right distance, i.e. ideally under the camera and at the same distance from the speaker to avoid losing eye contact during the tutorial.
- **Rehearsing as much as possible and measuring time.** Although [Nadysil \(2013\)](#) recommends that the video should *"not exceed 10 minutes"* the right timing for short online tutorials could be considered as 5' maximum to help maintain the attention of the audience. It is important to note that dropping from 8' to 4' requires many rehearsals.
- **Asking colleagues** familiar or not with the domain to act as the public to obtain as much feedback as possible. This will ensure the content is clear.
- **Avoiding typing commands 'live'.** It is preferable to make slides, screenshots or web page tabs with the commands on to avoid stress, or misleading the audience if the commands are mis-typed.

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<sup>22</sup>These points are also available as a 3' 34" online tutorial from this page <https://cds.cern.ch/record/2202153>

- **Pointing to the content** referred to during the tutorial if there are slides. It will help the viewers to follow more precisely.
- Making sure **the web pages** of the application presented **are clear** for new-comers
- **Using a clean environment.** Remove desktop icons, browser tabs, other applications (email, skype) that could pop-up images and sounds while recording. In addition an untidy desktop full of icons or a browser with irrelevant tabs opened, risk to mislead the audience instead of encouraging them to focus on the tutorial content.
- If a **tool that works on multiple Operating systems** is presented, make a **generic introduction** and **short episodes per Operating System**. This will help to create short tutorials and will avoid frustrating viewers if the appropriate information for their environment is lost in the middle of a longer video which they might stop watching. It can also be frustrating if the video for their OS does not exist at all therefore lecturers are encouraged to address the different OS's.
- **Using a standard chair** e.g. without wheels to minimise body movements during the video and keep hands visible as *“their position and movements stress what is [shown] by the speaker and, sometimes, what is heard by the learner”*<sup>23</sup> (Chaumien-Wetterauer 2011).
- If the **package described** is **already installed, explain what happens**, i.e. whether the system will install it again or ignore it. This will avoid user stress if something unexpected happens.
- Making sure the **website mentioned is on the screen** to help users follow and know where they have to go.
- **Showing the viewers the link to “contact us” if they are encouraged to do so.** Provide a contact address to write to in the event of questions. As seen in the literature review (Hügi 2014, p. 12), acquiring knowledge with e-learning might isolate the learners. If something is unclear and they can not ask questions the risk is that the video could be useless.
- **Do not forget to say: \*READ\* the terms of use before agreeing, when clicking on licence agreements during the tutorial.** This is to avoid users having issues with a license if they accept the clauses without reading them.
- **Saying if everything is standard installation process for the given platform when skipping installation details.** Optionally, another screen capture video fast forwarded could be made. In this case, ensure this second video is available at the same place as the tutorial, or create a link to it.
- **Including 2 or 3 versions of the same video on the web page dedicated to a given tutorial.** Some browsers need extra plugins to show certain file types mainly due to copyright issues. It will help the browser to know which file type to use to play the video and, it will allow the user to visualise the video correctly.

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<sup>23</sup>Translation from French

#### 4.5.2.1.2 Points to improve speakers' experience

- **Whether recording for ourselves or as member of an organisation, comply with security rules.** For example, do not download content from untrusted sources and try to choose, if possible, an installation process which is standard, supported and sure.
- **Checking what is already available on the web:** the creation of content requires time and resources therefore be sure that the tutorial is really necessary. Again, this should be linked with [Figure 2](#)
- **Not using personal data.** i.e. personal emails, logins, passwords, etc., create fake accounts instead.
- **Choosing a quiet place and using a "Do NOT disturb" sign.** Put this sign on the door when recording, to avoid people entering or talking loudly.

#### 4.5.2.2 Pedagogical recommendations inspired by the literature review

As seen in the [point 2 literature review](#), there are many pedagogical modalities to take into consideration when creating an e-learning project. The concerns will be addressed specifically regarding the creation of rapid e-learning content.

Firstly, as Hügi [Hügi \(2014, p. 9\)](#) presents, the cognitive styles of learners might be slightly different. Furthermore, in the case of rapid e-learning, at least in this project, there is no face to face lecture as the aim is to provide short instructional videos. Attaching an additional document (at least the script prepared by the speaker) to the video to allow viewers to refer to video or text is recommended. This way if something is not clear in the tutorial, the learners can at any time find the necessary information by reading, or vice versa.

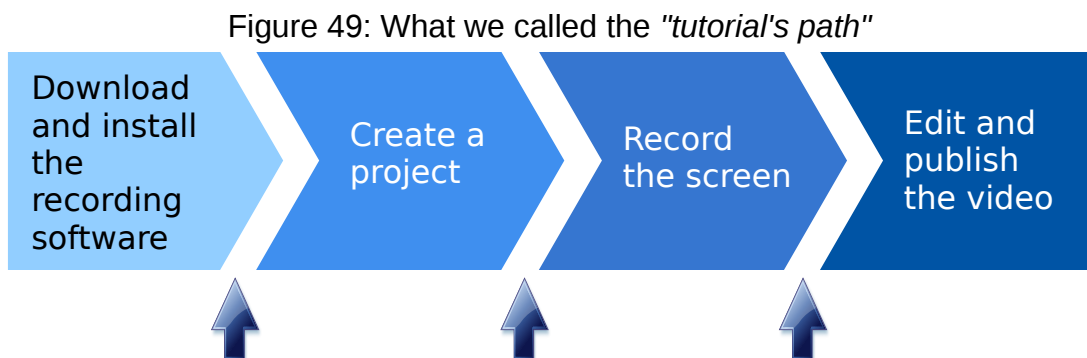
For the same reason, it is strongly recommended to allow users to contact the content owner to ask questions and obtain feedback. It could be an e-mail address, a forum or a comments' section on the tutorial page. In all cases, the active participation of the teachers (content owners), i.e. a quick response, will be a key success factor. Learners should also be encouraged to practice what they learned as just watching a tutorial is not enough to acquire, and also retain, knowledge.

Remembering what [Clark and Mayer \(2003\) quoted in Derouin, Fritzsche, Salas \(2005, p. 933\)](#) called the personalization principle; this way of giving a human dimension to the machine in order not to see it as only an agent which delivers information. For this reason, recording a video with an audio track is good practice which also offers additional information to the visual content. Optionally, one can choose to film the speaker as well, like the examples presented in [Figures 8, 17 and 18](#).

In this case, the camera should show the speaker first. The speakers are recommended to introduce themselves clearly and to smile while speaking.

Another important point is the control left to learners, e.g. to skip parts of a tutorial which they are already familiar with, i.e. what [Alberts et al. \(2007, pp. 55–56\)](#) called the “*process*” in their four Ps’ theory (see [point 2.6](#)). For the moment, not all CERN tutorials recorded by the content owners themselves, i.e. without the support of the audiovisual team, are registered in CDS and played through the CDS video player. However, CDS allows skipping content and has the ability to crop videos in various thumbnails in sync with the timeline, allowing users to skip steps already known (see [Figures 8, 17 and 18](#)). It is desirable to have the same functionality for the “*homemade*” tutorials.

Finally, a point which was not part of the literature review but rather of personal experience was identified, to be referred to as “*the tutorial’s path*”. i.e. packages of tasks performed one after the other to achieve a final objective. For example, to be original, let’s imagine the aim of creating a recording. Such a “*tutorial’s path*” would be as such:



The transitions shown by the arrows are critical points as they will have to be mastered by the person who will record the tutorial. If the lecturer is not confident with the process, this may result in a situation where the transitions are not clear, implying a lack of understanding for the viewers. Writing a short scenario including the tasks which compose the process completes the recommendation concerning the creation of a script (text) above.

#### **4.5.2.3 Technology as a service to pedagogy**

Throughout this work, we have observed that, sometimes, the technology is criticised in the field of education as it can lead to disadvantages regarding pedagogical aspects. Nevertheless, it is fair to list its benefits as well.

Firstly, in the work dedicated to the recording tools, we observed that there are products on the web which allow the creation of “real” e-learning content (see [ActivePresenter](#)) in other words educational content, i.e. content enhanced with, for example, notes, animations or multimedia files. This enhances the learners' experience as it enables them to navigate through interactive compositions, improving their ability to retain knowledge. In this context, it is recommended to use such additional features when it could add something more for the learners. It has to be noted that such tools should be easy to use for the lecturers in order to take into consideration the cost-benefit ratio (see [point 2.6.3](#)).

Regarding audio, nowadays almost every laptop is equipped with a built-in microphone. Nonetheless, it is recommended not to use it. Using a real and effective microphone offers non-negligible benefits especially as they exist for a good price-performance ratio. Actually, according to [Nadysil \(2013\)](#), audio is more important than the video track itself and although the image must be of good quality, we agree entirely with this. After several attempts on different laptops with built-in microphones, the conclusion is that recording with them is not recommended due to the sound quality which could cause users to quit the video. Moreover, editing a video with poor sound quality is difficult. It is possible to slightly improve the track with respect to the original file however the audio remains unpleasant to listen to.

Finally, various products today take into consideration the fact that the video will probably be displayed on several devices, e.g. mobile phones or tablets. It is therefore important to use software which enables content creation for such equipment. Most of the tools tested during this work allowed it however, the content owner must be aware of which resolution to use depending on the devices. It should be stressed that if the content is well prepared and adaptable to the mobile world, it could greatly enhance the e-learning advantages by extending the possibility to acquire knowledge outside of the traditional locations for learners.



## 5. Discussion and future work

There are several considerations to be taken into account regarding the discussion of this work. Firstly, regarding the points treated in the chapter dedicated to the methodology, participation in the *“Agile infrastructure and Puppet for service managers”* tutorial was already mentioned. Our role was to determine which type of recording method would be the most relevant for such content. It was a valuable experience as it allowed us to realise the usefulness of a slightly different tool, i.e. asciinema, rather than the ones for screencasting. However, attending this lesson was a challenge as it implied having a lot of programming skills which was not the case; we did not study in the field of computing sciences despite personal interest in this field. It became clear that improving our skills could help to be more confident. We therefore experienced the notion of the Technology Acceptance Model (TAM), particularly in terms of Prior Experience (PE) using computing technologies (see [point 2.5.2](#)).

Secondly, regarding the tutorial audience, it should be noted that it is difficult to take the profiles of all learners into consideration. The main reason is that everyone is different concerning their preferred way to acquire knowledge. For example, one colleague told us that he was not a *“huge fan”* of Youtube instructional videos, as he considered they lacked information density. Others often use Youtube videos to gather information about a given subject. Therefore the means to learn depends on many personal factors making it very complicated to create instructional content of relevance for everyone.

Furthermore, concerning the choice of recording packages, many challenges were also faced. Considering on one hand the primary criteria defined at the beginning of the project to find, if possible, free, open source and cross-platform tools to match CERN's philosophy and budget. On the other hand, the majority of the targeted audience are Windows and Mac OS X users which are not open source operating systems and the applications for those platforms are often not free. This led to a search for free, open-source tools for all OS's and the discovery of FFmpeg. Nonetheless, FFmpeg can be quite complex and time-consuming to learn. We therefore had to consider making user's experience easier by recommending using the Mac OS X built-in tool and other products for Windows not all of which complied with the primary criteria. This therefore led to recommendations about the tools which are different than those which could be drawn from the scores obtained in the comparative table established, already stressed at the beginning of the [point 4.5. Recommendations to create a good tutorial](#).

Regarding the context and points related to our personal planning, it was difficult initially to understand the complexity of an organisation like CERN, as well as its field of interest. The use cases for which tutorials had to be created were therefore not so easy to understand. In the beginning, it did not help to clearly identify which tools to choose and how to address the use cases. Moreover, being at CERN only two days a week due to lectures at University was not the most practical. Working for CERN as a full-time equivalent could have helped make more progress.

Moreover, as outlined in section [2.7.1](#), it was decided to conduct a survey to gather information about e-learning processes in similar organisations. That was not the primary objective regarding this work and it fell at a time when there were a lot of other important things to address, therefore, not enough time was taken to establish the structure of the questionnaire. This resulted in a lack of methodology and probably explains why so few answers were received; only ten complete replies despite sending the questionnaire to many organisations. At least the answers obtained offered useful information.

Finally, regarding future work, given the characteristics of the products, the progress expected in the field of learning technologies as well as those in the domain of education, creating short online tutorials for CERN has to be considered as an iterative process. There also are other fields of interest which should be considered, e.g. screen recording on mobile devices, i.e. smartphones and tablets.

At the time of writing, this project began six months ago, and recently people started to show more interest by providing more compelling use cases to address. In this context, it might be useful to maintain the focus on this project and continue to improve the processes developed so far. Given its domain of interest, staff profiles and culture, as well as its collaborations with other such organisations throughout the world, CERN could draw substantial benefits from rapid e-learning processes. It might also be useful to establish partnerships with educational technologies' specialists, to improve the means to deliver knowledge to employees by sharing their recent findings on the subject.

## 6. Conclusion

The progress made in the field of technology these last few years increased drastically the ability for people to acquire knowledge through various means, avoiding the constraints of place and time. In the meantime, a new word appeared: e-learning. As already expressed, it is often difficult to know exactly what is covered by this term. While people became more familiar with the popular concepts of MOOC or blended learning, fewer people know precisely what rapid e-learning actually is, although most of them use it almost every day. According to the literature review, this particular branch of distance learning was already defined: to provide quick instructional content by, for example, making available short online tutorials. This was precisely the purpose of the project.

It was identified in point 2.7.1 Figure 5 that, in organisations similar to CERN, blended learning and online video tutorials were the most common types of e-learning practised. Following participation in some courses at CERN, the analysis of the e-learning content creation within the organisation, as well as experience as teaching assistant in the Department of Information Sciences at the HEG, we are not so surprised. In our opinion, both types of “*e-teaching*” are those which could bring high benefits to acquire knowledge for a relatively good cost-benefit ratio.

Furthermore, having studied the technological variable of this work, i.e. the evaluation of screen recording tools, it should be stressed that, very often, the main point of failure regarding e-learning is that often people seem to be more interested in technology rather than pedagogy. Despite the fact that the technology helps to increase knowledge acquisition, the pedagogy should not be ruled out as it is one of the most important points ensuring that a distance education program will be successful.

These aspects were considered in the recommendations as they evolved during progress of the thesis. In fact, the first discovery concerning the tools was software which matched the required primary criteria perfectly. However, it did not match one of the most important pedagogical principles, i.e. ease of use. For this reason, other products were recommended, not totally in accordance with other criteria considered as important.

Returning to a fact considered interesting concerning the open source environment versus the proprietary environment. Dealing with the open source environment was challenging and in terms of personal interest, really exciting and useful to improve

computing skills. Using the proprietary environment was much easier and quite “*standard*” regarding understanding software knowledge. The same conclusions cannot be given for all the products in these environments, anyway, only a sub-category, the screen recording tools, was addressed.

Choosing a tutorial recording software must be a process which takes into consideration the nature of the content itself. For example, for a Powerpoint-based slides presentation, or a standard software installation process, a simple screen recording should be enough. Whereas for a more advanced use case, such as programming in the shell environment, a terminal recording tool like asciinema would seem more appropriate.

The final conclusions we would like to draw as a result of this work are the following. A standard user, doing his daily job in the context of an organisation without support for an open source environment, should stay on the platform he is most familiar with. However, if he is interested in “*diving into the free world*”, he should do so but be aware of the time needed to achieve relatively similar quality results.

An organisation wanting to promote an open source environment should have the human resources and time available to address the maintenance of such tools, mainly as the support is relatively demanding in terms of configuring the products and fixing issues.

To conclude this work, we would like to say that given the different tests performed so far, finding tools which match well each user's need regarding the creation of e-learning content (without spending a lot of money) could be compared to going through the jungle, armed with a simple Swiss Army knife. In short, difficult but not impossible. However this work offered us the opportunity to learn more advanced computing skills, and to quote, once again, [Botturi and Tagliatesta \(2001, p. 2\)](#) “[...] *learn to learn is the law of the knowledge society jungle [...]*”.

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## Appendix 1 : Complete results of the survey

What type of organisation are you?



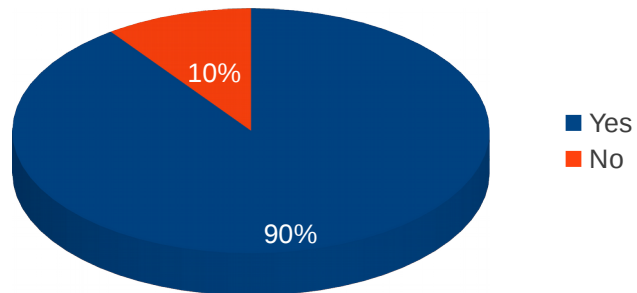
How many employees, approximately, are working in your organisation?

|      |
|------|
| 2300 |
| 30   |
| 200  |
| 1800 |
| 1700 |
| 7000 |
| 7500 |
| 7500 |
| 600  |
| 4000 |

### What is your principal domain of activity?

|   |
|---|
| fundamental research (particle physics) |
| operation lead                          |
| Computer Scientist                      |
| HEP                                     |
| training                                |
| Learning and teaching                   |
| Particle Physics                        |
| Learning and Development                |
| international trade                     |
| Learning Technologies                   |

### Do you practice e-learning ?



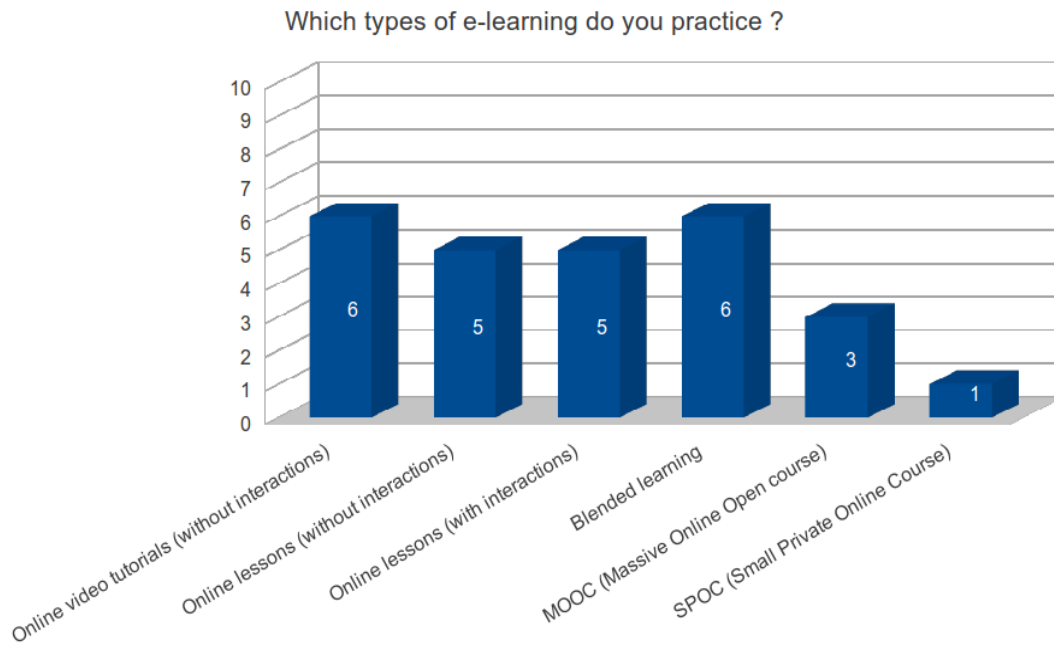
### If no, why?

No budget and man power to maintain a system like that

### If you practice e-learning, since when?

|                 |
|-----------------|
| March 2016      |
| 2016            |
| a few years ago |
| 2012            |
| 2006            |
| 2006            |
| 2013            |
| 2005            |
| 1995            |

## Which types of e-learning do you practice?



## What are the purposes of e-learning in your organisation?

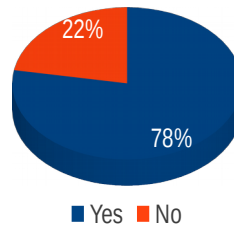


**If you selected "Other" please develop.**

|  |
|--|
| How to use new systems.  |
| Dissemination activities connected with EU projects                    |
| Required training for specialized job categories.                      |
| training of government officials on the agreements of the organization |

**Do you use a LMS (Learning Management System) to create and manage your e-learning content ?**

Do you use a LMS to manage e-learning content ?



**If no, why?**

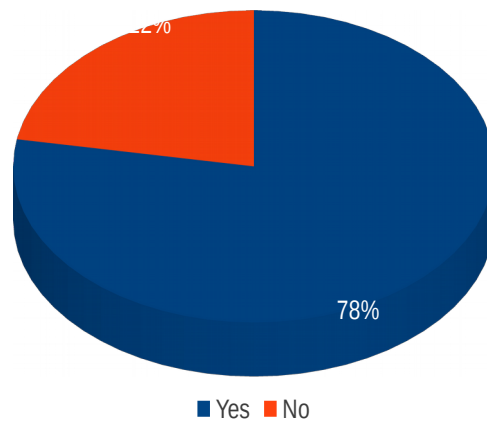
|  |
|--|
| It is purchased but not yet deployed       |
| We have our own system developed in house. |

**If yes, which one(s) ?**

|                       |
|-----------------------|
| OpenOLAT              |
| Moodle                |
| Moodle                |
| Cornerstone on Demand |
| MOODLE                |
| No answer             |
| LUVIT                 |

## Is there a team assigned to e-learning projects in your organisation?

Is there a team assigned to e-learning in your organisation ?



### If no, then how do you do it ?

|  |
|--|
| When we need it, people who knows the topic are asked to prepare.                              |
| Servers are managed by the ICT support. The organizers of every event take care of the content |

### If yes, how many people are part of this team?

|    |
|----|
| 2  |
| 3  |
| 4  |
| 5  |
| 2  |
| 6  |
| 12 |

### How many FTEs (Full Time Equivalent) work on e-learning?

|     |
|-----|
| 0.8 |
| 3   |
| 4   |
| 5   |
| 1   |
| 0   |
| 10  |

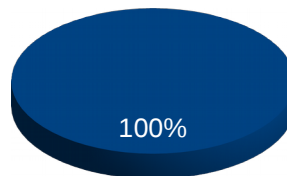


**Which department is responsible for the e-learning projects in your organisation?**

|   |
|---|
| IT  |
| Professional Development and Environmental, Safety, Health and Quality (ESHQ) |
| unité support pédagogique   |
| Center for Educational Development  |
| HR  |
| Training and Technical Assistance   |
| IT Services   |

**Did e-learning bring positive elements to your organisation?**

Did e-learning bring positive elements to your organisation?



■ Yes ■ No

**Which ones?**

|   |
|---|
| Solidarity, time gain, collaboration  |
| Hard to say, cause it is new, but rather Yes - autonomy.  |
| Savings in travel expenses, better organization of material.  |
| -Just-in-time training; Manage time more effectively; Consistent training materials and presentation; On-line testing and reporting to track training completions; Cost effectiveness |
| Formation a plusieurs d'étudiants   |
| Better visibility and reputation of the organisation, especially abroad   |
| outreach, better knowledge of the agreements, participation of countries in the organization's activities   |
| Access to learning for all staff members  |

## Appendix 2 : Screen recording tools' documentation

### Screen capture tools to record online tutorials

*This document is made to explain how to use ffmpeg and QuickTime to record mini tutorials on your own computer. FFmpeg is a cross-platform tool available for Windows, Linux and Mac. Installation and use process depends on your operating system. This info is taken from (Bellard 2016). Quicktime Player is natively installed on most of Mac computers. This tutorial focuses on Linux and Mac.*

### Introduction

FFmpeg is a powerful command line tool that allows you to record your computer screen and your voice. You can also easily convert videos to several formats. The tool is rich in functionality but these simple configuration instructions allows you to start easily. We will see here how to install and use this tool on Unix based systems (Mac OS X and Linux).

### Linux

#### FFmpeg

installation for Linux

***These installation instructions have been made on Linux Ubuntu Trusty 14.04 LTS***

To install FFmpeg, type the three commands below in your terminal :

add the PPA (Personal Package Archive) ppa:mc3man/trusty-media to your software sources with :

```
sudo add-apt-repository ppa:mc3man/trusty-media
```

then type *sudo apt-get update*

and finally *sudo apt-get install ffmpeg*

Type *ffmpeg* in your terminal. If you see a text beginning with *ffmpeg version* that means FFmpeg is now installed on your computer.

***On Ubuntu, Libav ([Libav 2016](#)) is normally the native product but FFmpeg works well.***

#### ***Add necessary components***

Now add the 3 packages which will be important for recording in good quality and for conversion purposes later. For example to convert a video in a .webm format (webmedia) to stream on the web. So, add :

```
sudo apt-get install libx264-dev for H264. It allows you to record in a great video quality.
```

```
sudo apt-get install libx265-dev for H265 which is another format to record in a
```

very good quality. `sudo apt-get install libvpx-dev` which will allow you to convert a video in a .webm format.

Note that an alternative is also to compile FFmpeg from sources (Edgewall Software 2016a).

Screen recording with FFmpeg

**Note that some text below is in French because of the settings of the computer used. According to your own settings, the display will be in English, French or other languages.**

*List devices to know which one to record*

Type :

`arecord -l`

for a summary of your devices.

The terminal will normally return something like that :

```
**** Liste des Périphériques Matériels CAPTURE **** carte 0: AudioPCI
[Ensoniq AudioPCI], périphérique 0: ES1371/1 [ES1371 DAC2/ADC] Sous-
périphériques: 1/1 Sous-périphérique #0: subdevice #0
```

or :

`arecord -L`

for more details.

- default
  - Playback/recording through the PulseAudio sound server
- null
  - Discard all samples (playback) or generate zero samples (capture)
- pulse
  - PulseAudio Sound Server
- sysdefault:CARD=AudioPCI
  - Ensoniq AudioPCI, ES1371 DAC2/ADC
  - Default Audio Device
- front:CARD=AudioPCI,DEV=0

- Ensoniq AudioPCI, ES1371 DAC2/ADC
  - Front speakers
- surround40:CARD=AudioPCI,DEV=0
  - Ensoniq AudioPCI, ES1371 DAC2/ADC
  - 4.0 Surround output to Front and Rear speakers
- iec958:CARD=AudioPCI,DEV=0
  - Ensoniq AudioPCI, ES1371 DAC2/ADC
  - IEC958 (S/PDIF) Digital Audio Output
- dmix:CARD=AudioPCI,DEV=0
  - Ensoniq AudioPCI, ES1371 DAC2/ADC
  - Direct sample mixing device
- dsnoop:CARD=AudioPCI,DEV=0
  - Ensoniq AudioPCI, ES1371 DAC2/ADC
  - Direct sample snooping device
- hw:CARD=AudioPCI,DEV=0
  - Ensoniq AudioPCI, ES1371 DAC2/ADC
  - Direct hardware device without any conversions
- plughw:CARD=AudioPCI,DEV=0
  - Ensoniq AudioPCI, ES1371 DAC2/ADC
  - Hardware device with all software conversions

***Record screen and audio from your computer***

In your terminal, go to the folder you want to put your video :

*cd Path/to/my/videos*

and type the command to record :

*ffmpeg -video\_size 1280x800 -framerate 30 -f x11grab -i :0.0 -f alsa -ac 2 -i hw:0 -c:v libx264 -qp 0 -preset ultrafast out.mp4*

Press *Enter* to start recording.

Press *q* to stop recording.

Command options :

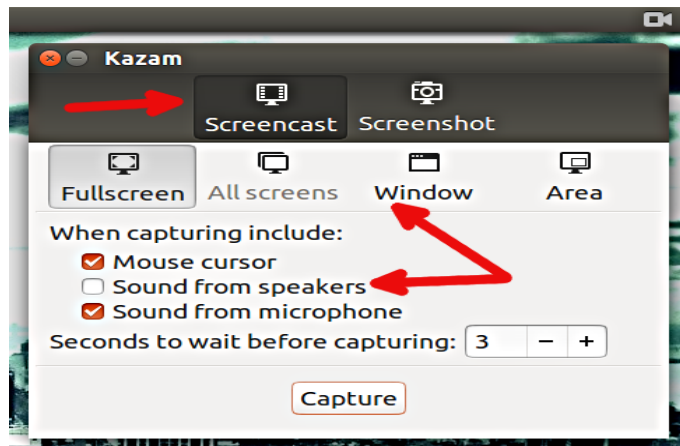
- *-video\_size 1280x800* is your screen resolution. Adapt with yours.
- *-framerate 30* is the number of images/seconds
- *-f x11grab* is the tool to grab your screen on Linux
- *-i :0.0* is to specify which part of the screen you want to record. In this case (0:0) you record all the screen
- *-f alsa* is the tool for audio recording
- *-i hw:0* is to specify (with 0 in this case) which audio device you want to record. Please refer to the number related to your computer. You can find this number with the commands *arecord -l* or *arecord -L* saw above
- *-c:v libx264* is for H264 format for a good quality video
- *-qp 0* & *-preset ultrafast* are for a better quality recording
- *out.mp4* specifies the name and the format of the output you want

Please note that specific codecs are for specific output formats. For example *libx264* is for *.mp4* while *libvpx* is for *.webm*. If you try to record a video in *.mp4* format with *libvpx* codec you will get an error.

## **Kazam**

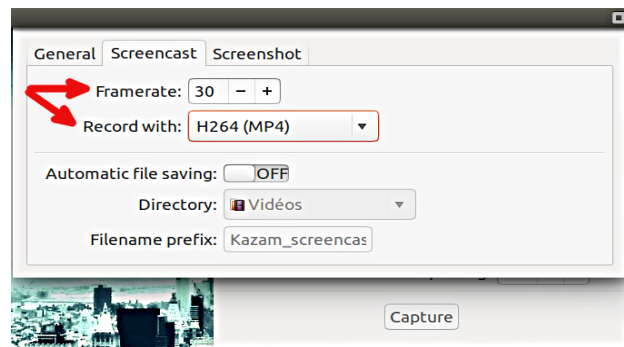
### **Installation for Linux Ubuntu**

*“Kazam provides a well designed and easy to use interface for capturing screencasts and screenshots”* ([Canonical Ltd 2012](#)). To get it, download it from the Ubuntu apps official directory, or type *“sudo apt-get install kazam”* in a shell. Once it is done, launch Kazam from the applications folder and you should normally have a display as presented below.



### Screen recording with Kazam

As one can see, it is possible to select a screencast or a screenshot as well as full screen, window, area or even multiple screens recordings. The Figure below shows the preferences which we can reach by clicking “File → Preferences”.



It is possible there to choose the numbers of images per second and the format between .mp4, .avi or .webm. Then we click on “Capture” and the process begins. Once it is recording, a little camera icon with a red point appears in the menu bar as illustrated below.



Then we click on that icon to stop the recording. One can also select “pause” and restart from the point where we stopped. While stopping the recording, the software asks to save the file or edit it directly. We choose

where to save the file, and the process is over, the video is recorded.

## Mac OS X

To record your computer screen and your voice on Mac OS X you can use Quicktime Player. It is natively installed on most of Mac Computers. This is why you can find below a quick description about how to record your screen and audio with this software.

ffmpeg needs to install some dependencies on the computer. After several tries on different Mac computers it appears that if the computer is not up-to-date, it can create errors and issues during the installation process. Although, we recommend to try to follow at least the points in the section "*FFmpeg installation*" below for conversion purposes later.

### Requirements

#### Homebrew

You will need to have homebrew installed on your Mac. Homebrew is a package manager for Mac (**same as apt-get for Linux**) which allows you to install several packages not present in the system. Get Homebrew from the site of [Howell and Prévost \(2016\)](#) and read the documentation. In brief, type :

```
/usr/bin/ruby -e "$(curl -fsSL  
https://raw.githubusercontent.com/Homebrew/install/master/install)"
```

in your terminal. Follow the installation process (**it could take some time**) and normally Homebrew is now installed.

#### FFmpeg Installation

Once Homebrew is installed, then, it's just so easy to install FFmpeg in no more than one command. Go to Edgewall Software (2016b) under the *FFmpeg through Homebrew* section and copy / paste this command :

```
brew install ffmpeg --with-fdk-aac --with-ffplay --with-freetype --with-libass  
--with-libquvi --with-libvorbis --with-libvpx --with-opus --with-x265
```

All the arguments like *--with-libvorbis* or *--with-libvpx* are very important because we will need it later, for conversion purposes for example. With this command, your FFmpeg installation is normally now complete.

#### Screen recording

In order to have a neutral environment on your computer. Please first hide the desktop icons with those commands:

```
defaults write com.apple.finder CreateDesktop false
```

and then:

*killall Finder*

**With Quicktime Player** ([Apple Inc. 2007](#))

Go to your applications folder and open Quicktime Player.

In the menu bar, select :

*file → new screen recording*

A new window is now open.

- Click on the little arrow in the right up corner and choose your input audio device
- Choose also if you want the mouse clicks to be shown in the video
- Choose the video quality
- Finally click on the recording button

Quicktime Player will ask you if you want to record the entire screen or just a part of it. Follow the instructions related to your choice and start the recording.

Click on the square button to stop recording. The video should now be where you specified to save it.

**With ffmpeg**

To capture your screen on Mac OS X with FFmpeg, type the following commands in your terminal :

***List devices to know which one to record***

Type :

```
ffmpeg -f avfoundation -list_devices true -i ""
```

The terminal will normally return something like that :

```
[AVFoundation input device @ 0x7fae4ac00460] AVFoundation video devices: [AVFoundation input device @ 0x7fae4ac00460] [0] Caméra FaceTime HD (intégrée) [AVFoundation input device @ 0x7fae4ac00460] [1] Capture screen 0 [AVFoundation input device @ 0x7fae4ac00460] AVFoundation audio devices: [AVFoundation input device @ 0x7fae4ac00460] [0] Apowersoft_AudioDevice [AVFoundation input device
```



@ 0x7fae4ac00460] [1] Built-in Input

### **Record screen and audio from your computer**

In your terminal, go to the folder you want to put your video :

```
cd Path/to/my/videos
```

and type the command to record :

```
ffmpeg -f avfoundation -i "1:1" -c:v libx264 -qp 0 -preset ultrafast out.mp4
```

Press *Enter* to start recording

Press *q* to stop recording

Now your video should be in folder *Path/to/my/videos*.

Command options :

- *-f avfoundation* is the tool to grab your screen on Mac OS X
- *-i <screen device index>:<audio device index>* are the numbers corresponding to your devices listed with the command *ffmpeg -f avfoundation -list\_devices true -i ""* above. In this case you can see it's 1 for the screen and 1 for the audio Built-in Input.
- *-c:v libx264* is for H264 format for a good quality video.
- *-qp 0* & *-preset ultrafast* are for a better quality recording.
- *out.mp4* specifies the name and the format of the output file.

Please note that specific codecs are for specific output formats. For example *libx264* is for .mp4 while *libvpx* is for .webm. If you try to record a video in .mp4 format with *libvpx* codec you will get an error.

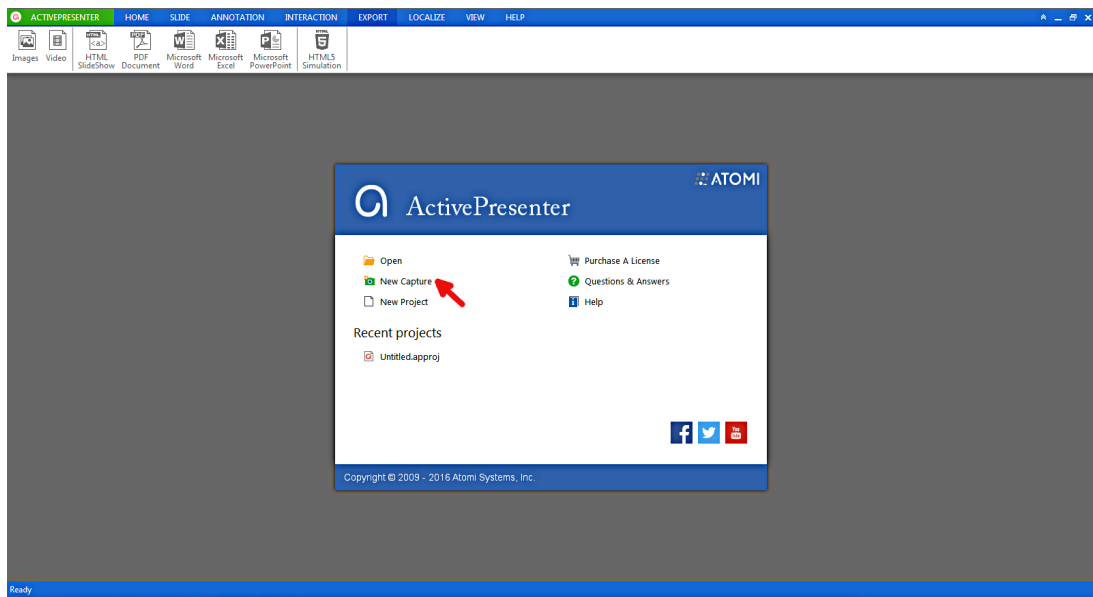
## **Windows**

### **ActivePresenter for Windows**

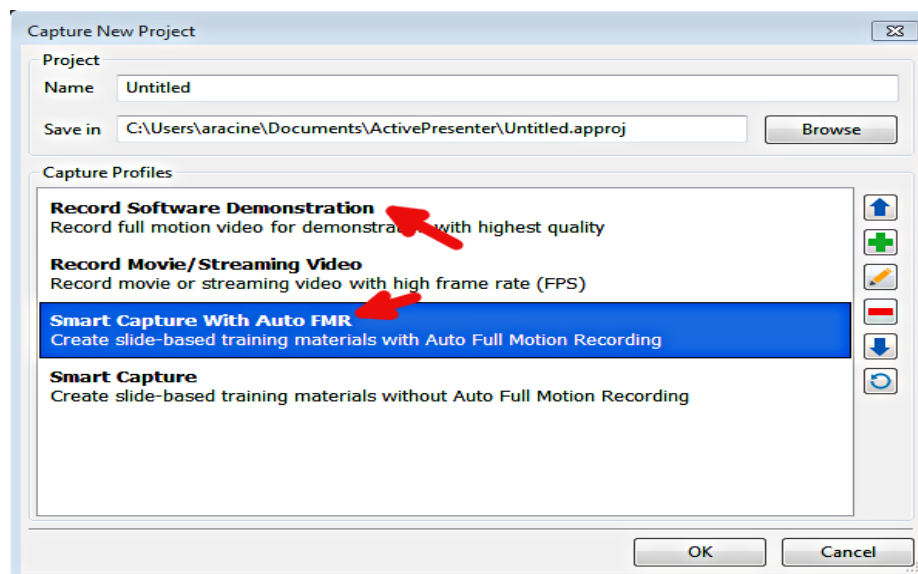
#### **Installation**

First of all, download the software on its official website ([Atomi Systems Inc. 2016](#)) and follow the installation process. It is a standard process for Windows. It means double click on the .exe file downloaded and run the wizard. Once it is installed, the start page should be as illustrated in the Figure below.

## Screen recording with ActivePresenter

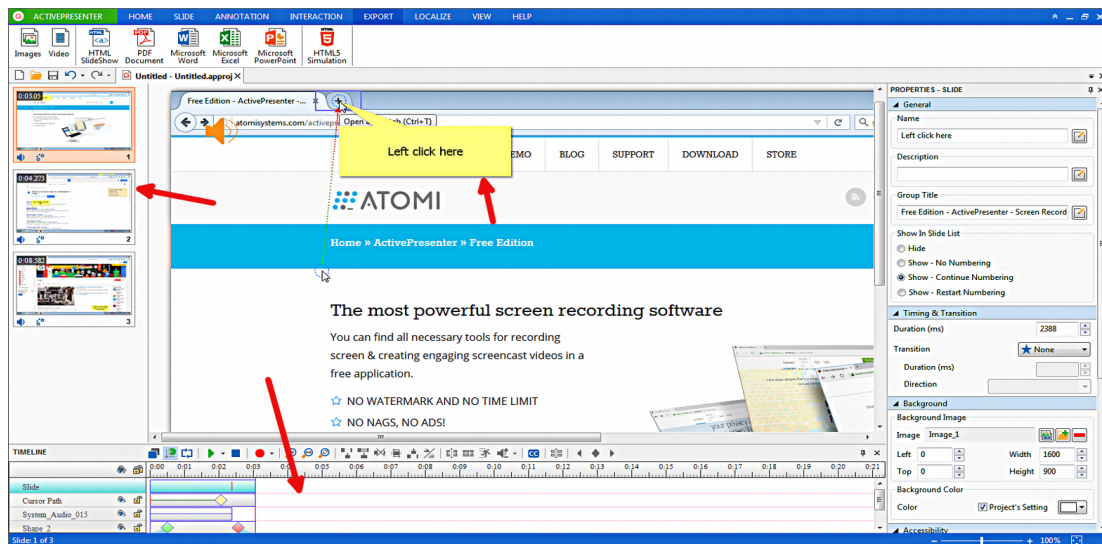


To start, click on “*New Capture*” to create a new video. Then a pop-up window is open and allows to choose between different types of recordings. For example, the “*Software Demonstration*” is just a video, e.g. simple tutorial, while the “*Smart Capture With Auto FMR*” is a more advanced one, cropped into multiple slides. It is possible then to annotate the slides and create smart paths while browsing.

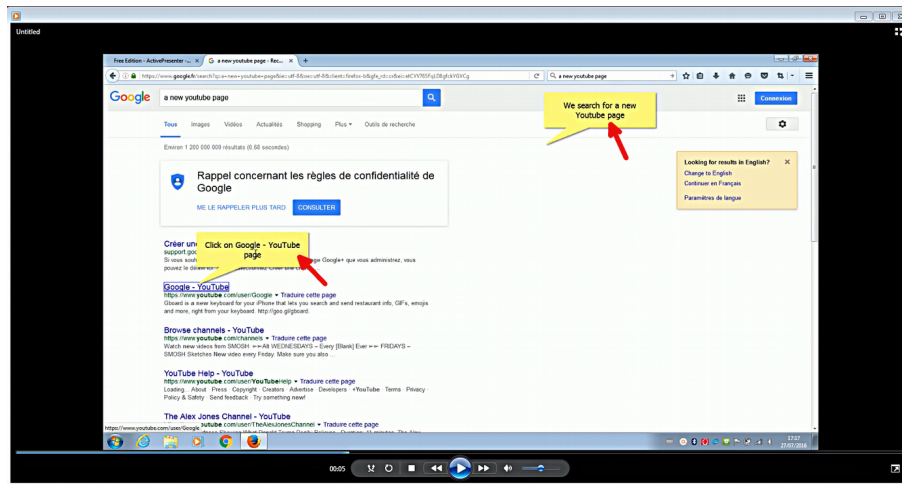


Then, it is possible to select whether one wants to record the entire screen or a defined area, as well as the audio devices. Finally, when

the recording is done, go to the menu bar, click on the application's icon, and resume, stop or discard the recording. Below one can find an overview of the output provided in *“Smart Capture With Auto FMR”* mode.

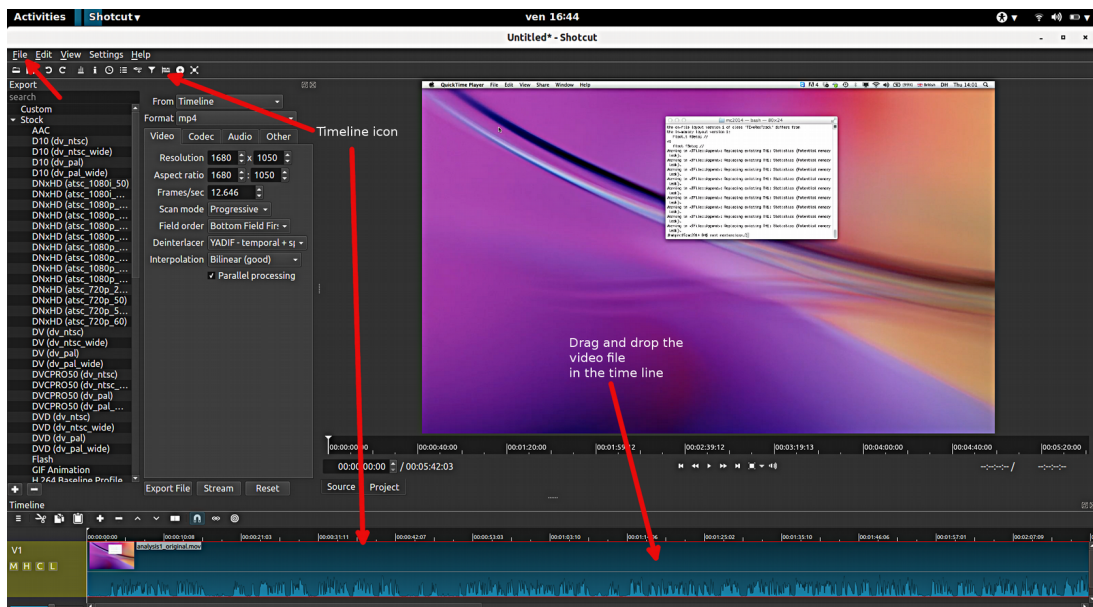


As one can see the video is separated in three slides allowing thereby to manage the tutorial slide by slide by annotating it. Then in the bottom of the picture, it is possible to edit the tutorial directly before publishing, by for example adding an audio track. Finally, the export provides one only video composed with the several edited slides as illustrated below.



## Shotcut: a free, open-source and cross-platform video editor and converter (Meltytech LLC 2016)

Shotcut is available for Windows, Linux and Mac OS X. It is free. And it supports multiple file formats as well as various features which are interesting for such software in its range. It is quite complete so we will not see here all details but rather go through its main points of interest with the screen shots below. One can download Shotcut from its official website download's page. Once Shotcut is downloaded and opened, the layout is as such:

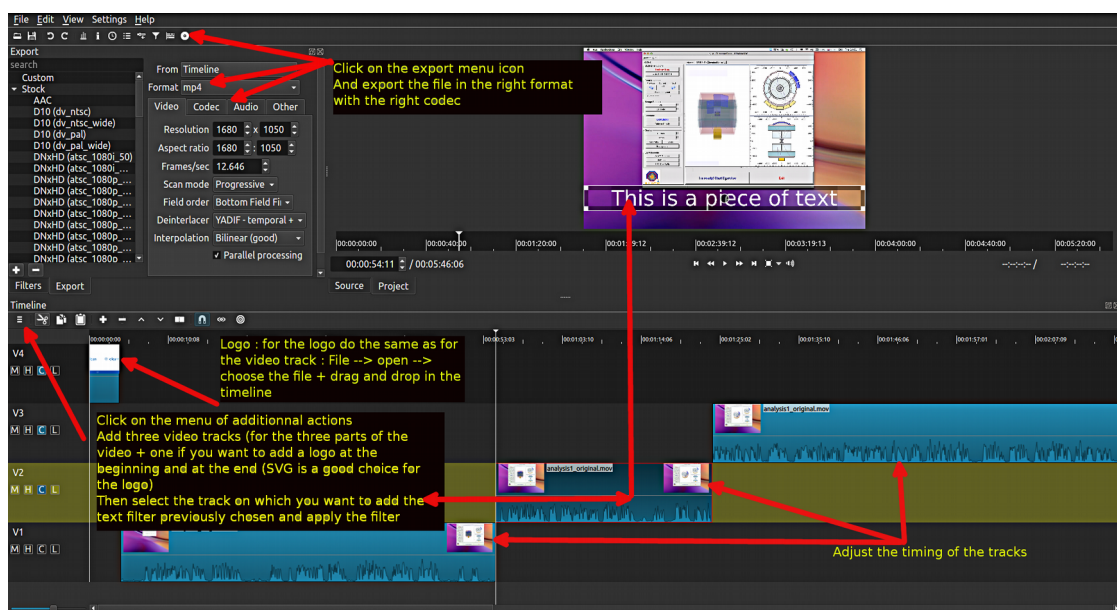
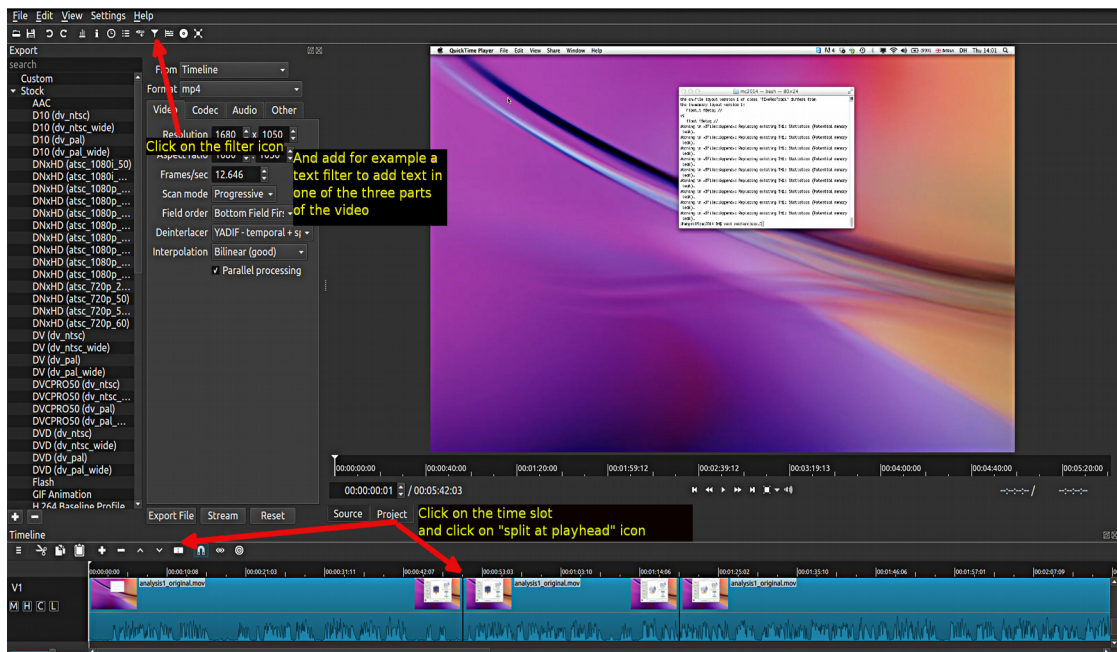


As one can see, by clicking *"File → Open"* it is possible to select the video file to edit. Then, click on the *"Timeline"* icon to open the timeline. Finally, drag and drop the file from the centre area to the timeline. The file is ready

to be edited.

To remove the unnecessary seconds at the beginning or end of the recording, e.g. when you launch or stop the screen recording tool, you just have to crop at the right time slot + select the part to be removed + BACKSPACE or DELETE.

To crop the track, just position the cursor at the right time slot in the timeline and click on the "Split at playhead" icon as presented in Figure below. This Figure also shows that you can add various filters on the different parts of the track. As illustrated in the two Figures below, you can add, for example, a text area in the second part of the video.



Here you can see we added three supplementary video track for all the cropped parts of the video + a CERN logo. Finally, you can export the video in several formats by clicking on the export menu and selecting the appropriate parameters, e.g. .mp4 format with H264 video codec and aac audio codec.

## Conversion and format issues

It can happen that video formats create issues while trying to play a video in a browser. This is mostly due to patent issues. For example, we identified on Firefox for Mac OSX that a .mp4 video could not be watched correctly sometimes. In the meantime, the same video played without any problems on Firefox for Ubuntu. Below are some steps to be sure your video is well supported by every browser.

.mp4, .webm and .mov are three formats currently supported.

### Format issues

***This information is taken from [w3schools \(2016\)](#) and [kentuckyfriedtakahe \(2016\)](#)***

#### Using the HTML <video> element

To show a video in HTML, use the <video> element like this example :

```
<video width="320" height="240" controls>
  <source src="movie.mp4" type="video/mp4">
  <source src="movie.mov" type="video/mov">
  <source src="movie.webm" type="video/webm">
```

Your browser does not support the video tag.

```
</video>
```

As you can see there are three <source> elements for the video. Multiple <source> elements can help if one format is not well supported, the browser will play the first recognized video. So at this point we recommend to have the video available in more than one format to prevent issues.

.mp4, .webm and .mov are three formats currently supported by <video> element. The *controls* attribute add buttons control like play, pause and volume. The text between the two elements is shown only if your browser does not support the video tag.

## Appendix

### Use dedicated scripts with FFmpeg

To simplify user's experience some basic shell scripts automate the process of tutorial recording. For the moment these scripts can be found on the Github page of [Racine \(2016\)](#).

In this Github repository you will find two main folders. Folder named "video\_with\_audio" contains two scripts (**video.sh** and **cut\_convert.sh**). They allow you to record the video (**video.sh**) in the same process (audio & video altogether) and then cut your file at your preferred time slots and convert file in both .webm and .mov formats to stream well on every browser (**cut\_convert.sh**). Then finally rename your final file as you want.

For several reasons, it could be better to record the audio and the screen separately. For example to limit the CPU usage and avoid listening the noise of your computer's ventilation. Or for example if you need to do some editing tasks (e.g. accelerate) on your video before to stream it.

To do this, folder named "video\_audio\_split" contains four scripts (**video.sh**, **audio.sh**, **merge.sh** and **cut\_convert.sh**). They allow you to record the video in two stages. First the image (**video.sh**) and then the audio stream (**audio.sh**). Then you merge (**merge.sh**) the video and audio files. **Finally** you can cut your file at your preferred time slots, convert it in both .webm and .mov formats to stream well on every browser (**cut\_convert.sh**) and rename your final file as you want. In brief with this process in two stages the structure is as such :

1. Run the **video.sh** script to record only the video stream
2. Run the **audio.sh** script to record only the audio stream while watching the video previously recorded. The audio file should be in the same folder as the video file previously recorded to allow merging files in a second step.
3. Run the **merge.sh** script to have one only final video.
4. Run the **cut\_convert.sh** script to cut the original merged .mp4 file at the time slots you desire. Then it will convert automatically the **cut.mp4** video in the both **.webm and .mov formats** to stream correctly in every browser. Finally it will **rename your final three files** (.mp4, .mov, .webm) as you want while keeping the original (**non-cut**) audio and video files.

The scripts are interactive and will ask you fore some informations (e.g. your screen resolution) in order to adapt the *ffmpeg commands* according to your Operating System (Linux or Mac). If you don't know some of these values, you are prompted with some friendly commands to discover them. **When the scripts ask you to enter the path to save your files, please use auto completion or do not forget to end the path with a slash "/"**.

### Conversion with FFmpeg

**Note that those commands are for ffmpeg but the conversion process can also be done in iMovie for Mac users or with Shotcut as just mentioned above.**

These commands work for Linux and Mac.

Type those commands :

```
ffmpeg -i path/to/out.mp4 -c:v libvpx -crf 18 -b:v 0 -c:a libvorbis  
path/where/you/want/out.webm
```

for a video in .webm format or :



```
ffmpeg -i path/to/out.webm -c:v libx264 -crf 18 -b:v 0 -c:a aac  
path/where/you/want/out.mp4
```

for a video in .mp4 format

Note in the commands above, *libvpx* is for .webm and *libx264* is for .mp4

Press *Enter* to start converting.

The conversion process takes several minutes.

Command options :

- *-i* is the name of your input (in this case out.mp4 or out.webm)
- *out.mp4 / out.webm* are the names of the inputs
- *-c:v libvpx* or *-c:v libx264* are the codecs to convert in .webm / .mp4 format
- *-crf 18* is the Constant Rate Factor. It changes the quality. 0 is for the best quality but is really too long to convert. A good practice is around 18 - 20
- *-c:a libvorbis* is the codec for the audio in the .webm video
- *-c:a aac (for example)* is the codec for the audio in the .mp4 video
- ***out.webm / out.mp4* are the names and the formats of the outputs you want**

## Editing videos with ffmpeg

### Cutting a video

These commands work for Linux and Mac.

To avoid showing terminal at the beginning and at the end of the videos you can cut it at the time slots you want. You can also do this if you simply want to have just a part of a video. To do this type this command :

```
ffmpeg -i path/to/your/video.mp4 -ss HH:MM:SS -t HH:MM:SS -async 1  
path/to/your/cut/video.mp4
```

Command options :

- *-i* specifies you want to give an input file
- *path/to/your/video.mp4* is the path and the name of your video
- *-ss [start time]* is the starting point where you want to cut
- *-t [duration sequence]* is the duration you want (for example if you want to have the video cut from the 4<sup>th</sup> second to the 20<sup>th</sup> second of the original file, you have to specify *-ss 00:00:04 -t 00:00:16* (i.e. 4 + 16 = 20)
- *-async 1* is to keep the audio while cutting the video
- *path/to/your/cut/video.mp4* is the path and the name of your cut video

### **Accelerate a part of the video**

If your video is too long maybe you would like to accelerate some parts of it which are less interesting. You can do this by cutting your video in multiple parts as saw above, accelerating the desired parts and then concatenate again all the parts to have one only video as output. Here is the command which allow to accelerate :

```
ffmpeg -i path/to/your/video.mp4 -filter:v "setpts=[speed]*PTS" path/to/your/accelerated/video.mp4
```

Command options :

- *-i* specifies you want to give an input file
- *path/to/your/video.mp4* is the path and the name of your video
- *-filter:v* specifies you want to accelerate only the video and not the audio
- *"setpts=[speed]\*PTS"* e.g. *"setpts=0.3\*PTS"* specifies how speed you want to accelerate the video. For example "0.5" is 2x. Shorter the number is, speeder the video is. As opposed, if you want to slow down, you have to specify a number bigger than 1.

- `path/to/your/accelerated/video.mp4` is the path and the name of your accelerated video

### **Concatenate the multiple parts to have one only video output**

After for example cut in multiple parts and speed up the needed parts, concatenate the parts to obtain one only video output. To do this, type this command :

```
ffmpeg -f concat -i <(for f in ./part*.mp4; do echo "file '$PWD/$f'"; done) -c copy output.mp4
```

**For any further information about ffmpeg, refer to the official website (Bellard 2016) and the official wiki documentation (Edgewall Software 2016c).**

**For any further information about Quicktime Player, refer to the official documentation (Apple Inc. 2007)**

**For any further information about video formats issues on the web, refer to those pages ([w3schools 2016](#)) and ([kentuckyfriedtakaha 2016](#))**

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## Appendix 3 : asciinema documentation

### asciinema installation for Mac os x & Linux (Windows not supported)

*Note that Windows does not support asciinema due to some Unix capabilities missing on Windows terminal.*

#### Introduction

asciinema is a nice and convenient tool which allows you to record your terminal session to generate a video you can share later with other users. You can provide the video directly from your website (in your case the CERN website). The video, based upon a structured text format (.json) allows users to watch it and copy / paste the content and commands directly from the media. We will see here how install this tool on Unix based systems (Mac os x and Linux).

#### asciinema installation for Mac os x

- Go to [asciinema's homepage](#) and click on **Start Recording** button. The command proposed here needs to be run with **homebrew** for Mac os x.
- You will need to have **homebrew** installed on your computer. Copy / Paste this command: `/usr/bin/ruby -e "$(curl -fsSL https://raw.githubusercontent.com/Homebrew/install/master/install)"` described [here](#). **Homebrew** is a package manager for Mac os x which is able to install several packages Apple didn't.
- Once **homebrew** is installed, type `brew update && brew install asciinema` in your terminal. Follow the process. asciinema is normally now installed.

#### asciinema installation for Linux

- Go to [asciinema's homepage](#) and click on **Start Recording** button
- Then, click on the **See other installation options** link. You will find different ways of installing asciinema, depending on your Linux distribution.
- For example, for **Ubuntu**, type these commands:
  - `sudo apt-add-repository ppa:zanchey/asciinema`
  - `sudo apt-get update`
  - `sudo apt-get install asciinema`

- For **debian**, type this command:  

```
sudo apt-get install asciinema
```

Note that the **sudo** at the beginning of each command means you'll need to have the root privileges.

- Follow the process. asciinema is normally now installed.

## Start recording with asciinema

- Once asciinema is installed and ready to run, type `asciinema rec` in your terminal. It will start to record your terminal session.
- When you're finished, type `ctrl+D` or `exit` to stop recording. On **Mac os x**, type `ctrl+c` if you want to cancel the recording. If you're ok with your recording, press `Enter` and it will generate an URL on asciinema website. On **Linux** the terminal will simply ask you if you want to upload the video. Type `Y` (for yes) and it will generate an URL on asciinema website or `N` (for no) and it will cancel the recording.

## Watch & Embed the video

- Copy / Paste the URL generated in your favorite web browser.
- You will reach your terminal session video on asciinema website. Click on the **Download** button in the right corner below.
- Download the recording in **asciicast format** as a **.json** file.
- Then, below, under the **Use with stand-alone player on your website** title, click on **player's releases page** link where you can download the [asciinema-player.css](#) and [asciinema-player.js](#) files.
- Finally, create a simple **.html** page where you will copy / paste the script proposed under the **Use with stand-alone player on your website** title. This script links to **asciinema-player.css**, **asciinema-player.js** and your **asciicast format .json** file. Put all the 4 files on your web server and watch carefully that the path to the files is correct in your **.html** page.

Share and enjoy you terminal session recording.