Journal of Universal Computer Science, vol. 14, no. 10 (2008), 1763-1774
submitted: 3/10/07, accepted: 11/2/08, appeared: 28/5/08 © J.UCS

Using Taxonomies to Support the Macro Design Process for the Production of Web Based Trainings

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Abstract: Recently Web Based Training (WBT) starts to be widely used as a new way of teaching. Unfortunately, this mode of teaching imposes new requirements and constraints. It has made the creation of learning material a complex and demanding task for the instructors as it takes much time and demands a multitude of skills, in particular technical skills that must be developed and continuously updated. Hence, we propose a collaborative authoring methodology based on division of labour as a way to produce WBTs where the processes of production are clearly separated to meet the existing and needed skills of persons involved in WBT production. This paper presents an efficient method to support instructor's guidance during the first phase of the WBT production called the Macro Design using the Rhetorical Structure Theory (RST) and the taxonomies we developed.

Keywords: e-learning, production of Web based training, taxonomies, collaborative Authoring, knowledge modelling, semantic design, instructional design support tool
Categories: H.4.0, H.5.4, I.6.5, K.3.1, M.1

1 Introduction

Since the integration of web technologies in teaching environments, education has undergone a shift in paradigm. An example of this shift may be demonstrated in Web Based Trainings (WBTs) that can be offered at any time and any location as long as an Internet-enabled computer is available. However, this new mode of teaching imposes new requirements and constraints. It has made the creation of learning material a complex and demanding task for the instructors because it demands a multitude of skills, in particular technical skills that must be developed and continuously updated [Lehmann 06]. In contrast, an instructor (at school or university as well as in a company) is a domain expert first and usually lacks technical skills needed for WBT authoring and media creation (figure 1) [Aqqal 07].

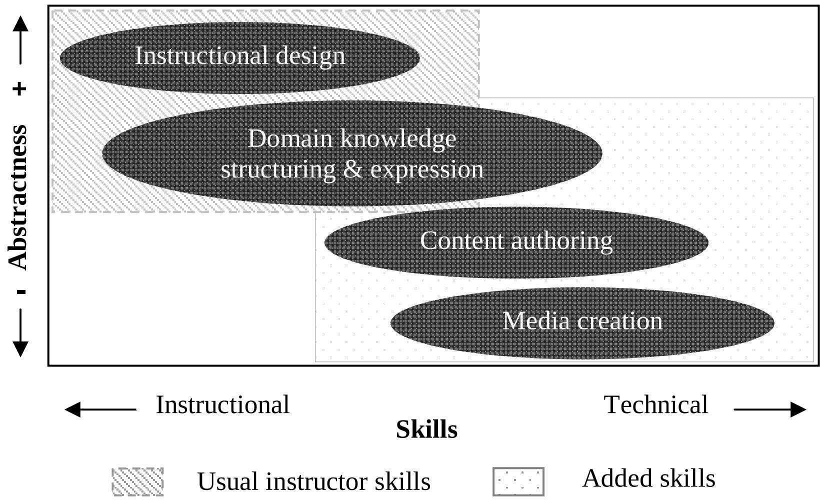

Figure 1: Skills needed in WBT production

Consequently, the reasonable way to deal with this complexity is the adaptation of the production approach to the instructor's skills. Otherwise, teaching aspects risk to be completely neglected as long as the development of required technical skills remains a priority for the instructors. Hence, one of the important requirements of an adequate approach to produce WBTs is that the technical efforts spent by the instructors in authoring and media creation should be reduced to a minimum so that instructors can refocus on didactic and instructional aspects rather than technology [Helic 02]. With this idea in mind, we have proposed a collaborative authoring methodology based on a division of labour as a way to produce WBT where processes of the production are clearly separated to meet the existing and needed skills of the persons involved in WBT production. Figure 2 shows the process-map of our authoring platform.

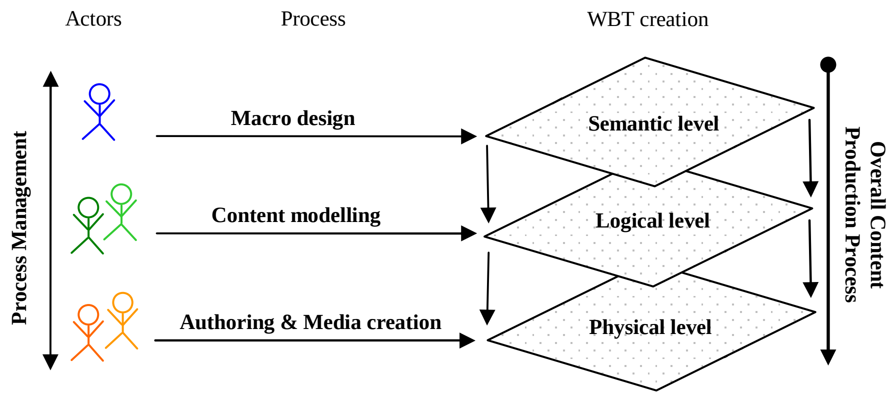

Figure 2: The proposed approach for the overall content production

We propose that WBT conception and production should be done in three different levels of abstraction: the semantic, logical and physical levels handled respectively by three processes: the so called “Macro Design”, the content modelling and the content authoring & media creation. In addition we define vertical to these processes a production management process in order to harmonize the collaboration between actors during the whole collaborative production.

In this way of abstraction, the instructor can focus on Macro Design where he uses his didactic skills and can record his ideas about the WBT in an abstract model on a semantic level. Such abstract model is necessary to build a content model and to author a WBT matching instructor's intentions.

The so called “Macro Design” will be explained in the next section in detail. We explore why taxonomies are necessary to support the creation of an abstract representation of WBTs. Section 3 describes the application of the Rhetorical Structure Theory (RST) as a mechanism to enhance the expressiveness of WBT design and to assist instructors when designing WBTs. We shortly introduce our developed taxonomies that enrich and extend the RST to meet our requirements. An example is given to illustrate our approach. The fourth section surveys related work and discusses the shortcomings regarding our requirements. Finally, we present some conclusions and remarks for further work in this area.

2 The Macro Design as a support of WBT modelling in collaborative framework

2.1 The need of the Macro Design for WBTs production in a collaborative framework

In contrast to existing ways of WBT production, we postulate a phase in an addition to content modelling, authoring and media creation which is often neglected or not fully taken into account, namely the “the design thinking”. This phase covers instructor’s ideas about what kind of WBT to produce, about a motive and reasons for a specific target group and about a list of themes that need to be taught. The instructor defines implicitly cognitive boundaries of main concepts of his WBT and semantic relations among these concepts according to both knowledge and learner domains.

The design thinking is done in the mind of the instructor only. He could explain his ideas by speech or by writing it down. Tool support starts in the content modelling phase nowadays. Most times WBT modelling is done using the table of content paradigm. Such a table of content records the main concepts which are used in content authoring only. The relationships between the main concepts as well as the instructional impact can not be expressed in such a simplified model. Being always only “in the instructor mind”, most of the design thinking and parts of the modelling implicit data evaporates as soon as another person is consigned with the authoring and if the WBT is produced.

We introduce the “Macro Design” as an explicit modelling phase corresponding to the design thinking in order to record what instructors have in mind and to forward instructors ideas to all others involved in the WBT production from the instructional level to the technical level [Aqqal 07].

The Macro Design must absorb the instructor intentions. It could be, for example, to justify why to choose a certain WBT form for a defined group of learners. The Macro Design must go beyond a simple structural design of WBTs where a sequence of e-learning material in form of a path through the WBT is specified. The capturing of such intentions aims to describe WBT production as a usage experience easily learnable by other production partners. This will definitely enhance their awareness and comprehension of the production context. To store the instructor intentions as metadata will increase consequently the chance to re-use parts of a produced WBT.

Simply stated this Macro Design could be summarized into answering explicitly the following questions:

1. Why to produce a WBT and for which audience?
2. What to produce (in term of knowledge)?
3. In which form to produce this WBT and why in this form?

In this paper we are principally concerned with the third question. At this point our goal is to develop a mechanism that supports an instructor to transform his intentions resulting from his design thinking into an explicit how-to-produce specification given via small editing steps. We aim to guide the production via a comprehensive description of the WBT in terms of instructional information, capturing of content intra-relations and didactic intentions.

2.2 Existing support of CBT and WBT production by tools

Over the past sixteen years many approaches (in academia and industry) were purposed to support the WBT production by tools [Pernin 06]. However, few suppose that the WBT production is done in a collaborative way supporting different roles and skills. Hence, using existing tools for a collaborative way of working will be quite fuzzy. In particular, these tools fail usually to support a Macro Design as stated in the previous section.

For instance, web page editors (e.g. Macromedia Dreamweaver, FrontPage and Netscape Composer) and text editors (e.g. Microsoft Word, PowerPoint and Open Office) support the authoring phase only. Contrary course composers (e.g. WebCT, TopClass or Blackboard) and some educational modelling languages (e.g. TeachML, LMML) support rather the content modelling phase [Lehmann 06]. WBT composers (e.g. Authorware, Toolbook, Mediator and Easy Prof) are professional WBT authoring tools and support both content modelling and authoring. Some academic approaches like GenDoc [Bachimont 04], ResourceCenter [Hoermann 05], WBT-Master [Helic 02] and SCENARI [Bachimont 04] could be listed in the same category too. But generally, not all aspects of Macro Design are considered in these approaches.

Therefore, the survey of existing WBT production tools leads us to conclude the absence of Macro Design support as it was introduced. In the next section we will specify the main requirements that the proposed approach should fulfil and introduce the need of taxonomies to support the Macro Design.

2.3 The requirements and the need of taxonomies for the Macro Design

Our goal is to build a tool supporting Macro Design without overhead for the instructor. To realize this, *Macro Design* has to meet some requirements; most importantly it has to be simple and intuitive. The tool should not impose a certain pedagogical model for the instructor to avoid any semantic mismatch conflict between instructor intentions and the model mapping his intentions. Secondly, guidelines are needed to determine how the instructor should express his intentions, how to supervise and progress the whole production process. This can be done via step-by-step guidance. Therefore a semantic taxonomy is required as vocabulary for the representation of the WBT including "design thinking" data. Thus the instructor will be supported in instructional design and the structuring and expression of his domain knowledge away from more technical content authoring and media creation (figure 3).

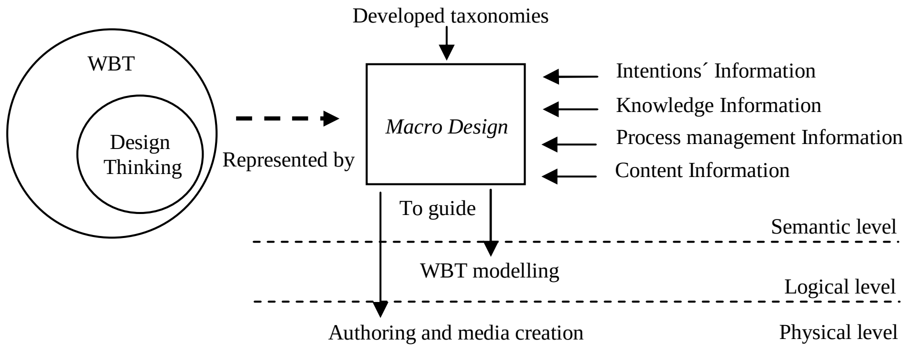

Figure 3: Using the Macro Design to support the WBT production

Semantic taxonomies in general are declarative classifications of different semantic elements in terms of a uniform vocabulary. We distinguish in our area of application at least two kinds of taxonomies: (1) taxonomy used for the representation of the WBT into aggregation of semantic parts called semantic units and (2) taxonomy of semantic relations among these elements and the way they are connected in the WBT to reflect the instructor's intentions and the knowledge mapping as well.

To suit our scenario of use developed taxonomies have to support an instantiation by queries and should establish the correspondence between instantiated elements and the instructor's intentions. It should also reinforce a separation between the different production levels so that each level will be mastered before progressing to the next. Using taxonomies in this way for the WBT production provides many advantages over traditional authoring methodologies. Notably an increased separation of design and authoring levels as well as an abstraction mechanism to support a step-by-step production via suggested proposals given to the instructor instead of free-to-write forms. Thus the production is easy, fast, and deterministic. The next section introduces our developed taxonomies and their usage.

3 Towards an adaptation of Rhetorical Structure Theory (RST)

3.1 Introduction

The goal of each training apart from skill training is to transfer knowledge from a given domain to the learner. Formally it can be expressed as follows: Web Based Trainings transfer knowledge from the WBT knowledge domain (the WBT domain) to the learner knowledge domain (the learner domain). Both WBT domain and learner domain are collections of concepts, where a concept is an independent unit of knowledge. The learner domain is supposed to be a subset of the WBT domain before starting the training and should be equivalent to the WBT domain at the end. For example, "how to insert an image into a Web page" could be a concept in WBT domain called "HTML introduction". In *Macro Design* both WBT domain and learner domain have to be described by the instructor.

3.2 Development of a taxonomy for semantic units

To get a WBT model representing the ideas of an instructor, the instructor has to be supported to determine the elementary units of the WBT first. Additionally, a general way describing semantic interrelationships among these units should be provided. Many related authoring approaches proposed hypotheses about what constitutes an elementary WBT unit. These hypotheses are based either on logical criteria (e.g. paragraph, section) or physical criteria (e.g. size, layout, image or page) [Aqqal 07].

For our scenario of use we developed an initial taxonomy where we distinguish 8 types of WBT units and their instances to fit the *Macro Design* adequately (table 1).

Semantic Unit	**Semantic Rule**	**Examples of instances**
Principal unit	Concept presentation	Definition (concept, theory, etc.)
Alternative unit	Concept restatement / unit's reformulation	Summary, abstract, preview
Illustration unit	Concept illustration	Simulation, elaboration, example
Activity unit	An activity description	According to the learning design
Assessment unit	Measure and evaluation of grasped knowledge	Test, exam, quiz, evaluation
Reference unit	To refer or designate a used concept or unit	Metadata, glossary, references, bibliography
Supplement unit	Supplement, information about a concept/unit	FAQ, help, read more, index
Connection unit	Join units to bridge semantic transitions	Background, planning, motivation, table of content

Table 1: The developed taxonomy of the semantic units in the WBT

Our segmentation of WBT documents is rather grounded on semantic basis, where fragmentation and modularization of WBT units is determined by the existence of a certain meaning or didactic function in each unit. This unit called a "semantic unit", should be stand alone and didactically well-recognized. For instance, an illustration composed of an image and its description in paragraph format will not be considered as two units but only as one. This way of modelling fulfils our requirements. It leads to a separation between the different production's levels. If so the instructor has the ability to abstractly define desired content in form of a set of semantic units.

This taxonomy categorizes, in a matrix, semantic units and their instances needed for WBT production. It also assures a minimal associative linking between a given semantic unit and its "typical" logical formatting since those semantic units are composed of logical units and seem to respect certain aggregation likelihood.

So far, our intent was to generate a plausible taxonomy of a WBT's units to allow the *Macro Design*. To preserve our prior concepts a mechanism has to be found that could be a suitable framework for a design of a navigational model between semantic units and their mapping to the WBT domain. By this the intention why the WBT was produced in a certain form can be described.

3.3 Using RST to support the Macro Design

We have adopted the Rhetorical Structure Theory (RST) as an additional mechanism to support the *Macro Design*. The RST is used, in our context, as a navigational model to contextualize and freeze the instructor's intentions beyond a simple hierarchical structuring of sections. RST [Mann 87] is a framework for analyzing discourse structure and speech statements by positing hierarchical relations between spans of text (figure 4 (a)). These relations are defined functionally in terms of what their intended effect on the reader is.

RST has been chosen because it has many features meeting our requirements. First, RST is a natural and neutral mechanism for semantic modelling that specifies a rigorous set of annotation guidelines without imposing any prior model for the conception. Secondly, RST respects perfectly our developed semantic taxonomy and its requirements. It assumes that a text is divided semantically into autonomous units according to the speaker's intentions. These units are related by named rhetorical relations and structured into two kinds (a nucleus and a satellite) that reflect their importance according to the speaker's intention. We also suppose that WBT segmenting (implicit or explicit) and relations between segmented elements reflect instructor intentions (figure 4 (b)).

Finally, since the discourse generation and WBT production are two analogue processes, the taxonomy of semantic relations developed already by the RST community [RST 07] is seen to be relevant for our scenario of use. This taxonomy of relations should be extended beyond the application area it was originally designed for. The extended taxonomy should be significant enough in converting the WBT structuring into a way to explore the instructor's intentions.

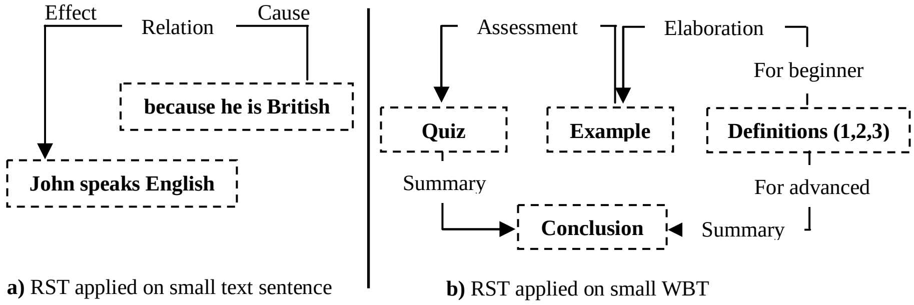

Figure 4: Examples of RST application on small text sentence (a) and WBT (b)

3.4 An RST based Macro Design Component as part of a WBTs' production tool

To implement a RST based tool to support the *Macro Design* we had to adapt RST formalism to our scenario of use. This RST based modelling will be implemented in a tool and allow the instructor to express his Macro Design (didactic modelling, domain knowledge modelling and WBT segmenting) for the ongoing production process. To understand this figure 5 depicts an example of design via RST from a given learner and WBT domains to an abstract representation of the WBT.

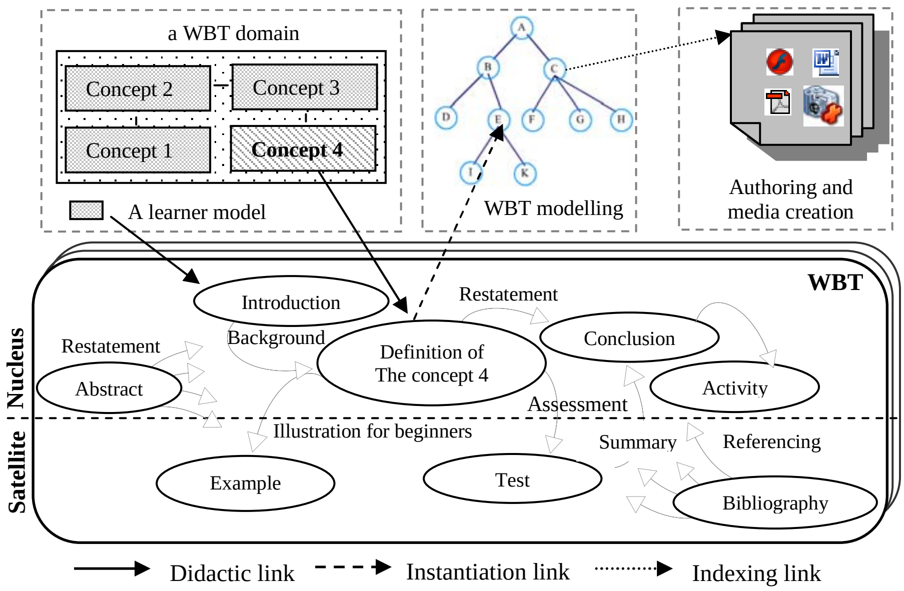

Figure 5: Using RST and taxonomies to support the Macro Design

In this example, the WBT semantic modelling shows only WBT segmenting into didactic elements and rhetorical relations among them to express some of the instructor's intentions. Here, the first thing which has to be considered is what are the concepts that our WBT domain should include, and what are the concepts known by the learner (i.e. learner domain). This specification will be quite easy since we have adopted a neutral and simple way of knowledge modelling. The second step is to map those concepts to certain semantic units which serve as abstract containers of knowledge. All information which is needed about each semantic unit has to be defined explicitly such as its mapping to given concepts, its semantic features or rules (e.g. nucleus/satellite), its intentional relations with other units and authoring properties if required. This specification is based on the RST framework and on our developed taxonomies. Later on the resulting representation of the WBT when it is completed should be instantiated into a specific WBT model so that the last step to do is to enable this model by authoring and creating needed media. The modelling and authoring of WBTs must fulfil the representation and requirements given by the instructor and should be done via iterations by the process management [Aqqal 07].

4 Related Work

Unlike our requirements the traditional way of WBT design focuses on a flat structuring of WBT toward developing a modular view to fulfil existing technical standards requirements [Duval 03] [Verbert 06]. Indeed, these standards (e.g. LOM, SCORM Content Aggregation Model [SCORM 04]) have been generally limited to the modelling of object-oriented schemas because they have put significant effort into developing mechanisms to manage the reuse of materials located in a repository in form of learning objects not necessarily semantically annotated. The attributes of semantic modelling are generic and not directly considered, making it more difficult to view and access the WBT model at different levels of abstraction.

In addition, and away from the conceptualization of a scientific knowledge domain itself, there are a number of taxonomies and ontology based models that conceptualize learning resources and their mapping to the knowledge domain in a more or less precise way. For example, Verbert and Duval [Verbert 06] [Zouaq 06] studied six content models and showed that they could be mapped on their abstract model called ALOCoM [ALOCoM 05]. ALOCoM is an ontology-based content model to facilitate the process of learning content authoring. It tries to extract and to transform content produced via authoring tools (e.g. MS PowerPoint, OpenOffice.org etc.) into ontology-aware content compliant to the ALOCoM output format. So far, ALOCOM refers only to slide presentations as materials to be authored [Bergsträßer 06]. Similarly, the Learning Resource Content Representation (LRCR) [Bergsträßer 06] was developed as part of a Re-Purposing framework. A conceptualization of Learning Resources based on the (LRCR) ontology is used to support users through different kinds of context-based adaptations. Unfortunately, both approaches are grounded on repurposing of existing resources and do not go beyond the traditional way of WBT authoring.

The Knowledge Puzzle Content Model [Zouaq 06] is an ontology-based content model too. It uses a set of taxonomies to decompose a document from a structural and an instructional point of view to create Learning Knowledge Objects (LKOs) from annotated content. However, this model targets mainly retrieving assets and aggregating LKO stored as knowledge base for an intelligent tutoring system.

On the didactic level, Didactic Ontology developed by Meder is well structured but rather complex and without further developments instructors need to be highly familiar with the vocabulary [Schapke 02]. Bloom's Taxonomy [Bloom 56] [Zouaq 06] is a relevant taxonomy to expresses educational objectives and serves as a sort of checklist to answer the first two questions listed in the section 2.1 rather than to follow all semantic connections of a WBT in terms of intentions, degree of modularity and how the authoring process will explicitly occur.

IMS Learning design (IMS-LD) could be listed in the same category. The LMS-LD specification supports the design of a wide range of e-learning situations. However, it considers that the focus of learning is the activity not the content. It attempts to model the learning process in form of activities that contain content as black box or contain no content at all [Lehmann 06] [Pernin 06]. Therefore by being so abstract, generic and constructivist oriented, IMS-LD does not meet all our requirements.

5 Conclusions and further research directions

In this paper we presented a novel conceptual contribution to the Web Based Training creation. We motivated a collaborative production as a way to meet instructors' skills for an efficient WBT production. The proposed methodology points out the so called "Macro Design" as an independent task to be supported. The Macro Design is innovative in two ways. First it extends the existing way of content design by supporting instructors in expliciting their intentions and instructional data that are often not captured. Second it demonstrates the possibility to use the Rhetorical Structure Theory (RST) as a communicative mechanism to give an explicit perception of the expected content. Hence, we have developed taxonomies that are RST adapted and fit the Macro Design requirements. We will continue to further refine these taxonomies to fully suit our scenario of use.

As proof of concept, we plan to implement an extension of the ResourceCenter tool [Hoermann 05] to support the Macro Design by addition of a *Macro Design* component up on this tool and to support the processes management. ResourceCenter was chosen because it constitutes a browser based and instructor-friendly tool. Moreover it supports the content modelling and authoring separately and implements some required functionalities that we need for the collaborative production. One area of interest is the evaluation of the Macro Design concepts on the networking domain of knowledge to be web trained but our methodology can easily be reapplied on other knowledge domains as well.

Acknowledgment

The main result of this paper was obtained during a two years' visit of the first author to the KOM Multimedia Communications Lab. The first author gratefully acknowledges the support from the German Academic Exchange Service (DAAD) and the Technische Universität Darmstadt.

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