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TLIC PAPER

Prospective Experience Patterns of Training Based on Modifications of Past Play States

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ABSTRACT

Occupational accident prevention is a task of societal relevance for the protection of health and life of humans, for the avoidance of damage and large financial losses, and for the protection of the environment. In the industry, accident prevention training is inevitable. Due to the fascination of game play, game-based training is easily accessible, may be affective and, thus, effective. Time travel prevention games have proven their worth. Human trainees who fail to solve a training mission successfully are offered the opportunity to travel back in time, i.e. back in the game play history. Time travel prevention games allow for the experience of stories of success that are worth to remember and, thus, establish sustainable learning experiences. They are even worth telling. Didactic and game design is intricate, in particular, the design of the digital game's artificial intelligence guiding every trainee individually to success. Prospective experience patterns are a novelty among intellectual design tools. The introduction of patterns of prospective experience requires putting an end to misconceptions about string patterns. The approach relies on formal language theory and first order logics. Prospective experience patterns are design patterns by nature. They are properties of play states that characterize forthcoming experiences of game play, i.e. of training and learning. By way of illustration, largely varying variants of zugzwang as well as widening a bottleneck turn out to be prospective experience patterns. Didactic and game design makes use of these patterns by setting up or even dynamically changing the game mechanics such that a desired play state property that shall be experienced becomes true. Time travel allows for modifications of past states that impact the future.

KEYWORDS

occupational accidents, industrial accidents, accident prevention, digital storytelling, story engagement, time travel prevention games, adaptivity, patterns of prospective experience, modification of past play states

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1 INTRODUCTION

This paper expands on the authors' *The Learning Ideas Conference 2025* paper [1]. It is their first comprehensive contribution with pep and much emphasis is put on pep. The word *pep* is short for *prospective experience patterns*. Alternatively, the concept might also be called *patterns of prospective experience*, but the acronym *pope* is more delicate to deal with.

These patterns play a role in the design of games for accident prevention training, especially occupational accident prevention in the process industry to preserve human health and lives, to avoid injuries and material losses, and to protect the environment. This is the authors' area of research, development, and application.

The novel term of prospective experience patterns was coined in [2] where the first patterns of this type discussed in detail are *bottleneck* and *widening a bottleneck*. Similarly, the 8 variants of *zugzwang* introduced and investigated in [3] are patterns of this type, though they are not yet called pep. A unifying perspective is still missing.

Seen from the viewpoint of interactive digital storytelling, the main source [1] deals with learner adaptivity through successive narrowing the space of stories that may be experienced. Gradually stronger guidance leads to stories of ultimate success. Another recent paper of the authors develops a complementary approach to trainee centricity by expanding the story space, like widening a bottleneck, for increasing the likelihood of the learner's own way to complete a training session successfully [4].

This contribution is an amalgamation of previous papers [1, 2, 3, 4] from 2025 taking the authors' prior work [5–12] into account. It contains novelties far beyond the limits of these 12 sources.

2 BACKGROUND

To set the stage for the introduction and for in-depth investigations of novelties, some background is inevitable. This section is intended to structure this background. In most cases, the authors confine themselves to a sketch only and direct the reader to relevant references. In contrast, the particular background area of design patterns deserves a separate section following the present one.

2.1 The application background

Occupational accident prevention is a task of societal relevance and so is education including accident prevention training. The addressees of the authors' work are more than 1,600,000 insured individuals from more than 36,000 enterprises in Germany. Preferably, training takes place in virtual environments (see Figure 1) implemented by Fraunhofer IFF. All screenshots and cutouts of screenshots in the present contribution demonstrate details of these application modules. In complex and risky conditions, errors and accidents are likely, but may be tolerated as long as they are only virtual. Nothing is more affective and, thus, effective than a self-induced disaster [5–12].

2.2 Activity-based learning

The authors adopt the opinion that to be effective, learning should have a firm foundation in the brain sciences and, so to speak, should have the brain in mind [13]. As Boles put it, "learning experiences should incorporate interactive activities that stimulate various brain regions involved in memory formation, attention regulation, and emotional processing" ([14], p. 26).

The call for active learning corresponds to the guiding assumptions of Mayer's cognitive theory of multimedia learning [15]. Besides the dual-channels assumption and the limited-capacity assumption, there exists the active-processing assumption. The authors' approach respects all the assumptions, but the present contribution puts much emphasis on the activity aspect. The dual-channels assumption is underlying the design and implementation of training environments as illustrated by means of Figure 1. The limited-capacity assumption is one of the driving motivations behind the authors' time travel concept.

The crux is that training activities in real industrial installations involve a high risk. The authors prefer active learning in virtual environments such as illustrated by Figure 1.

Fig. 1. One of the virtual factories from Fraunhofer IFF deployed by the German Institution for Statutory Accident Insurance and Prevention for Raw Materials and Chemical Industry, Training Center Berlin, for accident prevention training in paint and coatings industries

Interactive training activities shall be tailored toward activation of varying regions of the brain that, following Boles [14], are related to memory, attention, and emotion. These high demands led the authors to game-based learning and training [1–12].

2.3 Game-based learning and time travel prevention games

Beyond the limits of conventional game-based learning, the authors are interested in learner activities that challenge further brain functions such as mental time travel. Mental time travel is considered important to the human mind's evolution [16, 17]. Consequently, virtual time travel bears enormous potential in game-based education. In particular, mental time travel proves to be a form of knowledge representation [18]. For the fundamental concept of *time travel exploratory games*, interested readers are directed to [19–21] and to section 2 of [3]. For the purpose of the present contribution, the authors focus the sub-class of *time travel prevention games*, a term coined in 2015 on the conference and expo called the German Prevention Day [22].

The key approach to time travel games means a design concept visualized by means of the second figure within the present paper.

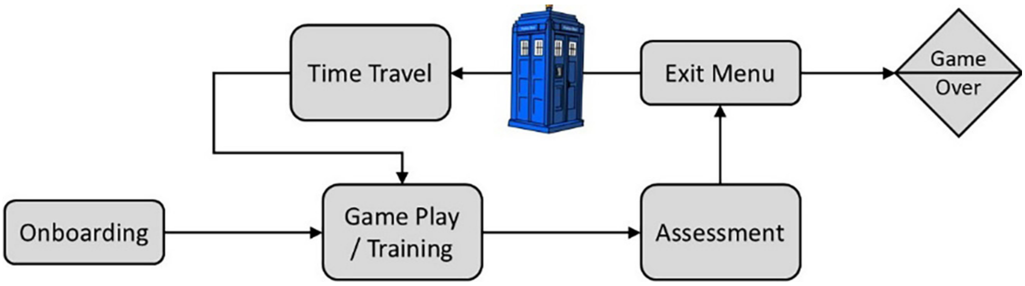

Fig. 2. Top-level structure of a time travel prevention game determined by a storyboard graph

Apparently and easily recognizable in Figure 2, the game feature of virtual time travel brings with it potential cycles of game play. In case the assessment after core training reveals unsatisfactory results, the game system offers the trainee an opportunity to travel back into the history of play to do better the next time. In the authors' approach, the ultimate goal for every human player/learner/trainee is an own story of success.

2.4 Dynamic plan generation and digital storyboarding

Stories to be experienced by a human in training playfully are anticipated a priori. As said before, time travel exploratory games and time travel prevention games bring with it potentially unbounded loops of interaction. This is challenging didactics and digital game design. The structural complexity of emerging stories goes far beyond the limits of branching scenarios [23]. The story space [24] is potentially infinite.

The design methodology of choice is storyboarding à la Jantke and Knauf [25]. Readers interested in more detail might find the exemplified introductions of [5, 6] helpful. Furthermore, [26] and [27] contain several larger storyboard cutouts that are illustrative and possibly supportive.

Game play that succeeds ultimately may be seen as a plan that has been executed. The crux is that this plan is not known in advance. It emerges through game play. Didactic and game design through storyboarding is dynamic plan generation [28]. Those plans and, thus, those storyboards are hierarchically structured graph families. The finally successful game play is not known in advance at planning time, i.e. at the time of design. Neither the designers, the system nor the human trainee knows that. Planning is learning [29].

2.5 Interactive digital storytelling

Storytelling is an ancient VR technology [30]. Human trainees do not only get told stories of accidents and how to prevent them. They experience stories, they actively participate in stories that unfold when playing. As the present authors put in [5], instead of the conventional term *interactive digital storytelling*, they coined the term *interactive digital story engagement* that is more appropriate. The story is emergent.

In [10] and [12], the authors put emphasis on varying issues of story engagement.

2.6 Stories of disaster vs. stories of success

Telling stories of disaster is a preferred approach to accident prevention [31–35]. There is the long-standing belief in "empirical evidence of the decremental effects of reward on intrinsic task interest and creativity" [31]. In contrast, there is a corpus of work on mental time travel [36–41] encouraging the preference for stories of success. Trainees imagine how they could have done better. As the authors put it, time travel prevention games make "a trainee's daydreams come true in unfolding stories" [12].

So, how to avoid frustration? How to guide every individual to an ultimate success in a personalized way? How to make an experienced story worth remembering and, even more ambitious, worth telling? Those are questions for the digital game system's intelligence and how to implement it. The answers given in the present contribution will be based on *prospective experience patterns*, i.e. accident prevention with pep.

2.7 A modal logics perspective

A trainee's journeys back in time aim at the revision of modalities of events for, so to speak, turning the tide. Disasters that seemed unavoidable lose their fright and ways out become possible.

For an in-depth analysis that supports appropriate design decisions, the authors adopted a modal logics point of view [8, 9]. More specifically, they developed their own deontic approach, where [9] is slightly more axiomatic in spirit.

Deontic logic deals with the essentials of the ought-to-do [42, 43], a perspective that is fundamental to prevention training and possibly to a wider area of education.

2.8 A touch and feel of training with time travel prevention Games

For a better foundation of the present contribution, a deeper impression of the touch and feel of time travel prevention training might be helpful. Interested readers are directed to the authors' prior publications [5–12] that contain dedicated sections.

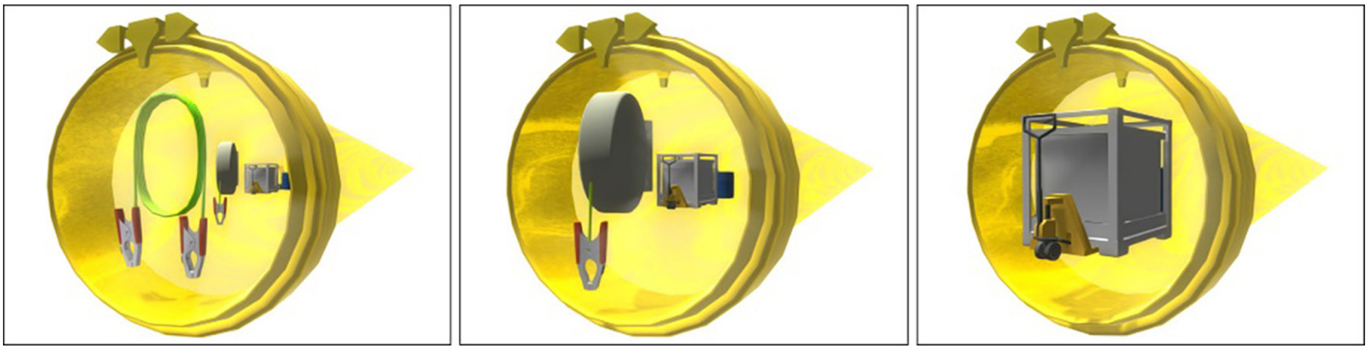

Fig. 3. A time tunnel specifying destinations by means of objects that represent scenes of inter-action from the past–scenes within the episode of Core Game Base Training, see Figure 2

For this contribution, a short look at the time tunnel should suffice. Every scene experienced in past game play has an iconic representation (Figure 3). Human trainees traverse the time tunnel back and forth using the upper left and right button, resp. Using the centered button, they select the destination represented by the current icon.

3 PATTERNS OF GAME PLAYING EXPERIENCE

The concept of patterns entered the scientific discourse first in architecture [44]. Nowadays it is present in computer science almost everywhere.

The present contribution deals with game play that is discrete in the sense that it may be represented by sequences of (inter-)actions, i.e. by strings of finite length. Patterns are something general. What is found in practice are instances of patterns. Patterns may have many different instances, possibly infinitely many. And an instance may belong to varying patterns. This insight establishes the pattern inference problem. Given instances, what is the pattern behind? What do the instances have in common? Dana Angluin has introduced a particularly simple and clear concept of patterns [45] motivated by problems of inductive inference from positive data, i.e. learning [46, 47].

3.1 Patterns common to a set of strings

Investigating strings and string properties systematically, several assumptions are necessary. Foremost, there is an alphabet M, i.e. a finite set of elements called letters. The notation M shall resemble the word move. In digital games, moves are actions of players or those of the digital game system. The spectrum ranges from a mouse click or a touch with the finger to playing a cutscene or moving objects in the virtual space. Furthermore, higher levels of abstraction are helpful for higher level investigations. By way of illustration, think of the action to enter a room. This higher level action may require lower level actions such as turning a key or bringing a ladder. Notice that elements of M may also describe actions that are not observable by the human player. By way of illustration, in most digital games there take place actions of bookkeeping. The authors' contribution [48] discusses an example based on the game Treasure [49]. Treasure is a pervasive game. Players act in a real park where–virtually–treasures are hidden. During game play, the game system undertakes bookkeeping of the locations where treasures are hidden, of the players' positions, and of their pockets that may contain virtual treasures they picked up. Pickpocketing is among the players' actions.

With these ideas in mind has been coined the term *layered languages of ludology* first investigated in [50] and later on extensively applied in [51] to a comprehensive study of the game Shadow of the Colossus, Sony Computer Entertainment, 2005.

Whatever alphabet M is assumed, game play is described as strings of finite length, i.e. finite sequences of actions including those by the game system. Letters of M may also describe actions taking place in parallel. The set of all strings built over M is denoted by M* including the empty string ε.

Dana Angluin assumes furthermore a set of variables X disjoint from M. Formally, $M \cap X = \emptyset$. For simplicity, we assume $X = \{x_1, x_2, x_3, \dots\}$. According to Angluin [45], patterns are finite strings of letters from M and/or variables. A few simple examples based on M = {a, b, c} are x_3, abc, x_1aaax_2, $bx_{77}bcx_{77}c$, aax_1x_2cc, $x_1abcbax_2$, and x_1x_2. Variables are to be substituted by non-empty strings of M*. By way of illustration, the first pattern allows for the generation of everything in $M^* \setminus \{\varepsilon\}$ just by substitution, whereas the second pattern does not generate anything different from abc.

Angluin demonstrates that every pattern is learnable from finitely many instances.

3.2 The misconception of visual perceptibility

Let's have a closer look at more of the seven pattern examples in the preceding subsection. The third pattern allows for the generation of all strings that contain somewhere inside the substring aaa, provided that anything precedes aaa and anything follows. The instances of the fourth pattern contain one string that, first, appears in parentheses built by the letter b followed by another occurrence in parentheses, this time built by the letter c. The last pattern allows for the generation of all strings that have at least two letters. Seeing all the instances aa, ab, ac, ba, bb, bc, ca, cb, and cc, one may guess the underlying pattern x_1x_2. (Renaming of variables does not matter.) The only alternative explanation would be a pattern consisting of just one variable.

All this suggests that the key characteristics of a pattern are visible in its instances. As a general assumption, this is a misconception. Science and engineering are full of misconceptions [52].

Let's come back to the last case discussed before. Seeing the nine instances above, guessing the concept of 'all strings of length 2 or longer' assumes the knowledge of numbers and the ability of counting. But Peano arithmetic is not sitting in the strings. It is background knowledge outside of the instances under consideration. It is context.

For the purpose of didactic and game design, we will have to go beyond the limits of Angluin's approach. Let's take a first step by means of a more expressive study. Let's undertake a gedankenexperiment, like a quiz. The authors did agree about some pattern and present a few instances. What is the underlying pattern? What follows are three sentences being instances: We are going from Bonn through Köln to Hamburg. We are going from Erfurt through Magdeburg to Berlin. We are going from Bielefeld through Hannover to Berlin. Engaged in our experiment, one might guess this pattern: We are going from x_1 through x_2 to x_3. The variables are to be substituted by names of cities in Germany. The authors present two sentences that serve as counter-examples. We are going from Erfurt through Leipzig to Dresden. We are going from Erfurt through Weimar to Jena. Apparently, background knowledge or context, respectively, is missing. This knowledge does not sit in the strings. It is not visually perceivable. For the purpose of this toy example, the context is the number of inhabitants of cities. From x_1 through x_2 to x_3, the number of inhabitants should be growing.

3.3 Patterns as string properties in context

Patterns of interest refer to play states, i.e. to strings of M* representing game play. To clearly express a pattern, one constructs a formula p that contains a free variable x for the play state under consideration. The notation p(x) is appropriate. The patterns of *zugzwang* [3] and *widening a bottleneck* [2] may serve as introductory illustrations.

Whether or not a formula $p(\pi)$ is valid for an instance π substituted for x appears as a logical problem that depends on background knowledge BK including arithmetics. For any formula p that describes a pattern and for any concrete string $\pi \in M^*$, the term $BK \models p(\pi)$ denotes logical validity, i.e. the string being an instance of the pattern.

A decisive insight that derives from the perspective of the present subsection is that a target pattern can be 'made valid' by modification of the underlying knowledge.

4 DIDACTIC AND GAME DESIGN WITH PEP

The concept of *prospective experience patterns* (pep, for short) was introduced in the authors' paper [2] with emphasis on extending the space of future experiences. The pattern of *widening a bottleneck* of game play was developed as a motivating and illustrative example. In contrast, paper [1] being the origin of this contribution had a narrowing of the space of future experiences in focus. Such a narrowing corresponds to the introduction of variants of zugzwang [3]. To make a pep effective, there have been introduced *modifications of past play states* (mops, for short) [1, 4], where [4] in contrast to [1] and intentionally similar to [2] deals with some story space extensions. This paper aims at a synthesis of prior work including the introduction of novelties.

4.1 Notions and notations in a nutshell

The authors pick up a few basics from the preceding background section based on formal language theory and on mathematical logics stripped down to the essentials.

"Everything that can be thought at all can be thought clearly. Everything that can be said can be said clearly." (Wittgenstein in [53], 4.116, Ogden/Ramsey translation)

Notions and notations as introduced in [54, 55] and subsequently applied to digital games studies in [56–58], e.g., provide a firm basis of thinking and speaking clearly. They are adopted subsequently, but technical details are widely kept under the hood to save space as well as the reader's time for the demonstration of design decisions illustrated by means of the authors' module implementations for prevention training.

As already said in the preceding section, we consider game play that is discrete.

This is similar to the traditional representation of game play in conventional chess. The so-called immortal game, Adolf Anderssen vs. Lionel Kieseritzky, 1851, London, that may be found on dozens of pages on the internet serves as a valuable illustration. The formal representation is a string of length 45 beginning with the letter [e2e4], when algebraic notation preferred by FIDE, Fédération Internationale des Échecs, is assumed. The description ends with the three letters [Qf3f6] [Ng8xf6] [Bd6e7]. Notice that we have introduced brackets to separate moves just for readability.

To sum up the chess example, there exists a finite alphabet of actions (moves) M. The set of all finite strings including the empty string ε is denoted by M^*. Depending on the game, some of the strings in M^* denote complete game play and others do not. On a set of strings, there is defined an intuitively clear operation of concatenation that does not need any operator symbol. For two strings $z_1, z_2 \in M^*$ one simply writes z_1z_2 to denote their concatenation. For some purposes, the concatenation of sets is useful. Given $K, L \subseteq M^*$, it holds $KL = \{z_1z_2 \mid z_1 \in K \wedge z_2 \in L\}$. For any given game G, the set $\prod(G) \subseteq M^*$ contains exactly the strings in M^* that abstractly represent complete game play according to the given game mechanics of G. Consider any string $\pi \in M^*$. This is a play state, if there is at least one continuation $z \in M^*$ satisfying $\pi z \in \prod(G)$. The abbreviation $\prod_\pi(G) = \{z \mid \pi z \in \prod(G)\}$ will prove fundamental subsequently.

Loosely speaking, the term represents the relationship between current game play and forthcoming experiences. Given π, what concatenations z may come depends on the game mechanics of the game G.

4.2 Notations of time travel

Because of its outstanding role within the present contribution, the authors have detached from the preceding subsection the issues of time travel notation.

Assume that in a play state $\pi' \in M^*$ a trainee decides to go on a journey in time backward to a play state $\pi \in M^*$ experienced before that is represented in the time tunnel by a certain icon. π must be an initial segment of π' formally written as $\pi < \pi'$. For completeness, the definition of the binary relation $< \subseteq M^* \times M^*$ is supplemented.

First, $\pi \leq \pi'$ holds exactly if there exists a continuation $z \in M^*$ satisfying $\pi z = \pi'$. Intuitively, z abstractly denotes the trainee's game play after π until π′ is reached. Second, $< \subseteq M^* \times M^*$ denotes the irreflexive sub-relation of the relation $\leq \subseteq M^* \times M^*$.

Travel itself is a sequence of actions including actions of traversing the time tunnel and the selection of the destination. This sequence is denoted by $\tau \in M^*$. Essentially, the gist of time travel is expressed by the equality $\Pi_{\pi'\tau}(G) = \Pi_{\pi}(G)$. Intuitively and loosely speaking, after travelling back in time from π′ to π, everything is as before.

Notice that the focus of the current investigations including implementations is on abandoning $\Pi_{\pi'\tau}(G) = \Pi_{\pi}(G)$.

4.3 Creative design of the future with prospective experience patterns from a Bird's Eye view

Prospective experience patterns are an intellectual design tool to shape the future of human experiences of game play, i.e. of training, learning, and entertainment, based on the technology of modifications of past states (mops). In quite condensed terms, *the present contribution is about didactic experience design with pep based on mops*.

In [5, 10–12], the authors have discussed this design process from the viewpoint of interactive digital storytelling with emphasis on the design as a process of planning. Based on dynamic plan generation [28], the design technology is storyboarding [25] understood as *the organization of experience* ([25], p. 25), i.e. dramaturgical design seen as "the design of emotional experience. For digital games that are intended to tell a story, game design includes anticipation of the players' experiences, which will lead to excitement, fascination, thrill, perhaps to immersion and flow" ([59], p. 370).

How to create a game component in such a way that the desired experiences unfold when playing the game? Imagine a human trainee's experiences take place as desired, determined or, at least, enabled by the game mechanics. To ask the question for the reasons behind means abduction [60, 61]. Logically, abduction is backward reasoning from observations to possible explanations. Didactic and game design that aims at the unfolding of certain experiences of trainees during forthcoming game play is driven by the creation of explanations, so to speak. We want observable experiences and, for this purpose, create the underlying reasons.

To be adaptive to largely varying needs and desires of different human players', the creation of underlying reasons takes place dynamically when playing the game. This corresponds to the adopted approach to dynamic plan generation [29].

The feature of time travel is decisive. Changes of the past impact the future and even the present. Modifications of past states are the authors' original approach [1, 3].

In formal terms, a modification of a past state is an action $\mu \in M$ executed by the digital game system. The authors' design principle is to execute the modification μ immediately after time travel τ.

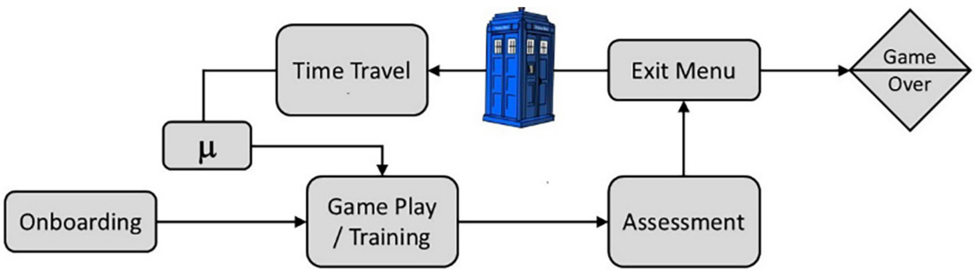

Fig. 4. Top-level view at the modification of a past play state immediately after time travel

In terms of digital storyboarding [25], the modification μ in a storyboard graph as on display in Figure 4 is a scene. The authors did not yet investigate the more general perspective of seeing a modification as an episode.

Scenes like μ have an elementary semantics in the application domain. By way of illustration, the modification μ may be implemented by the disappearance of buckets, by their visually perceivable dissolution, or even by their flapping away as in Figure 5. The dynamic interpretation of scenes in a storyboard is logically controlled depending on dynamic data such as the history of game play. For the issue of interpretation vs. compilation, interested readers are directed to [62].

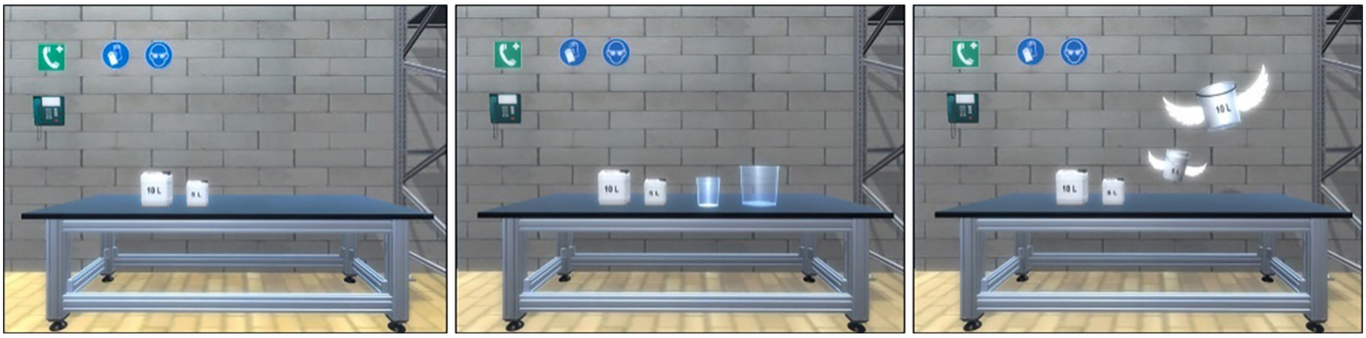

Fig. 5. Three alternative interpretations of a mops in dependence on the history of game play; trainees who repeatedly fail due to using buckets instead of jerrycans get explicit hints

In conditions of modifications of the past, when a trainee arrives at the destination, the past may be no longer what it used to be. Aiming at a visit to the past state $\pi \leq \pi'$, the trainee arrives at the play state $\pi'\tau\mu$.

In contrast to the assumption $\Pi_{\pi'\tau}(G) = \Pi_{\pi}(G)$, the relation between $\Pi_{\pi'\tau\mu}(G)$ and $\Pi_{\pi}(G)$ is in focus. The relation between an Index z and $\Pi_{z}(G)$ establishes the pattern.

By way of illustration, the string of the first 43 letters of the immortal chess game discussed above establishes a pattern of immediate zugzwang [3]. Let's abbreviate this play state by z, i.e. z = [e2e4] … [Qf3f6]. The key property is the existence of some action $\zeta \in$ M that satisfies $\Pi_{z}(G) \subseteq \{\zeta\}M^*$ indicating an immediate zugzwang. However to continue, ζ comes next. As we know, ζ equals [Ng7xf6].

The validity of $\Pi_{z}(G) \subseteq \{[Ng7xf6]\}M^*$ in dependence on z is determined by the game mechanics, i.e. the rules of play.

4.4 Stronger guidance with restrictive prospective experience patterns

Aiming at the human trainee's experience of an individual story of success [10–12], patterns are of interest that restrict the space of forthcoming experiences satisfying the formula $\Pi_{\pi'\tau\mu}(G) \subset \Pi_{\pi}(G)$. A pattern meeting this condition is called a *restrictive pep*. Figure 5 illustrates examples from a training module for the paint and coatings industry.

The author's earlier papers [5–12] report in varying detail a training module dealing with inflammable liquids. Selecting a wrong pump may cause an explosion with fire. To deal with the issue, the authors have developed and implemented a modification of the past whereby the pump comes to life and runs away leading to $\Pi_{\pi'\tau\mu}(G) \subset \Pi_{\pi}(G)$.

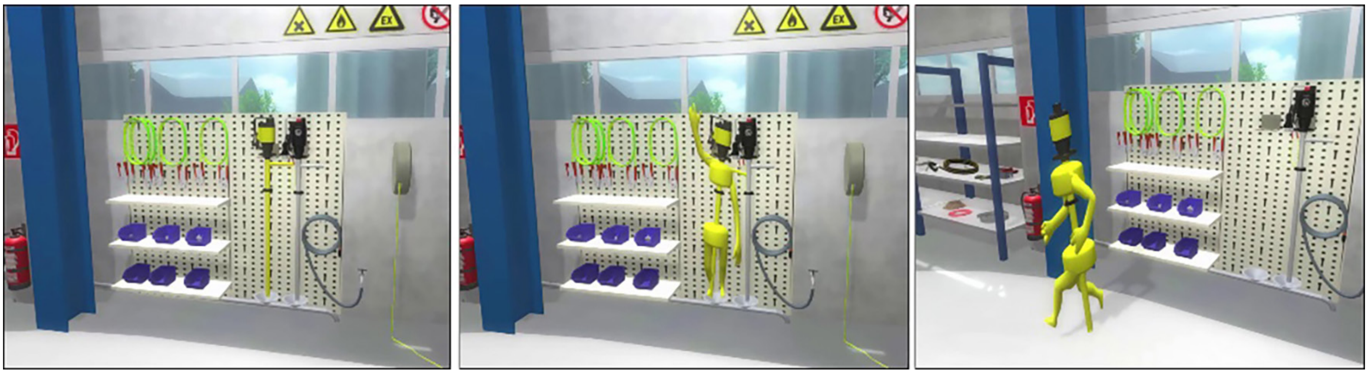

Fig. 6. The inappropriate pump prevents the human trainee from using them by running away

The disappearance of an inappropriate pump reduces the trainee's options such that the likelihood of success increases. Restrictive peps result in a stricter guidance and some of them are apparently worth to remember and even worth telling.

4.5 Novel opportunities with expanding prospective experience patterns

An *expanding pep* represents a didactic principle complementary to the preceding. A related modification of the past results in $\Pi_{\pi'\tau\mu}(G) \supset \Pi_{\pi}(G)$. Novel actions become available to enable trainees to be more successful the next time.

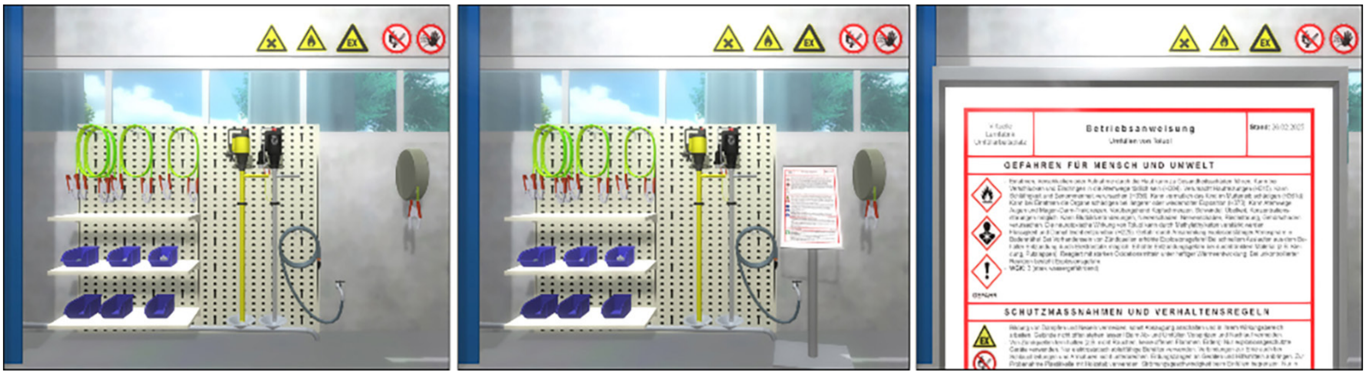

Fig. 7. A new opportunity offered by the appearance of a put-up hinge with a clickable poster

By way of illustration, another modification of a past state is illustrated in Figure 7 by means of screenshots from the authors' training module. A put-up hinge appears. There is a poster on display that is clickable. The enlarged text informs the trainee about essentials of selecting the correct pump. This is less spectacular, but effective.

5 CONCLUSIONS

The prevention of occupational accidents for the protection of human life and health, for the avoidance of damage and large financial losses, and for the protection of the environment is a task of societal relevance that deserves the highest level of commitment and innovative technologies such as time travel prevention games.

The authors aim at attractive and affective game-based training that allows for highly personalized story engagement that is worth remembering and worth telling. Stories emerge at play time in response to human play and are not fully predefined. Didactic and game design aims at the creation of dynamic story spaces. The design is complicated by dynamic time travel occurring in individually varying conditions.

Design aims at the specification and implementation of forthcoming experiences expressed by the term $\Pi_z(G)$ in dependence on game play encoded in the play state z. Properties of $\Pi_z(G)$ are valid within the static context of the game mechanics and the dynamic context of play. *Modifications of past states* make the full context dynamic. Innovative design principles such as *restrictive prospective experience patterns* and *expanding prospective experience patterns* arise from the formal conceptualization.

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