Immersive Process Models

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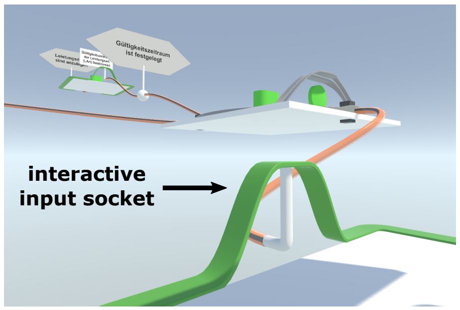

Figure 1: First person VR view of an immersive process model. The user looks back at the process and sees the green input socket in front.

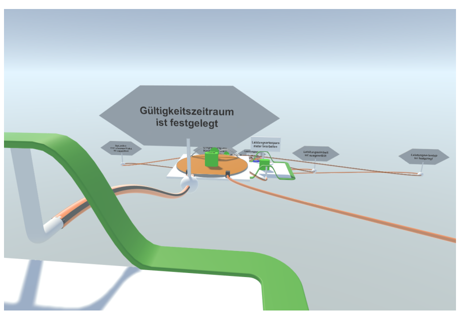

Figure 2: The user looks down at the remaining parts of the process. All screenshots depict EPCs labelled in German.

ABSTRACT

In many domains, real-world processes are traditionally communicated to users through abstract graph-based models like event-driven process chains (EPCs), i.e. 2D representations on paper or desktop monitors. We propose an alternative interface to explore EPCs, called immersive process models, which aims to transform the exploration of EPCs into a multisensory virtual reality journey. To make EPC exploration more enjoyable, interactive and memorable, we propose a concept that spatializes EPCs by mapping traditional 2D graphs to 3D virtual environments. EPC graph nodes are represented by room-scale floating platforms and explored by users through natural walking. Our concept additionally enables users to experience important node types and the information flow through passive haptic interactions. Complementarily, gamification aspects aim to support the communication of logical dependencies within explored processes. This paper presents the concept of immersive process models and discusses future research directions.

CCS CONCEPTS

• **Human-centered computing** → **Virtual reality**; *Information visualization*; • **Applied computing** → **Business process modeling**.

CHI'19 Extended Abstracts, May 4–9, 2019, Glasgow, Scotland UK

ACM ISBN 978-1-4503-5971-9/19/05.
https://doi.org/10.1145/3290607.3312866

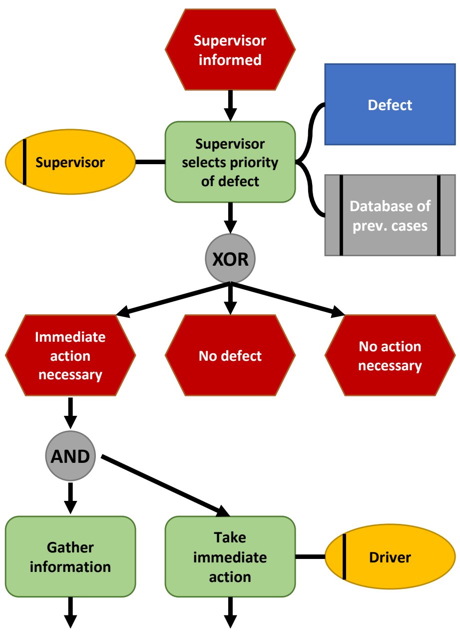

Figure 3: 2D representation of an EPC.

KEYWORDS

Virtual reality; event-driven process chains; immersive data analysis; passive haptics.

ACM Reference Format:
André Zenner, Sören Klingner, David Liebemann, Akhmajon Makhsadov, and Antonio Krüger. 2019. Immersive Process Models. In *CHI Conference on Human Factors in Computing Systems Extended Abstracts (CHI'19 Extended Abstracts), May 4–9, 2019, Glasgow, Scotland UK*. ACM, New York, NY, USA, 6 pages. https://doi.org/10.1145/3290607.3312866

INTRODUCTION

In conventional desktop applications, abstract data is commonly conveyed to the user by means of text, pictures, videos, charts, graphs or one of the many other representations that we have become used to interpreting. While many of these formats are successful in communicating abstract data to us, the rise of novel human computer interfaces, such as virtual reality (VR), motivates research exploring how abstract data can be communicated in alternative ways.

In this paper, we investigate the communication of event-driven process chains (EPCs) [2], a representation of business process models used in a broad range of contexts. Traditionally, these 2D flow charts representing processes and workflows are displayed as 2D graphs with nodes and edges (see Figure 3). Users explore the encoded processes by looking at the 2D EPC charts on paper or using desktop user interfaces. However, such EPC presentations primarily target the visual channel of the user to convey the logical connections and dependencies within an organizational process – other senses are typically not involved, which limits the user experience.

As the process portrayed by an EPC becomes more sophisticated and increases in size, the corresponding 2D chart becomes more complicated and harder to read. Utilizing the multisensory capabilities of VR, we aim to make reading and understanding EPC diagrams easier, more enjoyable, more interactive and more memorable. We present the concept of a novel system that leverages the additional dimension of a 3D virtual environment (VE), passive haptic feedback, gamification and other immersion techniques to create an alternative way to experience EPC graphs. The system allows users to dive into the graph, experiencing an immersive first-person, room-scale walkthrough through the process chart, as shown in Figure 1 and Figure 2. In this context, we introduce a mapping of flat, 2D EPC graph nodes to a spatial 3D representation by transforming nodes into connected, room-scale floating platforms in the virtual space. We further introduce tangible packets, a novel interaction concept designed to involve users interactively in the exploration of an EPC chart. Finally, we describe a complementary gamification approach to support the user in understanding logical dependencies within an EPC. The introduced concept serves as the basis for future user experiments planned to study the impact of these novel elements on EPC interpretability and memorability.

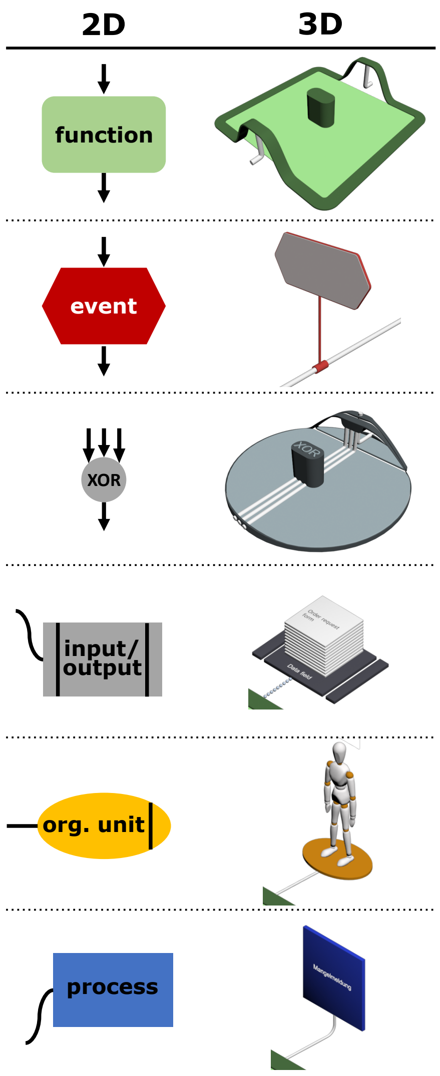

Figure 4: Mapping from 2D to 3D.

RELATED WORK

In the following, we briefly review EPCs, multisensory VR and immersive data analysis.

Event-Driven Process Chains (EPCs)

Among other formats such as Business Process Model and Notation (BPMN), Event-Driven Process Chains (EPCs) are a graphical representation format describing general processes by laying out involved steps using a graph structure [2]. Graphical process models are used in a variety of contexts, e.g. for documentation, education, optimization, evaluation, simulation or worker guidance [3]. Being 2D representations, EPCs consist of *function*, *event*, and *logical connector* (*and, or, xor*) nodes, connected by arrows indicating the process flow. Additional process information is represented by node types such as *organization unit*, *input*, *output*, or connections to other EPCs. *Events* are passive elements and can trigger functions. *Functions*, in contrast, are active elements representing activities. Graphically, each type of node is assigned a representative 2D shape and color. Figure 3 shows an example.

Multisensory Virtual Reality & Immersive Data Analysis

In contrast to traditional 2D visualizations, immersive VR stimulates the user's visual, auditory and haptic senses to convey a VE, be it realistic or a spatial representation of data. As a result, the user can feel present in a virtual scene [5]. As we aim to turn graph exploration into a memorable virtual journey, we let users (1) explore the graph in 3D visually, (2) provide corresponding sound effects, and (3) let users interact with haptic props to increase presence [1]. Concerning locomotion within VEs, previous research found natural walking to be superior in terms of presence compared to more stationary techniques [6]. Thus, our concept combines teleportation for long-distance travel with natural walking within nodes to benefit from the improved proprioception when walking in VEs.

Researchers also investigated VR as an interface for large data sets [4, 9]. In immersive data analysis, large setups are not new, as besides head-mounted displays (HMDs) [9], large-scale projections (e.g. CAVEs) have also previously been employed and the importance of immersion has been highlighted [4]. As HMDs become more affordable, space previously used for projections could be used for setups as presented in this paper to enable multisensory data exploration beyond the visual domain.

IMMERSIVE PROCESS MODELS – EXPERIENCING EPCS IN VIRTUAL REALITY

We present the concept of immersive process models – a novel way to represent EPCs leveraging the unique characteristics of immersive VR. Our implementation of this concept is still a work in progress. As such, some features described in the following sections have already been implemented in a first version, while others, e.g. the haptic feedback approach, are still in a concept development or an early implementation stage. These features are primarily sketched from a conceptual point of view.

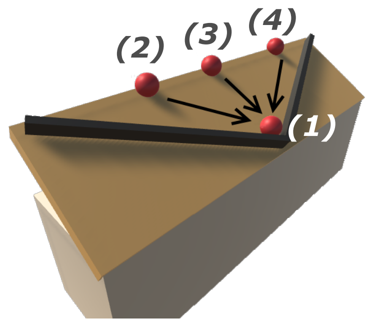

Figure 5: Rendering of a physical funnel prop. (2), (3) and (4) mark possible locations to drop a physical packet prop; (1) marks the funnel and pick-up location.

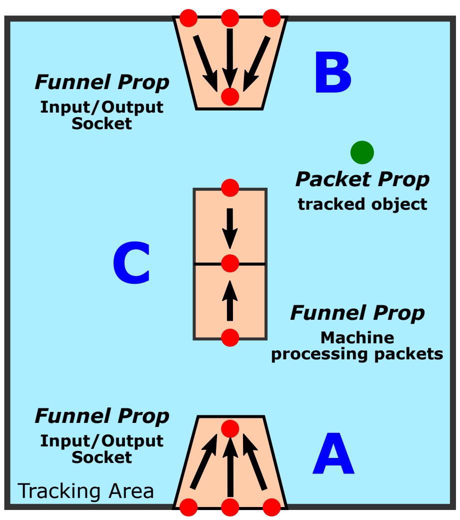

Figure 6: Symmetric (not-true-to-scale) tracking area and involved physical props. The blue area maps to virtual platforms.

Mapping 2D EPCs to 3D Virtual Environments

To enhance the user experience when investigating EPCs in VR compared to traditional 2D representations, the visualization of the graph is extended by a 3rd dimension. The graph is represented as a virtual world of room-scale floating platforms that represent graph nodes. Platforms are connected by a tube system that transports information (packets) from one platform to the next. To indicate flow direction and to support orientation within the process, a layout algorithm places child nodes at a lower altitude than parent nodes, yielding a descending platform layout, as can be seen in Figure 1, Figure 2 and Figure 8. Users can naturally walk on each platform and teleport to other platforms using the VR controller. Being purely passive, event nodes are an exception to this, and are included in the VE as tube labels or signs, which indicate a system state change occurring when information flows from one function to the next. To highlight the fact that function nodes represent activities which can take time, these active nodes carry an interactive machine. To proceed when on a function platform, users are supposed to take incoming packets, process them by putting them into the machine first and only then deliver them to the output tube. The state of processing is indicated by the packet's color which changes when the packet is processed. Similarly, users located on logical connector platforms control the packet flow by interacting with a 3D decision module (shown in Figure 9) and the in- and outgoing packets. Figure 4 shows the mapping from 2D nodes to 3D platforms. To transfer knowledge about traditional EPC representations to the immersive 3D representation, the design of the platforms is based on the appearance of the original nodes, taking shapes and colors into account.

Experiencing Function and Operator Nodes through Passive Haptic Packets

To complement the audio-visual experience we aim to include passive haptics to increase presence [1], making information flowing through the EPC physically graspable. By letting users manually transport information packets from the input sockets to the output sockets of walkable nodes, we aim to raise the awareness that function nodes represent actions that take time, and that operators impact the process flow. For this, information packets will be represented by tracked physical balls, e.g. implemented by spherical meshes with trackers inside. Wherever information flows into or out of a walkable node, at operators, and at the function machine, interactive sockets can be found in the VE (see Figure 1 and Figure 9). These virtual sockets are implemented by simple physical structures as sketched in Figure 5, called funnel props. A tilted surface allows users to drop packet props anywhere above two funneling wooden slats, e.g. at locations like (2), (3), or (4). These positions could represent different output tubes of a node in the VE, connected to the next platforms. When released, physical props will roll down and gather at location (1), where they can be picked up again later in the experience.

Each walkable platform maps to the physical setup in Figure 6. It includes one funnel prop at each end of a platform (A and B, to pick up incoming and release outgoing packets), as well as a symmetric

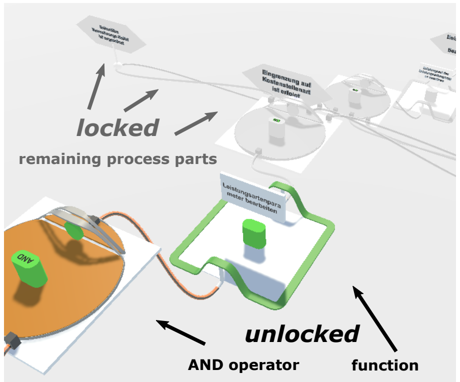

Figure 7: Partly unlocked 3D EPC.

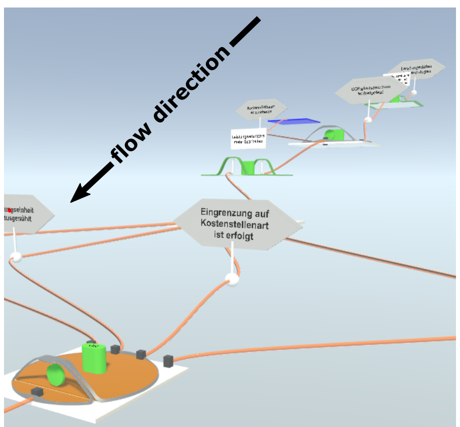

Figure 8: Descending platform layout indicating the process flow. The root node of the process starts at the highest altitude and descends child-by-child to provide an intuitive orientation within the process.

funnel prop at the center representing the machine (C). Operator interactions take place at any outer funnel prop. When dropping a packet into the function machine, the machine is shown processing the packet, which visually reappears at the gathering location of the funnel (1) upon completion of the processing. Dropping a prop at an outgoing socket, the packet is visually animated to flow to the next node. When teleporting from the output of the current node to the input of the next node, the user's virtual view is rotated 180°, mirroring the mapping of the virtual platform to the symmetric physical setup (i.e. the virtual representations of A and B swap). This allows users to proceed by interacting with the same physical prop since they can pick it up again as an input on the next platform.

EPC Traversal with the Logical Walkthrough

Besides free exploration, our concept incorporates an alternative mode of EPC traversal: the logical walkthrough. This mode provides additional guidance as it only allows the user to explore an EPC in a logically meaningful order. By traversing the model node by node, the user unlocks its elements one by one. The walkthrough starts at the root node and the user accompanies a packet to the end of the process, with all platforms and transitions but the first being locked and greyed-out initially (see Figure 7). To unlock a child node, the user has to process the packet at the currently visited function platform and send it to the child platform via the output socket. To proceed at an operator node, the user must fulfill all necessary requirements, e.g. visit all parent nodes in the correct order to provide packets on each input of an *and* node. This unlocking mechanism represents a basic form of gamification intended to add automatic guidance and a motivating element to the exploration.

DISCUSSION & OUTLOOK

Immersive process models provide a drastically different experience than traditional 2D representations. We imagine this to be suitable for applications focusing on learning and understanding process models, e.g. in education, evaluation or training contexts. In future work, we plan to study how exploring EPCs using immersive process models compares to studying conventional 2D representations, focusing especially on user experience, interpretability and memorability of EPCs of different complexity levels. Interesting research questions also include exploring (1) if transforming the flow visualization from 2D arrows to descending platform layouts provides benefits, and (2) how closely the 3D representations of graph nodes must match 2D counterparts. To study the impact of the haptic modality, we plan to integrate alternative modes of feedback. Comparing exploration without haptics to vibrotactile, passive, or dynamic passive haptics [8] will likely yield further insights into the benefits of multimodality. With haptic controllers, immersive process models could also become accessible to desktop-scale professional environments. For this, natural walking could be substituted by alternative navigation methods to implement a seated mode. Future research could also consider multi-user scenarios, either with multiple immersed users, or using projections to include non-VR bystanders [7].

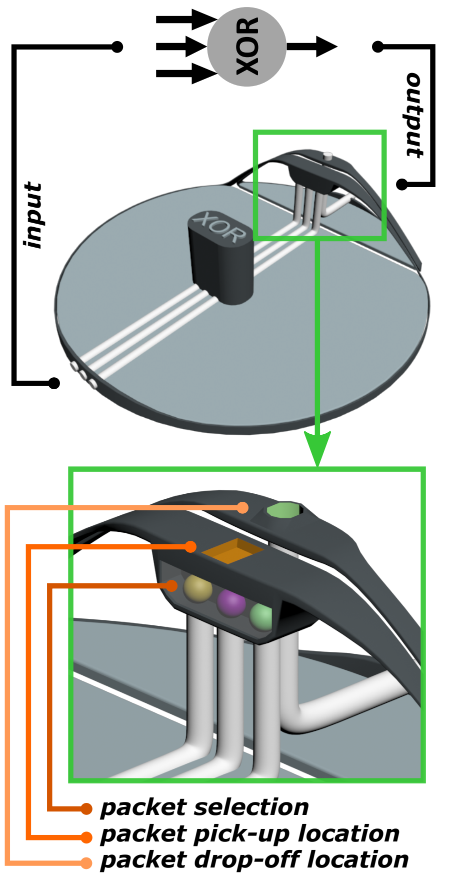

Figure 9: A 3D operator platform (XOR). The user can select exactly one incoming packet and picks it up at the orange pick-up location (gather location at the funnel prop). To send it to the next node, the user drops the packet again at the green drop-off location (edge of the funnel prop).

CONCLUSION

We presented the concept of immersive process models – a technique that allows users to explore EPCs in a multisensory VR experience. Our concept maps 2D EPC graphs to 3D environments of floating platforms that can be explored by means of teleportation and natural walking. We introduced logical walkthroughs to support users in experiencing the dependencies within a process, and present the idea of interactive tangible information packets providing haptic feedback. We concluded by outlining future research directions and look forward to further exploring the presented concept.

ACKNOWLEDGMENTS

We thank Scheer Holding for supporting this project. This research was funded in part by the German Federal Ministry of Education and Research (BMBF) under grant number 01IS17043 (project ViRUX).

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