COGNITIVE ASPECTS OF COLLABORATION IN 3D VIRTUAL ENVIRONMENTS

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Introduction

- Part of the project: „Influence of cartographic visualization methods on the success of solving practical and educational spatial tasks“
  - March 2016 – December 2018
  - Work in progress …
  - Interdisciplinary research
    - Faculty of Science – Department of Geography
    - Faculty of Arts – Department of Psychology
    - Faculty of Education – Department of Geography
    - Faculty of Informatics – Department of Computer Graphics and Design
Research Aims

Main research questions:
- how different methods of visualization and user interfaces (UI) affects the way of solving spatial tasks by individual person or by group of people
- and how they affect the efficiency of processing and interpretation of spatial information and learning

Partial aims are the assessments of the impacts of:
- basic types of cartographic expression variables on cognitive processing and interpretation
- elementary perceptual and memory processes in the interpretation of maps and remote sensing materials
- various cartographic methods and types of visualization on cognitive processing and interpretation
- different UI on the formation of adequate mental representations and decisions in experimental tasks
- various types of UI in the context of cooperative education
Published studies

Virtual Reality and Collaboration

- **Collaboration** (or cooperation)
  - is as a social activity that uses the knowledge, skills and efforts of a few individuals to achieve group goals, which could not be achieved by individuals working alone (Levan, 2004)

- Virtual collaboration

- **Virtual reality** (VR)
  - is the application of computer technologies to create interactive, 3-dimensional world, where the operator feels to be present (Bryson, 1999)

- **Multi-User Virtual Environment** (MUVE)
  - importance of social, cooperative, on-line communication and interaction are emphasized
Psychological Perspectives

- Brunswik's theory
  - cyclic activity based on the active motor action of observer
- Embodied cognition theory
  - bodily elaborated information has different quality than only visually communicated information (Meteyard et al., 2012)
- Presence or also immersion
  - “the feeling of being there”
  - Described in detail by Mania et al. (2006)
- Engagement
  - the involvement of users into VR (Bakker et al., 2011)
Cartographic Visualization

- Variety of cartographic visualization methods suitable for 3D environment
  - from realistic visualization (photorealistic rendering)
  - to the abstract simplistic depiction
- Functionality (efficiency) of selected cartographic visualization methods is also influenced by purpose of visualization, given task, used UI, user abilities …

Photorealistic visualization (Google Earth) and abstract visualization of 3D noise map. Area of city district Nový Lískovec (Brno, Czech Republic)
Available Equipment

- Two stereoscopic projection walls with passive glasses, both with Motion Capture systems
- Several 3D monitors with shutter glasses
- Several Oculus Rift DK2
- Oculus Rift DK2 with SMI Eye Tracking HMD Upgrade
- AR glasses (e.g. Vuzix Wrap 1200AR)
- Nintendo Wii controllers, Microsoft Kinect sensors, 3D mouses, touch screen, …
- SMI RED 500 and EyeTribe
- …
Software

- **Hypothesis**
  - web based platform for experimental testing, which was designed especially for the assessment of map usability
  - can be used for the research of virtual collaboration based on 2D visualizations
  - is developed by Department of Geography (Faculty of Science) and Department of Psychology (is described in detail in Šterba et al., 2015)

- **VRECKO**
  - software platform for 3D visualization
  - is applicable to providing only individual task solving or direct cooperation of users
  - is developed by the Department of Computer Graphics and Design

- **Unity**
  - is originally cross-platform 3D game engine currently modified by Department of Computer Graphics and Design
  - can be used for virtual collaboration with spatial data and networking thanks to the multiplayer mode support
Possible Utilization of Equipment

- Three types of collaboration

a) 2D or Pseudo 3D visualization

- shared space
- direct eye contact
- interaction takes place undisturbed

b) Real 3D visualization

- shared space
- difficult direct eye contact
- increased focus on 3D map

c) Real 3D visualization

- shared virtual space
- on-line communication
- users monitor the activity of the second user
Our Version of MUVE – *type b*

**Stereoscopic projection wall**
**VRECKO / Unity**

**USER 1**
- 3D glasses
- Nintendo Wii RC

**USER 2**
- 3D glasses

**RESEARCHER**

direct communication
Our Version of MUVE – type b

Individual user is solving task in 3D virtual environment

These technologies can be used in practice for example in education (teacher showing geographical phenomena to students) or in crisis management (planning of interventions by emergency committee).
Current Version of MUVE – *type c*

**USER 1**
- Occulus Rift
- Unity
- Nintendo Wii RC

**USER 2**
- Occulus Rift
- Unity

**RESEARCHER**
- PC monitor

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**Interaction**

**Depiction**
Our Version of MUVE – type c
Future Version of MUVE – type c

**USER 1**

- Oculus Rift
- Unity

**USER 2**

- Oculus Rift
- Unity

**RESEARCHER**

- PC monitor

**Interaction**

- Nintendo Wii RC

**Depiction**

- virtual communication
Future Development

- We suggested the possibilities of establishing the variable platform for the research of virtual work and collaboration, but many of the theoretical, technological and methodological aspects still remain to be explored
- Development of software platform
  - On-line audio communication
  - Support of multiple devices for user interaction
- Use of multiple devices (Motion Capture, mobile eye-tracking, EEG) for evaluation of users strategies
- Pilot test, 1st experiment, 2nd experiment, 3rd experiment, …
THANK YOU FOR YOUR ATTENTION!

QUESTIONS …

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