SPATIAL COMPUTING

at UNDP

Handbook on the current state of exploration

– including example projects

Novembe

1 Purpose of this document

The main aim of the documents is to serve as an internal and external-facing strategy document that describes the UNDP's leadership in finding innovative applications for spatial computing. It will discuss how the use of cutting-edge copresence and remote collaboration technology can make its operations faster, safer and more efficient. It will also explain how shared 3D visualization displays can make data more comprehensible, increase communication bandwidth and enable smarter data-driven decision-making

It was developed in the context of UNDP's "Presence Anywhere Anytime (PAA)" project, which was one of the frontrunners from the first UNDP Digital Sprint Cohort, started in February 2020. This document describes the concrete use cases that were identified as part of the project and summarizes the completed case studies including example outputs and lessons learned. The main objectives of the document are to support UNDP project managers in identifying use cases for spatial technologies in their work, as well as to provide practical guidance for the implementation of such projects.

These pilot projects are part of PAA's broader exploration of spatial computing's potential as a tool for UNDP's data-driven, integrated approach. We're learning how data-driven storytelling can combine with co-presence - the ability for people in different locations to work together as if in the same room. In recent years, UNDP has spent $200 million per year on travel, often to high risk areas where UNDP has mandates and is assisting Governments with development. As the world's challenges become more complex and travel is limited to avoid the spread of the pandemic, spatial computing could also enable UNDP to engage governments and the public across the globe in more insightful data conversations while maintaining staff safety, reducing carbon emissions and limiting expenditures of public resources.

This document is built upon finding at the meetings with relevant UNDP colleagues, partners, extensive communication with Flow Immersive, Spatial and Magic Leap companies which were also present at the meetings and desktop research. The main purpose of this document is, therefore, to provide an overview of findings, examine what are the possibilities for introducing the technology in UNDP (what are the possible directions to work together) and to draft a roadmap for a joint pilot and deployment.

- *Background*

At the beginning of July 2019, UNDP Alternative Finance Lab and Magic Leap started to explore the potential of spatial computing to 1) quickly and vividly communicate the impacts of climate change; 2) translate complex climate data and systems into 3D visual model that can assist in identifying new climate patterns and perspectives; 3) create new emphatic experiences for the viewers. During that time the team (UNDP and Magic Leap) created an engaging immersive experience presentation called 'Climate Change Spares No One' that brought to life visceral implications of climate change on delta cities – New York, Mexico City, Amsterdam. The interactive presentation was shown during the 74th General Assembly in NY, where during the Social Good Summit, and together with Achim Steiner, Magic Leap team presented how digital innovation and spatial computing can help UNDP to meet the Sustainable Development Goals. Partners were the German Space Agency, Magnopus and BadVR, that helped us to create on-device demonstrations for delegates and members of the UNDP, showing how spatial computing can illustrate many of these global challenges. One of the points that came from the event and closed up talk with Achim Steiner, was to see how spatial computing companies could assist to UNDP in creating the strategy of how the future of development might look like, by introducing telepresence, and integration with global and local information networks that can enable lower costs, CO2 reduction in flights and faster and better collaboration and communication.

This created a baseline for further exploration, when PAA team was invited to participate in first ever UNDP Digital Sprint (Sprint) coordinated and sponsored by new UNDP unit - The Chief Digital-**UNDP, led by Robert Opp**. Presence Anywhere Anytime project and team were selected (among other ideas and teams) and started to work on project scope, activities and spatial computing business models.

During the digital sprint planning session, **Data Visualization** and **Remote Co-Presence** (or "Spatial Telepresence") surfaced as the strongest use cases through the analysis of potential cost savings and emissions reduction from cutting back on the amount of travel. These became the Presence Anywhere Anytime pilot that is currently in flight as of October 2020.

2 The Presence Anywhere Anytime (PAA) Project

2.1 Context: UNDP Digital Strategy and the PAA project

UNDP Digital strategy: the first of its kind in the UN system is exploring how technology rapidly transforms the way development is done. With the Digital Strategy UNDP is transforming the use of technology and with that is leading the future of development (UNDP Digital Strategy, CDO, UNDP Digital Offer, PAA..)

With the Digital Strategy, UNDP set out on an ambitious transformation journey focused on harnessing technology and innovation for sustainable development. One important element and objective of this journey is to better understand the potential of digital technologies, articulate their use and value and readily apply them to better serve our partners in their efforts to achieve the Sustainable Development Goals.

Based on the objectives described in the Digital Strategy, UNDP will explore and deploy new collaboration models, introduce supporting systems, structures, and mechanisms, and build capabilities to develop and apply digital solutions that will enhance the quality, efficiency and effectiveness of our work.
Exploring the use of spatial technology for UNDP was chosen as one of the first "Sprint" projects supported and funded by the UNDP Chief Digital Office. The novelty of the technology and the huge potential benefits for the organisation (see 4.3), were the main factors for that.

The Presence Anywhere Anytime (PAA) leverages spatial computing technology for the same purpose: to make UNDP operations faster, easier and safer.

The PAA program focuses on applying spatial technology to two specific problems. One is making data-driven approaches to SDG easier and more effective. One of the challenges of data-driven work is becoming overloaded by the amount of data available. By visualizing data in a three-dimensional interactive format, spatial computing makes the key insights gained from this approach more easier to see and communicate.

The second problem is remote collaboration. Even before the pandemic, UNDP's work involved expensive, time-consuming and environmentally costly travel. Now, travel is even more difficult. The PAA program will pioneer the use of spatial computing to create virtual shared workspaces, where workers hundreds or thousands of miles apart can work together and interact with the data as if they were in the same room.

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- *The Presence Anywhere Anytime Pilot*

UNDP's 2019 annual report states "it took a pandemic to amplify the role digital technology plays in development." As the UN's leading agency for development with offices in 170 countries around the globe, the UNDP has been focused on publishing accessible, insightful and actionable development data, such as the Human Development Index. Yet, as data volume and complexity have increased, the need to add a dimension to our data analysis has grown. Today, with the added hurdle of COVID-19, travel restrictions have made meaningful, collaborative data analysis simultaneously more difficult and essential to robust policy decision making.

UNDP plans to empower country offices with fully interoperable augmented reality (AR) solutions. AR promises to enable a) deeper data insights with b) more included participants at c) a lower cost while d) reducing travel-related carbon emissions and e) supporting public health and security recommendations.

- *SDG Integration Use Cases*

Although initially tasked to visualize COVID-19 impacts as a part of the Data Platform, 3D data visualizations by Flow were used initially as part of the SDG Moment and SDG Action Zone presentations at the UNGA. These presentations were then repurposed and included as part of the Data Platform. These engaging data stories could empower UNDP to communicate challenges and opportunities within the data, and therefore build appropriate socio-economic recovery plans quickly and implement short and long term social potential measures.

- *Zimbabwe Economic Data Visualization*

Zimbabwe's information food economy is the second largest in the world and some of the most vulnerable population groups depend on it to live. We took Knowledge Transfer Africa's food supply and price data to build spatial data stories that leverage spatial computing in order to better understand economic shock and identify vulnerable groups within the country. By using 3D visualisation in Flow, we were able to illustrate and communicate the differentiated impacts on vulnerable population groups in a more engaging way than through traditional presentation formats.

- *Colombia Use Cases*

UNDP Colombia is interested in exploring alternatives to holding multinational in-person meetings without the need for traveling. For example, it would take an estimate of 25 flights, 200 combined hours, with some carbon footprint, in order to have the meeting where five world leaders discuss the development challenges and potential crisis management solutions surrounding the Amazon forest. This is a great opportunity to leverage spatial computing to do real-time remote collaboration and spatial telepresence where attendees can get a sense of physical presence and review 3D data and other documents together, aiming to accelerate the speed of decision making.

- *Flow Expansion beyond the PAA*

Flow Immersive has expanded the definition of AR/VR/MR back into the practical day-to-day realities of remote conferencing during COVID. The company likes to say "You can lead a horse to

water, but you don't want to dunk its head in." AR/VR headsets hold great promise - maybe even greater promise of presence in the time of COVID - but rolling out new hardware when many users are stuck at home has practical limitations. Also, Zoom and Teams have become universally-adopted tools for large and small meetings. Here Flow, using 3D visualizations presented on flat screens, has found a niche and is growing rapidly through the organization.

The SDG Moment presentation was widely seen, and directors and even deputy directors started asking colleagues about using Flow for more events.

Flow Immersive's data story presentation system has found continued success in applications within other areas of the UNDP beyond the PAA. These include:

- *Data Insights Platform integration*

data.undp.org

The SDG Moment Flows were repurposed into country-specific pages in the platform as embedded (i-frame) presentations within the page.

- *Vertical Funds Internal Controls for GEF/GCF/AF Resources*

https://a.flow.gl/#/flow/fo131s0

Pradeep Kurukulasuriya asked for a presentation to better show the context of projects flagged for auditing within the overall success rate of the VF portfolio. Digging deeply into the data provided him with what he felt was one of his most successful presentations on this topic. This was presented using standard screen-sharing software, sharing Flow in a browser window. Future efforts may include dynamic

collaborative meetings around live portfolio data.

- *Integrated Support for the Aral Sea in Uzbekistan*

https://a.flow.gl/#/private_flow/6ac6a09a32ab

In about a week, a Flow was built for the Uzbekistan CO to provide a presentation for the senior ministers of the Uzbekistan government around a very difficult topic. Only a small amount of data was available to discuss the project, but Flow could be successfully used to help explain concepts of systems analysis and the detailed plan and timeline of the project.

Global Policy Network Board Meeting

https://a.flow.gl/#/flow/hk0u77u

The internal annual Executive Board meeting of the Global Policy Network contained a Flow, shared via zoom, as presentation material for George Conway, Deputy Director of the Crisis Bureau, and Adriana Dinu, Deputy Director of the Bureau for Program and Policy Support. The Flow presented the financial overview of 2020 accomplishments and status of many programmes in the time of COVID.

2.2 Overview of Spatial Computing

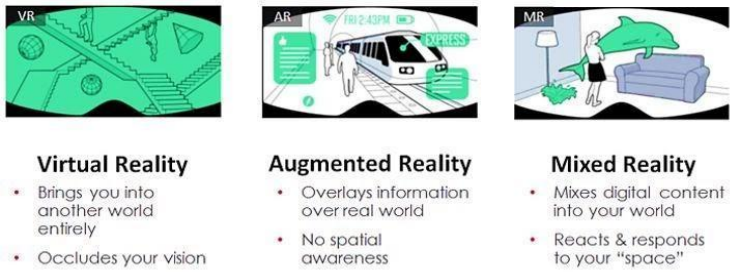


Image Credit: How2shout.com

What is spatial computing? It's a new paradigm in digital technology. It means working with information through three-dimensional displays instead of flat screens. Spatial computing uses wearable head-mounted devices (HMD's) that make interactive digital content exist in our world - comprehensible and intuitively accessible the way objects in our world are.

The term 'Spatial Computing' describes the full spectrum of Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR). AR and MR overlay or integrate virtual content into the physical world, whereas VR technologies fully immerse the user in a purely digital world. AR and MR are the focus of this document. They allow users in the same space to still be connected to one another as well as interact with the physical objects in the room (such as a keyboard).

Sub-categories of Spatial Computing

Virtual Reality (VR)

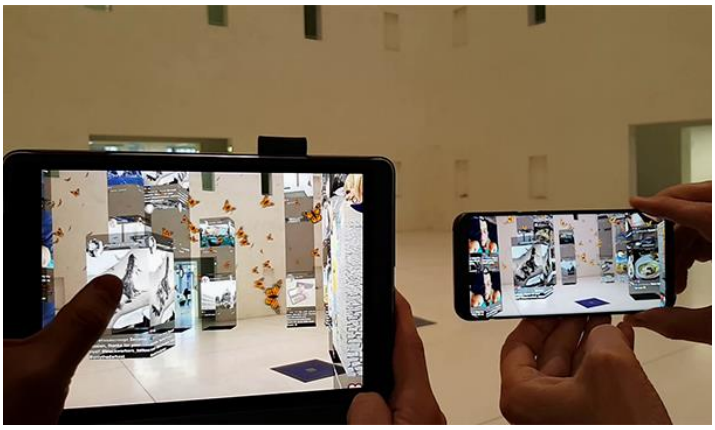
Virtual Reality is a purely simulated experience that will immerse a user in a 3D virtual world through a headset. The user's vision is entirely occluded and 100% of their experience takes place in this

virtual environment.

Images source: wikipedia

Augmented Reality (AR)

Augmented Reality is a holographic display technology that overlays virtual content over the physical world through a transparent screen or a transparent pair of glasses. In this case, the holograms or virtual content does not have an understanding of your physical environment.



Images source: wikipedia

Mixed Reality (MR):

Mixed Reality is the merging of the real world and holograms to produce new environments and visualizations where physical and digital content co-exist and interact in real-time. The holographic content and environment sensing is done through externally facing cameras on the device, whether it be a pair of glasses or a phone.

Images source: microsoft.com

- *Different usage of Spatial Computing*

All three types of Spatial Computing (VR, AR, and MR) offer a wide range of use cases and are increasingly being employed across every industry. For example, the most common usage of Virtual Reality is for training simulations and for the creation of shared spaces. They are most effective at immersing the user in a realistic digital environment to allow them to learn new skills in risky scenarios such as medical surgery or space flight training or provide a shared online space for classrooms, conferences, workspace collaboration, or for social interactions. Augmented and Mixed Reality provide the same tools as Virtual Reality for users who are either together in the same physical space or benefit from seeing digital content alongside their physical environment. Common usages are in on-site urban planning visualization and 3D data visualization.

2.3 Potential of Spatial Computing for UNDP

- *Data Visualization*

An integrated approach to SDGs necessarily involves finding relationships between different SDG goals and related systems. In a data-driven project, the challenge isn't just collecting that data, but making it readable - finding the previously unseen patterns and correlations in the data sets. The new technology can create three-dimensional graphs and data projections, projected in a shared workspace. The data can be made interactive, which means you can shift axes and datasets dynamically to find a significant comparison.

Edward Tufte, one of the pioneering scientists on data visualization, wrote that: "It is not how much information there is, but rather how effectively is it arranged." A better visual representation of a dataset makes it easier to see the story that information contains. You might say, it takes the cognitive load of processing that information away from your brain, and lets your eyes do it much faster and more easily.

In line with UNDP's effort to becoming a truly data-driven organisation as part of #nextgenUNDP, improving our engagement with data is a key objective.

- *Remote Collaboration and Co-Presence*

One of the primary applications of Spatial Computing is creating powerful shared workspaces (remote Co-Presence) for local and remote collaboration. Digital workspaces will allow UNDP colleagues to be present and communicate as three-dimensional avatars and work with the same three-dimensional displays and interactive models just as if they were in the same room. Spatial Computing will enable real-time translation through subtitles, and by reducing the need for travel it can help the UNDP reach its goal of reducing its carbon footprint. In a larger sense, Spatial Computing's ability to create connections between people will help facilitate the widespread international cooperation needed for effective climate action.

Spatial computing uses computerized goggles to create a three-dimensional version of the digital world. Their display can take any digital information and display it in the room with you as a three-dimensional, interactive object made of light. The goggle also maps the world around you, and using this information it makes the virtual objects respond to the world as physical objects would. Lastly, the goggles are aware of their context, including you. You can interact with virtual objects through a controller, or your movements, gesture and voice.

Spatial Computing applications, particularly Data Visualization and Digital Collaboration Workspaces (Remote Co-Presence) have a lot of potential to improve UNDP's efficiency and effectiveness.

Specifically, the use of spatial computing applications is expected to provide the following benefits for UNDP:

Data Visualization

Deeper data insight and improved data-driven decision-making: Spatial computing data visualization can assist with taking large quantities of complex data and displaying them in an easier to understand format. By moving away from large spreadsheets and databases towards interactable 3D models and contextual graphs, the technology can provide new insights that were not apparent before, allowing for better data-driven decision making.

More and deeper engagement around data

3D data visualisations are more engaging than traditional data visualisations (e.g. PowerPoint). They enable conversations which are strongly focused on data and improve UNDP's ability to convey important messages and results.

Visualizing Data on a Greater Scale

UNDP and development organizations are using huge amount of data which makes it hard to visualize the impact and the real depth and complexity of what is happening (especially complex interrelationships in climate change projects whereby removing 2D screens we can get the ability to see and sense climate change as it is HAPPENING NOW and as we are the PARTICIPANTS not viewers).

Empathic Experience

Spatial computing and smart visualization technology are encouraging empathy towards the community by creating an "empathetic experience," by making the reality of SDGs closer to personal experience. UNDP spatial computing projects could offer a new experience and a new visual storyline to expand people's view on climate change and unify them around common and global climate challenges.

The Future of Storytelling: UNDP spatial computing projects could create a future reality where we could translate and showcase huge amounts of SDG data to be seen and experienced first-hand. Immersing people in the extreme reality of the (e.g. impacts of global warming of 1.5 °C above 2°C) or more yet to come may encourage them to demand policy change today.

Remote Collaboration (Co – Presence)

- Reduction of cost by replacing in-person meetings and travel: Travel is one of the main contributors to UNDP's carbon footprint and operational costs. Application of spatial computing digital collaboration and co-presence can reduce the need to travel for internal in-person meetings and missions. A reduction of UNDP's travel by 10% would lead to cost savings of 20 million USD annually.
- Reduction of carbon emissions by replacing in-person meetings and travel: In 2018, 42% of UNDP's greenhouse gas emissions resulted from air travel. Replacing in-person meetings with virtual co-presence meetings will cut air travel of staff and thus reduce UNDP's carbon footprint. Since the organization has set an ambitious goal to cut emissions by 50% until 2030, reducing travel is a key organizational priority for UNDP.
- Increased safety and improved efficiency in fragile contexts by replacing in-person meetings and travel: UNDP operates in more than 170 countries and territories all over the world, many of them suffering from conflict. Virtual co-presence could eliminate the need to travel to dangerous areas and improve UNDP's ability to connect with beneficiaries and government on the ground.

3 Spatial Computing use cases and case studies

3.1 Use Case 1: Data visualization

The first use case of spatial technology at UNDP is 3-D data visualization. As the complexity and volume of the data that UNDP handles increases, adding a third dimension provides a more engaging way to work with data. Today, with the added hurdle of COVID-19, travel restrictions have made meaningful, collaborative data analysis simultaneously more difficult and essential to robust policy decision making.

3.1.1 Case Study 1: Visualization of Covid-19 impact data to support Administrator presentation at UN General Assembly

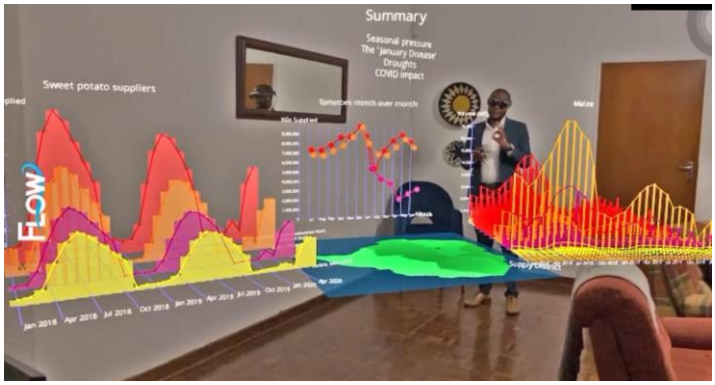
The UN General Assembly began on 22 September in New York. Due to COVID-19, the annual gathering was held predominately online. As part of the SDG moment, UNDP Administrator Achim Steiner as well as the Executive Directors of UN Women and UNEP held a presentation on the progress towards achieving the SDGs. 3D data visualizations were used for these three presentations which were also streamed live on UN Web TV. The link to the video of the presentation can be found in the Annex. The presentation was created with the software company Flow Immersive (see 7.2). Afterwards, the three presentations were updated with overlay narrative text to be stand-alone and have been integrated into the UNDP socioeconomic COVID-19 recovery data insights platform (data.undp.org). While not strictly AR/VR, these presentations are AR/VR ready, and because of the flexibility of the Flow system, the visualizations can be experienced within headsets or on mobile devices using AR.

Presentation of UNDP Administrator Achim Steiner at SDG Moment September 18th 2020

3.1.2 Case Study 2: Multi-dimensional visualization and analysis of economic data

Zimbabwe's information food economy is the second largest in the world and some of the most vulnerable population groups depend on it to live. PAA team together with Flow Immersive company was using a data-driven approach to understand the food resilience in Zimbabwe.andsee what are the vulnerabilities that are determined by multiple interacting systems. For example, produce for sale at any given market has gotten there through a multistage supply chain involving both farmers and one or more middlemen, a network whose behavior has been disrupted by the pandemic. This issue is juxtaposed with seasonal effects. Because rainfall varies on a seasonal cycle, many crops alternate between scarcity and abundance, and their price varies accordingly. However, under pandemic conditions many have failed to entirely rebound from their most recent seasonal low point. There are even more factors layered on top of these - variations by type of produce, the ability to store goods, a seller's proximity to national borders and the merchant's gender all impact price points.

We took Knowledge Transfer Africa's food supply and price data to build data stories that leverage spatial computing to better understand economic shock and identify vulnerable groups within the country. Flow Immersive has a simple online toolset that allows us to upload datasets and use them to create three-dimensional, immersive presentations. Data can be charted along three different axes and viewed from all sides in a shared online space.



Visualisation of economic data: Output of project with Zimbabwe Accelerator Lab

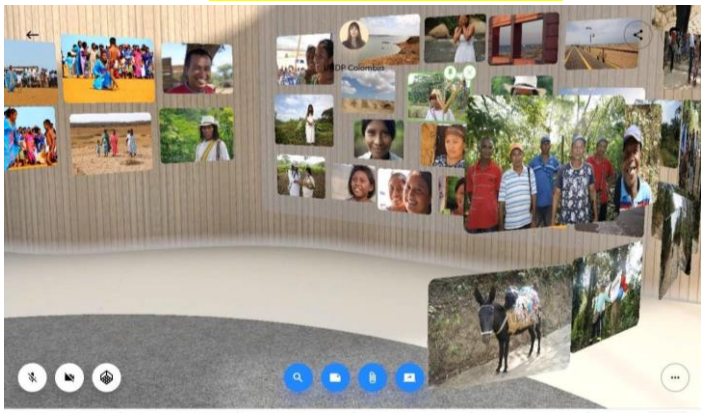
The presentation format allowed us to map and explore data for the multi-stage supply chain, environmental effects, prices and additional factors such as drought, fluctuations in consumer purchasing power, government pricing controls, etc.

3.2 Use Case 2: Remote Co-Presence

Remote Co-Presence describes an online meeting with spatial computing technology. Through virtual, augmented, or mixed reality hardware, participants can engage in a 3-D world which creates a sense of physical presence. In addition, participants can collaborate around data which is projected in the meeting.

3.2.1 Case Study 3: Remote co-presence meeting with high-level government representatives

UNDP Colombia is exploring alternatives to holding multinational in-person meetings without the need for traveling. It would take an estimate of 25 flights and 200 combined travel hours to have a meeting where five world leaders discuss the development challenges and potential crisis management solutions surrounding the Amazon forest. This is a great opportunity to leverage spatial computing to do real-time remote collaboration and spatial telepresence where attendees can get a sense of physical presence and review 3D data and other documents together without the actual need to travel. The pilot case study with UNDP Colombia country office is ongoing as of November 2nd 2020.



Visualisation of virtual co-presence meeting room for meeting with Colombia government

4 Lessons learned from PAA project

The pilot case studies have provided a lot of insight for the potential benefits of spatial technology for UNDP as well as some of the pitfalls that must be avoided in the application of the technology. The most important lessons learned are:

High degree of effort and specialization needed for 3D data visualisation: Content creation for 3D data visualisation turned out to be more complex than just setting up a remote co-presence meeting as it requires deeper analysis, research, storytelling, and user experience design. The creation of 3D models requires higher degrees of specialization and the aid of a professional 3D artist. As 3D models are more desirable than 2D images and documents for spatial meetings, a lot of effort also has to go into preparing a successful co-presence meeting.

Additional effort required for so called "data storytelling": Once raw data has been successfully transferred and visualized in 3D spatial formats, the presentation of the spatial data also has to be optimized to create the desired impact or "call to action". Creating beautiful data visualizations is not enough. Spatial data must be treated more like pictures on a screen or a movie. The order of how the data is shown is important as well as what is spoken or "narrated" over it. For the UNGA presentation, the PAA team consulted a spatial computing storyteller expert on the best way the spatial information can be presented.

Lack of hardware compromises experience while procurement cost remains high as of today: We have strategically selected our software applications to ensure interoperability and cross-platform participation from users who do not have access to expensive AR headsets. This flexibility has proven to the right choice, however it created some challenges around building enough engagement to dive into participating in the pilot. The application did not look very novel when experienced from phones and computers. We had traded some of the impact of using a new technology for practicality and ease of access. In the future, if we want to maximize impact, we will have to dedicate more effort in hardware distribution and onboarding. This is also contingent on hardware maturity and cost. Currently, the cost of procuring a VR headset ranges from 550 USD to 3,500 USD. However, this is suspected to drop significantly over time with slimmer and cheaper hardware expected as early as Q1/2021.

5 Toolkit for implementing a Spatial technology project

5.1 Choice of hardware

We investigated and engaged with a few hardware companies that have built AR/MR glasses and VR headsets in order to build a partnership with them. The following hardware companies are considered to be the best functionality fit for a potential partnership:

Magic Leap (https://www.magicleap.com/en-us)
1st generation AR/MR glasses. The hardware has 3 components: glasses, power pack, and controller. It comes with an app store with ready to download applications. The UNDP has an existing partnership with Magic Leap and have been collaborating on use case development since 2019.

Microsoft Hololens (https://www.microsoft.com/en-us/hololens)
Microsoft has two generations of the AR/MR Hololens, both available for consumers. Functionality is considered equivalent to that of the Magic Leap headset. The hardware is an all-in-one headset and has an app store with ready to download applications.

NReal
https://www.nreal.ai/
The NReal glasses are the newest AR/MR on the market, however as of November 2021 the consumer version is only available in China and Korea. The development-kit is available for purchase. The hardware contains the glasses and a power pack, with an option to plug the glasses into an android mobile device.

Facebook Oculus (https://www.oculus.com/)
The 2nd generation Oculus VR headset is now available for consumers at a low cost. This VR technology has reached the mass market and is very stable and easy to use for newcomers. This is an ideal option for more immersive type applications.

Other Common Devices: In addition to these new-to-market headsets, we are including common devices such as computers (PCs), phones, and tablets as part of the pilots to ensure the tools and applications are inclusive to as many users as possible.

5.2 Tested software providers

We have developed relationships with the following software companies through our project:

5.2.1 Flow Immersive

Flow Immersive, or 'Flow', is a SaaS software company focused on data storytelling. Flow provides a remote meeting and content system using data visualizations and diagrams for data-driven decision-making.
Flow is a web-based system with many performance modalities to reach different audiences. This includes real-time meetings (synchronous) in person or remote, and a variety of (asynchronous) sharing via email or posting online. An example of a number of these are condensed into this video: https://youtu.be/uY8KMe_LxPE . Flow can create both asynchronous and synchronous use cases:

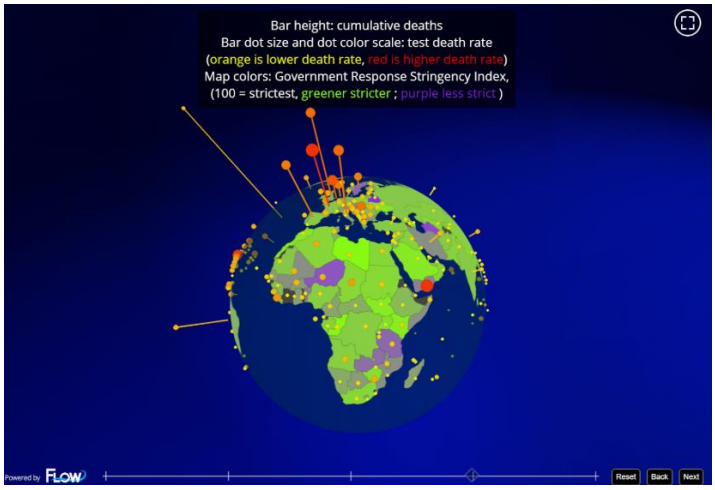


Image Credit: Flow Immersive, Inc.

Asynchronous experiences:

- Embedded visualization in a web article (interactive iframe within an article)
- A direct link with narrative text overlay, optimized for computer and mobile devices - https://a.flow.gl/#/flow/8ulv25t
- AR Video creation (captured with a cell phone running Chrome on Android, no post-processing here) - https://youtu.be/QulduT6vEJk
- Computer screen capture video recording a remote meeting with an SME walking through the data - Record a virtual session with an expert walking through to post on any video site.

Synchronous experiences:

- Presented from a big screen in a live in-person event
- Shared in a Zoom call with screen sharing
- Remote meetings with multiuser synchronized steps, full interactivity for all participants joining via web browsers on computers and phones
- Multiuser AR/VR meetings with simple avatars and laser pointers, experienced within AR/VR headsets, Mobile AR, and any other device with a browser

5.2.2 Spatial

https://spatial.io/
Software application provider of spatial computing digital workspaces ("remote co-presence). We used spatial for our pilot case study with Colombia (see 5.2.1).


Image Credit: Spatial.io

5.3 Interoperability between software and hardware

Because spatial computing is still considered a new technology, not all software applications are compatible at this time with all hardware options. We performed an analysis of hardware and software combinations that could potentially deliver the most value to the UNDP use cases identified during the PAA project (Link to analysis matrix). Our most important criteria was cross-platform

capabilities. Although these software applications are best viewed and experienced on a spatial computing headset, it was critical to ensure they could also be used with a phone, a PC, or tablet. Other criteria used in the decision-making process were overall cost of headsets and software licenses, ease of use, readiness for the General Assembly week, and customization options of features.

We used the following hardware and software in our project:

Case Study 1
Magic Leap (primary), phone, tablet, PC to use Flow Immersive

Case Study 2
Magic Leap (primary), phone, tablet, PC to use Flow Immersive and Spatial

Case Study 3
Magic Leap (primary), phone, tablet, PC to use Spatial

		Hardware & Devices						
Criteria	App License	Hololens 2	Magic Leap 1 (45 Day Trial)	Magic Leap 1 (Direct Purchase)	NReal	VR (Oculus)	Phones	Web
Cost (1 Headset)		$3,500 US	-	$2,300 US	$1,299 US	$547 US	-	-
Cost (4 Headsets)		$14,000 US	$5,000 US	$9,200 US	$5,458 US	$2,188 US	-	-
Duration		-	45 days*	-	-	-	-	-
Spatial App Compatible	$29,700 US*	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Flow App Compatible	$20k US*	Not Yet	Yes	Yes	Not Yet	Yes	Yes	Yes
BlippAR Apps		No	No	No	No	No	Yes	No
Fracture Reality		Yes	No	No	No	No	No	No
Works for Covid-19 Pilot Use Case		Not for Flow	Yes	Yes	Not for Flow	Yes	Yes	Yes
Works for Zimbabwe Use Case		Not for Flow	Yes	Yes	Not for Flow	Yes	Yes	Yes
Works for Colombia Use Case		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Works for UNGA (September 17)		Not for Flow	Yes	Yes	Not for Flow	Yes	Yes	Yes
Easy for non-technical users		Yes	Yes	Yes	No*	Yes	Yes	Yes
Hardware Deciding Factor Comments		Least reasonable option.	Would be a good option if Magic Leap can extend the trial to the end of the year.	This is a good option if you want Flow and Spatial to work by UNGA and for all plots.	Good longer term option once the consumer headset is available ($500 each) and Flow works.	This is a good option if you want Flow and Spatial to work by UNGA and for all plots.		

Screenshot of Trade-off Matrix

5.4 Practical guidance for getting started

The following chapter provides step-by-step guidance for anyone who wants to start using spatial computing technology at UNDP, either for a project or for trial or experimentation.

5.4.1 Using existing UNDP Spatial applications completed in the PAA project

- Recommendation to use a wearable headset first, such as a Magic Leap or Oculus, that is available on-site.
- If a headset is unavailable, go to the Spatial or Flow URL provided from your computer or phone to join a virtual session.
- Best experienced with one other person in the session. Two people should join the session through the Spatial or Flow URL.

5.4.2 Setting up new spatial computing applications

- Provide 1-2 spatial computing headsets at multiple locations.
- To set up a custom Spatial virtual workspace room, visit www.spatial.io and log in with your UNDP email address from a computer. Click "New Room" to create a fresh empty room.
- Once inside the empty room, upload any desired image, video, or 3D model files using the "import" button.
- Once uploading is complete, wear a spatial computing headset and activate the virtual room using the QR code on the web browser.
- From inside the virtual room from your headset, you will be able to rearrange the imported files and assets spatially around the physical room.
- You may then provide the URL of the room to other users and invite them to join your room from any device.
- Best experienced with one other person in the session. Two people should join the session at the same time via the URL.

5.4.3 Creating presentations with Flow Immersive

- The Flow Immersive team (jason@flow.gl) will assist you in identifying the goals and audience of the presentation or spatial application.
- A "presentation" Flow is built out of data visualizations that are shared with a broad audience through screen sharing, pre-recorded video, or live projection screen. It can be shared any number times with a variety of reordering, data refreshing, new text and images, and simple swarm additions.
- Some presentations ("Flows") can be created internally using the Flow Editor, available at https://a.flow.gl. (note: this process is best done by an experienced data analyst or staff member who has been trained by the tool). The Flow Editor allows you to import CSV files, create visualizations, and organize them across a step-by-step presentation.
- A Flow "spatial application" is a collaboration where users can select and filter data within the data visualizations, and those selections are shared with the remote users in real-time. Two to a dozen fully interactive simultaneous users can be joined by dozens of less interactive observer users. This is a data visualization 'application' instead of a simple "presentation." It usually requires the help of Flow staff to create.
- Once the Flow is created, a URL may be shared with other users to invite them to join a Flow multi-user session.
- Flows are best viewed through a spatial computing headset but are also available through computer browser and phone.

6 Appendix

6.1 Links and materials

Flow Data Visualizations

- SDG 2.6 - https://a.flow.gl/#/flow/kejhdo75
- Achim SDG 1.5 - https://a.flow.gl/#/flow/edle12i
- GDP 2.0 - https://a.flow.gl/#/flow/ecy4q5s
- Social Protection 4.0 - https://a.flow.gl/#/flow/et4bvf4
- Rwanda and Climate Action: An SDG Investment 01. - https://a.flow.gl/#/flow/et4b6ae
- Rwanda SDG Climate Linkages - https://a.flow.gl/#/flow/kerbfkw7
- Social Protection 2.0 - https://a.flow.gl/#/flow/esohdp1
- SDG 1.3.1 Over Time - https://a.flow.gl/#/flow/ernegt8
- Vulnerable + Columbia 4.0 - https://a.flow.gl/#/flow/erii0w0
- Hottest Coldest Months - https://a.flow.gl/#/flow/keovjitk
- Women's Empowerment to GDP - https://a.flow.gl/#/flow/eq6i2tm
- Gender Poverty - https://a.flow.gl/#/flow/kerlk0wa
- Disasters - https://a.flow.gl/#/flow/keon24ni
- Covid US Counties 8/29/2020 NYT Data 2 - https://a.flow.gl/#/flow/kekk3y7t
- Life Expectancy Tennis Court Size - https://a.flow.gl/#/flow/eloz9gd
- Life Expectancy 4 Tennis Court Size - https://a.flow.gl/#/flow/ekzezw5
- Registered Investment Advisor Sample 3.0 - https://a.flow.gl/#/flow/dq3enaq
- Zimbabwe UNDP Food Resilience Post-Covid 0.2 - https://a.flow.gl/#/m/7debb0
- Zimbabwe Tomato Supply and Price v0.2 - https://a.flow.gl/#/flow/kd9qa9ke
- Zimbabwe Carrots Supply and Price v0.2 - https://a.flow.gl/#/flow/kdz4ovvy
- Zimbabwe Banana Supply and Price v0.2 - https://a.flow.gl/#/flow/ke98oat7
- Zimbabwe Leafy Vegetable Supply and Price v0.2 - https://a.flow.gl/#/flow/kdfg0f1a
- Zimbabwe Onion supply and Price v0.3 - https://a.flow.gl/#/flow/dhirfol
- Zimbabwe Sweet Potato Supply and Price v0.2 - https://a.flow.gl/#/flow/kdz4hpo5
- Zimbabwe Maize Supply and Price v0.2 - https://a.flow.gl/#/flow/ea6wjjm
- Zimbabwe Cabbage and Price v0.2 - https://a.flow.gl/#/flow/kdffzcg9
- Zim Resilience Monitoring 0.01 - https://a.flow.gl/#/flow/e1ot9q1
- Vulnerable Population 4.0 - https://a.flow.gl/#/flow/kdkrjvur
- Zimbabwe Map Experiment 1.0 - https://a.flow.gl/#/flow/kds0xjwl

Videos, Blogs, Supporting Documents

- Video of SDG Flow - Youtube Link
- SDG Moments Script - Link
- Final Zimbabwe Pilot Video - Link
- Final Zimbabwe Script - Link
- UNDP Zimbabwe Blog - Link
- PAA Blog #2 - Link
- Covid 19 Discussion Document - Link

Spatial Rooms

- PAA Welcome Room: https://app.spatial.io/rooms/5f17308dfa7f114d66075087
- Colombia Room: https://app.spatial.io/rooms/5f6e4442fa7f116d571509da?share=2211436399804128799
- eVIN Room: https://app.spatial.io/rooms/5f7c8d9dfa7f116d5715c18e
- UNDP and a2i - https://app.spatial.io/rooms/5f7496aafa7f116d57155bfd
- Zimbabwe Room: https://app.spatial.io/rooms/5f218380fa7f11267ee10e7c