NOTES AND INSIGHTS

Reflections on adapting group model building scripts into online workshops

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Introduction

Group model building (GMB) is an important social process in system dynamics (SD) for creating a shared understanding of complex systems and providing a platform for stakeholders to exchange information and ideas (Antunes *et al.*, 2015; Sedlacko *et al.*, 2014). Gathering stakeholders around the table to discuss a contentious issue can provide important insights for SD modeling (Hovmand, 2014; Rouwette and Vennix, 2006; Van den Belt and Dietz, 2004; Vennix, 1996; Vennix *et al.*, 1992).

While online meeting platforms and collaborative tools have made great leaps forward in recent years, systems mapping has largely continued with in-person facilitation. And with good reason: in-person facilitation has proven to be an effective way to generate discussions among stakeholders (Stave, 2010). Many in the SD community have long seen the potential in using interactive platforms for GMB with stakeholder participation (e.g. Kenzie *et al.*, 2018). Yet, to our knowledge, there are no documented efforts of a fully online GMB workshop. In our case, the COVID-19 virus and sudden change in travel and work patterns meant that an anticipated GMB workshop could not be executed as planned. Instead of canceling or postponing the workshop, we used this disruption as an opportunity to test the potential of running GMB processes online.

One key advantage of online GMB is that it can make room for more—and more diverse stakeholders—at the table, no matter where they may be in the world. This can improve access and participation, although groups with strong power dynamics may require skillful facilitation. Online GMB can also greatly reduce the need for travel, which could reduce the amount of time and money needed for a workshop in addition to reducing carbon

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footprints. The lack of travel logistics can also mean that workshops could be planned with less advance notice and perhaps be more responsive to current issues.

In order to move an interactive GMB workshop online, we needed to:

- Find an online architecture that supports divergent activities (e.g. drawing graphs) in a collaborative and interactive way;
- Adapt standard GMB scripts to online interactions; and
- Develop and define roles within our group to support the various challenges we could face before, during, and after the workshop.

Online GMB, with stakeholders sitting alone in front of their computer screens, is fundamentally different from in-person GMB workshops, and there are limitations to how much one can substitute for the other. We found, however, that we could recreate many of the strengths of an in-person GMB workshop in an online environment.

Our positive initial experiences with online GMB indicate that it's worthwhile to build on and further develop methodologies for online stakeholder engagement. We propose that online GMB, a practice with its own set of strengths and weaknesses, should be further developed as its own set of methodologies parallel to traditional (in-person) GMB. This research note includes a description of our experiences and lessons learned as well as areas for further development.

Context

The workshop was planned to gather representatives from the business sector, public policy sector, and academia to work on two cases. The first case addressed the Bergen, Norway, goal of becoming "fossil fuel free" by 2030, and the second case focused on innovation across sectors for ocean technology and offshore industry. The workshop was the first phase in a larger project. Subsequent phases include a hackathon in which SD students and practitioners use the causal loop diagrams from the workshop to generate models and ideas for policy interventions. In phase three of the project, winning submissions from the hackathon are refined and presented at an "innovation festival" in Bergen.

Objectives of the workshop:

- Introduce systems thinking and system dynamics to participants;
- Engage diverse stakeholders;
- Build a shared understanding of a complex issue; and
- Motivate participants to consider where and how to intervene in the system to achieve systemic change.

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The workshop had been planned for early June 2020 as an in-person, five-hour GMB session with a focus on systems mapping. When it became clear that the workshop could not be held as planned due to Covid-19 and social-distancing requirements, we assembled an international team to redesign the session as an online workshop on the same date.

Participants had little or no previous experience with systems mapping, systems dynamics, or systems thinking. The workshop was advertised as a "Crash Course in Systems Thinking," and all participants referred to the possibility of learning a new skill or perspective (as opposed to having strong stakes in the issue we were mapping) as a major reason for registering. Our participants were fairly homogeneous in education levels and technological savvy. Further, all participants were from Norway, a society typically characterized as egalitarian and "flat," with an expectation that everyone's contribution should be heard. Working with more diverse (ethnicity, familiarity with technology, language abilities, etc.) groups, or groups with more complex power dynamics, in an online environment will require more sophisticated facilitation techniques, but that is not the focus of this research note.

Creating a workable architecture

The first step in moving our workshop online was finding a digital platform that could support the activities and interactions in a GMB workshop. Particularly, we were looking for a collaborative platform that could ideally support both divergent and convergent activities:

- For divergent activities, we needed a workspace that allows for independent, synchronous work by the participants. This includes tools for drawing graphs, adding variable names or other information as text, as well as for easy navigation across the mentioned elements.
- For convergent activities, we needed a platform that allowed for different view levels, both a full-frame view of activity areas or the causal map, as well as the opportunity to "zoom in" and focus on specific areas. Specific features to draw causal maps were also a significant requirement, including arrows that could "stick" to text boxes and graphs, to allow for easy rearrangement of elements in the systems map.

A significant consideration for our design was to minimize the transitions between workspaces and the learning curve for participants. While existing SD softwares offer increasingly sophisticated causal-loop diagram abilities, they do not allow for real-time group editing. Some members of the group had experience with other online tools such as Kumu, Sheetless, Padlet, Loopy, Mental Modeler, and Meetingsphere, but none of those platforms met all our needs for divergent and convergent activities.

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After much searching, we realized that there was no perfect online platform, but that one platform, Miro (miro.com), came close. Miro is a very flexible, collaborative, and interactive online platform that includes a large board, onto which different types of notes, discussions, and diagrams can be placed. Everyone with access to the board can add or take away text or drawings. Other valuable features include a timer and a "share screen" feature that allows a facilitator to bring everyone to the same part of the board. Miro includes a video chat function, though it only shows the videos of up to three people at a time, and the facilitator could not mute all participants at once. Lastly, although Miro's tools include "sticky" arrows, we could not easily assign +/− symbols to the arrows (though arrow color could be changed to show polarity). Another important limitation of Miro is that it does not offer the possibility for turning the systems map into a simulatable model in later stages of the GMB process.

As Miro could not meet all our needs, it was used in conjunction with Zoom, email, Google Drive, and WhatsApp during various phases of workshop planning and execution (Figure 1).

Preparing for the workshop

Both divergent and convergent group activities were selected from standard scripts, which define essential elements of the GMB workshop, the steps needed to complete the script, and the outputs produced from the scripts (Andersen and Richardson, 1997; Hovmand *et al.*, 2011; Hovmand *et al.*, 2012). The modeling team then adapted the scripts to the online workshops and developed the workspace.

Every aspect of the workspace layout had to be built "by hand," as Miro does not include empty graphs or other templates that we needed. The main design challenge was to find ways the platform could support the strengths of the different activities. For divergent activities, we needed to give control to the participants to produce their ideas. For this, we designed individual workspaces that the participants could zoom in to and work without disruption or distraction. For convergent activities, a balance was necessary between viewing large clustering or mapping spaces with the minimum possible loss of information on individual variables. Text boxes that automatically resize depending on the zoom were particularly useful in this respect, and a more "tight" design was selected to reduce information loss.

All members in the modeling team were trained in GMB methods, and the entire team needed to be familiarized with the online workspace and their roles to generate the best results. The roles included meeting opener/closer, facilitators, modelers, and recorders, as indicated in the scripts. We also included an additional role specific to the online architecture: the stage manager who controlled the view of the workspace areas. The stage manager

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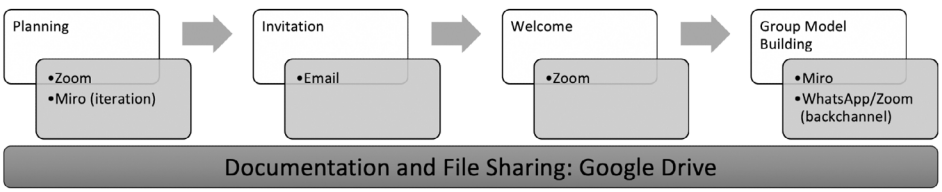

Fig 1. Applications used in different phases of online group model building.

used the "Share Screen" mode and the "Bring-To-Self" feature to guide stakeholders to different parts of the board while activities were described and demonstrated with examples. For individual activities, the "Share Screen" mode was turned off, and participants could navigate and zoom in and out of the board as they desired.

Adapting GMB scripts

We used established scripts from Scriptapedia to facilitate the GMB workshop (Andersen and Richardson, 1997). The main steps, time required during the session, and outcomes, were essentially the same from the original scripts. The scripts we used are:

a. Graphs Over Time;
b. Variable Elicitation;
c. Initiating and Elaborating a Causal Loop Diagram;
d. Model Review;
e. Action Ideas;
f. Next Steps and Closing.

The differences between the original and adapted scripts for the virtual environment, were (i) the materials, which were replaced by the tools in Miro and (ii) some parallel activities in Miro that needed to be paired with the corresponding step in the script. We created a Google document with the steps in each script, timing, and the specific activities that the stage manager and modeler needed to follow in Miro along with the facilitator's activities. This adapted script was applied in both case studies.

As an illustration, we present an example of how we adapted the Graph Over Time script to Miro's workspace. For practical reasons, we combined the Graphs Over Time script with the Variable Elicitation script. Participants first generated a set of graphs with the key factors they considered were causing the problem, and we used those graphs as a starting point to elaborate the CLD. Participants could then add variables using a text box as they were building the diagram with the modeler's help.

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To develop the layout and material for the script in Miro, the design team focused on what usually "works" in the in-person execution of the script and attempted to mimic, to the extent possible, the experience of a GMB workshop. Due to the small size of the group, we were able to create individual virtual desks for independent work. Graphs Over Time templates were placed on each workspace to reduce the need for moving elements in the platform, and a "stack" of additional templates was placed next to each desk. Following the script, a board for clustering ideas and a large area for systems mapping were developed, accompanied by "parking lot" and "duplicates" areas (Figure 2). In Table 1, we detail the activities and roles for online implementation of the Graphs Over Time script.

After the Miro layout and the script were adapted, the entire team conducted two practice rounds to test technical issues, visibility and ease of use of elements on the board, and timing for different steps in the process. Through the trials, the entire team could test the workshop experience in real time and practice using tools and navigating the board as a participant. In addition, team members developed familiarity with the script, roles, and tasks and practiced interactions among each other to ensure a smooth experience for participants. These practice rounds resulted in a number of ideas and adjustments for streamlining the workshop and improving user experience.

During the workshop: the stakeholders' experience

The day before the workshop, participants were sent an email with instructions for creating an account on Miro, a brief video (made by a team member) showing participants how to use some of the tools on Miro, and links to a Zoom meeting and the Miro board. The participants also received a workshop agenda describing each activity (see Table 1).

The workshop started in Zoom, a platform we knew most stakeholders were familiar with (Figure 1). Here, we introduced the workshop and the GMB process. We then asked participants to join their relevant board in Miro via a link that had previously been sent to them in an email. A facilitator stayed on Zoom to chat with participants who had trouble accessing the Miro board and joining the video chat there.

The first activity on Miro was an icebreaker in which participants drew a picture about their interests and wrote a few words about themselves. In addition to getting people familiar with each other, this had the advantage of encouraging participants to use the writing and drawing tools in Miro that they would be using in the workshop activities (Figure 3). The modeling team then followed the adapted scripts according to their roles. A summary of the activities of the workshop is presented in Table 2.

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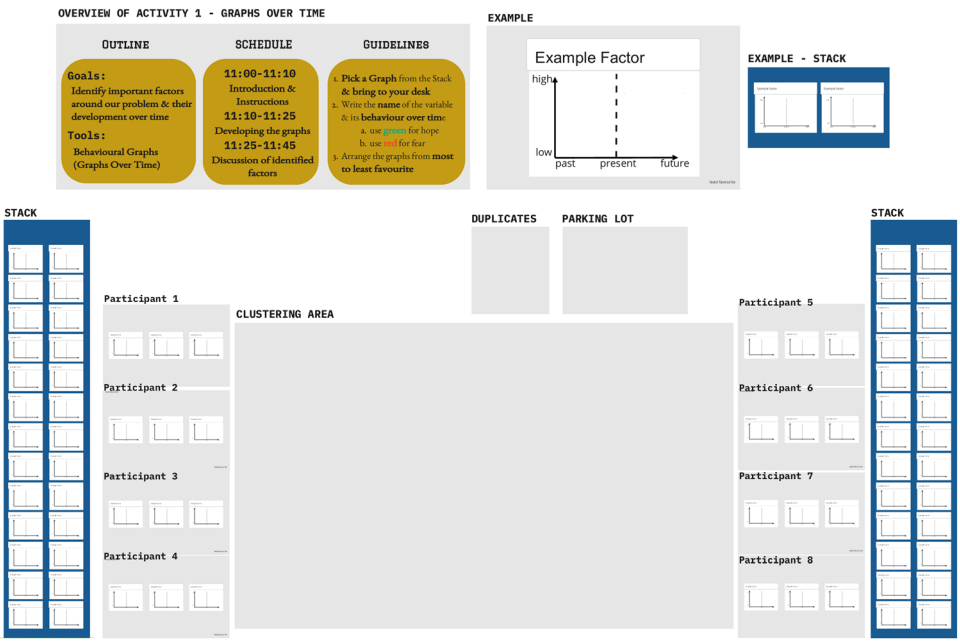

Fig 2. The full view of the Graphs Over Time activity. [Color figure can be viewed at wileyonlinelibrary.com]

During the workshop: behind the scenes

The workshop team used communications apps (Zoom and WhatsApp) to communicate privately both during active parts of the workshop and during breaks (Figure 1). Direct messaging via WhatsApp allowed us to discuss issues related to the workshop without disturbing participants and give each other feedback on what we were observing. During breaks, we used Zoom to discuss and edit the CLD. By muting ourselves in Miro, we could discuss freely and collaboratively without disturbing participants who kept their sound on. Facilitators, modelers, and stage managers accessed the prepared scripts via Google Drive, and the same service was used by recorders to document the session. As members of the workshop team were using Miro, Google Drive, and a separate communications app at the same time, we found having two screens very helpful.

After the workshop: lessons learned

Planning and conducting an online GMB workshop provided a rich learning experience for facilitators and modelers in addition to participants. In a

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Table 1. Graphs Over Time script adaptation

Time (min) (total) 11:00 11:35	Activity	Facilitator	Stage manager	Modeler
2	Introduction	Introduction and activity description	[Share Screen mode] Frame: Graphs Over Time overview	
5	Example	Description of Graphs Over Time template	[Share Screen mode]	
		Description of example factor	Frame: Example factor	Draw example from facilitator's description
3	Instructions	Introduce workspace and stack	[EXIT Share Screen mode]	
		Describe moving templates	Zoom to table (follow facilitator's description)	
		Instruct participants to find the desk with their name and zoom in		
		Remind timing	Zoom out to see all desks + Bring-to-Self so participants see entire space to easily identify their desk	
10	Individual work	Team is muted and available for questions		
15	Group work	Inform that time is up and remind next steps.		
		Call on first participant to describe a factor. Move to second participant, etc.	Zoom to described factor on desk + Bring-To-Self	Move described variable to Clustering Area and cluster. Use Duplicates Area if needed
			[Share Screen mode] Top-View of Clustering Area and zoom in following modeler's descriptions	Describe themes and confirm. If needed, merge or create themes

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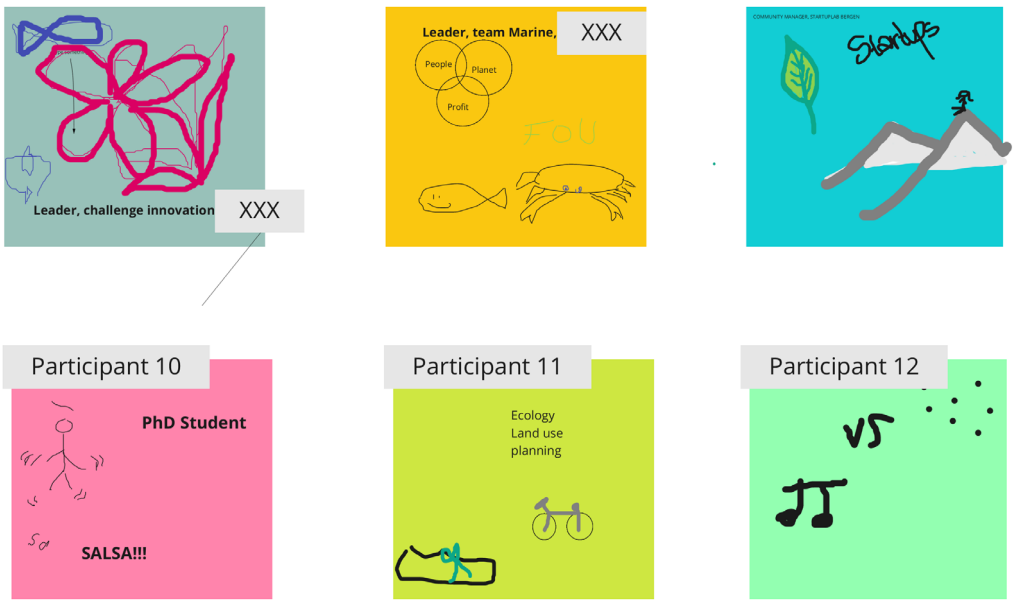

Fig 3. Example of results of the icebreaker activity. [Color figure can be viewed at wileyonlinelibrary.com]

Table 2. Summary of workshop activities

Activity	Description	Time (min)
Miro workspace/Zoom setup	Modeling team prepares the workspace and initial Zoom call.	30
Welcome, Introduction, Plan of the day	Project leader welcomes participants and opens the meeting. Introduction of modeling team and brief introduction to the activities that will be completed along the workshop.	10
Introduction to ST/SD—Group formation	Systems thinking and system dynamics are introduced by one member of the modeling team. Participants then directed to their respective workspaces in Miro.	15
Move between platforms	Modeling team ensures that all participants have migrated to Miro and joined the video call.	5
Icebreaker activity in Miro—within each case study (Figure 3)	Participants introduce themselves using Miro features while familiarizing themselves with the Miro's tools.	20
Problem articulation	Brief introduction of each case's problem to be addressed during the workshop.	10
Graphs Over Time (Figure 4)	Participants identify key factors around our problem and their development over time. Factors are clustered in a group discussion.	35
Break	Modeler moves the clusters to the large CLD area.	5
Causal Mapping/Feedback loop identification	Facilitator and modeler help participants find the connections between different concepts or variables that contribute to or are affected by the problem variable.	30
Lunch Break	Modeling team reconvenes over Zoom to clean and update the CLD	30
Model review		15

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Table 2. Continued

Activity	Description	Time (min)
	Facilitator gives a brief overview of how the map was updated during lunch break. The facilitator also checks and confirms the map together with participants in case there is something that needs to be added, removed, or changed.	
Action ideas	Participants identify possible actions that can alleviate the problem and how those fit into the systems map.	35
Model presentation (Figure 5)	Facilitator summarizes the map cocreated during the workshop and allows for further comments from participants.	10
Next Steps and Closing	Project leader thanks participants for their time, informs them of how their contributions will be carried forward, and invites them to stay after if they have feedback or questions.	15

debriefing after the workshop, we collated a list of insights that we would take forward into future online workshops. While some of these lessons learned are general "best practices" for any stakeholder engagement exercise, we highlight them here because we found them to be especially important in an online environment.

Lessons: preparing for the workshop

- Standard facilitation scripts used for GMB workshops are a good starting point for designing online workshops, but each activity needs to be

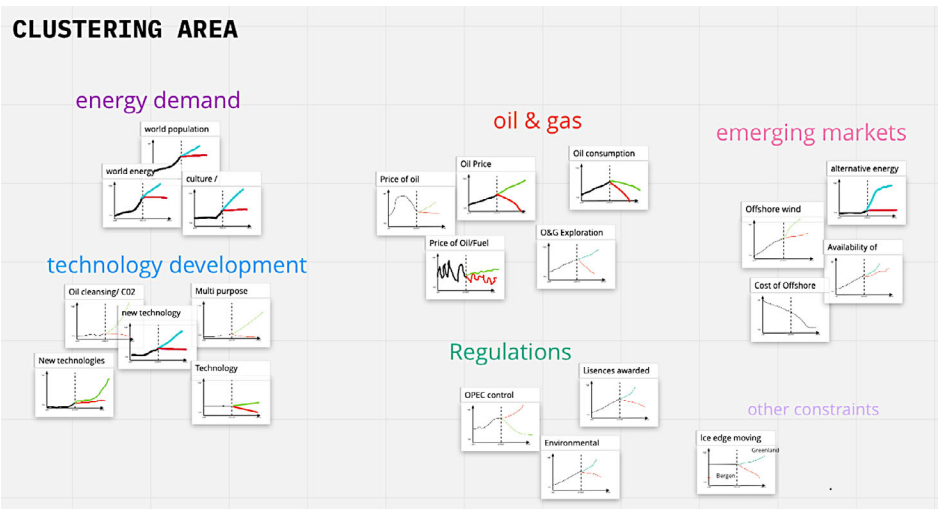

Fig 4. Behavior over time graphs, clustered (ocean business group). [Color figure can be viewed at wileyonlinelibrary.com]

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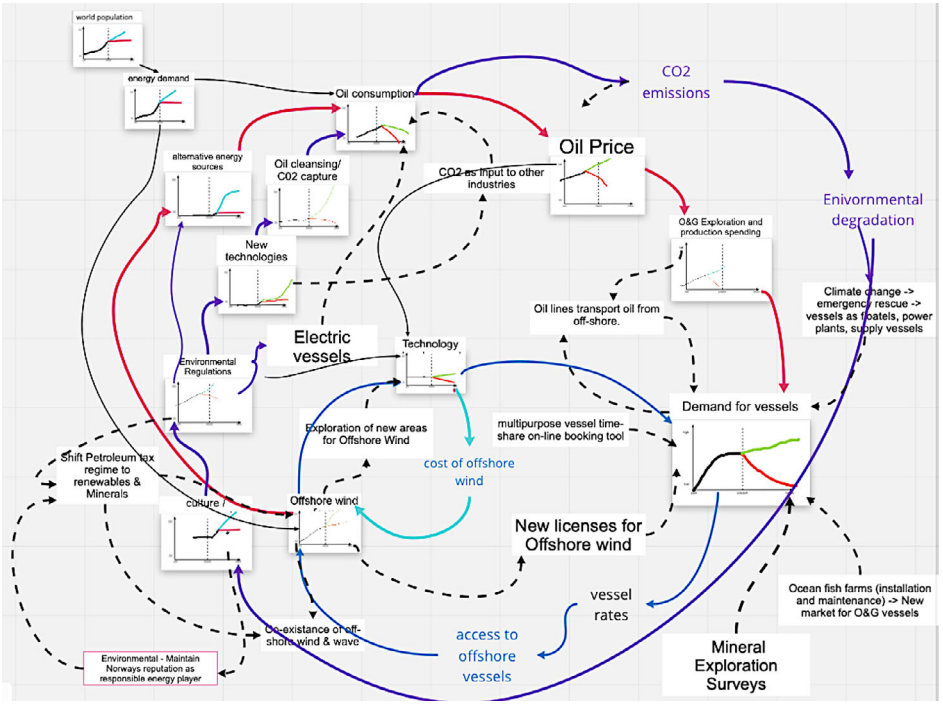

Fig 5. Model presentation (ocean business group). [Color figure can be viewed at wileyonlinelibrary.com]

carefully aligned with actions in the online platform. The script and online workspace need to be tightly coupled and tested iteratively before the workshop.

- The board should have a simple, intuitive layout that helps participants know where to look and what to do.
- The interface design team can become very familiar with the platform and its specific tools so that those seem more intuitive than they would be for users. It is especially important, therefore, to test the workshop activities and platform from a user's perspective to avoid overestimating usability.
- The modeler and facilitator need to collaborate effectively and efficiently during the workshop. The entire team should test and rehearse together prior to the workshop.

Lessons: during the workshop

Technical

- Allow time for technical problems, especially when migrating between platforms. Participants will need time to adjust audio and video settings,

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and so on. In general, limiting the number of platforms and transitions reduces the chances for problems.
- Different stakeholders will have different comfort levels with technology, and facilitators need to ensure that this does not impact one's ability to participate. Some participants felt comfortable moving their written ideas around the board, while others needed assistance to move their contribution to the right place. The workshop team needs to adapt to participants' needs.
- The screen sharing bring-to-me features on Miro are especially useful for ensuring that everyone was looking at the same place at the same time while we explained activities, and so on.
- Facilitators need to find the balance between letting participants manipulate the environment themselves versus moving elements on the board for participants. This balance point will depend on many factors including comfort with technology, time pressure, and a reading of participants' energy levels.

Facilitation

- Icebreakers are especially important in online environments. Having an icebreaker that encouraged people to use the tools on Miro that were relevant for the planned activities was very useful.
- Good facilitation is enhanced by in-person interaction with participants, and it is shaped by how we use our body and voice and read verbal and nonverbal cues. In an online context, facilitators can only rely on participants' voices and faces in a video frame. Facilitators need to find ways to compensate for the lack of physical presence, such as checking in with participants more frequently. Building a good rapport with participants in the beginning of the workshop can support active participation throughout the workshop.
- Online dialog is more formal. People can be more hesitant to speak up and more concerned about speaking over others. Asking for volunteers, especially in a larger group, can result in silence. Instead, the facilitator may need to proactively ask specific people to share their work or ideas. We used several rounds of sharing ideas to build up dialog.
- Our groups of stakeholders were relatively small (between 5 and 10 participants) and came from similar organizations and backgrounds. Participants communicated effectively with us and with each other throughout the workshop. Larger or more diverse groups will likely need more formal/advanced facilitation techniques.
- Small, frequent breaks for stretching, coffee, and checking email are necessary. We posted the schedule within the Miro board, so it could always be referred to. In general, participation in online workshops can be more

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energy demanding than participation in in-person workshops, and this should be a consideration when designing the schedule.
- Convergent activities are more challenging to facilitate than divergent activities in this setting. Facilitators need to be clear about who is speaking (e.g. ask the participant to repeat their name) and may need to assist the speaker in directing the focus to the part of the map or board that they want to discuss.
- Online script templates could be shared and reused in future workshops with context-specific modifications. As online GMB becomes more established, we envision that online scripts and templates could be paired and made freely available, much the way Scriptapedia functions today.

Further development and concluding remarks

We see several facets of online GMB that should be further explored and developed. Our experience points to the importance of good facilitation techniques. GMB likely works best with stakeholder groups with low levels of power differences (Vennix, 1996). It would be especially valuable to explicitly test to what degree facilitation techniques could address power dynamics in an online workshop. We also see the benefit in creating a guide or training to learn facilitation techniques for GMB in online environments.

Further research could also determine optimum group sizes for this methodology. Small groups allow for easier online dialog, yet larger groups can provide a greater diversity of perspectives and contexts. This balance point will depend on the chat and video capabilities of the online platforms in addition to the usual considerations for a workshop (e.g. topic complexity, group heterogeneity). Our workshop used common scripts (such as Graphs Over Time and Action Ideas), and we would welcome further explorations of implementing other GMB scripts (e.g. Causal Mapping with Seed Structure) virtually or even asynchronously.

Evaluations of long-term mental model changes, especially as compared to in-person workshops, would improve our understanding of the impact of online systems mapping on stakeholders. Surveys before and several weeks after the workshop could assess levels of engagement and information retention (Scott *et al.*, 2013). Paired studies, with some stakeholders assigned to an online workshop and others assigned to an in-person workshop on the same topic, could aid this understanding. If conditions in a multisession workshop allow, approaches that combine initial in-person meetings with subsequent online meetings, or that combine in-person convergent activities with online divergent activities, could be investigated. Due to power dynamics and facilitation challenges, we do not recommend having some participants in person and others online in the same workshop session. As more examples of online GMB workshops are assembled,

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we'd like to see more systematization and standardization of approaches in order to ensure comparability across workshops (McCardle *et al.*, 2009; Scott *et al.*, 2016).

Moving GMB workshops online is not without challenges, but we feel that the significant time and effort invested in bringing a system's mapping experience into an online environment was worth it. Our initial instinct was confirmed: online GMB works! We received positive feedback from a number of participants, including "I came out of [the workshop] with very useful experience and ideas for how we can carry out workshops and think holistically about our customers' problems" and "I learned a lot about systems thinking and system dynamics and want to learn even more now." This relatively simple workshop allowed us to test the possibilities we saw in online GMB and develop ideas for further exploration.

Choosing between online or in-person GMB depends on workshop aims. In-person experiences provide a wealth of interactions that open the space for creating a rich understanding of the issue at hand. That same depth of interaction cannot be recreated online, at least not with today's technology. Online GMB can, however, open up for a larger breadth of interactions by including people who, because of time, finances, or distance would otherwise be excluded. As online GMB takes place in a "neutral" space, it may also make it easier to bring people together from across organizations and institutions. In short, online GMB offers significant advantages that are fundamentally different from the advantages of in-person GMB.

We believe that further explorations of how best to include this breadth in a digital platform can enrich the practice of GMB as a whole. We view online group model building as a parallel methodology that warrants further development, and we look forward to learning from each other's' experiences in the system dynamics community as this methodology advances.

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