

Portable Planetariums in the Age of COVID-19

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Abstract. “Social Distancing” seating in a portable dome is challenging, but it can be done. If each person is a “single”, the maximum seating is 9 for a mirror system or 8 for a fisheye system in a 6m dome. However, if family groups of 2 or more sit together, the maximum seating improves considerably. Using open air “Discovery Dish” Eye-Domes allow more visitors to enjoy the dome safely. This white paper also makes suggestions on system cleaning and disinfection between groups and overnight. Air flow is also a consideration, with positive-pressure domes having generally more effective air flow and thus less time for contamination.

Background

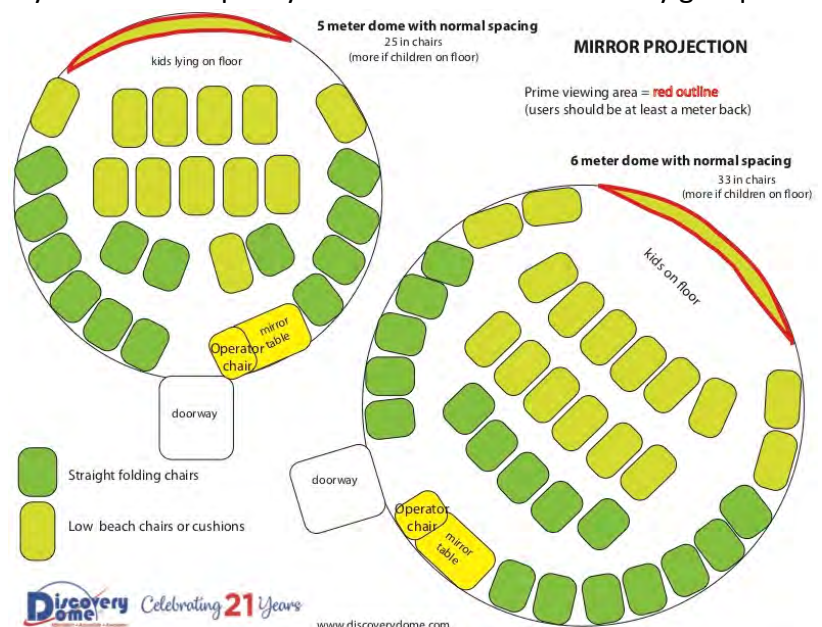
Portable planetariums are a cost-effective way to excited and engage students. The three-dimensional space has been shown to be effective in teaching three-dimensional concepts (Sumners et al., 2008), and students retain longer when exposed to the content in a dome rather than on a flatscreen (Zimmerman et al., 2014). Using portables extends urban museum outreach into the suburbs and neighboring towns for whom busses would be too expensive and time consuming. In the pre-Covid era, HMNS typically reaches 300,000 visitors annually in the Burke Baker planetarium (200 seats) and 60-70 thousand in portable planetariums for school and camp rentals. Rice University typically reaches 8 to 10 thousand annually in outreach events around the world.

In the age of COVID-19, planetariums are presenting shows online, and are creating special seating maps to maximize the number of viewers while maintaining social distancing. The Houston Museum of Natural Science, for example, has a seating plan for about 25% capacity if all the visitors are “singles” with nearly twice that capacity if the visitors come in family groups.

Portable planetarium capacity

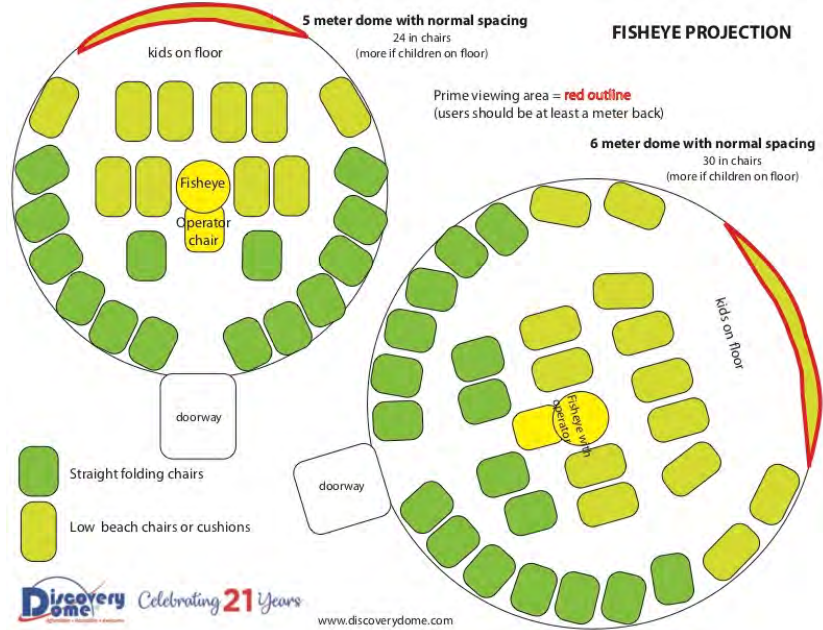
Before COVID, portable planetarium capacity was a matter of comfort. Generally, in a portable, to maximize seating, we seat adults in chairs in the back, then a second or third row of low chairs, with the children sitting on the floor in the front. Using only chairs (Figure 1) the

Figure 1. typical seating chart for mirror projection in a 5m (left) or 6m (right) portable dome.



capacity is less (25 for 5m and 33 for 6m) but all adults are in chairs. The prime part of the screen (red “smile”) is across from the mirror, not across from the doorway. For a fisheye projection (Figure 2), the capacity is only slightly less (24 in a 5m and 32 in a 6m)

Figure 2. Same as Figure 1, but now using Fisheye projection. The total useable seats are slightly fewer.

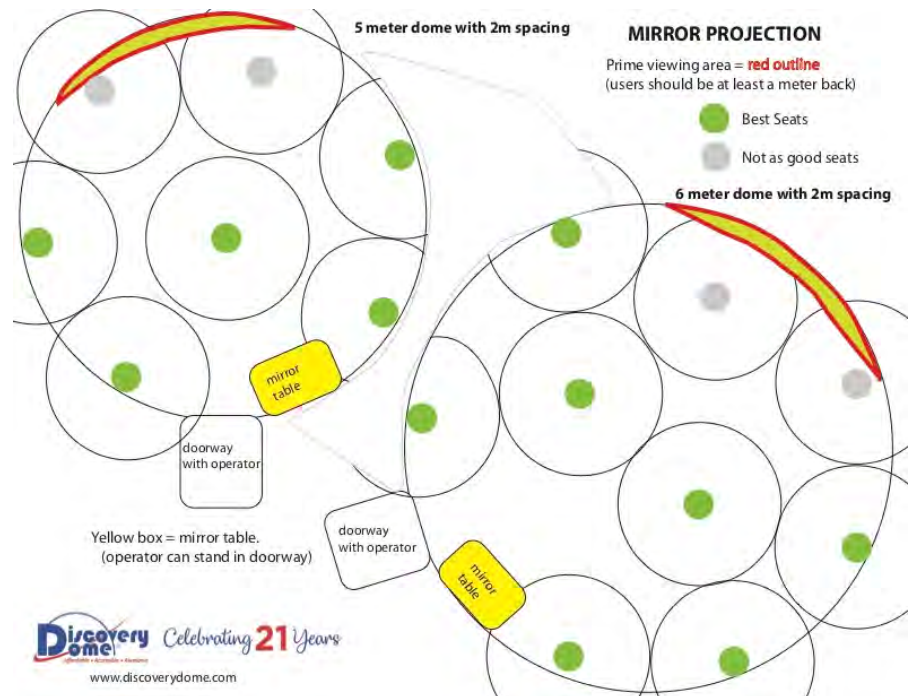


All domes shown here are standard or ringed inflatable

“Go-Domes”: <http://www.eplanetarium.com/domes.php>

“Social Distancing” With the COVID-19 pandemic, businesses and events need observe “social distancing” with each person 6ft from their neighbor. We have then used social distancing to see what the maximum capacity of the 5m and 6m domes are, using 2m spacing. Each circle has a 2m diameter. The operator can operate from inside the doorway to give one more seat. (Figure 3).

Figure 3. “Socially distanced” seating chart for the 5m and 6m domes as in Figure 1, but with each visitor seated in the center of a 2m circle. Only seven individual seats can be fit in a 5m dome and 9 for a 6m dome.



For a fisheye projection system, the projector must be in the center, so the seating is only slightly worse: 6 people for a 5m and 8 for a 6m (Figure 4).

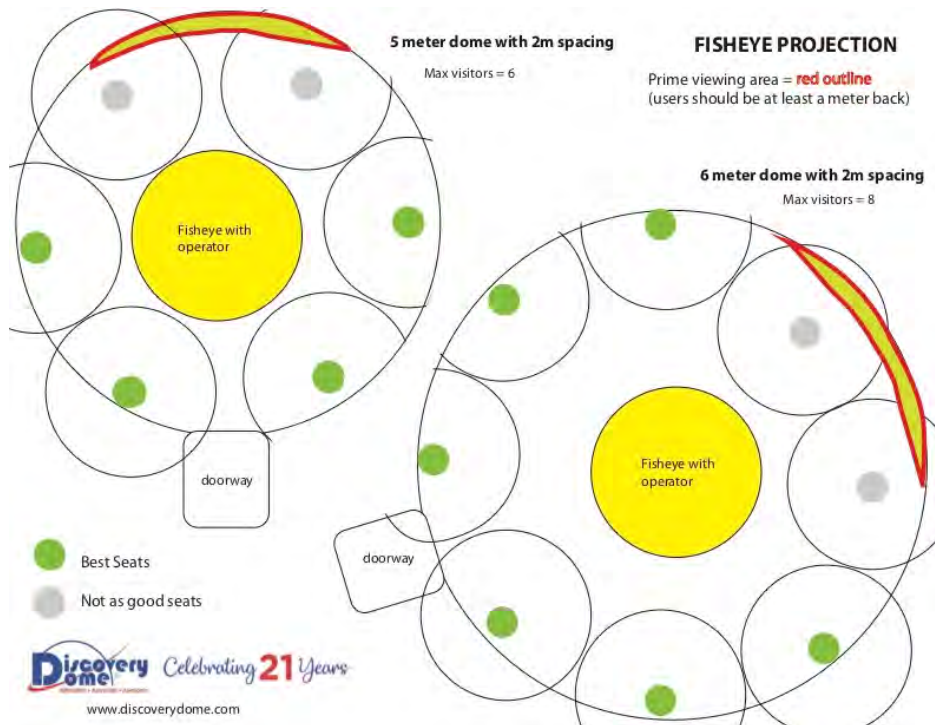


Figure 4. "Socially distanced" seating chart for the 5m and 6m domes as in Figure 2 (fisheye projector). Only six seats for a 5m dome and 8 for a 6m dome.

Family Seating The situation is not as bleak as it appears, however, because many visitors come as pairs or family groups. Note that if you have two single circles side by side, you can actually add two (or even 3) family members BETWEEN the two singles (light green in Figure 5).

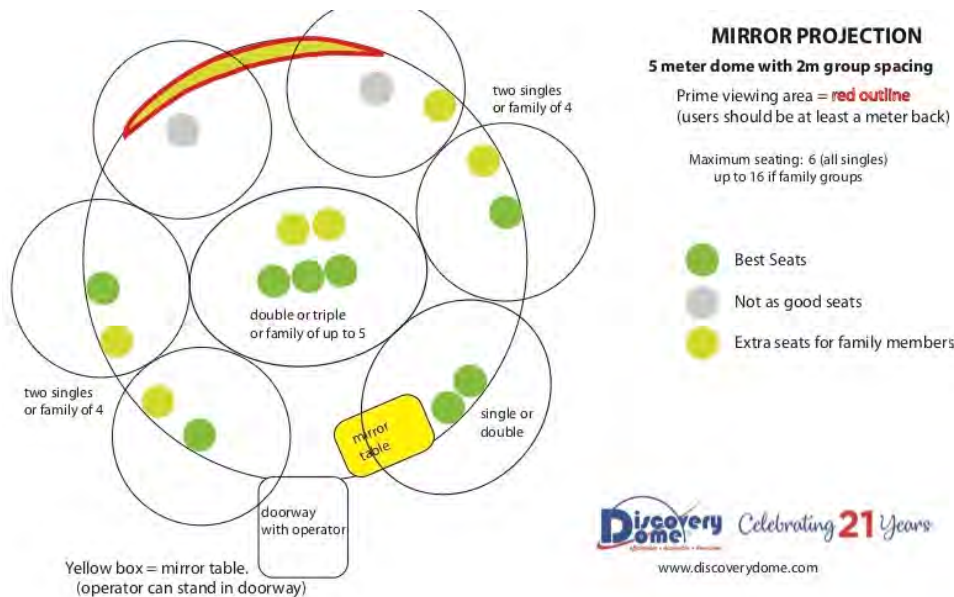


Figure 5. Maximum seating for a 5m dome, (mirror projection) if family groups sit together. Two touching "single" 2m circles can make a family group or 4 (or maybe 5); and kids can sit in front of the parents in some of the seating areas.

This can bring the capacity up to 16 for a 5m (Figure 5) or 22 for a 6m dome (Figure 6), for mirror projection, and slightly less for fisheye. (For other sizes, see appendix).

Figure 6. Maximum family group seating = 22 in a 6m dome (mirror projection).

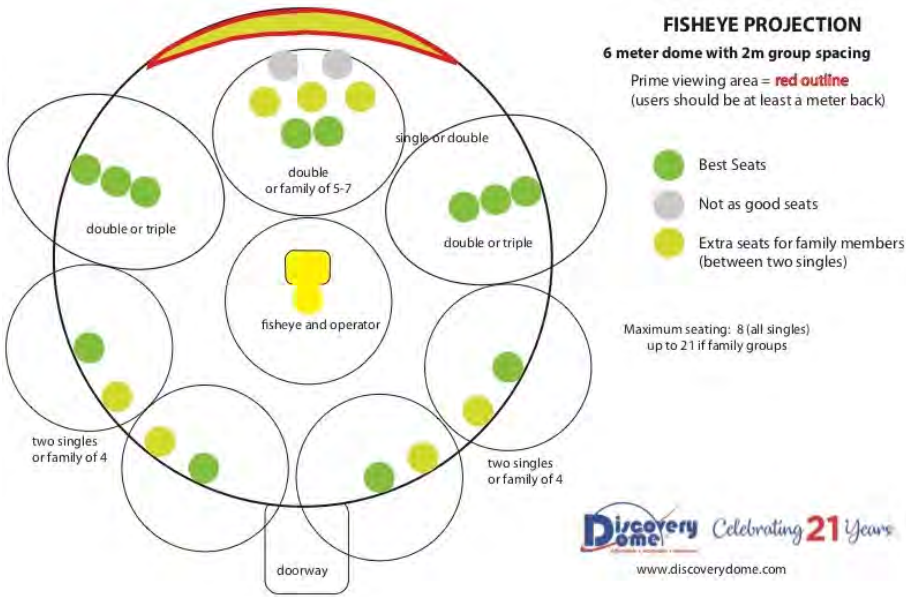
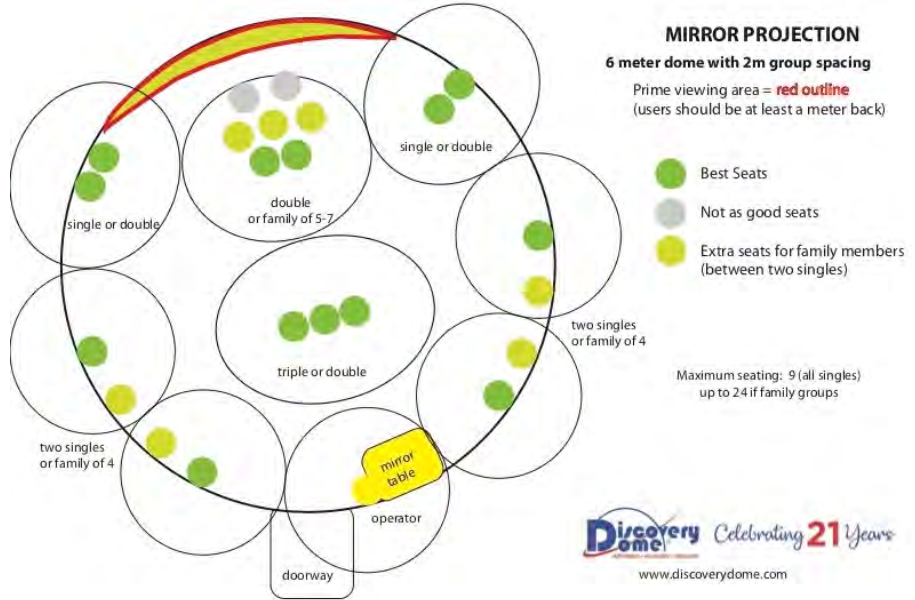


Figure 7. Maximum family group seating = 21 in a 6m dome (fisheye projection).

Viral Loading: In addition to “social distancing” one has to consider the viral load. The more people in a dome, and the longer the show, the more the viral load if one of the visitors is shedding COVID. The higher the viral load, the more likely for infection. In this case, positive pressure domes (with flow-through air) are safer than negative pressure domes without additional air handlers. For the Discovery Domes, the air entrance is near the door and the air exit is through the vents at the front of the dome (opposite the doorway). Air also exits the door when it is opened. Finally, the shorter the show, the better, to minimize the viral load. Our shows typically run 24 minutes but for events we run shorter (10-12 minute) versions.

Open-Air Domes (“Discovery Dish”, “Eye-Dome”): Another portable dome design is an open-air “Eye Dome” http://www.eplanetarium.com/discovery_dish.php that is only slightly less portable than a typical positive-pressure dome. Because the air flow is unimpeded, the viral load is far less, and more users can view the dome screen with social distancing, although those farther from “under” will have a less immersive view. HMNS is now using these domes (that they call “Discovery Dishes”) for their school rentals during COVID-19, where they serve 24 at a time: <http://www.hmns.org/education/educators/outreach-programs/discovery-dome/> .



Figure 8 (above). James Wooten (in the face shield) interacts with students using a Discovery Dish. The students were told to sit only on the yellow foam squares.

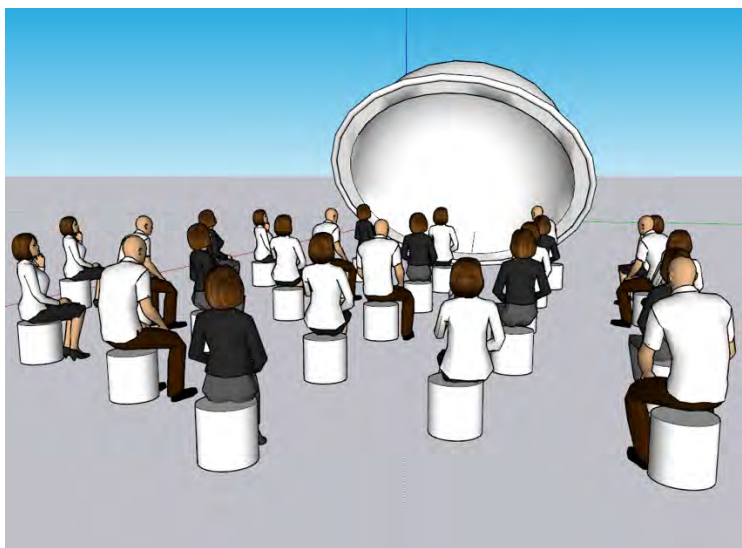


Figure 9 (left). Social distancing using a Discovery Dish for adults using hassocks or low chairs.

Cleaning and Disinfection procedures

(THESE ARE SUGGESTIONS; PLEASE REFER TO ANY LOCAL LAWS AND GUIDELINES).

The virus that causes COVID-19 does not generally last on surfaces more than a few hours, and at most a week. So, if you only rarely use your dome, it is probably fine. (Keep it in an airconditioned space).

Between groups:

1. Spray the seats with Lysol or spray alcohol
2. Wipe the keyboard if the operator will change
3. Do not spray or wipe the mirror. Ever. A fisheye lens could be gently cleaned with alcohol lens wipe.
4. The projector will be OK.

At "Lunch breaks" (1 or more hours)

1. Same as above, plus
2. Consider buying a freestanding "UV light sanitizer". Set it in the center of the dome. Let it shine on the interior for 15 minutes and then turn it off and let the air refresh for 30 minutes (blower on, projector off). I just ordered a 38W one from Amazon for \$69 (and added the protection plan for \$10 since it looks a bit fragile). It has a timer so you can set it for 15 minutes and go out to lunch and come back and be ready to go. It says it is good for a 40 Sq meter room so it should be good for all portable domes. **Be sure no one is inside the dome when the UV light is on.**

At the end of the day:

1. No need for sanitizing treatments if the dome won't be used again for a week.
2. If it will be used the next day, give it a 15 minute UV treatment after the last group leaves. Let it air out for a few minutes then flip the dome and pack up.

About Ozone generators:

Those are more effective but more dangerous than the UV lights. I would only use them in the dome to kill mold or mildew if some has grown on your dome during storage. Set it inside (blower on) with a timer (15-30 minutes) and then let it air out for an hour or more. Ensure NO equipment is inside (projector, mirror, laptop, sound). **Be sure no one is in the dome when the ozone generator is on; AND if it is set up in a relatively small room, people should not be in that outer room either since the blower must be on.** I do not guarantee that it will not cause degradation of the projection surface (I have only used it once). For light mildew, I have set up the dome outside in the sunlight and sprayed the inside (and outside if needed) of the dome with a VERY light spray of Lysol or alcohol and let the sun "bake it out".

Conclusions

Social distancing is challenging for a portable dome, but it can be done, particularly if spaces are reserved for siblings or partners. Open air domes allow more visitors safely.

References

Sumners, C., P. H. Reiff, and W. Weber, "Learning in an Interactive Digital Theater," *Advances in Space Research*, DOI:10.1016/j.asr.2008.06.018, Vol 42, p. 1848-1854 (2008).

Zimmerman, L., S. Spillane, P. Reiff, and C. Sumners, Comparison of Student Learning about Space in Immersive and Computer Environments, *Journal and Review of Astronomy Education and Outreach*, V1, p. A5-A20, (2014). Available from: <http://www.eplanetarium.com/news/pdf/JRAEO010101A5LZetal.pdf>

Appendix

Additional seating charts

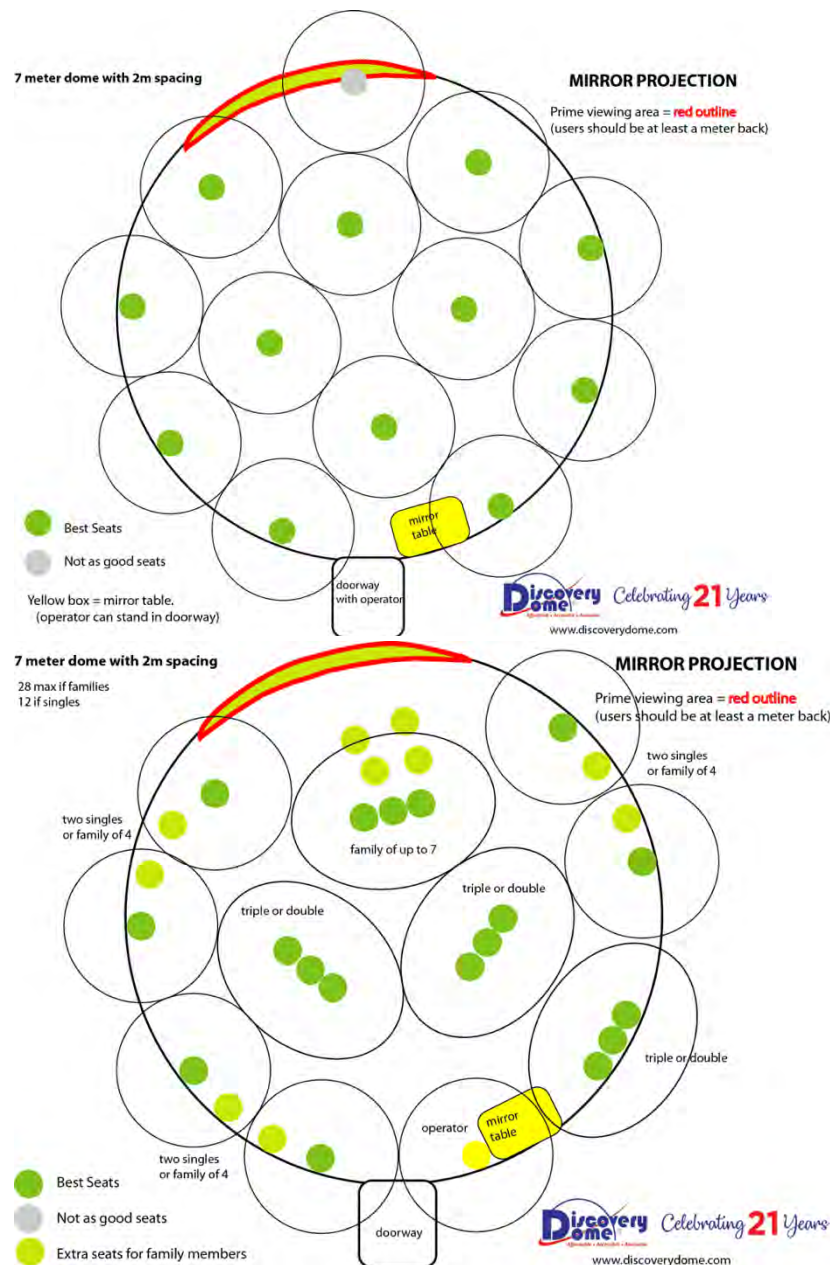


Figure 10. "Social distance" seating in a 7m dome (mirror projection). (13 seats, one not very good)

Figure 11. "Family seating" in a 7m dome (mirror projection). (29 seats including children). Each pair of adjoining singles can seat a family of 4-5.

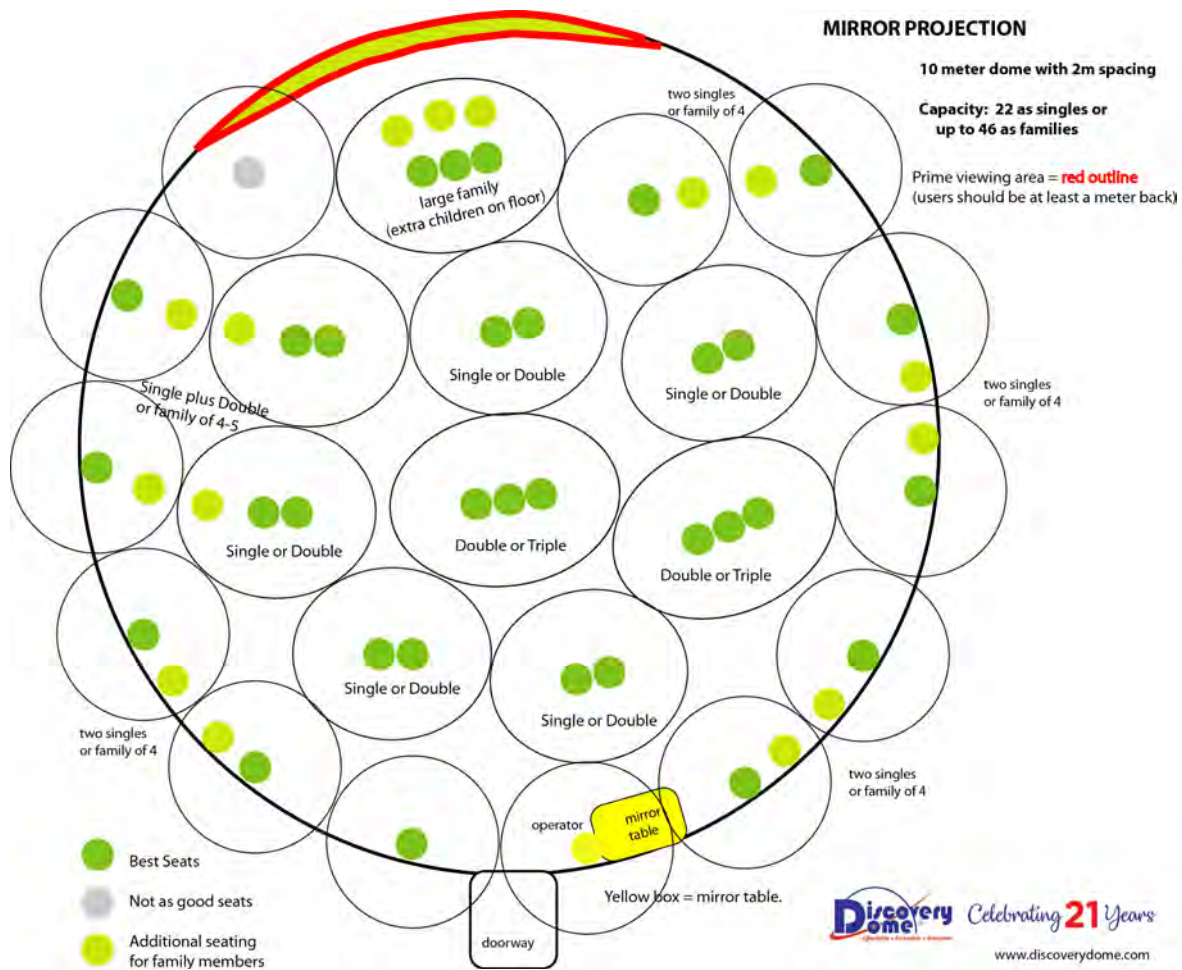


Figure 12. “Family seating” in a 10m dome (mirror projection). The capacity rises from 22 as singles up to 48 as families). Each pair of adjoining singles can seat a family of 4-5.