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Engaging the audience – what can we learn from them?**

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## **I. Introduction**

The International Astronautical Federation (IAF) Technical Committee (TC) on Near Earth Objects (NEOs) organized a Special Session (SpS) at the 70<sup>th</sup> International Astronautical Congress (IAC), held in Washington DC on 21 October 2019, titled “Get ready to protect Earth from asteroids – Planetary Defense in your hands”.

The aim of the session was to inform and educate the IAC audience, comprised mainly of engineers, scientist and managers, in an entertaining and interactive way about the basics as well as the current status of planetary defense. By having an interactive setup, the audience was encouraged to think about the topic and the presented problems that would allow them to contribute to the discussion.

The SpS consisted of an hour long hypothetical asteroid threat scenario that the expert panel put into context and allowed the audience to interact via the IAFastro App in several polls during the exercise and to submit and upvote questions for the concluding half an hour Q&A part. The exercise was based on the scenario used during the 2019 Planetary Defense Conference.

The focus of the panel was on four subjects:

- Detection and warning
- Geopolitical aspects
- Technical aspects of deflection missions
- Communication with the public

The panel consisted of: Bill Nye (The Planetary Society), Lindley Johnson (NASA), Dorin Prunariu (Association of Space Explorers), Mariella Graziano (GMV), Alex Karl (IAF TC on NEOs).

This paper will outline the scenario presented to the audience and focus on the five polls posted to the audience during the SpS, discussing the audience’s feedback. Further, the questions submitted by the audience will be analysed to identify what information the audience was most interested in at the end of the session. Resulting key points and recommendations for the PDC community will be identified.

The audience was estimated to be at around 200-250 people and remained fairly constant throughout the 90 minutes. An average of about 60 people participated in

the polls and about 40 questions were submitted which received a total of 90 upvotes.

## **II. Scenario and Poll**

The exercise scenario was based on the 2019 PDC Hypothetical Asteroid Impact Scenario [1] and was split into 5 segments, which described the story line of the events.

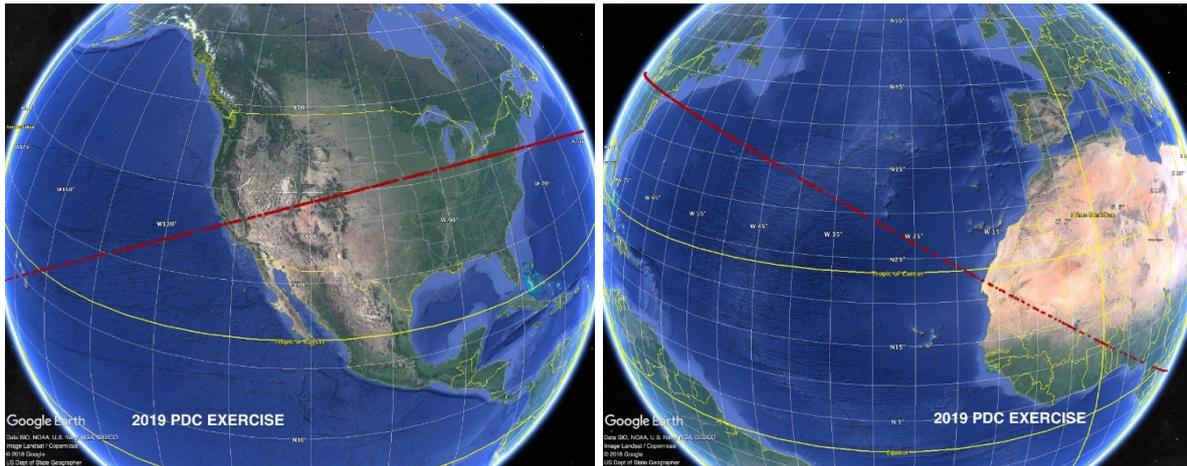
The polls were opened to the audience after each inject information had been given. The questions were posed in response to the updated scenario.

### Limitations of the poll

- Only the answer resonating most will be chosen, a potential secondary agreement to another option is thus not recorded.
- The limited number of choices does not reflect the actual thoughts of the people polled, but can only represent a rough direction of opinion.
- The available choices may contain bias that will determine a more likely chance of being selected
- The number of participants was around 60 and consisted of attendees of a professional space conference held in the US. Extrapolating the results onto the global general public is to be done with caution as the results are not representative.

### **Exercise Inject#1: Oct 21, 2019: NEWLY DISCOVERED ASTEROID POSES SMALL RISK OF EARTH IMPACT**

- The International Asteroid Warning Network has announced that a recently discovered near-Earth asteroid could pass very close to the Earth 8 years from now, on October 21, 2027, and there is a small chance – 1 in 100 -- that it could impact our planet.
- The asteroid, designated 2019 IAC, was discovered on September 18, 2019, by the Pan-STARRS near-Earth object survey project. It has been tracked nightly since then by astronomers around the world. By the end of June 2020 it will no longer be observable by Earth-based telescopes until about a year later in 2021 when we should know the orbit well enough to confirm if the asteroid will impact or not.
- Astronomers now estimate that the asteroid is roughly 100 to 300 meters (330 to 1000 feet) in size.
- The red dots are the possible positions of the asteroid on April 29, 2027, computed using the 5 weeks of tracking data since discovery. 1% of the red dots intersect with the Earth. As more observations are made, the uncertainty region will shorten, but we don't know exactly where.



### EXERCISE Poll#1: What is your reaction?

- A: 1% and 8 years? Nothing to worry about.
- B: Let's wait. Once we know if and where it will hit, there's plenty of time to react if needed.
- C: Just in case, let's get ready. Better safe than sorry.
- D: I'm really worried and losing sleep – we need to act now!

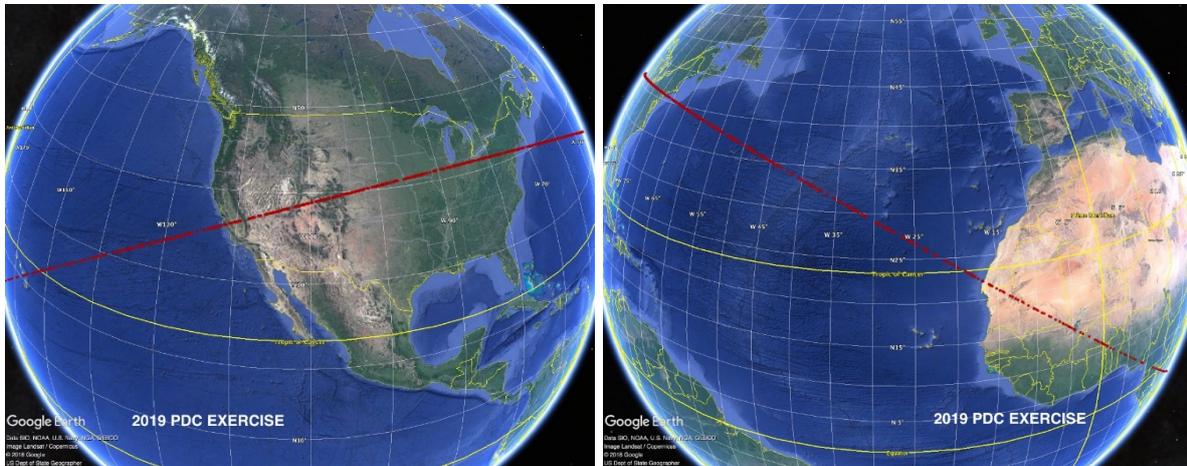
### Results:

- **76%** C: Just in case, let's get ready. Better safe than sorry.
- **17%** D: I'm really worried and losing sleep – we need to act now!
- **5%** B: Let's wait. Once we know if and where it will hit, there's plenty of time to react if needed.
- **2%** A: 1% and 8 years? Nothing to worry about.

### Exercise Inject#2: Jan 21, 2020: ASTEROID NOW HAS 1 IN 10 CHANCE TO IMPACT EARTH

- Hundreds of observations made by multiple observatories around the world have enabled IAWN experts to improve the understanding of the asteroid's orbital path and update the possible impact predictions made last October. Based on these observations the chance the asteroid designated 2019 IAC could impact Earth on October 21, 2027, is now 1 in 10. If the asteroid is headed for impact, we won't be certain until mid-2021 and until now it could be anywhere on the risk corridor.
- Astronomers were able to narrow the estimate of 2019 IAC's size to roughly 140 to 260 meters (460 to 850 feet). Based on this size estimate, in case of impact this asteroid could produce serious devastation over a large region. IAWN emphasizes, however, that this asteroid is too small to cause globally damaging effects if an impact were to occur.
- The international forum for space agencies called the Space Mission Planning Advisory Group (SMPAG) is meeting to consider a coordinated international response to the impact risk posed by 2019 IAC. SMPAG recommends that space-capable nations begin development of a suite of space missions to characterize the asteroid and be prepared to deflect it should it be confirmed it is likely to be on a collision course with Earth.

- Deflection moves the impact point only along the risk corridor, but if the deflection is large, it moves the trajectory entirely “off” the Earth. Even a few centimeters per second of velocity change can move an asteroid thousands of kilometers along the orbit path in just a few years.



### EXERCISE Poll#2: What is your reaction?

- A: 10% and 7 years, 9 months? Still nothing to worry about.
- B: Let’s wait until we know if and where it will hit and base our response on that. There is plenty of time.
- C: Let’s get ready and prepare for the worst. Better safe than sorry.
- D: I’m really worried and losing sleep – we need to act now!

### Results:

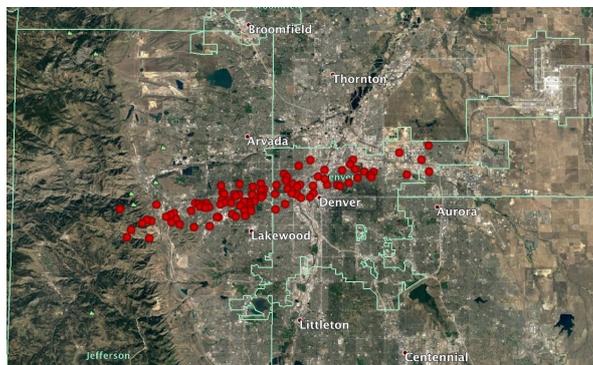
- **51%** C: Let’s get ready and prepare for the worst. Better safe than sorry.
- **42%** D: I’m really worried and losing sleep – we need to act now!
- **5%** A: 10% and 7 years, 9 months? Still nothing to worry about.
- **2%** B: Let’s wait until we know if and where it will hit and base our response on that. There is plenty of time.

### Exercise Inject#3: Jun 21, 2022: ASTEROID PREDICTED TO IMPACT NEAR DENVER, COLORADO ON OCTOBER 21, 2027: EFFORTS TO PREVENT IMPACT ACCELERATE

- Ground-based observations and a reconnaissance spacecraft that flew by asteroid 2019 IAC yesterday have determined with certainty that the asteroid is on a course to impact near Denver, Colorado on October 21, 2027, unless it is deflected IAWN reports. 2019 IAC is a contact binary 140 to 220 meters (460 - 720 feet) in size. The asteroid is large enough to cause major damage over a large region around the Denver area.
- NASA plans to launch two rendezvous spacecraft to gather data that will enable experts to more precisely determine the asteroid’s mass, density, porosity and structure. These data are vital to the success of any deflection efforts.
- Before the two spacecraft are able to arrive at 2019 IAC, 23 months from now, a fleet of six kinetic impactor spacecraft will need to be built and launched by NASA, ESA, JAXA, and the Russian and Chinese space agencies, who all

participate with SMPAG that was established for the purpose of collaborative efforts to mitigate an asteroid impact threat. The kinetic impact technique involves hitting the asteroid with a spacecraft to incrementally slow the speed of the asteroid to deflect it off its impact course with Earth. Execution of all kinetic impactor deflections are scheduled to take place in the last two weeks of February 2025.

- As an additional precaution, the rendezvous spacecraft being specifically built by the United States for monitoring this deflection campaign is being designed so that it might also carry a nuclear explosive device, which if flown could be detonated near the asteroid to complete deflection of it in the event of failure by some of the kinetic impactors to complete their missions. The United States, in negotiations with the United Nations and leaders around the world, is assessing the political and international treaty ramifications of launching a nuclear device before making such a decision.



### **EXERCISE Poll#3: What do you think about the plans to deflect the asteroid?**

- A: We should do nothing, as I don't think it will work and will just waste resources
- B: We should rather prepare Denver for impact than risking to fail and ending up in a new situation with less time
- C: We need to act but must make sure we are ready for all possible outcomes
- D: It is our responsibility to act when we can prevent disaster no matter what

### **Results:**

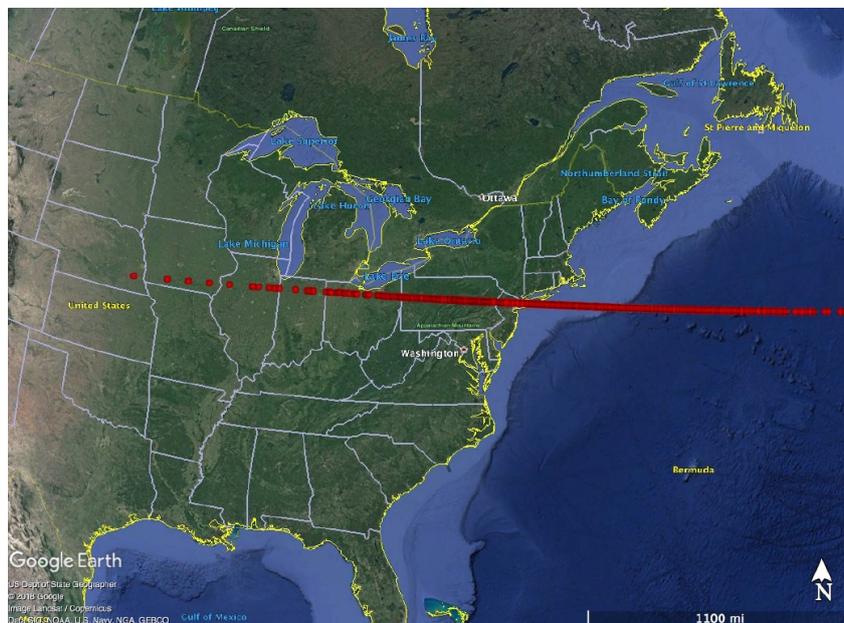
- **62%** C: We need to act but must make sure we are ready for all possible outcomes
- **30%** D: It is our responsibility to act when we can prevent disaster no matter what
- **5%** B: We should rather prepare Denver for impact than risking to fail and ending up in a new situation with less time
- **3%** A: We should do nothing, as I don't think it will work and will just waste resources

### **Exercise Inject#4: Feb 23, 2025: DEFLECTION PARTIALLY SUCCESSFUL BUT LARGE FRAGMENT REMAINS ON IMPACT TRAJECTORY, U.S. IMPACT STILL POSSIBLE**

- Three kinetic impactor missions have successfully deflected asteroid 2019 IAC's main body and it no longer poses an impact threat to Earth, but a large

fragment that broke off remains on a certain collision course with Earth on October 21, 2027, IAWN reports.

- The asteroid fragment is estimated to be 50–80 meters (165–260 feet) in size, and impact with Earth is certain. The exact location for the impact is not yet precisely known, but the Eastern U.S. and the Atlantic Ocean are currently at risk.
- NASA's rendezvous spacecraft was an observer-only and did not include the nuclear deflection device capability considered due to widespread controversy that was not resolved in time. No active spacecraft remain from the original fleet.
- SMPAG is now studying emergency plans for a space mission to disrupt the fragment still heading for the Earth using a nuclear device. The goal of disruption before impact would be to create smaller fragments that could burn up more completely as they impact the atmosphere and pose a lower risk of damage on the ground. The United Nations and leaders around the world are assessing the political and international treaty ramifications of launching a nuclear device.



#### EXERCISE Poll#4: Now what?

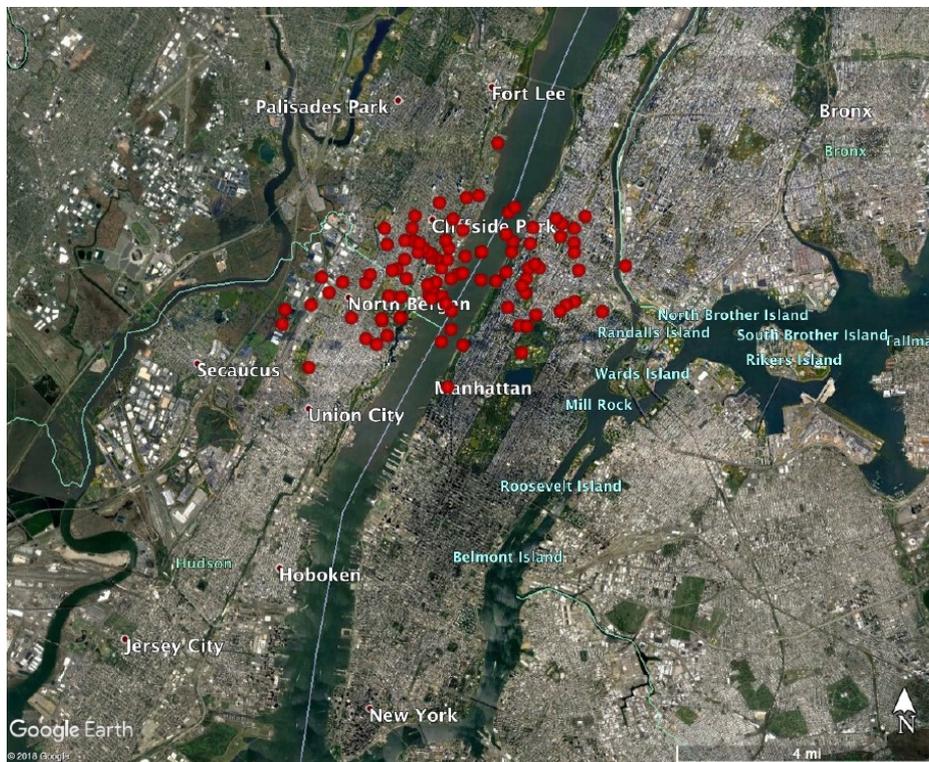
- A: Space is hard, let's try again and send the nuke
- B: They failed, my trust in NASA and the other space agencies is gone
- C: The nuke is too risky, there must be another option for deflection
- D: Too late for deflection, we must prepare for impact

#### Results:

- **47%** A: Space is hard, let's try again and send the nuke
- **39%** C: The nuke is too risky, there must be another option for deflection
- **12%** D: Too late for deflection, we must prepare for impact
- **2%** B: They failed, my trust in NASA and the other space agencies is gone

#### Exercise Inject#5: Oct 11, 2027: SMALL ASTEROID TO IMPACT OVER NEW YORK CITY IN 10 DAYS

- The 60-meter (200-foot) fragment of asteroid 2019 IAC is predicted to impact over the Central Park area in New York City just after midnight on October 21, 2027, 10 days from now, IAWN reports, after it had been known for 3 months that the NYC metro area will be affected .
- A last-ditch attempt to launch a nuclear explosive device to disrupt the asteroid could not be implemented within the time available.
- The small asteroid will enter Earth’s atmosphere at 19 km/s (43,000 mph) on October 21, producing a very large fireball or “megabolide,” and predicted to release the equivalent of 5 to 20 megatons of energy in the airburst.
- The U. S. Federal Emergency Management Agency (FEMA) has requested daily updates from IAWN on predicted impact location and damage estimates to finalize their nearly completed evacuation of residents and critical infrastructure, as well as other pre-impact measures, and to prepare for any casualties and, ultimately, for recovery.



**EXERCISE Poll#5: What do you think we need to work on most urgently?**

- A: Our detection capability
- B: Establishing geopolitical agreements
- C: Our deflection capabilities
- D: Communication with the public

**Results:**

- **53%** D: Communication with the public
- **27%** C: Our deflection capabilities
- **14%** A: Our detection capability
- **6%** B: Establishing geopolitical agreements

#### **IV. Audience Questions**

The audience was encouraged to submit questions for the Q&A part of the event throughout the ongoing scenario. In total, about 40 questions were received and 90 upvotes distributed. The following 8 questions received two thirds of the upvotes:

- Who should bear the financial costs of the mission? Does it depend on where the asteroid will hit?
- What's the best way to achieve the goal of finding 90% of all dangerous asteroids?
- What is currently the most promising method for asteroid redirection/elimination: kinetic impactors, nukes, or directed energy/ablation?
- What optics are used to determine the size, composition and trajectory of asteroids?
- How will the Osiris-Rex mission (and similar missions) effect our understanding of asteroid composition and the way we could potentially defend against them?
- Have we deflected any asteroids yet?
- How can efforts to find dangerous asteroids partner with efforts to find resources to mine for in-space use, such as water? How can mining help manage threats?
- It seems that during the past half year, quite a few asteroids had close pass by Earth. What's the reason for this?

#### **V. Discussion and Interpretation**

Looking at the results from the different polls, the following observations and deductions can be made.

##### Poll 1:

93% advocate action, 7 % support to wait and see. This can be seen as a clear mandate to actively work on planetary defense.

##### Poll 2:

A difference of 3 months and 9%, did not change the percentage of people advocating for action.

When comparing Polls 1 and 2, which have very similar questions but take place at different situations, it is noteworthy that the overall percentage of the audience agreeing with a proactive approach did not change (93%). However the distribution changed significantly. 25% of the audience shifted from agreeing to take action to getting really worried within just 3 months, when the impact probability rose from 1% to 10%, leading to a total of 42% that are worried and losing sleep. That is a significant portion of the audience. This leads to two aspects to be addressed and considered by the planetary defense community:

1. Risk perception needs to be taken into account when communicating any updates. In general life, 10% is usually considered a low probability, while in this case it seems to be regarded as a high risk. It would be worth investigating further, whether

this could be addressed with the way which information is communicated in what way and how the risks involved are put into context and are understood.

2. If over 40% of the people start to worry and are losing sleep almost 8 years ahead of an event that is very likely (90%) not going to happen, then this needs to be addressed. It is likely that this first reaction will decrease over time, but this brings up the potential effects on mental health before an impact is even confirmed which could be problematic in view of quality of life and productivity of large parts of the population for some time period at least.

Poll 3:

92% agree with proactive action. Which seems consistent with the 93% of Polls 1 and 2.

Poll 4:

Despite a failure, 86% still agree with continuing taking action in space. Further, it seems reassuring that a failure will not erode trust in space agencies. However, due to the limitations of the poll, this conclusion cannot be made this easily.

In this scenario the voting had just a small margin of 47 – 39 in favor of the nuclear deflection option among those who favored an active approach. It seems that the proactive audience is leaning towards the stance of the benefits outweighing the risks. It needs to be pointed out that the audience consisted largely of inhabitants of the affected zone, it needs to be seen whether a similar result would be achieved when the impact zone is elsewhere. In total, however 53% voted against the nuclear option. The issue remains controversial.

Poll 5:

This is an interesting one as it yielded perhaps the most surprising result of this poll. More than half of the audience thinks communication with the public is the most urgent matter to work on for the planetary defense community. It is noteworthy that the results are to some degree in the inverse order in which the planetary defense community is addressing the topic. This is not to suggest to change anything but rather to look at it from a communications point of view.

Q&A:

Most audience submitted questions were about deflection, a good number related to observations and a few to policy. Most questions were in direct relation to the scenario presented. The questions aimed mostly at details that were not addressed during the exercise or panel explanations and further show that the audience was interested to dig deeper into some aspects of the topic. All questions were answered by the panellists.

## **VI. Conclusion**

There are some conclusions that can be drawn from engaging the audience in an exercise scenario. First of all, it was fun for both audience and panel members. Lots of positive feedback was received. The audience was clearly interested and

engaged. It is certainly a good way to get the audience involved and the poll may yield some interesting insights and key points, such as:

- A vast majority of the audience is in favour of being prepared and taking action.
- Risk perception needs to be taken into account when communicating to the public.
- The potential effects of warnings on mental health should be considered and addressed.
- The use of NEDs is controversial.
- More than half of the audience thinks communication with the public is the most urgent matter to work on for the planetary defense community.

Some of these points could well be considered recommendations to the planetary defense community, such as considering and addressing communication and mental health aspects.

When possible during public events, adding a poll to engage the audience should be considered by the organizer or presenter to increase interaction as well as receiving feedback.

## **VII. References:**

[1] Planetary Defense Conference Exercise – 2019, <https://cneos.jpl.nasa.gov/pd/cs/pdc19/> [accessed 13 April 2021]