

# CYTO Lab Hacks: Inspiring innovation in cytometry through open collaboration

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## ABSTRACT

This article reports on a conference workshop conducted at CYTO 2018. During the workshop a new Open Science forum "CYTO Lab Hacks" has been launched within the International Society for the Advancement of Cytometry (ISAC). Its goal is to serve as an open, transparent, sustainable and accessible forum for innovation-exchange in cytometry. Here we report the captured status quo, the perceived requirements of the members in relation to open innovation sharing and dissemination and publicize the format of "CYTO Lab Hacks".

open science, free and open source hardware, network, cytometry

## INTRODUCTION AND AIMS

Open Science is an active process of a cultural change, shifting the research conduct from competition towards collaboration and early dissemination. Open Science can be defined as "transparent and accessible knowledge that is shared and developed through collaborative networks" Vicente-Saez and Martinez-Fuentes (2018). The International Society for the Advancement of Cytometry (ISAC) has been an early champion of Open Science in the biological sciences by introducing the MiFlowCyt Lee et al. (2008), FlowRepository Spidlen et al. (2012), FCS standard Murphy and Chused (1984); Spidlen et al. (2010). Here, we are proposing a new transparent platform for searching, disseminating and collaborative sharing of cytometry innovations.

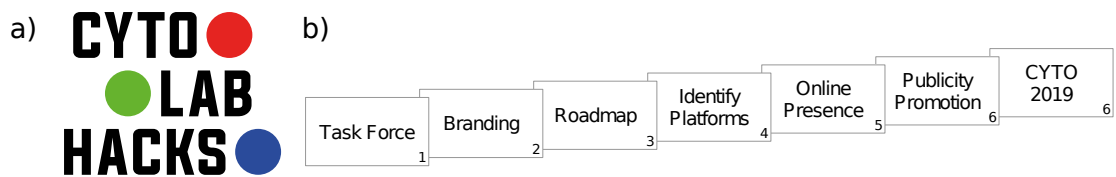
Cytometrists often generate innovations to protocols, instruments, methods, teaching materials and products. Efficient dissemination of these cytometry innovations delivers benefits to the innovator and the community Pearce (2015); Editorial (2013). Yet there are no dedicated platform to support sharing of cytometry innovations. Therefore authors resort to publishing them in redacted form as part of research articles, post them on websites (institutional websites, blogs, social media) or not disseminated them at all. Consequently, many cytometry innovations never reach their full potential by not being seen, used, or adapted by the community.

In this workshop, we launched CYTO Lab Hacks as an online free and open forum for sharing and collaborative development of cytometry innovation. A group of invested volunteers will build this forum from the ground up under the oversight of the ISAC CYTO Innovation Committee. CYTO Lab Hacks will be developed according to the principles outlined in the Global Open Science Hardware Roadmap Murillo et al. (2017). It will be resourcefully built on existing online platforms, which will be repurposed

to create a cytometry-specific network of resources. The overarching aim will be to enable streamlined deposition and sharing of cytometry innovation under a common and widely recognizable brand. The title "CYTO Lab Hacks", used throughout this manuscript for consistency, remains tentative and may still change in the future as discussed below.

Our workshop attracted a mixture of facilities managers, academic scientists, and industry representatives. We presented ideas and questions to the audience and processed their feedback and poll results. We gained the understanding of the needs, pains, experience level, and opportunities for the proposed innovation sharing forum. The workshop outcomes will help us guide the development of CYTO Lab Hacks. The aims are to accelerate and increase the impact of early stage cytometry innovation and to make ISAC the leader amongst the biological societies in the promotion and championing of Free and Open Science Hardware.

## METHODS



**Fig. 1.** (a) Proposed logo for CYTO Lab Hacks features colorful bright dots representing cells, dot plots and fluorophores, all common to cytometry. (b) Roadmap for the first year of the project.

We used three channels to collect information prior to and during the workshop: a pre-workshop survey, workshop polling, and a 90-minute moderated discussion with the audience. All three efforts were designed to understand the audience needs and to guide the future development of CYTO Lab Hacks. We gauged the existing level of awareness, usage patterns, licensing and publishing opportunities for free and open source software and hardware. We aimed to learn the needs, pains and opportunities in relation to searching for, sharing and collaboratively developing cytometry innovations. The workshop included a presentation of examples of recent cytometry innovations.

A pre-workshop online survey (Forms, Google, Mountain View, CA, USA) was repeatedly advertised prior to the conference on Linked-In, Twitter and multiple cytometry forums. We used a bespoke logo (Figure 1a) and an advertising poster to capture the intended audience attention.

At the start of the workshop, the audience was polled for objections to audio recording, which was intended only for use in writing this manuscript. Having no objections, the workshop audio was then recorded using the available AV technology. The workshop was started with a 20-minute motivational talk and 10-minute question time with J. Molloy (Cambridge University, UK). An Internet link using Skype (Microsoft, Redmond, WA) and a USB boundary microphone (UB-1, Samson, Hickville, NY) connected to the presentation computer facilitated this remote workshop contribution.

The rest of the workshop was structured as an open discussion of the panel (J. Nedbal, B. Coteleur, D. Gagnon) with the audience. The structure and timing was maintained through a slide presentation accompanied by live polling (Slido, Bratislava, Slovakia). The feedback from the audience was captured on the audio and through the live polling.

The workshop attracted 40-50 participants with 20 % contributing to the live poll.

## OUTCOME

This section summarizes the content of the discussion and the resulting feedback. We covered the topics of mission statement, branding, identity, platform, structure, licensing, vendor engagement, and outreach.

The aims of CYTO Lab Hacks (Figure S1), listed in the descending level of gained support are: (1) creating a sharing platform to boost the impact of cytometry innovations; (2) widening collaboration, engagement and participation; (3) advocacy, education and standards for sharing.

We assessed the branding proposal for CYTO Lab Hacks including the title, proposed logo (Figure 1a, Figure S2) and other branding assets. We identified problems with the title "CYTO Lab Hacks", potentially devaluing the "CYTO" brand. Alternative title suggestions have been proposed (Table S1) and an acceptable title will be selected shortly.

CYTO Lab Hacks should be organized by a task force overseen by the CYTO Innovation Committee (Figure S3). Actual "Lab Hacks" are to be demonstrated during CYTO Innovation and in the ISAC booth, to promote the initiative at the CYTO meetings (Figure S4). We proposed a visit to a local makerspace during CYTO 2019 and encouraged all cytometrists interested in innovations to engage with institutional bioengineering departments, workshops and makerspaces.

Licensing, safety and legal issues were identified as important consideration for CYTO Lab Hacks development. Careful management will be required to mitigate liability issues, manage intellectual property ownership, prevent endorsement of potentially unsafe practices and protect vendor interests as CYTO Lab Hacks develop. The discussed strategies include limiting contributions to registered users, adopting procedures followed by established project-sharing platforms and seeking legal advice.

## CONCLUSIONS AND PERSPECTIVES

Routinely cytometrists, as other scientists, develop innovations to methods, protocols, instruments, teaching materials and products. These innovations deliver additional benefits to the innovator and the wider community when disseminated efficiently. They generate community feedback, spark follow-up collaboration and further innovation. Currently, there are no clear incentives or standardized platforms for sharing cytometry innovations. Consequently, cytometry innovation dissemination, sharing and collaboration is cumbersome, ineffective or slow; relying on traditional publishing or a variety of scattered online resources.

CYTO Lab Hacks were established during the workshop to become a platform for searching and depositing cytometry innovations. The goal is to increase the innovation rate in cytometry by minimizing barriers in collaborative sharing of innovations according to open science principles Vicente-Saez and Martinez-Fuentes (2018); Murillo et al. (2017). CYTO Lab Hacks will enable sharing regardless of and alongside peer-reviewed journal publications. Both the wider cytometry community and contributors will benefit from CYTO Lab Hacks. Searching for ideas and innovations will become centralized and thus more effective. Contributors depositing innovations will increase their impact through higher visibility, proliferation rate, community feedback, follow-up collaborations and further innovations.

CYTO Lab Hacks will develop into a free, open, transparent community-run collaborative innovation forum within ISAC; revolving around an online platform. The development will take place in a series of steps guided by the workshop outcomes and summarized in Figure 1b.

CYTO Lab Hacks will be run by a group of volunteers recruited during the workshop. We will establish efficient communication channels to create and retain the momentum within this group. We will coordinate with the CYTO Innovation Committee to remain accountable and aligned with ISAC's needs, perspectives and bylaws. We will develop CYTO Lab Hacks to adhere to and champion free and open science principles. We will follow the Global Open Science Hardware Murillo et al. (2017) guidelines and synergistically engage with other scientific communities sharing similar aims.

CYTO Lab Hacks will develop gradually. We will first redefine the CYTO Lab Hacks identity (Table S1) to create an instantly recognizable brand. Then a roadmap for CYTO Lab Hacks will be developed to set goals and priorities over the following years (Figure 1b). Range of online social media platforms, collaborative project management tools, data repositories and open source project tools will be assessed to identify those best suited for CYTO Lab Hacks. The tools used by other science and maker communities will be analyzed to understand correct practices in licensing, communication and management. Channels will be setup within suitable online platforms under a common branding umbrella. These platforms will be promoted for the use in the cytometry community to share emerging innovations. Presence and activities at CYTO 2019 will be developed. These may consists of a showcase of innovations, workshop, tutorial and invitation of speakers championing open science.

We expect CYTO Lab Hacks to develop over the next years into a sustainable and instantly recognizable platform for cytometry innovation sharing. Its success will cement the position of ISAC as a leaders in promotion of open science amongst the biological societies.

## ACKNOWLEDGMENTS

We would like to thank ISAC for supporting this workshop, participants for their valuable contributions to the discussion and sound technicians for their help with the recording of the workshop.

# REFERENCES

- Editorial (2013). Sharing blueprints for better research. *Nature Methods*, 10(7):591–591.
- Lee, J. A., Spidlen, J., Boyce, K., Cai, J., Crosbie, N., Dalphin, M., Furlong, J., Gasparetto, M., Goldberg, M., Goralczyk, E. M., et al. (2008). MIFlowCyt: the minimum information about a Flow Cytometry Experiment. *Cytometry Part A*, 73(10):926–930.
- Murillo, L. F. R., Molloy, J., Dosemagen, S., Bild, D., Grey, F., Irujo, G. P., Toivonen, H., Serano, J., Maestre, J. P., Bernaldo, P., Nkoudou, T. H. M., Lowe, A., Thaler, A., Wolfenden, B., Foster, E., Federici, F., van den Boom, F., Austic, G., Keyser, H., Warren, J., Appiah, J., Ettinger, K., Khanal, K., Liboiron, M., Kauttu, P., Kishor, P., Pezzi, R., Bowman, R., Fobel, R., Jaber, S., Mohanty, S., Brown, T., Prabhakar, T., Maillart, T., Wenzel, T., Igoe, T., and Gaudenz, U. (2017). Global Open Science hardware roadmap. <http://openhardware.science/global-open-science-hardware-roadmap/>. Accessed: July 26, 2018.
- Murphy, R. F. and Chused, T. M. (1984). A proposal for a flow cytometric data file standard. *Cytometry: The Journal of the International Society for Analytical Cytology*, 5(5):553–555.
- Pearce, J. M. (2015). Return on investment for open source scientific hardware development. *Science and Public Policy*, 43(2):192–195.
- Spidlen, J., Breuer, K., Rosenberg, C., Kotecha, N., and Brinkman, R. R. (2012). FlowRepository: A resource of annotated flow cytometry datasets associated with peer-reviewed publications. *Cytometry Part A*, 81(9):727–731.
- Spidlen, J., Moore, W., Parks, D., Goldberg, M., Bray, C., Bierre, P., Gorombey, P., Hyun, B., Hubbard, M., Lange, S., et al. (2010). Data file standard for flow cytometry, version FCS 3.1. *Cytometry Part A*, 77(1):97–100.
- Vicente-Saez, R. and Martinez-Fuentes, C. (2018). Open Science now: A systematic literature review for an integrated definition. *Journal of Business Research*, 88:428–436.

# SUPPLEMENTARY MATERIALS

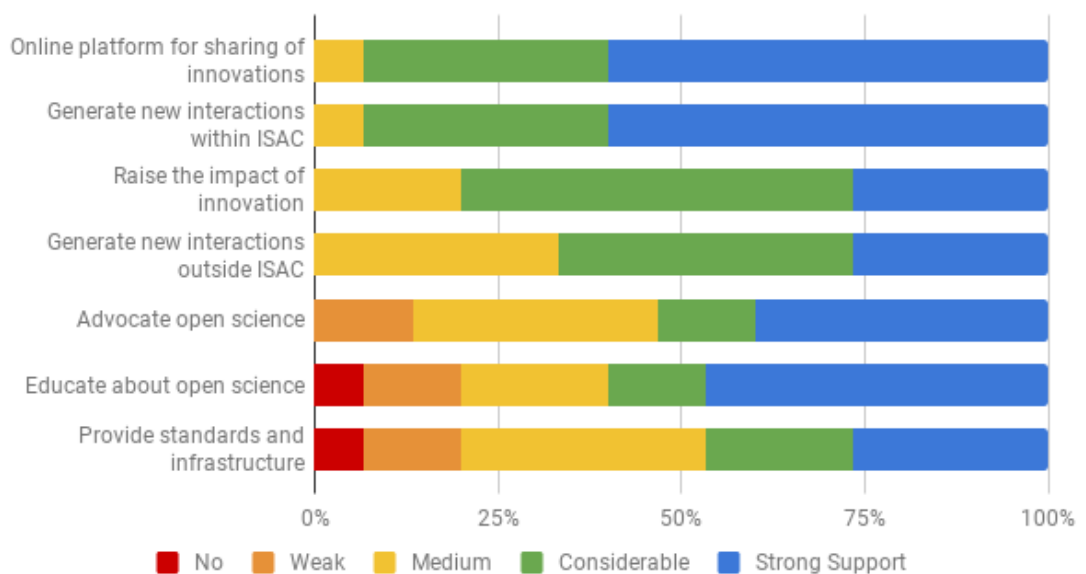
Table S1 contains a list of proposals and suggestions instead of the tentative name "CYTO Lab Hacks".

Figure S1 summarizes the poll results that we used to define the mission for CYTO Lab Hacks. Most support came for the provision of an innovation sharing platform. Figure S1 presents the feedback on the branding proposal. The proposed logo is in the main manuscript (Figure 1a). The polling indicates a split opinion on the adequacy of the branding. Figure S3 shows general agreement on the CYTO Lab Hacks developed by a task force of volunteers with the oversight of the CYTO Innovation Committee. Figure S4 shows the support for CYTO Lab Hacks presentation at the CYTO conferences, with highest preference of a showcase during the CYTO Innovation program. Figure S5 demonstrates the widely shared opinion that the main incentive to contribute to CYTO Lab Hacks would come from gaining the exposure to own innovation and also from seeing success demonstrated by existing contributions.

| Proposed Names                                                                                                                                                                        | General Suggestions                                                                                                                                      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>MacGyver Sessions</li> <li>OpenCYTO</li> <li>Cytovation</li> <li>Flopen / Flowpen</li> <li>ISAC Open Source Cytometry Lab Solutions</li> </ul> | <ul style="list-style-type: none"> <li>Avoid using "CYTO" in the title to protect the brand</li> <li>Clearly express the mission in the title</li> </ul> |

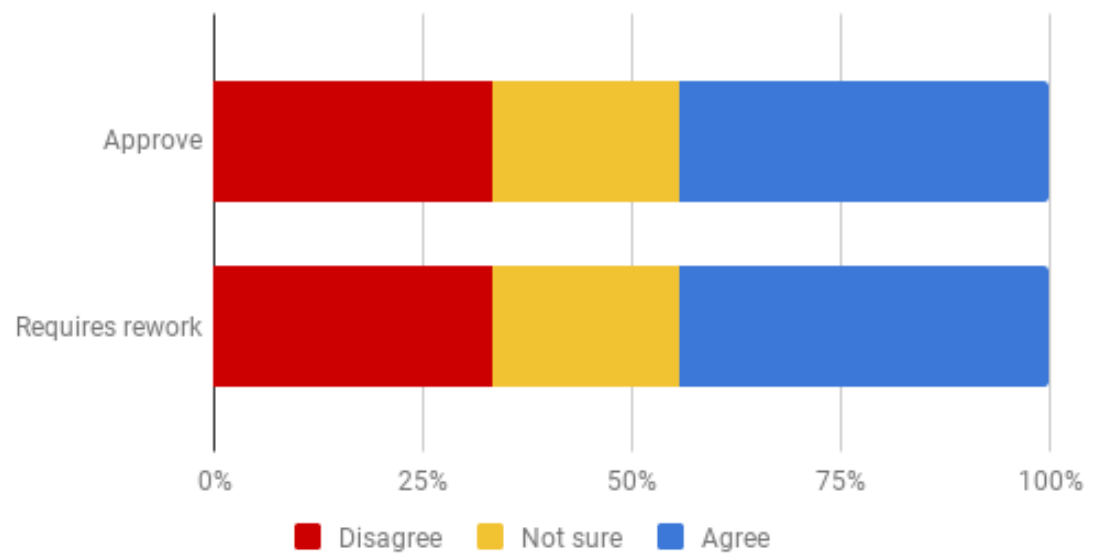
**Table S1.** Table to test captions and labels

## Mission



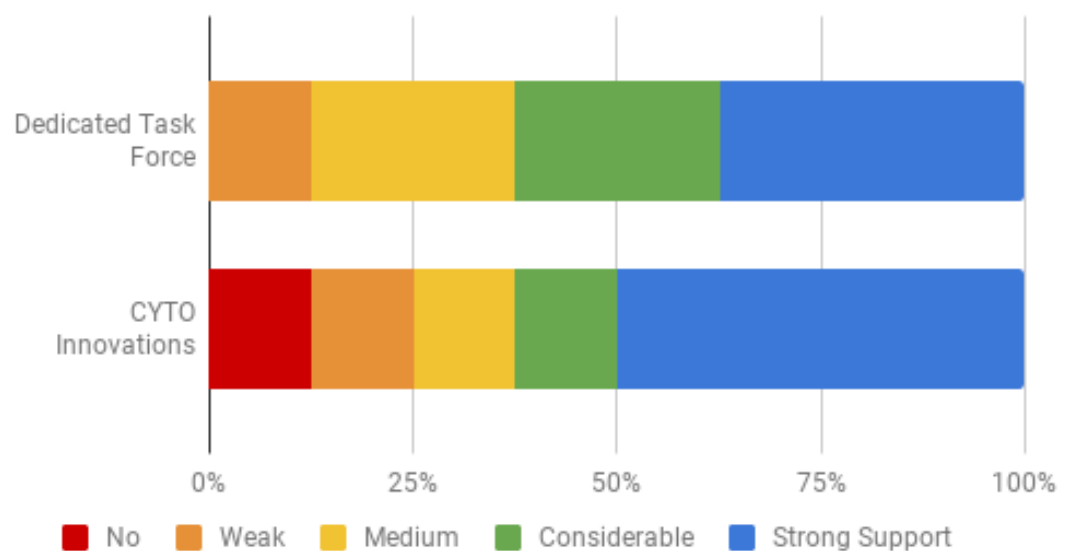
**Fig. S1.** Poll results on the mission for CYTO Lab Hacks.

# Branding



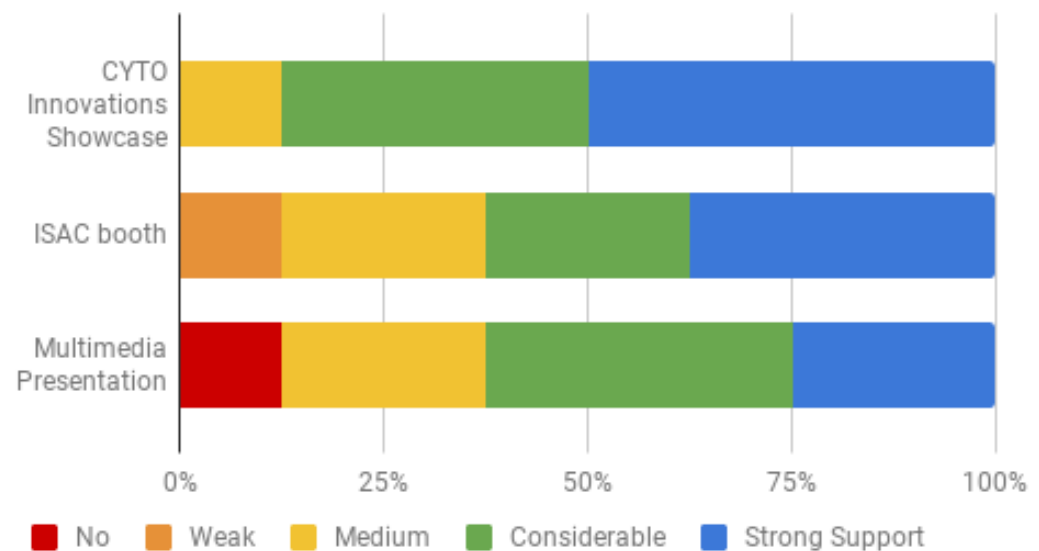
**Fig. S2.** Poll results on the branding of CYTO Lab Hacks.

# Formal Structure



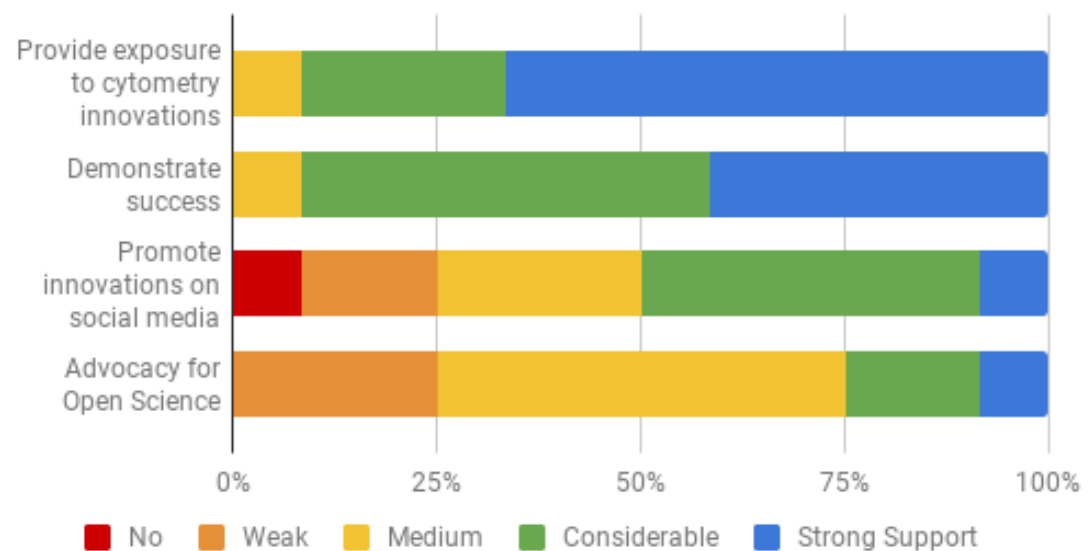
**Fig. S3.** Formal structure for the development of the CYTO Lab Hacks.

## Presence at CYTO



**Fig. S4.** Presentation of CYTO Lab Hacks at CYTO conferences.

## Incentives for contributing to CYTO Lab Hacks



**Fig. S5.** Perceived incentives to contribute to CYTO Lab Hacks.