

Executive Summary

Response Rates

For this workshop we see a good response rate of 62%, with a n of 42 respondents.

Notable Outcomes

- Overall, 97% of respondents said they probably will recommend, definitely will recommend or already have recommended an IMA workshop to a colleague. Also, 97% of respondents said this workshop met or exceeded their expectations. This indicates very high satisfaction with the workshop.
- This workshop survey had high diversity in academic statuses of respondents. Around half of respondents were full professors, with every other academic status also represented.
- Open-ended responses revealed that this workshop was particularly beneficial to participants because of the rich cross-disciplinary learning from high quality participants from varied sectors and fields.
- Almost all participants reported that the talks inspired meaningful discussions, they had gotten new ideas for the direction of their research, they had an increased desire to pursue interdisciplinary research, and that they could foresee working with colleagues met at this workshop in the future.

Notable Comments and Suggestions

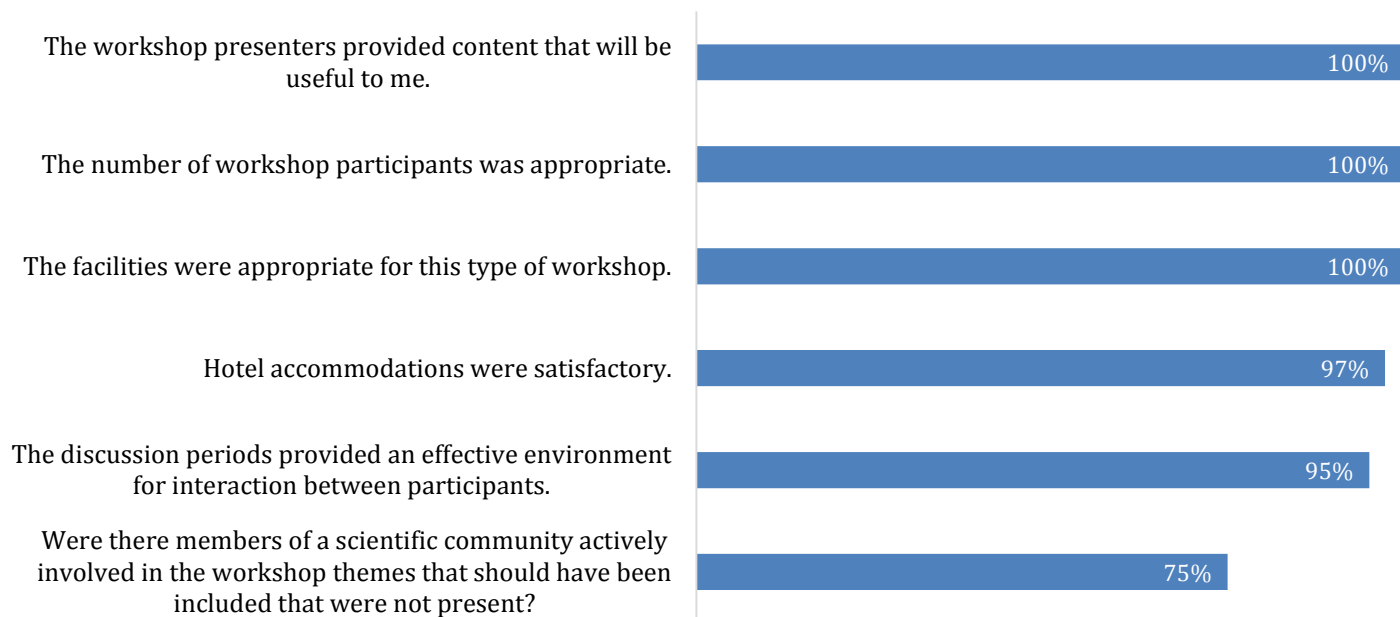
- “I had the chance to see that researchers outside of my usual community make use of the tools that I study and develop in order to solve problems arising from actual engineering applications. And also had the opportunity to visualize the areas of my research that haven't been applied yet and could potentially be adapted to meet the needs of engineers.”
- “The goal of the workshop was to bring together experts on hydraulic fracturing and inverse modeling. This allowed cross-fertilization of ideas, and I believe that it also allowed colleagues to identify problems that will require the collaboration of experts from both communities.”
- “(i) Balanced number of participants, covering a wide range of topics but small enough to keep interactions very effective. (ii) I highly appreciated that practically all the members were present for the entire time at the workshop. (iii) Excellent overall quality of the presentations.”
- “It did seem to be a workshop with mostly two distinct/disjointed communities coming together. Would have been nice to have a dedicated discussion about how the two communities could get closer together. The discussion sessions were not organized/structured and seemed to primarily focus on particular talk questions rather than on the connection between the two communities.”
- “The organizers should be commended for the organization. It was a good idea, well executed.”
- “This workshop gave a clear view about state-of-the art of the modeling and the numerical point of view of Hydraulic Fracturing. I was looking for something like that for years, and now I feel confident about should I do in terms of research. This is a kind of workshop that should exist more, interdisciplinary, researcher presenting what is more closest to the subject of interest. It was one of the workshop that I liked most in my all 25 years scientific career, I learned a lot. “

Demographics

I attended ___ days of the workshop	# of Respondents	% of Respondents		# of Respondents	% of Respondents
One	0	0%	Undergraduate Student	0	0%
Two	4	10%	Graduate Student	7	18%
Three	9	21%	Post-Doctoral Fellow	7	18%
Four	29	69%	Assistant Professor	2	5%
I was not able to attend any of the workshop	0	0%	Associate Professor	2	5%
			Full Professor	17	45%
			Other	3	8%

Workshop Satisfaction Quantitative Data (n=32=40)

Percent approval for each area*



*For question about diversity of the scientific community, the % reported is those answering “No”, for all other questions, the % reported is those answering “Yes”

Workshop Outcomes Quantitative Data

	Not at All	A Little	Some	A Lot	Total N
The talks inspired meaningful discussions throughout the workshop	0%	5%	34%	61%	41
This workshop has given me new ideas for the direction of my research.	0%	7%	41%	51%	41
This workshop has increased my desire to pursue interdisciplinary research involving mathematics.	0%	7%	34%	59%	41
I can foresee working with colleagues I met through this workshop in the future.	2%	10%	49%	39%	41

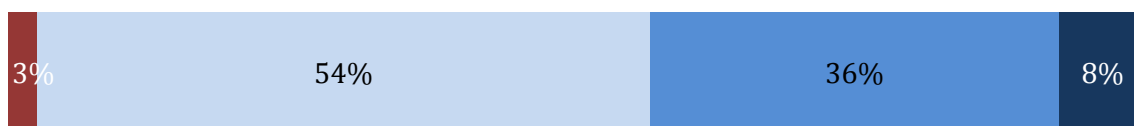
Interactions

Please rate how much interaction you've had with each of the following groups of people at this workshop.

	None	A Little	Some	A Lot	Total N
Participants within my field	0%	5%	40%	52%	42
Participants from other fields	2%	21%	45%	29%	42
Speakers within my field	2%	2%	36%	57%	42
Speakers from other fields	5%	21%	48%	24%	42

Workshop Overall

How did this workshop compare to your expectations overall? (n=39)



■ Below expectations ■ Met expectations ■ Exceeded expectations ■ Far exceeded expectations

How likely are you to recommend an IMA workshop to a colleague after attending this workshop? (n=40)



■ I definitely will not ■ I probably will not ■ I probably will ■ I definitely will or already have

Workshop Outcomes Open-ended Responses

What were the most valuable aspects of the workshop for you?

Most Common Themes

	# of Respondents Mentioned
Cross-disciplinary learning	12
Presentations	10
Networking	10
Discussion / interactions	8
Wide range of topics	7

Catalog of Responses

/ Hydraulic Fracturing material science modeling and the different numerical strategies

(i) Balanced number of participants, covering a wide range of topics but small enough to keep interactions very effectively. / (ii) I highly appreciated that practically all the members were present for the entire time at the workshop. / (iii) excellent overall quality of the presentations

1) Met some professors from some prestigious universities; / 2) Will have some potential collaboration with these professors in the future; / 3) Had some insightful discussions with professors.

An opportunity to interact with people from other fields, learn about modelling of hydraulic fractures, get a good overview and state of art of the subject and get ideas for possible research directions.

Attending seminar, Poster session, and interactions

Being an engineering scientist: / 1) presentations from industry / 2) presentations by mathematicians, with their different viewpoints

Better understanding fracture simulation and imaging as a whole process

Bridge academia and industry, provide opportunities for collaboration

Communication and discussions with new colleagues.

Description of hydraulic fracturing models and the challenges. I liked the spectrum of presentations ranging from tutorials through reduced models to complex coupled systems. / / I also liked the talks on microseismicity and reservoir characterization.

Diversity of the aspects relevant to this certain research (Hydraulic Fracturing).

Diversity of the participants and topics. / Small number of participants, many breaks, high quality of talks and People: This is the perfect mixture for a fruitful workshop.

General strategies to model multiple fractures in a rock.

Getting to see presentation from groups that I normally don't see at other professional meetings, and getting to socialize with those people on breaks and in the evening.

Hearing related talks on other inverse problems (not directly related to hydraulic fracturing) that were interesting and also learning about some of the detailed methods being used for crack/fracture propagation. Meeting some new folks I might wish to collaborate with in future.

I had the chance to see that researchers outside of my usual community make use of the tools that I study and develop in order to solve problems arising from actual engineering applications. And also had the opportunity to visualize the areas of my research that haven't been applied yet and could potentially be adapted to meet the needs of engineers.

I had the opportunity to talk with a lot of the researchers actively involved in the modeling and simulation of hydraulic fracturing. I think this possibility was very valuable.

I was able to form a somewhat better idea of what kind of important scientific problems arise in connection with hydraulic fracturing.

Interaction with other researcher from my field and related fields

It was an opportunity of update in how mathematics is used in oil engineering research, and broaden my perspectives on the possible applications of my own research, and the directions I can follow after graduation.

learned new techniques and discussed with other scientists

Learning about a field in which I'm not yet deeply knowledgeable.

mathematics of hydraulic fracturing and numerical approaches; / some approaches to inverse problems

Meet different people know what's new

Meeting new colleagues and listening to interesting talks

Meeting other researchers in domains close to my research.

Opportunity to connect with very active individuals across disciplines and geographical bases.

Overview of different approaches to address some problems.

Possibility to meet people in my area and learn something new from people in other areas as well.

The goal of the workshop was to bring together experts on hydraulic fracturing and inverse modeling. This allowed cross-fertilization of ideas, and I believe that it also allowed colleagues to identify problems that will require the collaboration of experts from both communities.

The overview talks from industry about the use of HF to increase yields of unconventional, talks by forward modelers on more recent numerical techniques (XFEM), informal discussions at meal times.

Which research themes that emerged from the workshop will most likely influence your work?

(i) identification of cracks, taking into account the configurations and constraints of hydraulic fracturing / (ii) small scale experimenting for hydraulic fracturing / (iii) opening discussions on peridynamics

Devising of numerical schemes for fluid/solid interaction that meet the needs of accuracy, simplicity and economy of computation for the modeling of crack propagation.

Hydraulic fracture modelling.

Hydraulic fracturing modeling.

I was eager to know better other numerical methods (XFEM), different from the method I use (FEM) for modelling hydraulic fracturing. This will influence my numerical developments in order to attain more efficiency.

I was most interested in the talks about simplified methods for hydraulic fracture modeling.

I'll cite a few: micro-seismicity, inversion for source localization, DFN mapping, etc

imaging thin objects

Including rock fracture growth in reservoir modeling.

Instabilities and inverse problems related to hydraulic fracturing, and numerical modeling of hydraulic fracturing.

Inverse imaging of fractures.

Inverse problem theory and subsurface fracturing modeling

inverse problems for the wave equation

Material science modeling, then phase field formulation and XFEM

mathematics and physics of hydraulic fracturing

Methods for modelling hydraulic fracture in 3D.

Models of fracturing !

Probably, related to finding and modelling of effective parameters of fractured media.

several. NOT EASY TO ANSWER NOW.

Study of fracturing such as crack propagation and identification

The formulation of inverse problems in connection with hydraulic fracturing.

The significance of tip modeling for XFEM

The variational methods

Uncertainty quantification; post-processing on FEM

Uniqueness of solution to certain inverse problems. Modeling of fractures/cracks.

use of approaches for investigating fracturing phenomena in inverse problem

Wave imaging and characterization of complex media

Do you have any other thoughts or comments regarding the workshop?

Again, an excellent workshop

Excellent administration, good environment for both talks and informal interaction, good chairing and academic leadership. / The inverse theory talks did not make much connection with forward modeling of HF.

Food was poorly organized. Breakfasts were not helpful, although they were getting better by the end of the workshop. Lunches were OK, but not organized. The cruise was good. The dinner at Surley's was a complete failure in my opinion. A better organization would help a lot.

I hope the discussions made it clear that the main problem is not the growth of one hydraulic cracks but the growth of a large system of hydraulic cracks, its localization into one crack, and the way to prevent such localization.

I think it is a good opportunity to meet with scientists from other fields.

I think the organization was great. I really enjoyed attending the workshop. It was a very positive experience.

I would like to thank the organizers for the great idea of organizing this workshop

It did seem to be a workshop with mostly two distinct/disjointed communities coming together. Would have been nice to have a dedicated discussion about how the two communities could get closer together. The discussion sessions were not organized/structured and seemed to primarily focus on particular talk questions rather than on the connection between the two communities.

It was a very good experience for me and hope to be involved in future IMA workshops

It's a great workshop.

Just perfect, it was great to be invited! Thank you very much.

The engineers present seemed to know each other very well, and formed a rather insular group. Perhaps there could have been a way to integrate the rest of participants better with them.

The organizers should be commended for the organization. It was a good idea, well executed.

This was a very beneficial experience for me and I am grateful to the organizers for having invited me.

This was an excellent workshop.

Workshop Satisfaction Open-ended Responses

Facilities

Except for Wednesday afternoon, the conference room and its location was outstanding.

I think the conference room was great. Also the workshop assistants were very friendly and attentive.

The room on Wednesday (I think) was too small, but otherwise a nice venue.

This was a very good and a very useful workshop with a very adequate organization.

Hotel

Hotel was very comfortable.

Hotel was very nice and a great location.

I stayed at Days Inn. but most of other workshop attendees were at Commons Hotel on campus which was more convenient with a better quality. The main bothering thing was the commute in rainy days with a very slow pedestrian-signals at the junctions along the way, especially when I had appointments with other colleagues who were residing in Commons hotel.

The hotel was excellent.

Very nice hotel, although I would be all right with staying in a dorm or sharing accommodations, it would probably be a little bit cheaper.

Discussion periods

But the discussion in the lecture room were too limited, because each lecture were over time. When I was running workshops, I always scheduled a period of time after each talk and each session, and assigned a very competent moderator to run each discussion period, someone who could stimulate discussion by raising his own questions and pointing our problematic aspects.

Fantastic

I found the overall format of the presentations and the time allotted per presentation very appropriate and conducive to discussion. It would have been nice if there was more time allotted to discussions, perhaps led by a panel consisting of some or all of the speakers.

I liked the long breaks between talks so that we had the chance to discuss in detail.

Scientific community

a few, yes

E.g., Dr. Sharma.

I am not sure.

I think perhaps the people from geophysical imaging and modelling community were a little bit underrepresented.

Invitees covered a broad spectrum of expertise. The mix was appropriate.

My answer only consider the talks related with "Modeling and Simulation" of Hydraulic Fracturing. I do not have the knowledge to assess if there were missing relevant members of the scientific community dealing with "Reconstruction and Characterization".

No doubt there were, but you can't expect to get everyone who might have made a valuable contribution.

Some geologists/volcanologists might have had an interesting perspective on multiple fracturing events

There were some I could think of, but I understand there are many meetings and everyone cannot attend every meeting. I don't know that it was because of lack of invitation. One person I am thinking of is Arash Dahi-Taleghani from LSU.

Content

I think most of the talks were useful and some of the speakers also provided useful references.

This workshop gave a clear view about state-of-the art of the modeling and the numerical / point of view of Hydarulic Fracturing. I was looking for something like that for years, and now / I feel confident about should I do in terms of research. / This is a kind of workshop that should exist more, interdisciplinary, resercher presenting what is / more closest to the subject of interest. / / It was one of the workshop that I liked most in my all 25 years scientific career, I learned a lot.