

THE 29TH ANNUAL INTERNATIONAL  
**SOLID FREEFORM  
FABRICATION** SYMPOSIUM  
– AN ADDITIVE MANUFACTURING CONFERENCE – **2018**

**August 13–15, 2018**  
**Hilton Hotel Austin • Austin, Texas, USA**

# FINAL PROGRAM

**Organized by** the Mechanical Engineering Department/Lab for Freeform Fabrication under the aegis of the Advanced Manufacturing and Design Center at The University of Texas at Austin.

**Sponsored by:**



[sffsymposium.engr.utexas.edu](http://sffsymposium.engr.utexas.edu)

# SCHEDULE OF EVENTS

Function	Time	Location
<b>Sunday, August 12</b>		
Registration	2:00 p.m. to 5:00 p.m.	Hilton Austin, Salon H Foyer
Pre-Conference Social Event	6:00 p.m. to 8:30 p.m.	Buffalo Billiards <i>*Must be 21 or older; Photo ID Required</i>
<b>Monday, August 13</b>		
Registration	7:00 a.m. to 5:00 p.m.	Hilton Austin, Salon H Foyer
Opening Remarks	8:00 a.m. to 8:15 a.m.	Hilton Austin, Salon HJK
Plenary Session and FAME Award Presentations	8:15 a.m. to 12:05 p.m.	Hilton Austin, Salon HJK
Break	9:55 a.m. to 10:25 a.m.	Hilton Austin, Salon HJK Foyer
Lunch	12:05 p.m. to 1:30 p.m.	On Your Own
Technical Sessions	1:30 p.m. to 5:00 p.m.	Hilton Austin, See Technical Program
Break	3:10 p.m. to 3:40 p.m.	Hilton Austin, Salon HJK Foyer
Welcome Reception	6:00 p.m. to 6:30 p.m.	Hilton Austin, Salon HJK Foyer
10th Annual Awards Program & Banquet	6:30 p.m. to 9:00 p.m.	Hilton Austin, Salon HJK
<b>Tuesday, August 14</b>		
Registration	7:00 a.m. to 5:00 p.m.	Hilton Austin, Salon H Foyer
Technical Sessions	8:15 a.m. to 12:05 p.m.	Hilton Austin, See Technical Program
Break	9:55 a.m. to 10:25 a.m.	Hilton Austin, Salon HJK Foyer
Lunch	12:05 p.m. to 1:40 p.m.	Hilton Austin, Salon H
Technical Sessions	1:40 p.m. to 4:00 p.m.	Hilton Austin, See Technical Program
Poster Session with Refreshments	4:00 p.m. to 5:30 p.m.	Hilton Austin, Salon JK
<b>Wednesday, August 15</b>		
Registration	7:00 a.m. to 5:00 p.m.	Hilton Austin, Salon H Foyer
Technical Sessions	8:00 a.m. to 11:50 a.m.	Hilton Austin, See Technical Program
Break	9:40 a.m. to 10:10 a.m.	Hilton Austin, Salon HJK Foyer
Lunch	11:50 a.m. to 1:10 p.m.	On Your Own
Technical Sessions	1:10 p.m. to 5:00 p.m.	Hilton Austin, See Technical Program
Break	2:50 p.m. to 3:20 p.m.	Hilton Austin, Salon HJK Foyer

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# ABOUT THE SYMPOSIUM

## REGISTRATION

The full-conference and student registration rates includes the following:

- Access to technical and poster sessions
- Sunday evening pre-conference event
- Monday evening awards banquet
- Tuesday lunch
- A flash drive copy of the post-conference proceedings

The daily registration rate includes the following:

- Access to technical and poster sessions that day
- One ticket to the social event on that day

## Registration Hours

The registration desk will be located in the Salon H Foyer of the Hilton Austin during the following hours:

**Sunday, August 12:** 2:00 p.m. to 5:00 p.m.

**Monday, August 13:** 7:00 a.m. to 5:00 p.m.

**Tuesday, August 14:** 7:00 a.m. to 5:00 p.m.

**Wednesday, August 15:** 7:00 a.m. to 5:00 p.m.

## Internet Access

Complimentary wireless internet is for attendees in the Hilton Austin meeting spaces. To access the wireless internet, open the wireless menu on your device and choose the network “**Hilton Meetings**” and enter the access code “**SFF2018**.”

## Technical Sessions

All technical and poster presentations will be located at the Hilton Austin. See the Technical Program on pages 23-114 for locations.

## Luggage Storage

Luggage storage will be available at no cost to attendees on Wednesday, August 15, from 7:00 a.m. to 6:00 p.m. in room 612 at the Hilton Austin. Please note that this room will not be secured and any items left for storage will be at the attendee's own risk. TMS and/or the SFF conference are not responsible for lost, stolen, or damaged items left in the room.

# ABOUT THE VENUE



Symposium programming and events will take place at the four-star Hilton Hotel Austin. The Hilton Austin is located at 500 East 4th Street in downtown Austin, adjacent to the Convention Center. Exclusive shopping, amazing restaurants, and fun live music venues in the 6th Street Entertainment District and surrounding areas are all just a few steps away from the Hilton Austin. The hotel also boasts fantastic views of the Capitol of Texas and Lady Bird Lake from 31 stories up.

Self-parking (\$32) and valet parking (\$41) are both available at the hotel. Visit the Hilton Hotel Austin website for more details.

# SOCIAL AND NETWORKING EVENTS

## PRE-CONFERENCE SOCIAL EVENT

6:00 p.m. to 8:30 p.m. • Sunday, August 12

### Buffalo Billiards

Come and meet old friends and make new ones before the “business” starts Monday! Enjoy a “Tex-Mex” style fajita buffet at Buffalo Billiards, 201 East 6th Street in downtown Austin. The restaurant is only 0.3 mi (0.5 km) from the Hilton Hotel Austin. There is no additional charge to attend for conference registrants. No transportation will be provided. Guests must be 21 years or older to attend; photo ID will be required to enter Buffalo Billiards.

### About Buffalo Billiards

From the Buffalo Billiards website: “This turn-of-the-century building was built in 1861 by the Ziller Family and named the Missouri House. Touted as Austin’s first boarding house and rumored to be a brothel, many a cowboy had a good time here.”

The entire venue consists of three full bars, 19 pool tables, seven shuffleboard tables, five foosball tables, 15 pinball machines, a collection of classic and modern arcade machines, and two air hockey tables. The SFF Symposium group will have the run of the place from 6:00 p.m. to 8:30 p.m.

## CONFERENCE LUNCH EVENT

12:05 p.m. to 1:40 p.m. • Tuesday, August 14

An informal networking lunch will be provided near the meeting rooms in Salon H at the Hilton Hotel Austin at the lunch break on Tuesday. The cost is included in the conference registration fee. There is no organized Tuesday evening social event this year.

## AWARDS PRESENTATION

Monday, August 13 • Hilton Austin

6:00 p.m.	Reception & Welcome
6:40 p.m.	Special Presentation
7:00 p.m.	Dinner
8:00 p.m.	Awards Presentation
9:00 p.m.	Event Concludes

### Special Presentation: Dr. Tony Rollett



Anthony Rollett is the co-director of the NextManufacturing Center at Carnegie Mellon University (CMU). Prior to joining CMU in 1995, Tony was with the Los Alamos National Laboratory. He has over 200 peer-reviewed journal publications that cover a wide range of topics. The main focus of his research is on the measurement and computational

prediction of microstructural evolution especially in three dimensions. His interests include strength of materials, constitutive relations, microstructure, texture, anisotropy, grain growth, recrystallization, formability and stereology. His most recent honors include: Member of Honor of the French Society of Materials (SF2M) in 2015; the Edgar C. Bain Award from the Pittsburgh Chapter of ASM International in 2016; and appointment as U.S. Steel Professor of Metallurgical Engineering & Materials Science at Carnegie Mellon University in 2017. Tony has used the third generation (synchrotron x-rays) Advanced Photon Source at the Argonne National Laboratory to produce remarkable videography of melt pool and vapor keyhole phenomena in metal powder bed fusion.

Tony will introduce, present, and discuss these measurements. However, Tony has accepted the challenge to pitch the entire talk at a level that a 10–12 year old might understand (!). In addition, Tony will close the program with some novel entertainment that everyone will enjoy.



<b>Barbecue</b>	<b>Mexican</b>	<b>American</b>	<b>Italian</b>	<b>Seafood</b>
<p><b>Coopers</b> (3<sup>rd</sup>/Congress)</p> <p><b>Lamberts</b> (W.2<sup>nd</sup>/Guadalupe)</p> <p><b>Iron Works</b> (Red River/Cesar Chavez)</p> <p><b>Stubbs</b> (Red River/E.8<sup>th</sup>)</p> <p><b>Terry Blacks</b> (Barton Springs Rd)</p> <p><b>Franklin</b> (E.11<sup>th</sup>/Branch)</p> <p><b>La Barbecue</b> (E.Cesar Chavez)</p> <p><b>Freedman's</b> (W. 24<sup>th</sup>)</p> <p><b>Micklethwait</b> (E.11<sup>th</sup>/Rosewood)</p> <p><b>The Salt Lick</b> (Round Rock/Driftwood)</p>	<p><b>La Condesa</b> (W.2<sup>nd</sup>/Guadalupe)</p> <p><b>El Naranjo</b> (Rainey St.)</p> <p><b>Manuels</b> (Congress/W.3<sup>rd</sup>)</p> <p><b>Iron Cactus</b> (E.6<sup>th</sup> St)</p> <p><b>Pelons</b> (8<sup>th</sup>/Red River)</p> <p><b>Benjis Cantina</b> (W.6<sup>th</sup>/West Ave)</p> <p><b>Uncle Julios</b> (Brazos/E.3<sup>rd</sup>)</p> <p><b>Michelada's</b> (2<sup>nd</sup>/San Jacinto)</p> <p><b>Matts El Rancho</b> (S. Lamar)</p>	<p><b>Cannon + Belle</b> (Hilton Austin)</p> <p><b>Moonshine</b> (4<sup>th</sup>/Red River)</p> <p><b>Parkside</b> (E.6<sup>th</sup>/San Jacinto)</p> <p><b>Searsucker</b> (Colorado/W.5<sup>th</sup>)</p> <p><b>Fixe</b> (W.5<sup>th</sup>/Nueces)</p> <p><b>Max's Wine Dive</b> (San Jacinto/E.3<sup>rd</sup>)</p> <p><b>Second Bar + Kitchen</b> (Congress/W.2<sup>nd</sup>)</p> <p><b>Emmer &amp; Rye</b> (Rainey St.)</p> <p><b>No Va</b> (Rainey St.)</p> <p><b>Swifts Attic</b> (3<sup>rd</sup>/Congress)</p> <p><b>24 Diner</b> (S.Lamar/W. 6<sup>th</sup>)</p>	<p><b>Italic</b> (W.6<sup>th</sup>/Colorado)</p> <p><b>Botticellis</b> (S.Congress/Gibson)</p> <p><b>La Traviata</b> (Congress/W. 4<sup>th</sup>)</p> <p><b>Taverna</b> (W.2<sup>nd</sup>/Lavaca)</p> <p><b>Winflo Osteria</b> (W.6<sup>th</sup>/Pressler)</p> <p><b>Cipollina</b> (W.Lynn/W. 13<sup>th</sup>)</p> <p><b>Vespaio</b> (S. Congress)</p> <p><b>Numero 28</b> (W. 2<sup>nd</sup>/San Antonio)</p> <p><b>Red Ash</b> (3<sup>rd</sup>./Colorado)</p>	<p><b>Café Blue</b> (2<sup>nd</sup>/Trinity)</p> <p><b>Eddie V's</b> (E. 5<sup>th</sup>/Trinity)</p> <p><b>Capital Grille</b> (W. 4<sup>th</sup>/Colorado)</p> <p><b>Trulucks</b> (Colorado/E.4<sup>th</sup>)</p> <p><b>Perla's</b> (S. Congress/Gibson)</p> <p><b>Surf and Turf Po Boy</b> (Lavaca/E. 4<sup>th</sup>)</p> <p><b>Trio (inside Four Seasons)</b> (San Jacinto)</p> <p><b>Clarks</b> (W. 6<sup>th</sup>/Blanco)</p> <p><b>Dock and Roll</b> (S.1<sup>st</sup>)</p>
<b>Steakhouse</b>	<b>Asian</b>	<b>Sushi</b>	<b>French</b>	<b>Pizza</b>
<p><b>Eddie V's</b> (E. 5<sup>th</sup>/San Jacinto)</p> <p><b>Vince Young's</b> (2<sup>nd</sup>/San Jacinto)</p> <p><b>Capital Grille</b> (W. 4<sup>th</sup>/Colorado)</p> <p><b>Perry's</b> (W.7<sup>th</sup>/Colorado)</p> <p><b>III Forks</b> (C. Chavez/Lavaca)</p> <p><b>Austin Land &amp; Cattle</b> (N.Lamar)</p> <p><b>Lonesome Dove</b> (5<sup>th</sup>/Colorado)</p>	<p><b>Wu Chow</b> (W. 5<sup>th</sup>/San Antonio)</p> <p><b>Kyoten</b> (E. 6<sup>th</sup>)</p> <p><b>Mai Thai</b> (San Jacinto/E.3<sup>rd</sup>)</p> <p><b>Sway</b> (S.1<sup>st</sup>)</p> <p><b>Elizabeth St. Café</b> (S.1<sup>st</sup>/W.Mary)</p> <p><b>Koriente</b> (E.7<sup>th</sup>/Sabine)</p> <p><b>Daruma Ramen</b> (E.6<sup>th</sup>)</p>	<p><b>Bar-Chi</b> (Colorado/W.2<sup>nd</sup>)</p> <p><b>Uchi</b> (S.Lamar)</p> <p><b>Uchiko</b> (N. Congress)</p> <p><b>Sushi Zushi</b> (W.5<sup>th</sup>)</p> <p><b>Piranha Sushi</b> (San Jacinto/E.3<sup>rd</sup>)</p> <p><b>Maiko</b> (W. 6<sup>th</sup>/Guadalupe)</p> <p><b>RA</b> (4<sup>th</sup>/Colorado)</p> <p><b>Lucky Robot</b> (S. Congress)</p>	<p><b>Justine's Brasserie</b> (E. 5th)</p> <p><b>Chez Nous</b> (5<sup>th</sup>/Neches)</p> <p><b>Peche</b> (W.4<sup>th</sup>)</p> <p><b>Blue Dahlia Bistro</b> (E.11<sup>th</sup>)</p> <p><b>L'estelle House</b> (Rainey)</p> <p><b>Elizabeth Street Café</b> (S. Congress/Elizabeth St)</p> <p><b>Le Café Crepe</b> (2<sup>nd</sup>/San Jacinto)</p>	<p><b>Backspace</b> (San Jacinto/E.6th)</p> <p><b>Hoboken Pie</b> (Red River/E.8<sup>th</sup>)</p> <p><b>Roppolo's</b> (6<sup>th</sup>/ Trinity)</p> <p><b>Home Slice</b> (S. Congress)</p> <p><b>Via 313</b> (Rainey St)</p> <p><b>Numero 28</b> (W. 2<sup>nd</sup>/San Antonio)</p>
<b>Burgers/Sandwiches</b>	<b>Vegetarian/ Vegan</b>	<b>Fusion/Misc.</b>	<b>Breakfast</b>	<b>Brunch</b>
<p><b>Easy Tiger</b> (E.6th/Sabine)</p> <p><b>Casino El Camino</b> (E.6<sup>th</sup>/Red River)</p> <p><b>Eureka</b> (6<sup>th</sup>/ Brazos)</p> <p><b>Hopdoddy</b> (S.Congress)</p> <p><b>Waller Creek Pub</b> (6<sup>th</sup>/ Sabine)</p> <p><b>P Terry's</b> (6<sup>th</sup>/Congress)</p> <p><b>Frank</b> (Colorado/W.4<sup>th</sup>)</p>	<p><b>Koriente</b> (E.7<sup>th</sup>/Sabine)</p> <p><b>Arlos (V)</b> (Red River)</p> <p><b>Counter Culture Café (V)</b> (E. C. Chavez/Clara)</p> <p><b>Bouldin Creek Café</b> (S.1<sup>st</sup>/W.Mary)</p> <p><b>Mr. Natural</b> (E. C. Chavez/Chicon)</p> <p><b>The Vegan Yacht (V)</b> (Spiderhouse)</p> <p><b>(V) = Vegan</b></p>	<p><b>Austin Taco Project</b> (Hilton Austin)</p> <p><b>G'RajMahal Indian</b> (Rainey St)</p> <p><b>Malaga Tapas</b> (2nd/ San Antonio)</p> <p><b>Clay Pit</b> (15<sup>th</sup>/Guadalupe)</p> <p><b>Russian House</b> (E. 5<sup>th</sup>)</p> <p><b>Buenos Aires Argentine</b> (E. 6<sup>th</sup>/Waller)</p> <p><b>Bangers</b> (Rainey St)</p>	<p><b>Cannon + Belle</b> (Hilton Austin)</p> <p><b>Forthright</b> (Cesar Chavez/Brazos)</p> <p><b>24 Diner</b> (S.Lamar/W.6<sup>th</sup>)</p> <p><b>Annies Cafe</b> (Congress/E.4<sup>th</sup>)</p> <p><b>1886 Café</b> (The Driskill)</p> <p><b>Counter Café</b> (E.6<sup>th</sup>)</p> <p><b>Le Café Crepe</b> (2<sup>nd</sup>/San Jacinto)</p> <p><b>South Congress Café</b> (South Congress)</p>	<p><b>Moonshine</b> (Red River/E.4<sup>th</sup>)</p> <p><b>El Naranjo</b> (Rainey St)</p> <p><b>Stubbs Gospel Brunch</b> (Red River)</p> <p><b>No Va</b> (Rainey)</p> <p><b>Swifts Attic</b> (Congress Avenue)</p> <p><b>Taverna</b> (2<sup>nd</sup>/Lavaca)</p> <p><b>Searsucker</b> (5<sup>th</sup>/Colorado)</p> <p><b>Little Barrel &amp; Brown</b> (S. Congress)</p> <p><b>Forthright</b> (Cesar Chavez/Brazos)</p>
<b>Cafes</b>	<b>Beer/Wine/Liquor</b>	<b>Grocery/Pharmacy</b>	<b>Tour Info/Pickup</b>	<b>Address</b>
<p><b>Starbucks</b> (Hilton Austin)</p> <p><b>Hounds Tooth</b> (E.4<sup>th</sup>/Congress)</p> <p><b>Jo's Coffee</b> (2<sup>nd</sup>/Colorado)</p>	<p><b>All American Liquors</b> (E 5<sup>th</sup>/Brazos)</p> <p><b>Twin Liquors</b> (Red River/E.7<sup>th</sup>)</p> <p><b>Austin Wine Merchant</b> (W.6<sup>th</sup>)</p>	<p><b>CVS Pharmacy</b> (5<sup>th</sup>/Congress)</p> <p><b>Royal Blue Grocery</b> (3<sup>rd</sup>/Brazos)</p> <p><b>Whole Foods Market</b> (W.6<sup>th</sup>/Lamar)</p>	<p><b>Austin Visitor Center</b> (512)-478-0098 (Red River/E.4<sup>th</sup>)</p>	<p><b>The Hilton Austin</b> <b>500 E. 4<sup>th</sup> St</b> <b>Austin, Texas</b> <b>(512)-482-8000</b></p>

# DOWNTOWN MAP



## Badges

All attendees are encouraged to wear SFF Symposium registration badges at all times during the conference to ensure admission to events included in the paid fee such as technical sessions, exhibition, and receptions.

## Americans with Disabilities Act



The federal Americans with Disabilities Act (ADA) prohibits discrimination against, and promotes public accessibility for, those with disabilities. In support of, and in compliance with ADA, we ask those requiring specific equipment or services to contact TMS Meeting Services at [mtgserv@tms.org](mailto:mtgserv@tms.org) in advance.

## Cell Phone Use

In consideration of attendees and presenters, we kindly request that you minimize disturbances by setting all cell phones and other devices on “silent” while in meeting rooms.

## Anti-Harassment

In all activities, the SFF Symposium is committed to providing a professional environment free of harassment, disrespectful behavior, or other unprofessional conduct.

Conference policy prohibits conduct that is disrespectful, unprofessional, or harassing as related to any number of factors including, but not limited to, religion, ethnicity, gender, national origin or ancestry, physical or mental disability, physical appearance, medical condition, partner status, age, sexual orientation, military and veteran status, or any other characteristic protected by relevant federal, state, or local law or ordinance or regulation.

Failure to comply with this policy could lead to censure from the conference organizers, potential legal action, or other actions.

Anyone who witnesses prohibited conduct or who is the target of prohibited verbal or physical conduct should notify a conference staff member as soon as possible following the incident. It is the duty of the individual reporting the prohibited conduct to make a timely and accurate complaint so that the issue can be resolved swiftly.

## Photography and Recording



The SFF Symposium reserves the right to all audio and video reproduction of presentations at this meeting. By registering for this meeting, all attendees acknowledge that they may be photographed by conference personnel while at events and that those photos may be used for promotional purposes, in and on conference publications and websites, and on social media sites.

Any recording of sessions (audio, video, still photography, etc.) intended for personal use, distribution, publication, or copyright without the express written consent of the individual authors is strictly prohibited. Attendees violating this policy may be asked to leave the session.

## Antitrust Compliance

The SFF Symposium complies with the antitrust laws of the United States. Attendees are encouraged to consult with their own corporate counsel for further guidance in complying with U.S. and foreign antitrust laws and regulations.

## Emergency Procedures

The chances of an emergency situation occurring at the SFF Symposium are quite small. However, being prepared to react effectively in case of an incident is the most critical step in ensuring the health and safety of yourself and those around you. Please take a few moments to review the map of the Hilton Hotel Austin printed in this program (back cover). When you enter the building, familiarize yourself with the exits and the stairs leading to those exits. When you arrive at your session or event location, look for the emergency exits that are in closest proximity to you.

The Hilton Austin has an emergency response team in place 24 hours a day. The hotel’s internal emergency number is 44 (can be dialed from any house phone). In the event of an emergency, calling the 44 emergency number will initiate the appropriate response. The hotel security department and a number of other hotel employees are also trained in CPR and First Aid.

Emergency evacuation routes and procedures are located on the inside of all guest room doors. The local fire department, police department, and paramedics are all approximately five minutes away from the conference location.

## A BIG THANK YOU TO:



The **National Science Foundation** for providing meeting support (Grant Number CMMI-1826959)

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**Stratasys Digital Manufacturing** (Jeff Rodocker, Pat Garner) for donating the FAME trophies.

**TyRex Group Ltd.** for hosting the refreshments during the Tuesday afternoon poster session.

**Taylor & Francis Publishing** for allotting a special issue of the *Virtual and Physical Prototyping Journal* for best papers for the meeting.

**The Minerals, Metals & Materials Society** for allotting a special issue of the journal *JOM* for best papers with a materials theme.

### International SFF Symposium Organizing Committee

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Joe Beaman, UT-Austin  
Rich Crawford, UT-Austin  
Carolyn Seepersad, UT-Austin  
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