2004, Stockholm
2022, Linköping
2010, Edinburgh, Scotland
2018, Cambridge, England
2007, Quebec City, QC
2008, Cologne
2000, Paris
2009, Seattle, WA
2019, Ottawa, ON
2001, Montréal, QC
2016, Heidelberg
2013, Istanbul
2011, Chicago, IL
2005, Philadelphia, PA
2014, Salamanca
2006, Florence
2017, Xi'an
1999, Sunnyvale, CA
1998, Las Vegas, NV
2015, Washington, DC
2002, Annapolis, MD
2012, Singapore
2020, VIRTUAL
2021, Sun City
2003, Cairns, QLD

25 YEARS OF ISIF

INTRODUCTION

The International Society of Information Fusion (ISIF) was formed in 1998 to be the sponsor of FUSION 1999. Over the next 25 years, ISIF has sponsored 25 annual FUSION Conferences on five continents, published the *Journal of Advances in Information Fusion* (JAIF), and the ISIF *Perspectives on Information Fusion* magazine. This paper reflects on the progress of ISIF at its 25th anniversary and summarizes its achievements in serving the information fusion community.

ORGANIZATION

ISIF was incorporated as a non-profit organization in September 1998, mainly to be the sponsor of FUSION 1999 [1]. Since there were no initial members, an organizing committee was formed to elect the first ISIF Board in December 1998. Jim Llinas was the first president. The Board decided that attendees of FUSION conferences would automatically become members. With members from the attendees of FUSION 1999, the Board for 2000 was elected and Yaakov Bar-Shalom became the president. Such a procedure was made official later by the ISIF Constitution and Bylaws.

The organization of ISIF has evolved over the years. A constitutional amendment in 2004 created the position of President-Elect, who will be the President in the subsequent year. Another amendment in 2008 enlarged the Executive Committee to include the most recent past presidents. These changes provide more continuity in the management of ISIF. Membership in the Executive Committee continues to evolve to reflect the changing needs of ISIF. For example, the Vice President (VP) Social
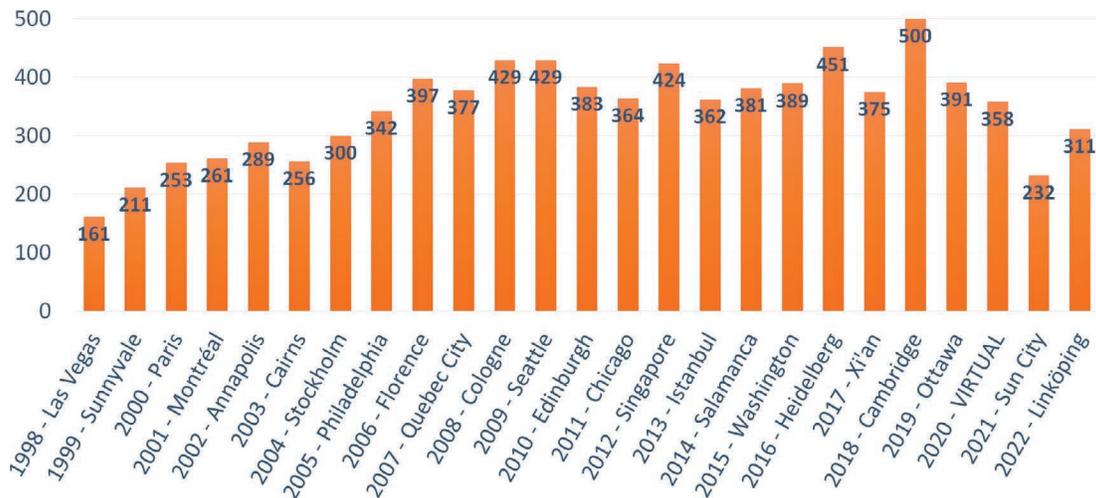
Media was added in 2022. The current ISIF Board of Directors consists of the President, President-Elect, Treasurer, Secretary, VP Communications, VP Conferences, VP Membership, VP Publications, VP Social Media, VP Working Groups, JAIF Editor-in-Chief (EiC), *Perspectives* EiC, the last two Past Presidents, and nine elected members, each serving three-year terms.

ISIF Board of Directors

FUSION CONFERENCES

ISIF was formed to sponsor FUSION 1999. Over the past 25 years, the International Conference on Information Fusion, simply known as the FUSION Conference, has emerged as the premier venue for the interchange of the latest research in information fusion and discussion of its impacts on our society. The conference is known for its inclusiveness for accepting innovative and valuable ideas that may not be completely polished. It is ultimately the people that are the lifeblood of any research community, and the FUSION Conference offers ample opportunity to meet with the leading experts in information fusion in both technical and social settings. It is the impromptu discussions that has led to new ideas and research projects. The combination of technical and social programs provides a unique experience for our research community.

The FUSION Conference that we know and love did take some time to evolve. A personal perspective of this evolution by the various conference organizers was reported last year in [2]. We will highlight a few critical milestones. The initial conference was a gamble by two Ph.D. entrepreneurs to hold a new

Figure 1
Attendance numbers for all 25 FUSION conferences.

data fusion conference in Las Vegas that was open to researchers from all over the world. Such an event did not exist before, and the two entrepreneurs had to start from scratch. They searched the internet for an influential, energetic, and willful data fusion researcher to help and attract papers. They identified and recruited X. Rong Li as that researcher and he agreed. Rong was able to rally a core group of experts to serve on the steering committee and convinced Yaakov Bar-Shalom to deliver the first keynote speech. The conference attracted 161 attendees and was a technical (but not financial) success that led to the formation of ISIF by attendees of FUSION 1998. The team then organized a second conference in Sunnyvale, CA that continued the technical success (attendance grew to 211) and provided surplus funds to help build up ISIF. The rest, as they say, is history.

Over the next decade, the technical program of the conference converged into the existing format that we all now expect with a tutorial day followed by three days each consisting of a plenary talk followed by three sessions of six–eight parallel tracks of oral presentations, along with a student paper program. The tutorial program and the student paper program were started at FUSION 2002. While the first two conferences did not have social programs, such programs started with FUSION 2000 in Paris—the first FUSION conference outside the United States—with a gala dinner on the Bateaux Mouches on the Seine River. Over time, each conference began to organize two–three social programs to provide experiences for our attendees that are unique to the location. The 2011 conference included a "5K fun run" that has been held ever since and offers attendees to the conference to participate in an early morning race around the hosting city.

Of the first few FUSION conferences, FUSION 2002 was particularly successful financially—it received record financial support and made a good profit of USD 46K, which contributed greatly to ISIF's "primitive accumulation of capital". It was also the first time for the IEEE to support the FUSION conference. By 2009, attendance grew to 432 participants with a record financial surplus of over USD 100K despite the Great Recession of 2008 and the swine flu pandemic of 2009. FUSION 2009 also marked the last year of significant sponsorship by US Government agencies such as the Army Research Office (ARO), Air Force Office of Scientific Research (AFSOR), and Office of Naval Research (ONR).

In the first decade, the conference locations expanded beyond the US into Europe, Canada, and one event in Australia. This led to a core cluster of ISIF researchers in North America and Europe. FUSION 2012 in Singapore marked the very first time the event was held in Asia. The intent was to grow ISIF beyond its research cores in North America and Europe and the conference attracted a record of 450 attendees and did help to create a new core of researchers within Asia and other parts of the world. The conference returned to Asia in 2017 with Xi'an, China serving as the host. Attendance peaked at 491 attendees at FUSION 2018 in Cambridge UK. At the 2017 conference in China, South Africa was picked to host FUSION 2020 with the idea of expanding the international reach of ISIF by building upon a strong cluster of researchers from that region.

Then everything changed in March 2020 with COVID-19. The South African team did an excellent job adjusting FUSION 2020 for the virtual format serving 278 attendees via the Zoom and Whova platforms. While the technical content remained strong, the lack of impromptu interactions within the hallways and at social events was clearly lacking. The ISIF Board, in conjunction with the South African team, decided to try again in 2021, hoping life would return to normal. The conference was even pushed back to November 2021 to improve the odds that people could travel. Then Omicron came and travel (while possible) was still very restricted. FUSION 2021 was a hybrid event with 170 virtual attendees and 50 in-person attendees, of whom 25 were international. The in-person attendees enjoyed a safari game drive. Nevertheless, most ISIF participants never experienced South Africa, and we hope the organizing team will eventually be able to rectify this unfortunate situation in the future after they recover from their two-year ordeal of decision making under unprecedented uncertainty.

FUSION 2022 returned to a fully in-person format in Sweden, but the effects of COVID-19 still lingered. Attendance increased to 311 but was still below pre-pandemic levels. As stated earlier, the combination of inclusivity, technical rigor, social interactions, and access to top fusion researchers is what makes the FUSION conferences so great. These features were difficult to offer during the height of the pandemic. We are hopeful that the conference will get back on its pre-pandemic trajectory (see Figure 1) and continue to grow its global influence, with FUSION 2024 in Venice, Italy and FUSION 2025 in Rio de Janeiro, Brazil.

JOURNAL OF ADVANCES ON INFORMATION FUSION

ISIF is surely best known for its highly successful FUSION conference series. However, the Society is much more than a series of conferences! Other key elements include its flagship publication, the *Journal of Advances in Information Fusion* (JAIF), the past and current working groups, the sponsorship of smaller workshops and symposia, and the website platform and social media presence that promote a constant exchange of ideas in the ISIF community and beyond.

JAIF was founded in 2005 and published its first issue in June 2006. An important characteristic of JAIF is that all published papers are freely available to the research community, without access restrictions. In fact, JAIF was the one of the first open-access journals. JAIF has a semi-annual cadence, and to date has yielded 34 issues over 17 years. The intent was, and remains, to provide a forum for high-caliber archival publications on information fusion, on par with the top IEEE journals and Transactions. Though JAIF does overlap in scope somewhat with *IEEE Transactions on Signal Processing* (T-SP) and *IEEE Transactions on Aerospace and Electronic Systems* (T-AES), as well as some other prestigious publications, it is unique in its focus on research and cutting-edge applications in high-level and low-level information fusion. As such, JAIF maintains a privileged position to publish top-tier work in these areas, while drawing quite naturally on expanded versions of the best FUSION papers presented each year. There are a mix of regular and dedicated, special-topic issues. To date, there have been five special issues, with more in early stages of planning for the coming years.

Dale Blair, who had considerable experience as EiC of T-AES, was the founding JAIF Editor-in-Chief (EiC). The founding of ISIF received strong encouragement and support from Yaakov Bar-Shalom, the ISIF VP Publications at that time, as well as from Bob Lynch, the first JAIF Administrative Editor. After eight years as EiC, Dale was followed by Uwe Hanebeck as EiC in 2014. Uwe remained in this position for six years and was then replaced by Stefano Coraluppi, the current EiC, in 2020. To this day, Dale remains active in his support to JAIF, serving in an oversight role as ISIF VP Publications. Another key contributor to the success of JAIF is David Krout, who replaced Bob as Administrative Editor in late 2015. The JAIF Editorial Board includes world-class experts in their respective fields. All are encouraged to explore available JAIF papers at

https://isif.org/journals/all, and to consider submitting their best work to the journal.

PERSPECTIVES ON INFORMATION FUSION

The ISIF *Perspectives on Information Fusion* magazine was started to be a sister publication of JAIF to publish articles of general interest to the information fusion community. These include expository papers on new research areas, tutorials, classroom notes, book reviews, and announcements. Archival papers containing new research are still published in JAIF.

Publication of *Perspectives* was approved by the ISIF Board at FUSION 2014 with Roy Streit as founding Editor-In-Chief. While Roy, his area editors, and Dale Blair, VP-Publications, had experience with editing/publishing technical journals, none of them had started a magazine before. Roy very quickly discovered that this was not an easy task because he could not use the same processes and tools as JAIF [3]. The first issue of *Perspectives* was published in 2016 and distributed to FUSION 2016 attendees in Heidelberg. Including this issue, six issues of *Perspectives* have been published, with hard copies distributed at (physical) FUSION conferences. The current goal is to continue to publish one issue per year, to appear just before the annual FUSION conference. Anne-Laure Jousselme is the current Editor-in-Chief.

AWARDS

ISIF has established three society awards to recognize individuals for their contributions to information fusion. Nominations are solicited from ISIF membership, and the selection is made by the Awards Committee, currently chaired by Dale Blair.

The premier award is the ISIF Lifetime of Excellence in Information Fusion award, given to a researcher or engineer for outstanding contributions to the field of information fusion throughout his/her career. It was first given in 2015 and subsequently renamed in 2016 for the first recipient, Yaakov Bar-Shalom. Subsequent recipients are Chee-Yee Chong (2016), Pramod Varshney (2018), Ed Waltz (2021), and Roy Streit (2023).

The ISIF Young Investigator Award recognizes a young ISIF member for outstanding contributions to information fusion. The goal is to encourage individual efforts and foster increased participation by younger researchers and engineers. This award was established in 2016. The recipients to date are David Crouse (2016), Marcus Baum (2017), Karl Granstrom (2018), Florian Meyer (2021), and Florian Pfaff (2023).

The ISIF Robert Lynch Award for Distinguished Service recognizes an individual who has provided significant service to the Society. It was established in 2016 in memory of Robert (Bob) Lynch, who was involved in the organization of the annual FUSION conferences and co-chaired FUSION 2009 in Seattle. He was a key contributor in founding and production of JAIF and founding of the *Perspectives* magazine, and single-handedly maintained the ISIF web-site for many years. Chee-Yee Chong is the recipient of the 2023 ISIF Bob Lynch Distinguished Service Award.

In addition to the three Society awards, there are two awards for best papers at the FUSION conferences. The Jean-Pierre Le Cadre Award was established in 2010 in memory of Jean-Pierre Le Cadre for the best paper of the FUSION conference. The Tammy Blair Best Student Paper Award was established in memory of Tammy Blair, who passed away from the swine flu the week after FUSION 2009 in Seattle, for which she was Administrative Chair. The best paper awards are managed by the Awards Committee of each conference. The list of best paper and best student paper awards from FUSION 2004 to FUSION 2017 can be found in [4]. Best paper awards for subsequent years are published in *Perspectives*.

WORKING GROUPS AND OTHER MEETINGS

A lesser known ISIF activity to serve its members and advance the state-of-the-art in fusion is the sponsorship of working groups (WGs). ISIF sponsors working groups to bring together researchers who share a common interest in a technical area of information fusion, generally an emerging area that needs collaboration by a group of dedicated researchers to develop a theoretical framework or software tools. ISIF support includes providing a free meeting room during a FUSION conference and related website links and support for virtual meetings.
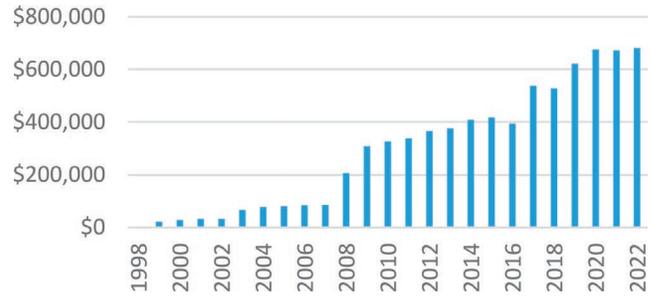
The Multistatic Tracking WG (MSTWG) was the first ISIF WG. Its objective was to promote collaboration among its members in multisensor fusion and tracking, with a focus on multistatic sonar and radar. From 2007 to 2016, when it was decommissioned, it held 17 regular meetings, five teleconferences, organized 11 special sessions at conferences, and analyzed seven common data sets.

There are currently two active working groups sponsored by ISIF. The first is the Evaluation of Techniques for Uncertainty Representation Working Group (ETURWG). The ETURWG has been meeting for over 10 years to refine, update, clarify, and implement the Uncertainty Representation and Reasoning Evaluation Framework (URREF) ontology. The working group activities include developing a URREF tutorial, incorporating artificial intelligence and machine learning (AI/ML), and defining metrics.

The other working group is the Open-Source Tracking and Estimation Workshop (OSTEWG), which supports Stone Soup in conjunction with a NATO Team Activity. Stone Soup has developed a software repository for state-of-the-art filtering/tracking algorithms and other algorithms, as well as user interfaces.

In addition to working groups, ISIF sponsors small meetings. Past meetings sponsored by ISIF include the:

- ► BELIEF international conference that addresses theoretical advances of belief functions, and promotes and expands the application fields of belief functions
- ► Canadian Tracking and Fusion Group (CTFG) workshop, and
- ► Sensor and Data Fusion (SDF) Symposium organized by Fraunhofer FKIE, Germany.

Figure 2
ISIF net worth (in USD) over time.

These sponsored events are smaller gatherings that connect many of the ISIF members outside of the annual conference.

MEMBERSHIP

FUSION conference attendees automatically become ISIF members with a part of their registration fee going to ISIF as membership dues. Thus, ISIF membership statistics closely track those of FUSION attendance, with a small deviation due to renewals by members who do not attend a conference, e.g., due to COVID-19. The geographical distribution of membership varies with the location of each conference. Membership in the host country generally surges the year FUSION is held and drops the following year since many conference attendees do not return to the next conference or renew their membership online. This phenomenon is especially prevalent with conferences held outside of North America or Europe. However, there is a core of members who attend FUSION conferences year after year. These are generally senior researchers in the field and include the Board of Directors. It is interesting to note that only two members, Yaakov Bar-Shalom and Chee-Yee Chong, have attended every FUSION conference since 1998.

Statistics about memberships are possible thanks first and foremost to Pierre Valin who built the first ISIF membership database. This database was maintained later by Elisa Shahbazian and subsequently by Anne-Laure Jousselme. The database allows ISIF to keep records of its membership since the very first conference.

To grow ISIF membership and reduce its dependence on FUSION attendance, we need to give people a reason a join ISIF besides conference attendance. One membership benefit we are exploring is an email address, member@isif.org, similar to member@ieee.org that IEEE provides for its members. Such email addresses are useful for members in industry or government where use of their employer email address for professional communication may be inappropriate.

FINANCES

ISIF was founded in 1998 with a private loan from Daniel Zhu, the entrepreneur who organized the first two FUSION conferences. The loan was repaid with the surplus from FUSION 1999. With the income from subsequent FUSION conferences

that were mostly financially successful, and careful management of expenses, ISIF has accumulated a healthy reserve (Figure 2). This reserve enables ISIF to support its publications, working groups, and other meetings, and take some financial risk in sponsoring FUSION conferences outside the usual locations of Europe and North America.

Since ISIF has no other sources of income, its net worth fluctuates with the surplus from the FUSION conferences, with a lag that depends on when ISIF receives the surplus. The jumps in the net worth are due to the conferences with the big surpluses. In descending order, the top three are: 2016 (Heidelberg), 2018 (Cambridge), and 2009 (Seattle), all with surplus over USD 100K.

The ISIF Board is trying to figure out how much reserve is needed to prepare for the proverbial "rainy day". Without the surplus from the top three conferences, the ISIF reserve would be reduced by more than 50%. This can be very risky if we encounter another situation that affects conference attendance such as another pandemic. We are indeed fortunate that skillful financial management produced a surplus for each of the last three conferences despite attendance affected by COVID-19.

LOOKING FORWARD

The information fusion landscape has changed drastically since the founding of ISIF 25 years ago. Information fusion is now a crucial component in many applications, not just traditional defense and aerospace systems. As an example, sensor fusion is a prerequisite for driver assistance and autonomous driving. At the same time, the traditional model-based information fusion approach is being challenged by data-driven machine learning, which has taken the world by storm.

These changes present challenges to ISIF because each application or technology area has its own conferences and journals that compete with FUSION and JAIF. However, there are also opportunities because ISIF is not tied to a particular application or technology. As a community that focuses on the common core issues of information fusion across applications, and agnostic to a particular technical approach, ISIF is in a unique position to advance the state-of-the-art in information fusion. The future of ISIF is bright.

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COMMENTS ON THE FOUNDING OF *PERSPECTIVES*

In Salamanca, Dale Blair and I were having a casual conversation on topics of mutual interest while queuing for an event at FUSION 2014. At some point he volunteered that the Board had decided to start a magazine that would publish information of general interest to the ISIF community, but not archival research. I agreed that was a good idea. I innocently asked, "What kind of information?" Almost whatever you want, was Dale's reply. I walked straight into that one, eyes wide open. Dale's implied offer was serious, and so was his reply. It took a few minutes, but I agreed to serve as the Founding Editor in Chief. That role was confirmed at the Board meeting a few days later, together with several Associate Area Editors who agreed to help.

What I did not realize at the time was how much work is entailed in starting a new publication. The magazine had no history, no name, no publication rate, no departments, no reviewing standards, no layout format, etc. The only resource it had was a manuscript submission system in which every submission was a "refereed journal article," which meant that the editor's correspondence letters were unsuitable. (That last bit sounds silly, but I was appalled when the system sent the first submission, the obituary of a friend and colleague, for technical review.) It is necessary to design/configure/fix a great host of seemingly small things that we all take for granted. But I digress. The first thing I did was choose a name. I chose *Perspectives*, because of the diversity of interests in the ISIF community. I gathered a half dozen similarly purposed magazines and decided what I wanted a notional Table of Contents to look like. That is when I asked the AEs to join the conversation.

There is a missing piece, a missing role. Can you see it? That role was pivotal, but completely unrecognized by me, and hence it went unfilled for the first few issues. I didn't even know the name for this role, but now I do. It is the Production Manager (PM). Belatedly discovering the role and asking the Board to fill it changed everything. The first and current PM is Kristy Virostek, and without her *Perspectives* could not be a regularly published magazine.

There is much more that could be said. Maybe I will write more for the next issue, but I will wrap these notes by saying the role of Founding Editor in Chief of any publication is no small task. More than once I regretted saying yes, but – in truth – it was incredibly satisfying to see the very first issue of *Perspectives* in print. Would I do it all over again? Yes, absolutely, but I'd do things a little differently – I would start by finding the right PM.

—**Roy Streit**