



100 YEARS OF U.S. AIR FORCE  
SCIENCE & TECHNOLOGY

***Integrity ★ Service ★ Excellence***

# Horizon Scanning Reports: A Template and Discussion

**6 Dec 2017**

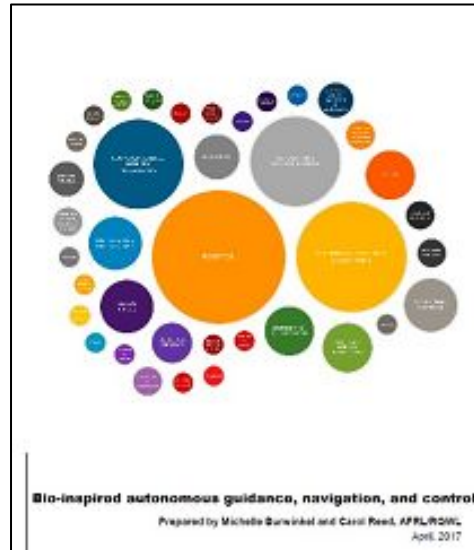
**Michelle Burwinkel &  
Carol Reed  
AFRL/RQWL**



# How We Came To Do These Reports



Air Force Office of Scientific Research  
(AFOSR):





# Horizon Scanning Reports



## Definition:

- Cover **priority topics** for specific research questions.
- Short, rapidly completed, '**state of play**' documents.
- Overview of **emerging** technologies and research.
- Assess the importance of the field and document previous research of note.



# Future-Thinking Methods



	Quantitative	Qualitative	Normative	Exploratory	Engagement	Testing robustness	Spotting the unexpected
Scenario method	x	x	x	x	x	x	x
Delphi method		x	x	x	x		x
Horizon scanning	x			x			x
Trends impact	x	x		x			

FROM: <https://www.oecd.org/site/schoolingfortomorrowknowledgebase/futuresthinking/overviewofmethodologies.htm>

*Their Sources: Foresight Toolkit U.K. and The AC/UNU Millennium Project*





# Template for Horizon Scanning Reports



- Introduction

- *Overview of the Field*

- When does the topic first appear?
    - When does it become a prominent topic?



# Evolution of Search Terms



- ("complex systems" OR "composite systems" OR "interconnected systems" OR "large scale systems") AND  
(autonomy OR autonomous OR "machine-intelligent" OR "human-intelligent" OR "intelligent agent" OR "human-machine teaming" OR "machine-machine teaming" OR "human systems integration" OR "human engineering" OR "human machine" OR "biological engineering" OR "synthetic biology") AND ("artificial intelligence" OR "intelligent agent" OR "adaptive interface" OR "adaptive automation" OR "multi-modal interface" OR "workload monitoring" OR "cognitive workload" OR "agent reasoning architecture" OR "decision making" OR "knowledge acquisition" OR "problem-solving" OR "visual attention")
- ("complex systems" OR "composite systems" OR "interconnected systems" OR "large scale systems") AND ("artificial intelligence" OR "intelligent agent" OR "adaptive interface" OR "adaptive automation" OR "multi-modal interface" OR "workload monitoring" OR "cognitive workload" OR "agent reasoning architecture" OR "decision making" OR "knowledge acquisition" OR "problem-solving" OR "visual attention")



# Definition of Search Terms



## First part of our search strategy:

- (((("optic flow" OR "optical flow" OR "insect vision" OR "insect chemodetection" OR "compound eye" OR "multiaperture optics" OR "sparse sensing" OR "compressive sensing" OR "wide field integration" OR ocelli)

## Second part of our search strategy:

- AND (biolog\* OR biomimetic OR bioinspired OR "bio-inspired" OR "bio-sensor" OR biosensor OR "nature-inspired" OR bioprincipic))



# Final Search Terms



## Our final segment:

- AND (((guidance OR control OR navigation) AND autonom\*) OR ("unmanned aircraft" OR "unmanned aircraft system" OR "unmanned air system" OR "unmanned aerial system" OR UAS OR "unmanned air vehicle" OR "unmanned aerial vehicle" OR UAV OR "unmanned system" OR "remotely powered aircraft" OR RPA OR "remotely piloted vehicle" OR RPV OR drone OR "pilotless vehicle" OR "small unmanned aerial system" OR SUAS)))





# Final Search String Strategy



## Final Search String Strategy:

- (((("optic flow" OR "optical flow" OR "insect vision" OR "insect chemodetection" OR "compound eye" OR "multiaperture optics" OR "sparse sensing" OR "compressive sensing" OR "wide field integration" OR ocelli) AND (biolog\* OR biomimetic OR bioinspired OR "bio-inspired" OR "bio-sensor" OR biosensor OR "nature-inspired" OR bioprincipic)) AND ((guidance OR control OR navigation) AND autonom\*) OR ("unmanned aircraft" OR "unmanned aircraft system" OR "unmanned air system" OR "unmanned aerial system" OR UAS OR "unmanned air vehicle" OR "unmanned aerial vehicle" OR UAV OR "unmanned system" OR "remotely powered aircraft" OR RPA OR "remotely piloted vehicle" OR RPV OR drone OR "pilotless vehicle" OR "small unmanned aerial system" OR SUAS))))



# Database Selection



## Databases

- Engineering Village: Broad overview of Engineering
- Scopus: World's largest commercial database
- Web of Science: Carefully vetted database



## Citation Analysis

- *Create graphs for:*
  - Top researchers
  - Top countries
  - Top journals



# Template for Horizon Scanning Reports



- Top Cited/Most Relevant Papers Found
  - *Show lists of papers for each database*
    - How do these lists differ?
    - What does this difference say about the research field?
  - *What do these papers say about the field?*
    - How is the field developing?
    - What is the Air Force likely to find interesting?

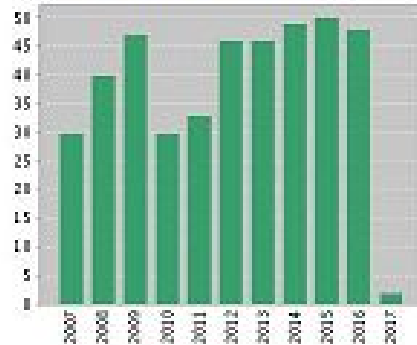


# Most Relevant/Top Cited

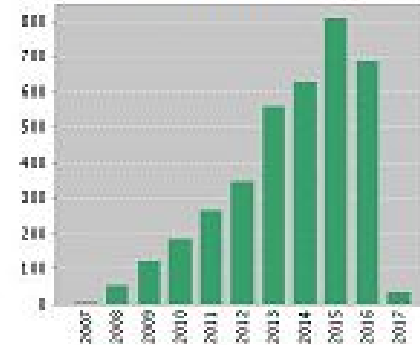


## Web of Science Top 10 Citation Analysis

Published Items in Each Year



Citations in Each Year



Results found: 421  
Sum of the Times Cited: 3718  
Average Citations per item: 8.83  
h-index: 27

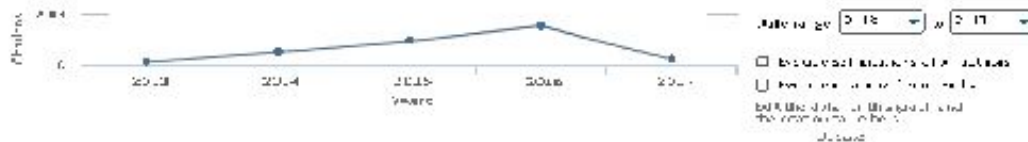


# Most Relevant/Top Cited



## Scopus – Top 5 Citation Analysis

Scopus – Top 5 Citation Analysis



### Documents

### Citations

		<2013	2013	2014	2015	2016	2017	Subtotal	>2017	Total
	Total	0	112	515	953	1537	227	3344	0	3344
1	Reinforcement Learning and Approximate Dynamic Programming f... 2013		11	32	32	31	3	109		109
2	A review of fuzzy cognitive maps research during the last de...	2013	8	15	32	27	8	90		90
3	Can quantum probability provide a new direction for cognitiv...	2013	3	26	24	21	2	78		78
4	Internet of things for enterprise systems of modern manufact...	2014		8	20	42	3	73		73
5	Networks in Cognitive Science	2013	3	11	30	22	3	71		71



# Development of the Field



We gathered the top conferences from all of the highly cited/most relevant papers.

1. 2012 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2012)  
<http://www.iros2012.org/site/>
2. AIAA Infotech at Aerospace, 2016 <https://arc-aiaa-org.wrs.idm.oclc.org/series/6.iaa>
3. 17th World Congress, International Federation of Automatic Control, IFAC, 2008  
<https://www.ifac-control.org/>
4. 2015 IEEE International Conference on Robotics and Biomimetics, IEEE-ROBIO 2015  
<http://ieeexplore.ieee.org.wrs.idm.oclc.org/xpl/mostRecentIssue.jsp?punumber=7397291>
5. Proceedings of SPIE - Micro- and Nanotechnology Sensors, Systems, and Applications V, 2013 <http://proceedings.spiedigitallibrary.org.wrs.idm.oclc.org/volume.aspx?volumeid=15958>



# Template for Horizon Scanning Reports



- Show the Top Researchers
  - *Who is citing them?*
  - *Where are they publishing?*
  - *Which conferences are they making presentations at?*
    - *How much of the conference is on their topic of interest?*
  - *Which associations do they belong to?*
    - *How do these relate to their research interests?*
  - *How large is their research lab? Who funds it?*



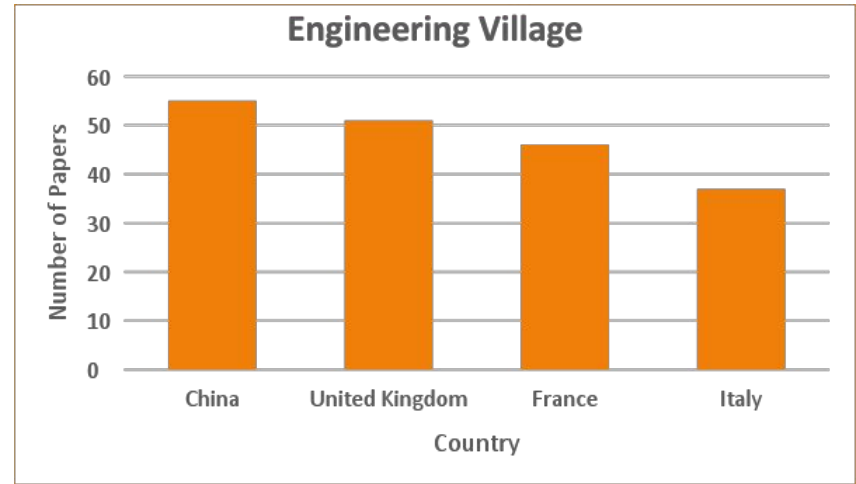
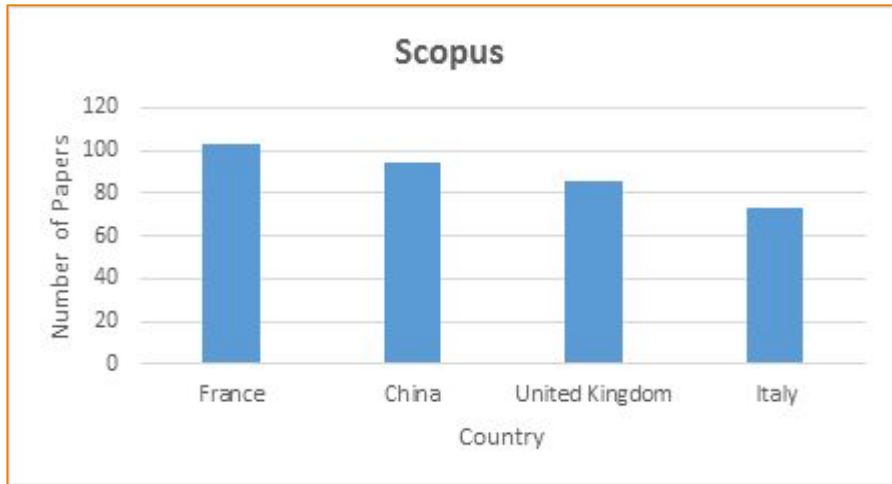


# Country Analysis



## Initial Country ranking, including the Top 4 Countries

- From Engineering Village, Scopus and Web of Science.

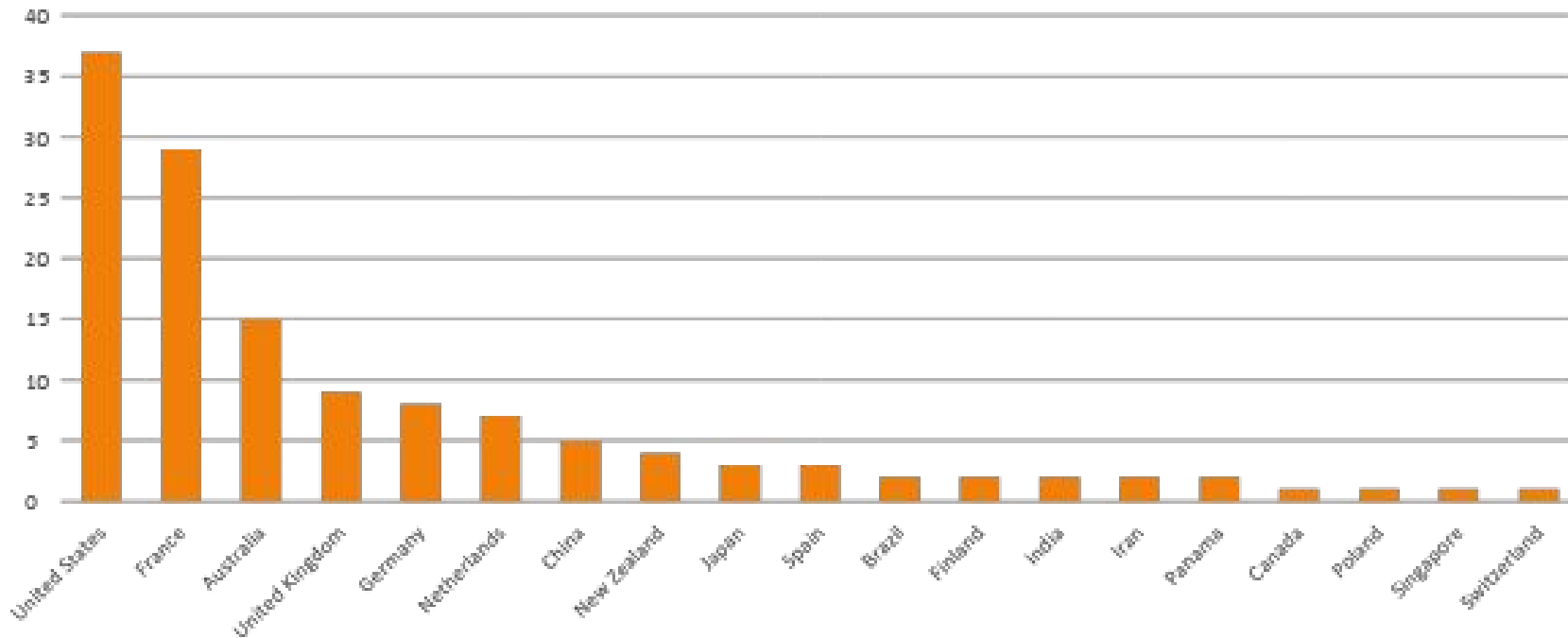




# Country Analysis



Research by Country - Engineering Village





# Template for Horizon Scanning Reports



- Innovations/Patents
  - *How many patents in this field?*
  - *Who are the patent assignees?*



# Patents



Most patents found were U.S. produced:

Patent Number	Title
JP2017500650	Data recording and analysis system and method   [データ記録および分析するシステムおよび方法]
US20170041534 WO2016198958	Biomimetic Integrated Optical Sensor (BIOS) System Autonomous and Non-Autonomous Navigation System for Unmanned Vehicles Based on Vehicle Dynamic Model
US20160364990 US20170024877 US8976269 US9578309	Autonomous and Non-Autonomous Dynamic Model Based Navigation System for Unmanned Vehicles Methods and Apparatus for Autonomous Robotic Control Compressive Sensing Based Bio-Inspired Shape Feature Detection CMOS Imager Adjustable parallax distance, wide field of view, stereoscopic imaging system
US9547804 US20160180126 WO2017013051	Retinal encoder for machine vision Method and System for Assets Management Using Integrated Unmanned Aerial Vehicle and Radio Frequency Identification Reader Head-Mountable Computing Device, Method and Computer Program Product



## Executive Summary & In-Depth Appendices

- Good overview of the topic and the researchers
  - A good feel for the field and the important players
  - Restrict the report to just a few pages of text
- Executive summary likely to be 6-7 pages, minimum.



# Template for Horizon Scanning Reports



Executive Summary & In-Depth Appendices

For the electronic version of these reports :

- "For more information, [click here](#)"
- Hot-link to in-depth research areas.

The full report could be the printed equivalent of  
at least 20 pages, if not more.



# Template for Horizon Scanning Reports



## Wish List for the Next Report (yes, there will be more):

- More time to complete the research and analysis (\*Always!\*)
  - More chances to use InCites graphics to display analytics
- More initial feedback and direction from the researchers
  - More of a mediated search, instead of several revisions/iterations
- Software for co-authorship social network analysis
  - Word co-occurrence software would also be useful, as would graphics programs, such as Sci2, Gephi, or VOSViewer



# References



- **Evidence for models of diagnostic service provision in the community: literature mapping exercise and focused rapid reviews:**  
<https://www.ncbi.nlm.nih.gov/books/NBK402211/>
- **Schooling for Tomorrow Knowledge Base › Futures Thinking › Overview of Methodologies:**  
<https://www.oecd.org/site/schoolingfortomorrowknowledgebase/futuresthinking/overviewofmethodologies.htm>
- **Australia and New Zealand Horizon Scanning Network - About Horizon Scanning - The Horizon Scanning Process:**  
<http://www.horizonscanning.gov.au/internet/horizon/publishing.nsf/Content/process-2>





# Questions

