



Identification of Experts using Social Network Analysis (SNA)

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ABSTRACT



Technologies are developing rapidly and the necessity of specific strategies and techniques that contribute to a more effective, congruent, and faster association of ideas are important. Many methods, tools, and techniques require the opinion of experts or debates of a certain topics. Finding these experts is not easy and the knowledge and experience on a determined field will determine the quality of the results. Therefore, research collaboration among experts has gained importance during the last decades, especially in the area of technology. Since 1960's, the idea of identifying the main actors in a society or a person that has a prestige in the community has gained interest. Social Network Analysis is a common method for finding who is the knowledgeable person in a community. In this paper, SNA and Bibliometric Analysis are used to determine the lead authors, co-authors, institutions, contact information in a period from 2005 to 2015. The main objectives of this paper are to identify experts in the area of Energy Efficiency - Commercial Refrigeration and to develop a methodology to identify experts by using Social Network Analysis and Bibliographic Analysis. The method is based on Social Network Analysis and Bibliometric Analysis using journal sources such as Web of Science and Compendex. Since the main objective is to identify experts that influence the research and development in the Commercial Refrigeration area, the study includes the identification of experts in the U.S. and around the world. A software was developed using "R". The results show a detailed information of the authors in order to be used in the specific research areas.



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OUTLINE




- 1) Introduction
- 2) Social Network Analysis (SNA):
 - a) Definition
 - b) Metrics
 - c) Methodology
 - d) Data Sources
 - e) Software
- 3) Application: Advanced Commercial Refrigeration
- 4) Conclusions

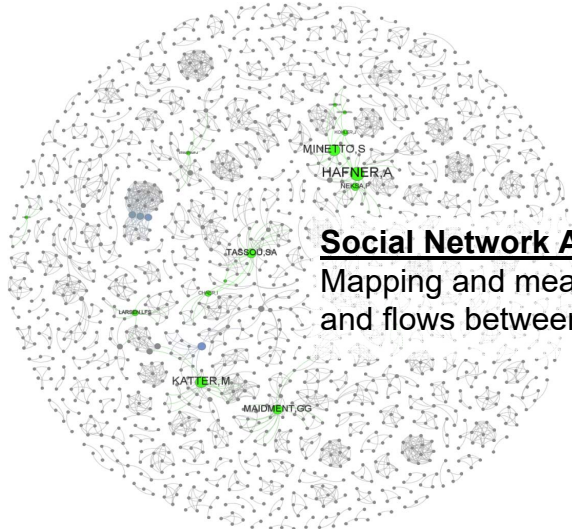
INTRODUCTION




- Identifying the main actors in a society has gained interest. [1]
- SNA is a method for finding who is the knowledgeable person.[2]
- SNA and Bibliometric Analysis are used to determine the lead authors information [3].
- Objectives:
 - To identify experts in the U.S. and around the world in the area of Energy Efficiency – Commercial Refrigeration.
 - To develop a methodology to identify experts by using SNA and Bibliographic Analysis.
- Data source – Period: Journal sources such as Web of Science and Compendex: 2005 - 2015

SNA DEFINITION






Social Network Analysis (SNA):
Mapping and measuring relationships
and flows between nodes



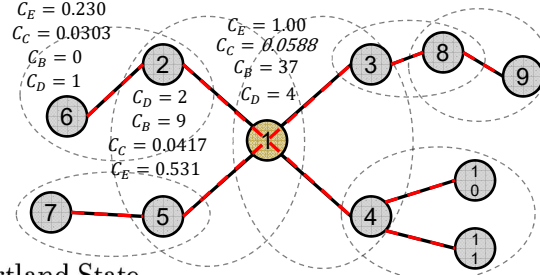
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SNA METRICS



- **Determining Centrality**
 - **Degree** – Number of direct connections in a network for node *i*.
 - **Betweenness** – Number of shortest paths between two nodes that node *i* resides on,
 - **Closeness** – Distance of node *i* to all other nodes in a network,
 - **Eigenvector** – A high eigenvector score is assigned to a node that is connected to other high scoring nodes.



$C_E = 0.230$
 $C_C = 0.0303$
 $C_B = 0$
 $C_D = 1$

$C_E = 1.00$
 $C_C = 0.0588$
 $C_B = 37$
 $C_D = 4$


$C_D = 2$
 $C_B = 9$
 $C_C = 0.0417$
 $C_E = 0.531$

$$C_B(i) = \sum_{i \neq j \neq k} g_{jk}(i) / g_{jk}$$

$g_{jk}(i)$ = shortest path between node *j* and node *k* passing through *i*
i = node of interest

$$C_C(i) = \frac{1}{\sum_{j \neq i} g_{ij}}$$

○ Publications



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UNIVERSITY *igraph* package in R for calculating metrics

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SNA METRICS



• Interpreting Centrality

- **Degree:** A node with the most direct connections is not necessarily better. What really matters is the position in the network and who the node is connected to.

- **Closeness:** A node close to all other nodes can monitor network information flows.

- **Betweenness:** A node with high betweenness has significant influence on network flows.

- **Eigenvector:** Chain effect when one node influences another, which in turn influences many others.



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SNA METHODOLOGY



- In Co-authoring, the relationship is reciprocated - Links are undirected.

- The main measures of centrality to be considered are: Degree and betweenness.

- The criteria of author selection based on:
 - Higher level of betweenness.
 - Degree together with the frequency of number of publications.

- High levels of degree is related to the direct number of co-author connections.

- Authors in the network with high betweenness and high closeness are authors that have easy access to others in the network and are able to control the information through other sections of the network.



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* The analysis are based on the information of [6]

SNA METHODOLOGY

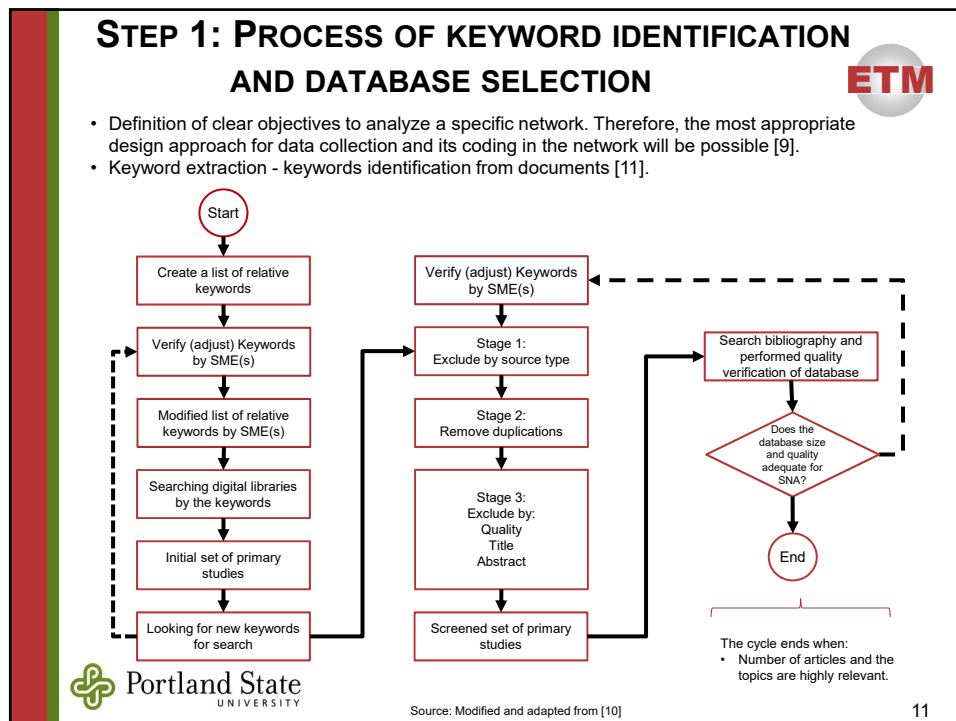
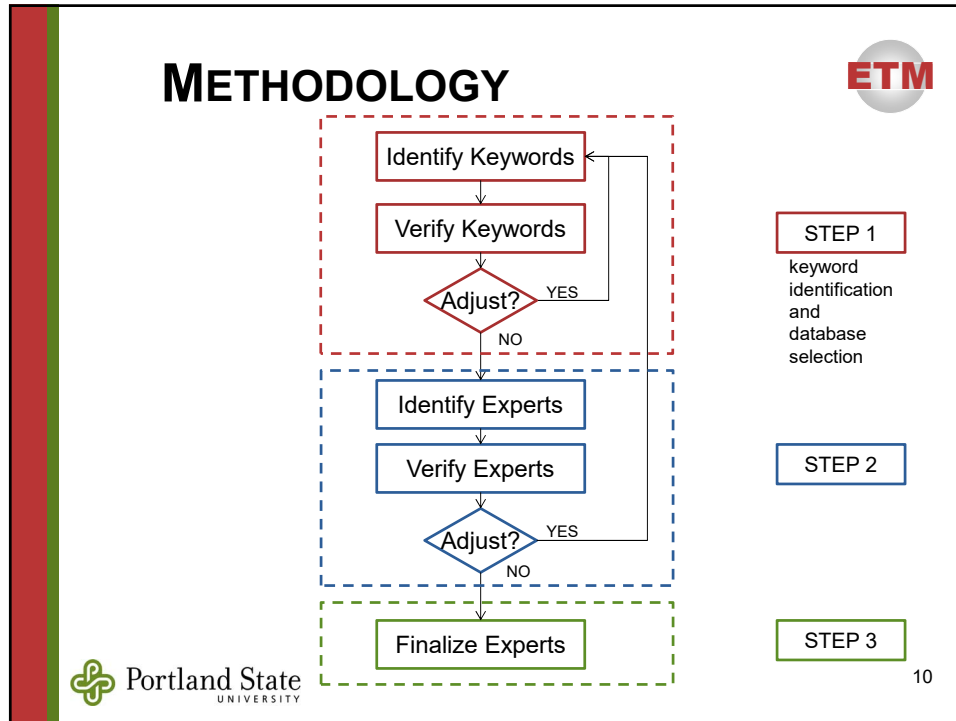


- **For this application:**
 - Nodes are authors.
 - Connections between nodes represents authors of the same publication.
- **For these types of networks:**
 - Closeness centrality is not meaningful since the network mainly disconnected.
 - Degree of centrality is not necessarily meaningful since it only represents the number of co-authors.
 - Betweenness centrality is the key metric because we are looking for subject matter experts.

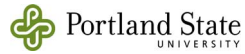
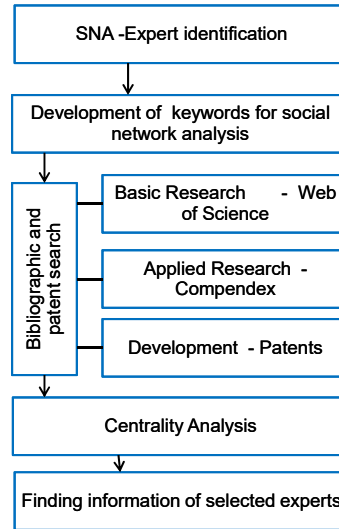
SNA METHODOLOGY



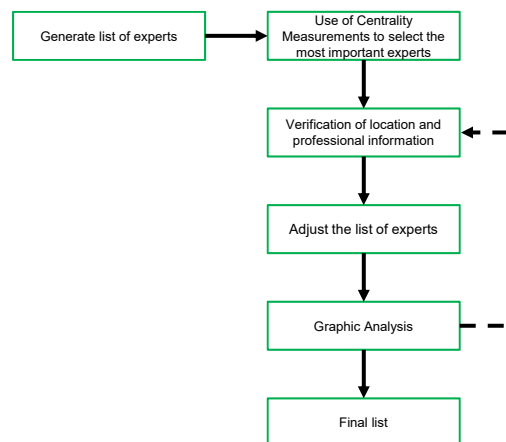
- Case study methodology combines social network and bibliometric analyses; similar processes have been used by other researchers (see [7] and [8]).
- This study's contribution is the systematic use of social network methods, bibliographic analyses, and data mining techniques for a real-world, practical application.
- SNA and data mining methods applied and adjusted iteratively.



STEP 2: SNA PROCESS AND METHODOLOGY



Step 3: Finalize Experts




SNA DATA SOURCES

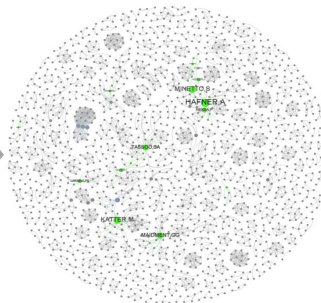
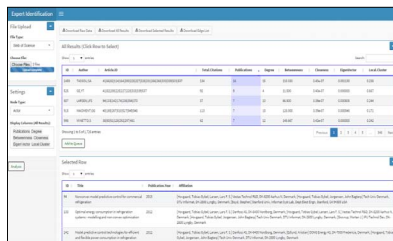


R&D Stage	Typical Source
Basic Research	Science Citation Index
Applied Research	Engineering Index
Development	Patents
Application	Newspaper Abstracts Daily
Social Impacts	Business and Popular Press

- Experts can be identified from different databases and approaches:
 - Basic Research - Web of Science (Citations, publications, and co-author network),
 - Applied Research - Compendex (Publications and co-author network),
 - Development - USPTO (Patent count and co-author network).


 Portland State UNIVERSITY [12]: J. P. Martino, "A Review of Selected Recent Advances in Technological Forecasting," Technol. Forecast. Soc. Change, vol. 70, no. 8, pp. 719–733, Oct. 2003.
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SNA SOFTWARE



R and Shiny tools used for data extraction and analysis

Output from R and Shiny imported into Gephi for visualization

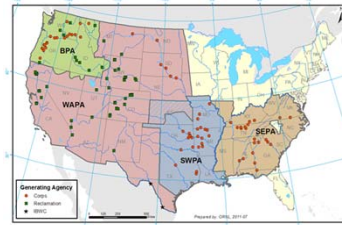

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APPLICATION: ADVANCED COMMERCIAL REFRIGERATION



- The Bonneville Power Administration (BPA) is a federal Power Marketing Administration providing wholesale electricity and transmission services within the U.S. Pacific Northwest.
- Since 2005 the BPA Technology Innovation (TI) Office has managed the Agency's R&D portfolio with annual budget of ~.05% of Agency revenues (~\$16M in 2016).
- The BPA TI Office has worked extensively with the Portland State University Engineering and Technology Management Department on a variety of technology research management projects.



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APPLICATION: ADVANCED COMMERCIAL REFRIGERATION




- In early 2015, BPA Energy Efficiency engineer sought knowledge on international experts in refrigeration technologies for commercial applications including grocery stores, supermarkets, and restaurants.
- Key topics & criteria:
 - Refrigerants: low global-warming potential (GWP); natural; hydrocarbon; halocarbon; ammonia; carbon dioxide (CO₂).
 - Technologies: magnetocaloric; electrochemical; thermoelectric; thermoacoustic; thermionic.
 - Affiliated institutions: research universities; national laboratories; manufacturers; design firms.




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APPLICATION: ADVANCED COMMERCIAL REFRIGERATION




SNA Project Steps

Step	Summary
1. Develop draft keyword list	BPA engineer provided technical literature to PSU ETM student
2. Finalize keyword list	Iterative processes between BPA engineer and PSU ETM student
3. Develop draft expert lists and diagrams	
4. Finalize expert lists and diagrams	
5. Conduct SNA tutorial for BPA staff	PSU ETM student


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APPLICATION: ADVANCED COMMERCIAL REFRIGERATION



Step 1: Develop draft keyword list

A Technical literature consulted to establish first-draft keyword list


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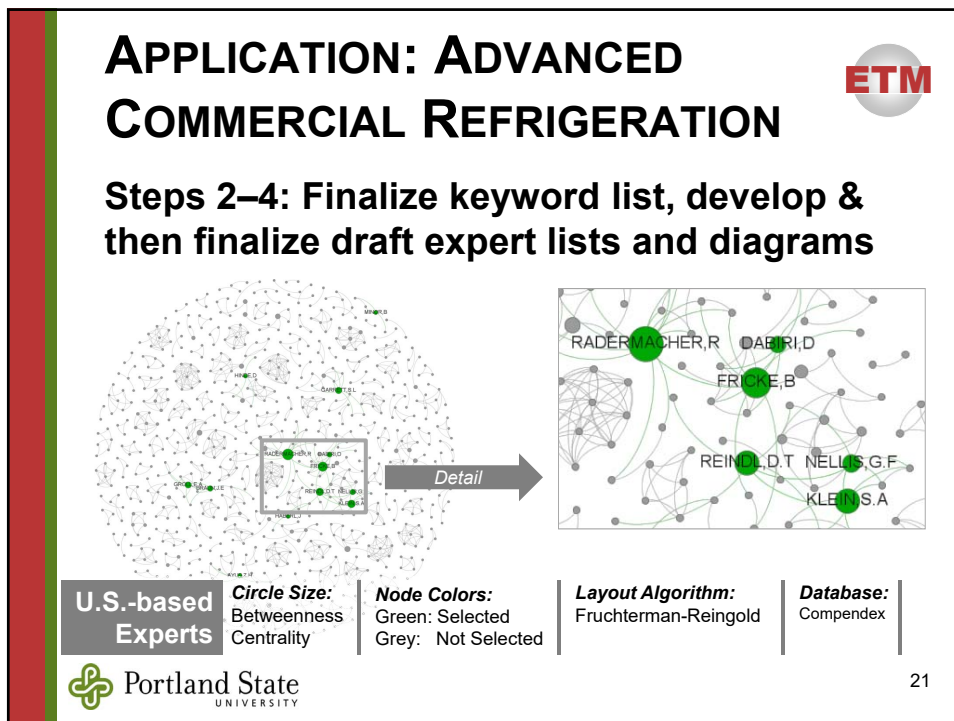
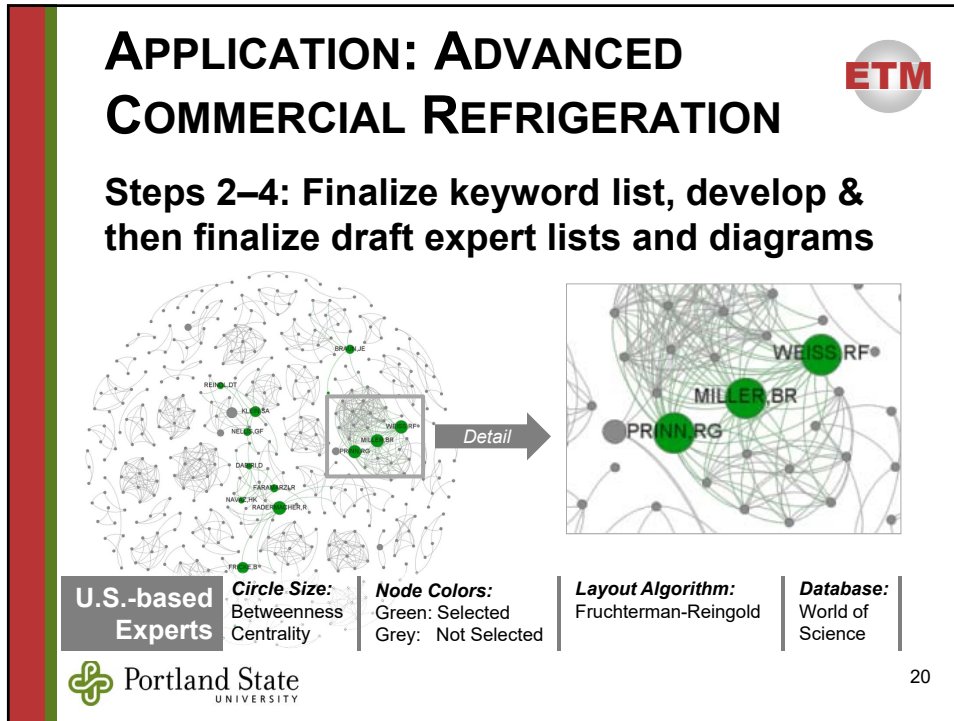
B Technology Applications
Grocery stores, supermarkets, restaurants, etc.

↓

C Keyword categories within the technology applications

Refrigerants <ol style="list-style-type: none"> 1. Hydrocarbon (Propane; Isobutene; Propylene; Ethane) 2. Halocarbon (R22; R134a; R404a; R507) 3. Ammonia 4. Carbon Dioxide 5. Natural 6. Low Global-Warming Potential 	Energy Efficiency <ol style="list-style-type: none"> 1. Vacuum Insulated Panel 2. Phase Change Material 3. Defrost Control 4. Electronically Commutated Motor 5. Variable Speed Drive 6. Heat Recovery 7. Heat Transfer 8. Microchannel Heat Exchanger 9. Microchannel Evaporator 10. HVAC Integration 	Technologies <ol style="list-style-type: none"> 1. Magnetocaloric Cooling 2. Electrochemical compression 3. Thermoelectric 4. Thermionic 5. Thermo-tunneling 6. Thermoacoustic 7. Magnetic
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APPLICATION: ADVANCED COMMERCIAL REFRIGERATION



Steps 2–4: Finalize keyword list, develop & then finalize draft expert lists and diagrams

U.S.-based Experts

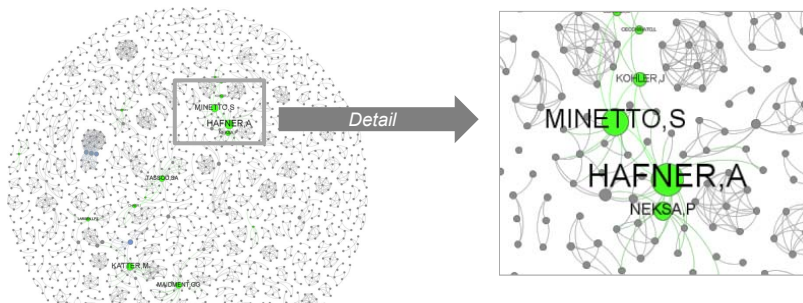
Author	Affiliation	Selected Article Titles
RADERMACHER, REINHARD	University of Maryland	<ol style="list-style-type: none"> 1. An evaluation of the environmental impact of commercial refrigeration systems using alternative refrigerants 2. An experimental study of the performance of a dual-loop refrigerator freezer system 3. Review of secondary loop refrigeration systems
FRICKE, BRIAN	Oak Ridge National Laboratory	<ol style="list-style-type: none"> 1. Comparative analysis of various CO2 configurations in supermarket refrigeration systems 2. An evaluation of the environmental impact of commercial refrigeration systems using alternative refrigerants 3. Comparison of Vertical Display Cases: Energy and Productivity Impacts of Glass Doors Versus Open Vertical Display Cases



APPLICATION: ADVANCED COMMERCIAL REFRIGERATION



Steps 2–4: Finalize keyword list, develop & then finalize draft expert lists and diagrams



International Experts

Circle Size:
Betweenness Centrality


Node Colors:
Green: Selected
Blue: U.S. Selected
Grey: Not Selected

Layout Algorithm:
Fruchterman-Reingold

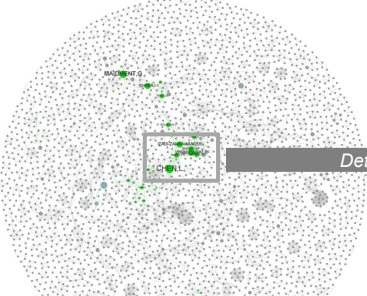

Database:
World of Science



APPLICATION: ADVANCED COMMERCIAL REFRIGERATION



Steps 2–4: Finalize keyword list, develop & then finalize draft expert lists and diagrams


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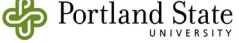
International Experts

Circle Size:
Betweenness
Centrality


Node Colors:
Green: Selected
Blue: U.S. Selected
Grey: Not Selected

Layout Algorithm:
Fruchterman-Reingold

Database:
Compendex

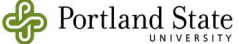

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APPLICATION: ADVANCED COMMERCIAL REFRIGERATION



Steps 2–4: Finalize keyword list, develop & then finalize draft expert lists and diagrams

International Experts		
Author	Affiliation	Selected Article Titles
HAFNER, ARMIN	SINTEF Energy Research, Norway	<ol style="list-style-type: none"> 1. Multi-ejector concept for R-744 supermarket refrigeration 2. Simulation models in the supersmart supermarket energy-benchmark tool 3. R744 refrigeration system configurations for supermarkets in warm climates
MINETTO, SILVA	National Research Council, Construct Technologies Institute, Italy	<ol style="list-style-type: none"> 1. Experimental analysis of a new method for overfeeding multiple evaporators in refrigeration systems 2. Simulation models in the supersmart supermarket energy-benchmark tool 3. Recent installations of CO2 supermarket refrigeration system for warm climates: data from the field


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APPLICATION: ADVANCED COMMERCIAL REFRIGERATION



Analysis of Results

- Use of results
 - Both deliverables are important: Visualization shows at-a-glance how experts are related and spreadsheet provides contact information and publications.
 - Contacted experts to confirm they are still active, confirm their collaborative networks, and gauge their interest in future collaboration.
- Potential uses of results
 - Recruit other collaborators for mutually-beneficial R&D projects.
 - Identify gaps between important research communities and envision ways to bridge those gaps.
 - Prepare for future technology roadmapping projects.

CONCLUSIONS



- Significantly reduces the time required for identifying experts; however, there are some important caveats:
 - Accurate keywords are necessary or results will be meaningless (“garbage in, garbage out”).
 - Expert input is required to validate results.
 - Only experts who publish will be identified.
- Analysis can go far beyond identifying experts:
 - Research areas of focus can be identified from titles and abstracts; this can help align roadmaps with emerging research topics.
 - Changes in research over time can be analyzed to estimate future technological changes.

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