INTERNATIONAL FEDERATION
OF AUTOMATIC CONTROL

IFAC Industry Committee

Survey: Identify needs and opportunities to shape the control research impact on technology

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Activity and Survey Scope

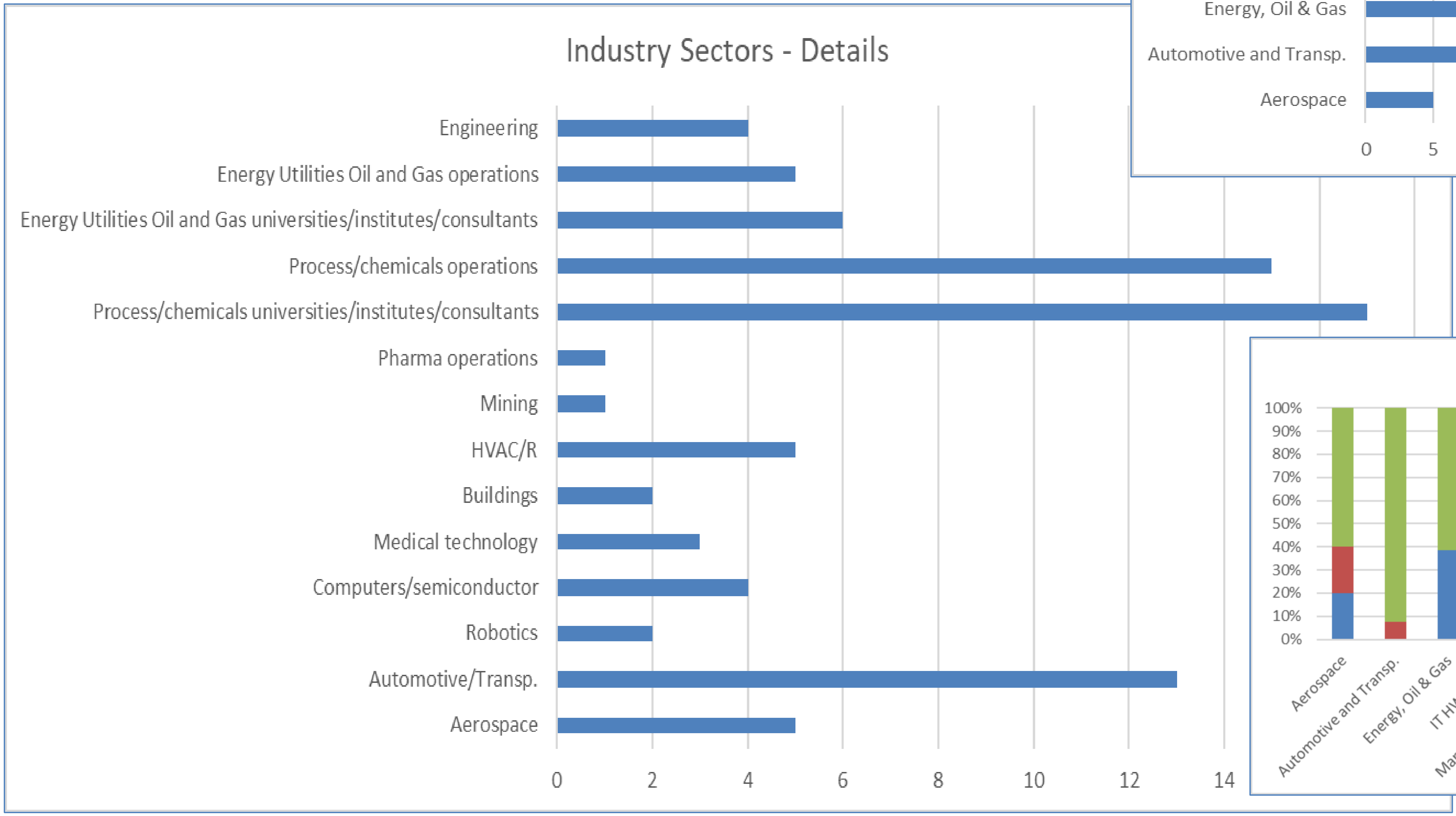
1. Identify emerging sectors and control applications and disseminate to academics:
   a. Survey industry to identify requirements for the next generation of products/processes
   b. Identify where control can have an impact and 'translate' the requirements in control scenarios
   c. Publish a set of next generation control problem

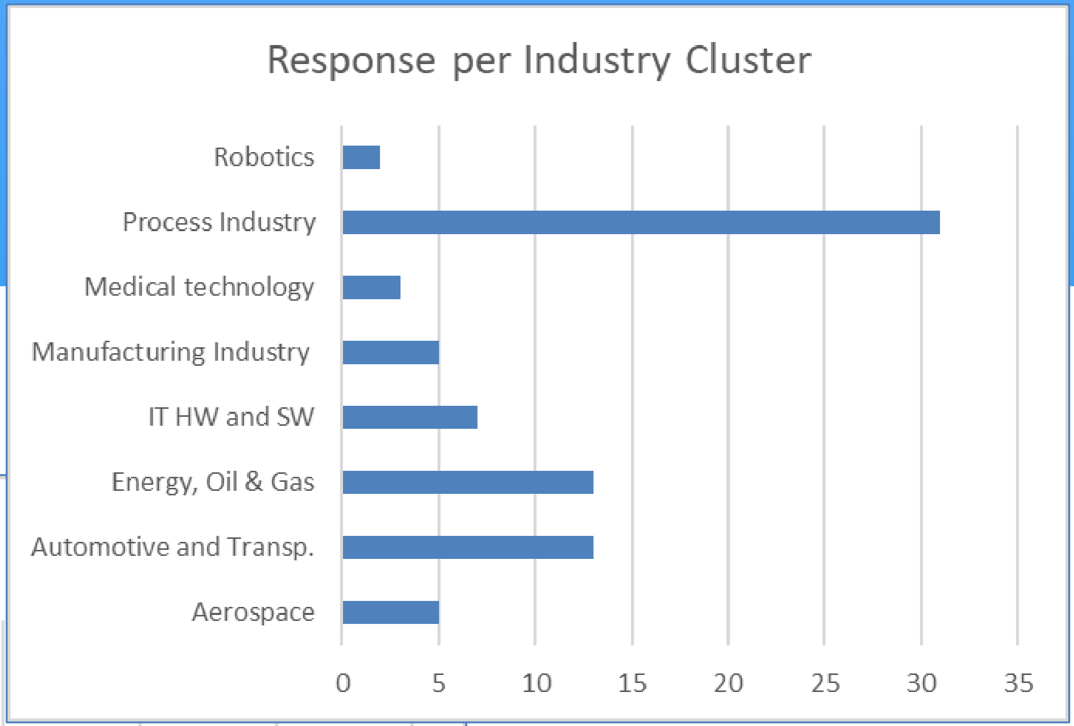
- Survey Statistics:

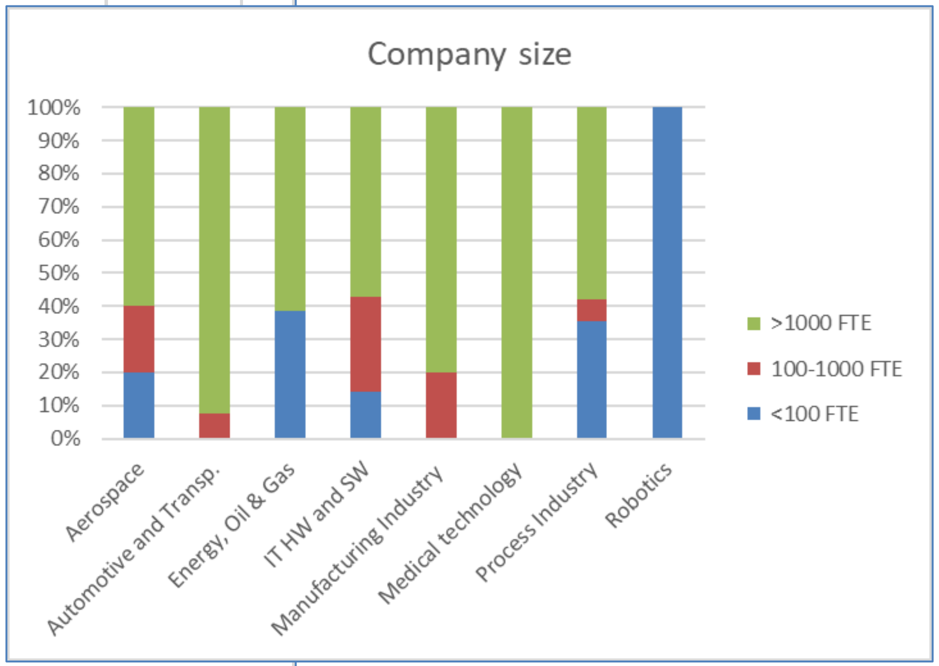
  Total responses: 79

  Industry Sectors: 14

Q1: Industry sector and institution size

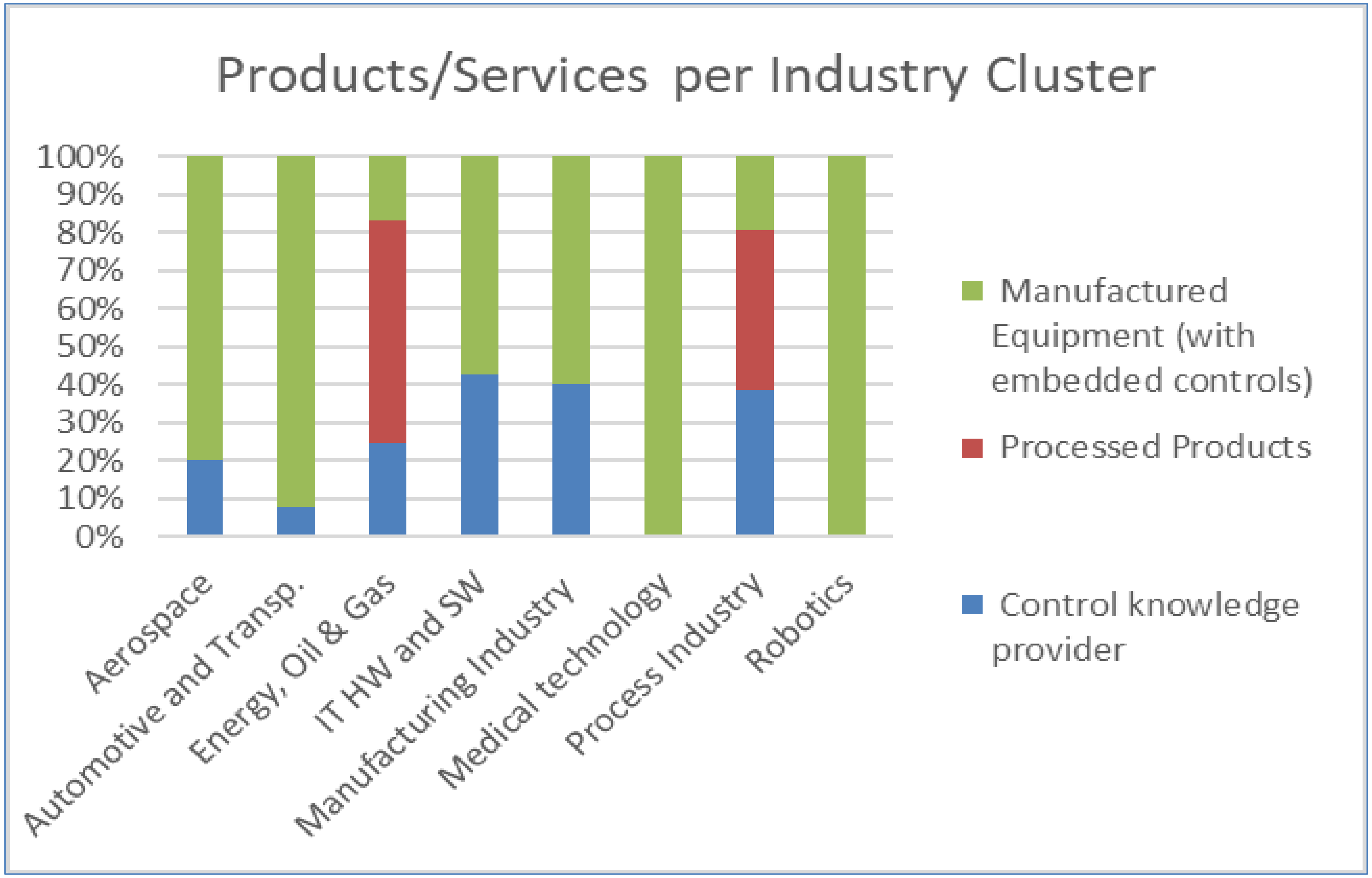






Respondents from all industry sectors, translated into 8 clusters relevant for further processing of results

Q2: What are key products, processes or services in your sector?



Process oriented Industry clusters more focused on *application* rather than control technology itself

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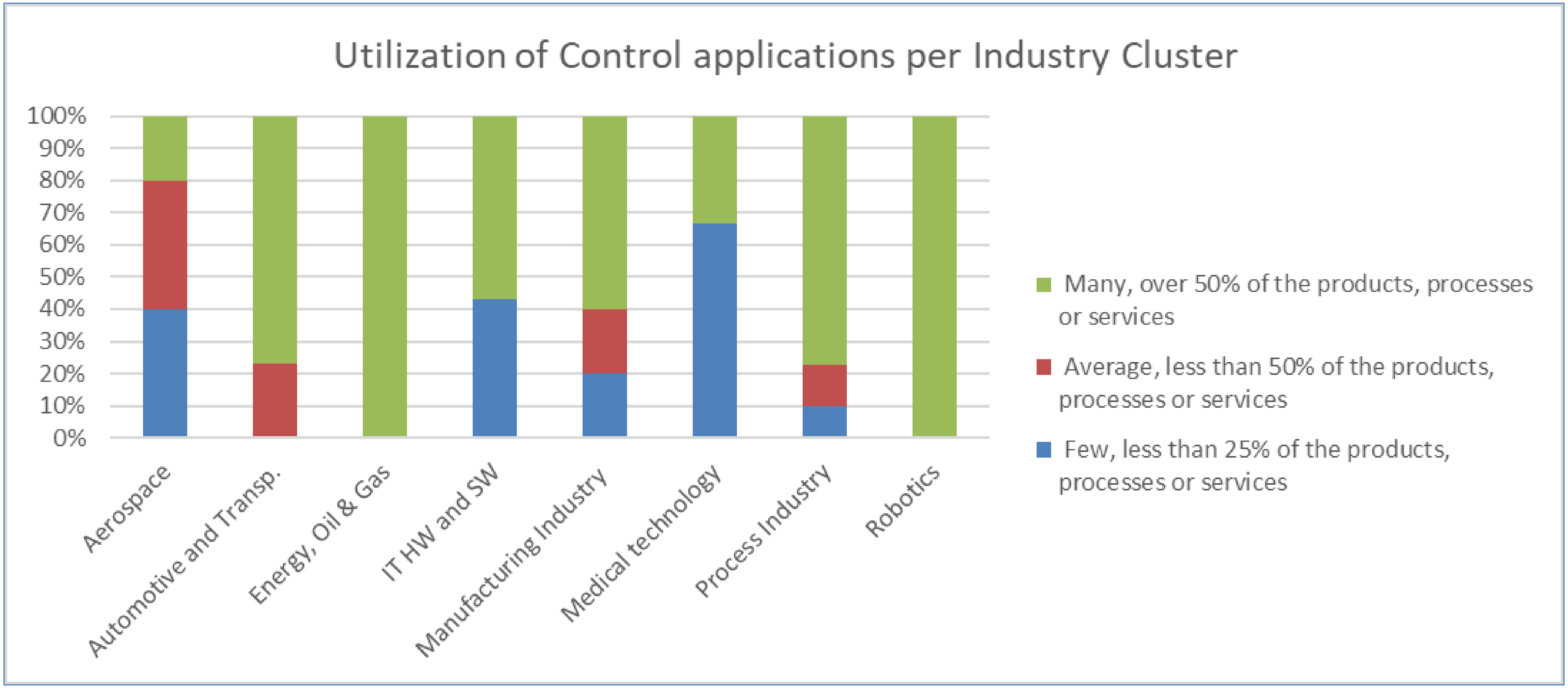
Q3: Current utilization of control technology



Aerospace, IT, Medical and Manufacturing are applying less than the other clusters

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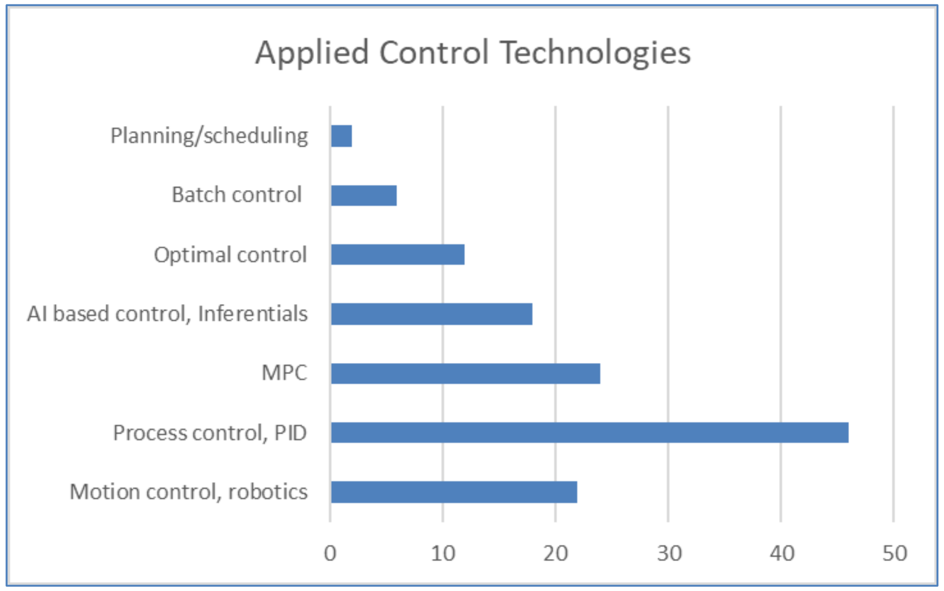
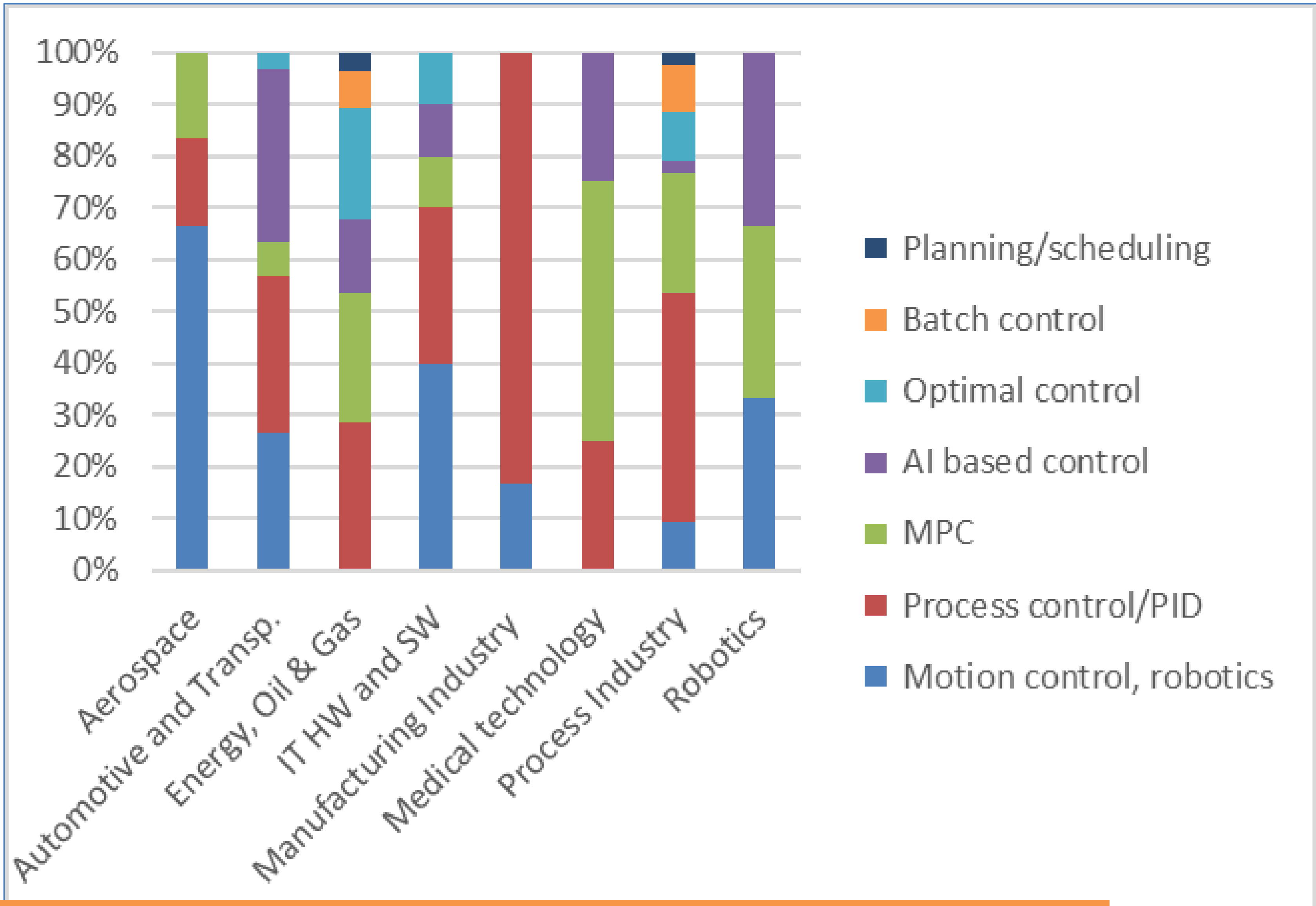
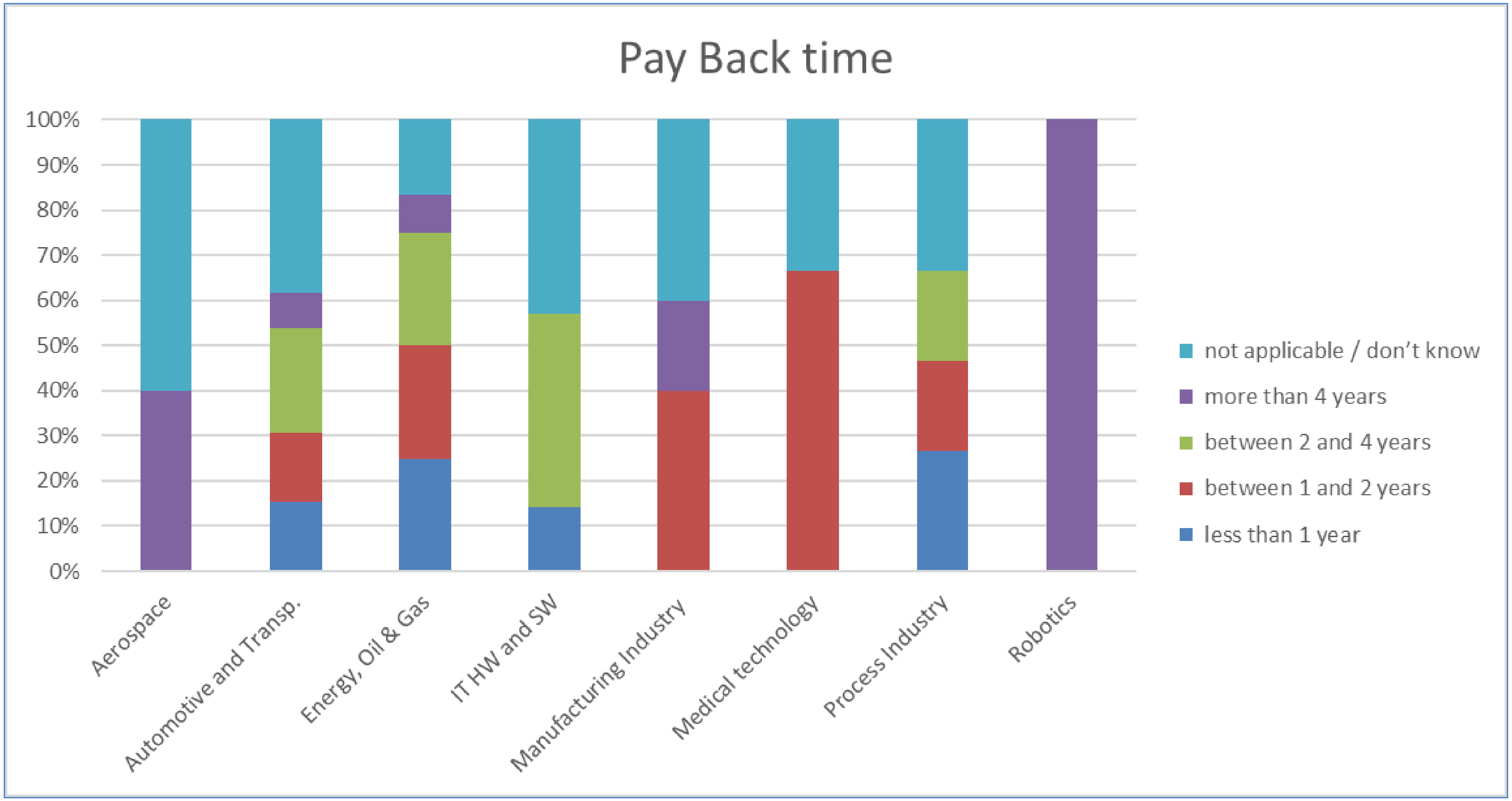
Q4: With regard to Q3, please list typical applications





Broad range of applications in Process oriented clusters, but also in Automotive & Medical. Much focus on basic technologies

Q5: Current utilization of control technology: What was the average pay-back time of control technology implementations in your company or business unit?



Process oriented clusters, Automotive, IT and Medical: best pay back.
Less benefits in Robotics and Aerospace.

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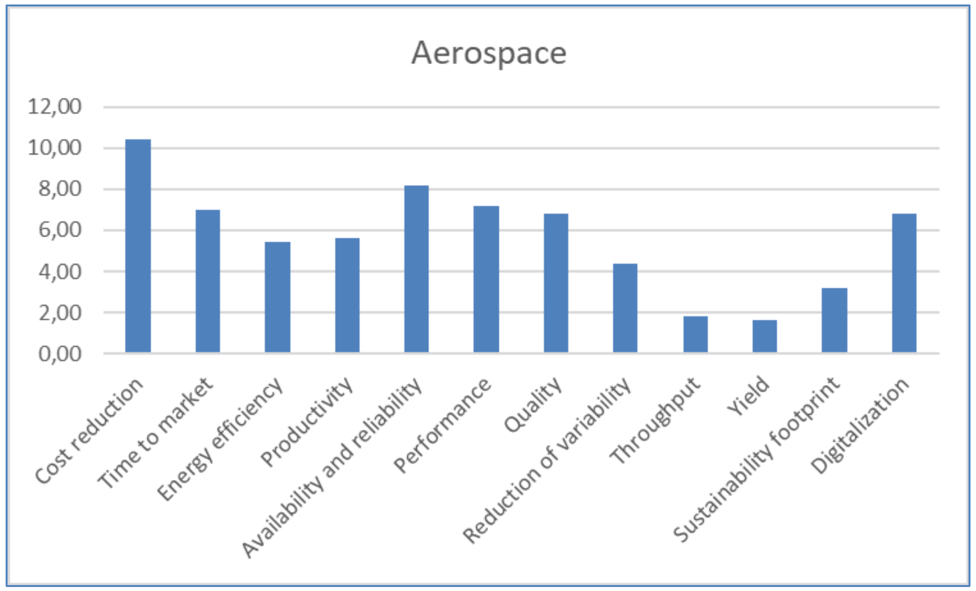
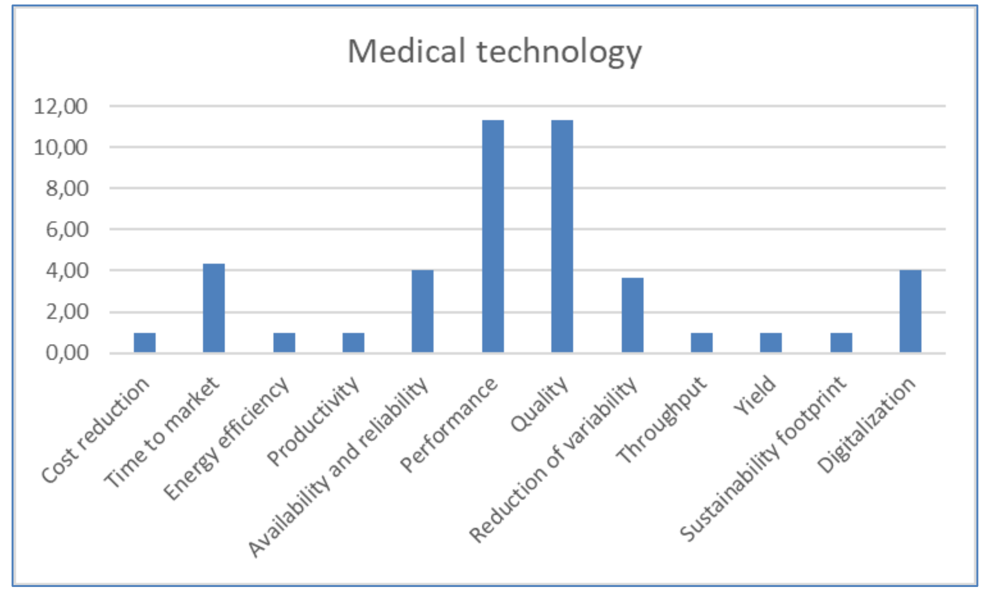
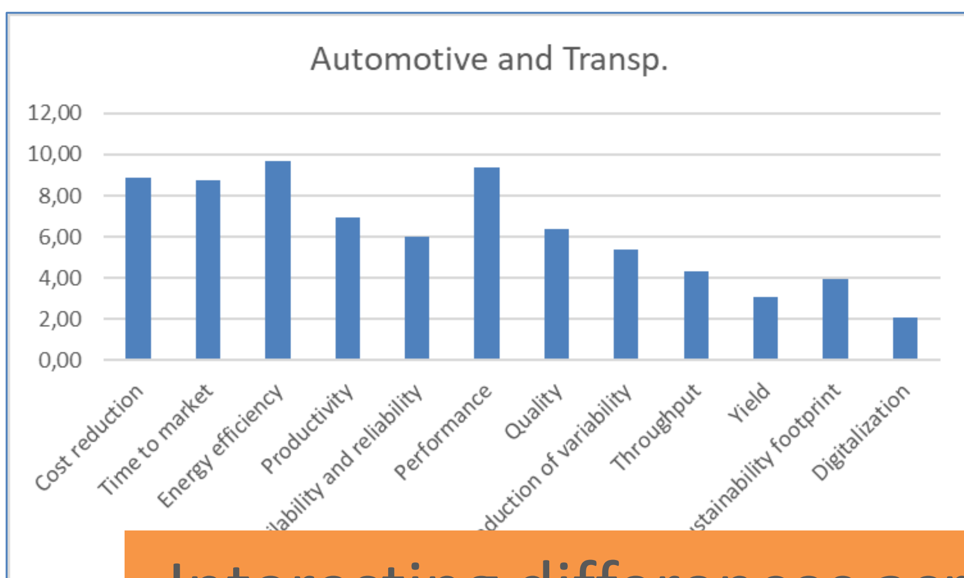
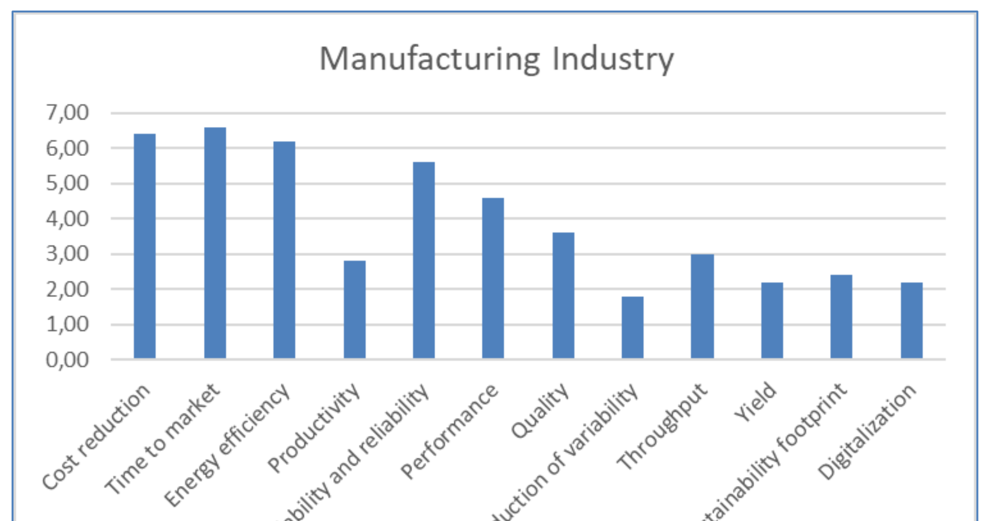
Q6: What are key drivers for further improvements for the future for the next generation of product/processes and services? (1/2)









Interesting differences across clusters: e.g. Medical: focus on Quality;
Aerospace: focus on Reliability.
Important to understand what business the industry is in.

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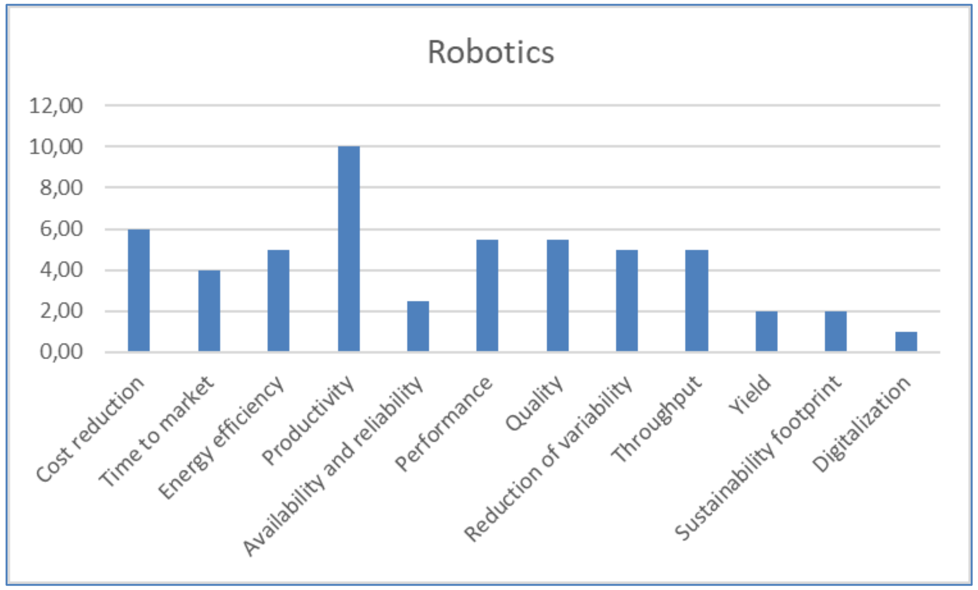
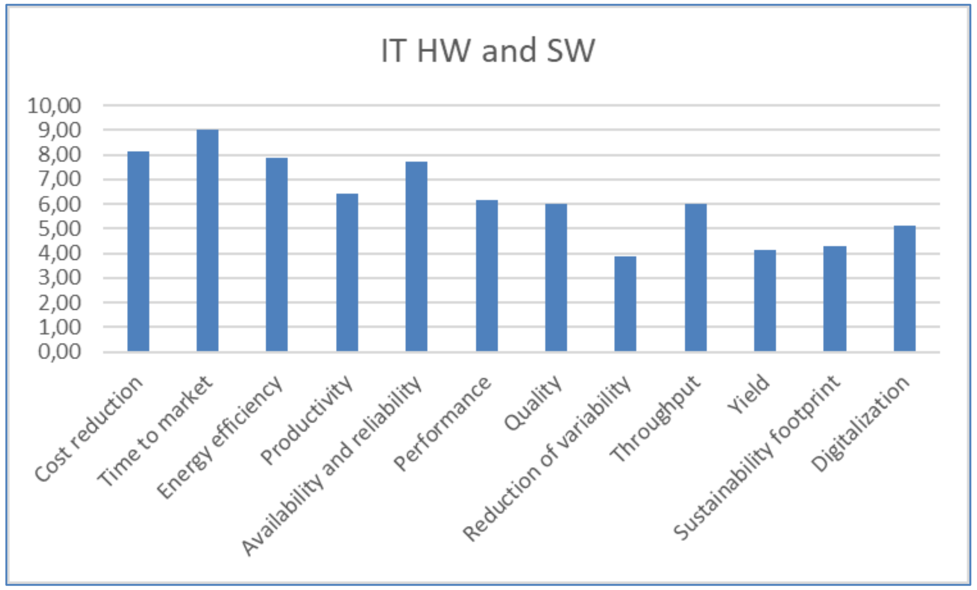
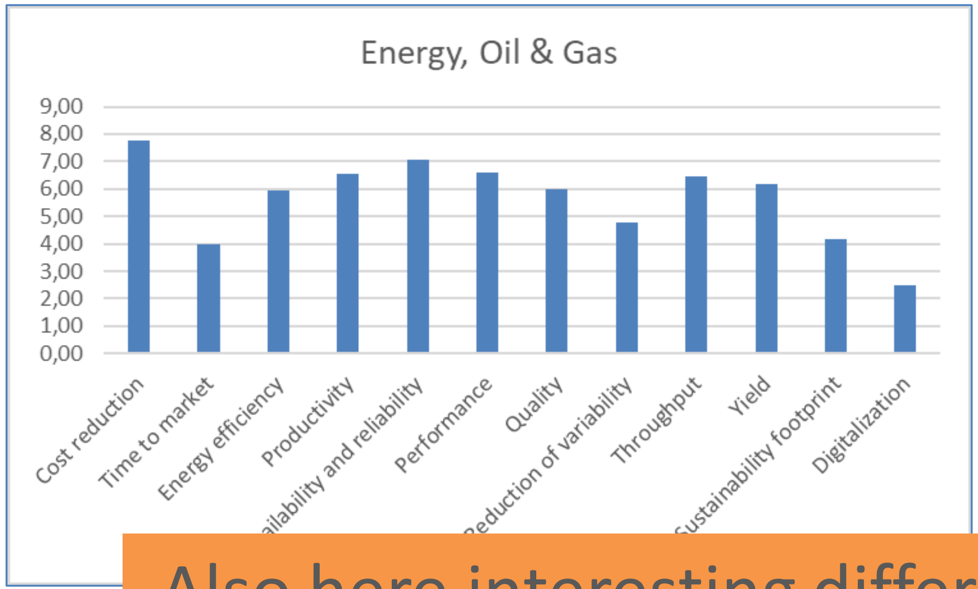
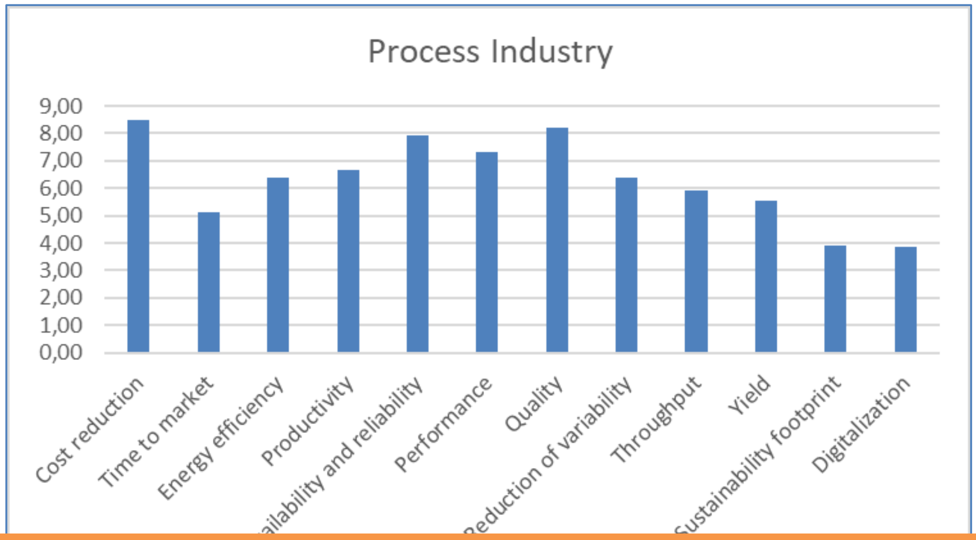
Q6: What are key drivers for further improvements for the future for the next generation of product/processes and services? (2/2)









Also here interesting differences: e.g. Robotics: focus on Productivity;
IT: Time to Market; Energy, O&G: Cost and Reliability;
Process: Cost and Quality.

Key challenges/limitations in enabling innovation

Challenges	Addressed by control technology/engineering/IT
1. Abundance of data - but limited contextualization	Interplay between control and AI: data classification for different applications
2. Data acquisition from the field and data reliability	Interplay between control and AI: data quality classification
3. Shorten design & development time (Agile approach)	Automated deployment
4. Complexity (of system and solution)	Interoperability of control system components (I/O, controllers, control applications, etc) and modularity
5. Solution integration within the full process or product	System level design approach, modularity and interfaces
6. Security	e.g. wireless secure data networks and cyber securities related to IoT field measurements, modularity, optimization for encryption?
7. Cost	Modularity of solution enabling application on different user platforms and cases; automation of processes requiring less human support/oversite; Automated configuration and maintenance. Intelligent control to reduce hardware cost, improve efficiency etc. (application specific)
8. Training of developers and operators. Legacy processes change management	Cultural change within control community and companies
9. Open platforms across vendors	IT
10. Human	
11. Market	

Point 1 to 7 can be possibly addressed by technological means where research problems can be formulated. Points 8 to 11 require to activate different channels: cultural changes in the communities, marketing and collaboration with IT

Cost and trained technical personnel and shorten deployment time dominate consistently across different fields. Technology challenges have to be addressed and classified in details for each specific sector.

Key challenges/limitations in enabling innovation (number of answers normalized with respect to the total number)

Challenges / Sectors	**Process Ind.**	**Energy/ Oil&Gas**	**Automotive and Transp.**	IT HW & SW	Aerospace	Manufacturing and Robotics	Med Tech
1. Abundance of data - but limited contextualization	13%	8%					
2. Data acquisition from the field and data reliability	7%	23%				14%	
3. Shorten design & development time (Agile approach)	10%	23%	15%	29%	40%		
4. Complexity	7%	8%	30%	14%	40%		67%
5. Solution/data integration within the full process or product	10%	15%			20%		
6. Security	3%	8%	8%				
7. Cost	13%	23%		29%	40%	29%	
8. Training of developers and operators. Legacy processes, change management	32%	23%	23%	14%		14%	33%
9. Open platforms across vendors	3%			14%			
10. Human Factors/ Old habits	10%	15%		14%			
11. Market acceptance	10%			29%			

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Research directions

1. Incorporate big-data/AI predictions with system model know-how (e.g. first principle models) as inputs to local controllers
2. Industrialization of the already known advance multivariable control techniques
3. Data-driven methods for implementing anomaly detection systems in industrial settings
4. Methods for estimating the quality/reliability of new data
5. Improve reliability and availability of products and processes (e.g. Self-calibrating, model-less APC for lower maintenance requirements)
6. Self-healing systems: Applications in HVAC/R, Automotive, Aerospace systems
7. Diagnostics and prognostics
8. Control for specific application
9. Nonlinear control to deal with linear design limitations (higher bandwidths & improved transient response)
10.Easy to use - better man machine interface, design tools

There is a clear request to address the interplay between AI and control. Data based solutions combined with control have to emerge to foster autonomy in operation and prognostics.

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Three main dominant groups can be identified across the different industry sectors: industrialization and user friendly tools, data driven solution and more autonomy

Key challenges/limitations in enabling innovation (number of answers normalized with respect to the total number)

Reasearch Directions / Sectors	**Process Ind.**	**Energy/ Oil&Gas**	**Automotive and Transp.**	IT HW & SW	Aerospace	Manufacturing and Robotics	Med Tech
1. Incorporate big-data/AI predictions with system model know-how (e.g. first principle models) as inputs to local controllers	13%	15%	15%		20%		33%
2. Industrialization of the already known advance multivariable control techniques	10%	23%	8%	29%	60%	29%	33%
3. Data-driven methods for implementing anomaly detection systems in industrial settings	16%	15%	15%		20%		
4. Methods for estimating the quality/reliability of new data	7%	15%	8%				33%
5. Improve reliability and availability of products and processes (e.g. Self-calibrating, model-less APC for lower maintenance requirements)	13%	15%	15%				
6. Self-healing systems: Applications in HVAC/R, Automotive, Aerospace systems	7%	8%	8%	14%		14%	33%
7. Diagnostics and prognostics	3%	23%	15%		20%	29%	
8. Control for specific application	3%	8%	8%				
9. Nonlinear control to deal with linear design limitations (higher bandwidths & improved transient response)	3%	8%		29%	20%	14%	
10.Easy to use - better man machine interface, design tools	13%	8%	8%	14%	40%	29%	

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Example of matching the requirements in a specific sector to enabling control features: Electric Transportation

Requirements and Enabling Control Targets: Electric Transportation

Requirements / Enabling control features	Improved power flow and dynamics across the chain	Reduce switching losses	Increased robustness margins	Adaptive recovery	Maximize traction effort
Volume and weight reduction	√	√			
New standards with strict requirements	√		√		
Improve systems Life Cycle Cost	√		√		√
Reliability (panto bounce, v sags, and slip/slide, sensor loss)	√		√	√	
Energy efficiency	√	√			√
Reduce costs		√	√		√
Fast deployment of solutions to reduce engineering effort			√		