



NFPA Roadmap Committee

March 4, 2021

1:00 PM to 3:00 PM Central Time

Zoom Link

<https://us02web.zoom.us/j/88087882855?pwd=dkMvamVrM0FXWnd5TzZta2xoUkdodz09>

Agenda

1:00 PM Welcome, Call to Order, Roll Call

Overview – Roadmap Process and Timetable

Survey on Fluid Power Customer Drivers and Capability Improvements

Discussion Items

- Final List of Customer Drivers
- Inclusion of Suggestions for New Capability Improvements
- Draft Capability Improvements and Working Groups

Wrap-Up and Next Steps

3:00 PM Adjourn

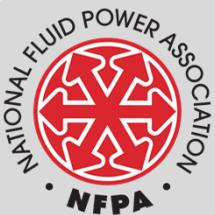


NFPA Anti-Trust Guidelines

Because of federal anti-trust laws, certain topics are not proper subjects for discussion at any NFPA function. In many cases, our members are competitors and any action or agreement which may eliminate, restrict or govern competition among members or their colleagues could be a violation of anti-trust laws. Those violating the anti-trust laws are subject to severe criminal and civil penalties.

This means that we must not discuss any items falling within the realm of competitive practices, such as current or future prices, terms of service, discounts, production or productivity rates, allocation of markets, profit levels, credit terms, or refusal to deal with a particular supplier or customer.

Please adhere strictly to these guidelines during all NFPA functions to protect yourself, your company and the NFPA from liability.



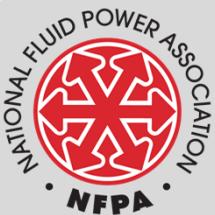
NFPA Technology Roadmap

The NFPA Technology Roadmap describes an industry-wide consensus regarding the pre-competitive research and development needs associated with improving the design, manufacture, and function of fluid power components and systems.

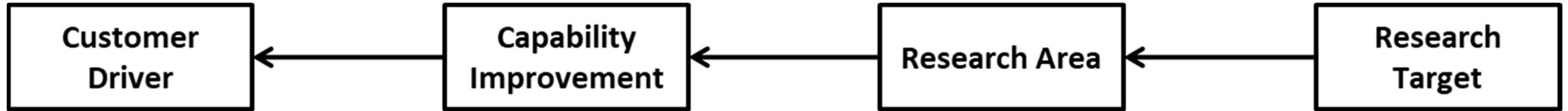
The research and development agenda it describes is focused on advancements that will help the fluid power industry meet the future needs of its customers, expand into new markets, and attract the best and brightest students to the field.

It is used by the NFPA and its academic partners to guide their research efforts, by NFPA members and other industry players to inform decisions about research partnerships and product development, and by academic, government, and other organizations that wish to pursue research and development projects of importance to the fluid power industry.

It is updated every two years under the guidance and leadership of the NFPA Roadmap Committee.



Roadmap Elements



Customer Drivers are the business or technology objectives of fluid power customers. They help them serve the needs of their own customers, and are not necessarily connected to their use of fluid power.

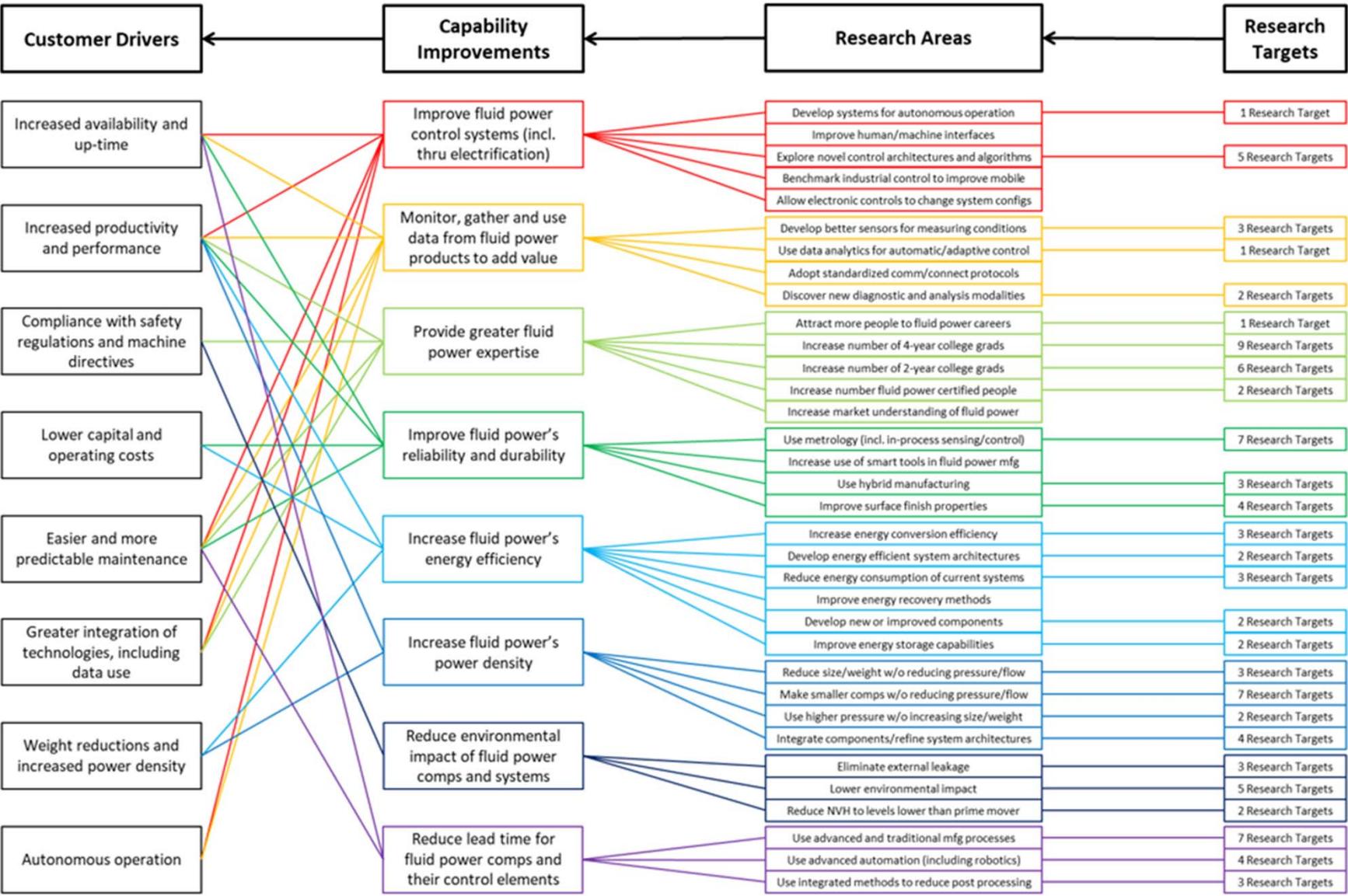
Capability Improvements describe the ways in which fluid power systems must improve if they are to meet or better meet the customer needs described by the Customer Drivers.

Research Areas are the broad areas of pre-competitive investigation that could assist in bringing about the Capability Improvements.

Research Targets are the objectives that quantify or otherwise describe successful strategies for pursuing the Research Areas.



2019 NFPA Technology Roadmap



2021 Roadmap Process and Timeline

Phase 1 – Customer Drivers

- Nov 12 Launch of survey on customer drivers
- Dec 17 Deadline to respond to survey on customer drivers
- Jan 21 Virtual committee meeting to discuss, define and prioritize customer drivers

Phase 2 – Capability Improvements

- Jan 28 Meeting report sent with prioritized customer drivers and setting the stage for fluid power alignment and capability improvements
Launch of survey on fluid power alignment and capability improvements
- Feb 18 Deadline to respond to survey on fluid power alignment and capability improvements
- Mar 4 **Virtual committee meeting at NFPA Regional Conference to discuss, define and prioritize capability improvements**

Phase 3 – Research Areas and Targets

- Mar 11 Meeting report sent with prioritized capability improvements and setting the stage for research areas and targets, including process for defining working groups for each capability improvement
Launch of survey on research areas and targets
- Apr 1 Deadline to respond to survey on research areas and targets
- Apr/May Virtual working group meetings to discuss and prioritize research areas and targets for each capability improvement
- Jun 3 Virtual committee meeting at NFPA Regional Conference to review and harmonized research areas and targets for each capability improvement

Phase 4 – Final Roadmap Document

- Jun Draft Roadmap document written
- Jul 8 Draft Roadmap document sent for review and comment
- Jul 22 Deadline to return comments on draft Roadmap
- Aug 17 Final Roadmap document presented at NFPA IEOC



Customer Drivers

Customer Drivers are the business or technology objectives of fluid power customers. Generally speaking, fluid power customers are the companies that build machines that incorporate fluid power components and systems. We sometimes refer to these customers as “machine builders.” The Customer Drivers help these machine builders serve the needs of their own customers (the companies or people that purchase and use the machines) and are not necessarily connected to their use of fluid power.

After a survey of 113 individuals across the fluid power supply chain, and a subsequent discussion by the NFPA Roadmap Committee, the following eleven Customer Drivers were proposed as those of highest importance to the majority of fluid power customer markets:

Customer Drivers

Fluid power’s machine builders want to provide their customers with machines that offer:

- Increased availability and up-time
- Decreased lead time in getting the machine
- On-time delivery of the machine
- Increased productivity and performance
- Increased energy efficiency
- Compliance with environmental and safety regulations and machine directives
- Lower capital and operating costs
- Easier and more predictable maintenance
- Increased use of integrated data and connected intelligence
- Autonomous functions and operation
- Weight reductions and increased power density



Capability Improvements

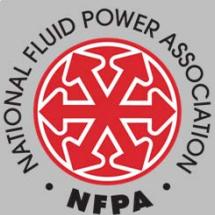
Capability Improvements describe the ways in which fluid power systems must improve if they are to meet or better meet the customer needs described by the Customer Drivers.

In the 2019 NFPA Technology Roadmap, the following eight Capability Improvements were identified as those of highest importance for the fluid power industry to pursue in order to meet or better meet the customer needs described by the Customer Drivers.

Capability Improvements

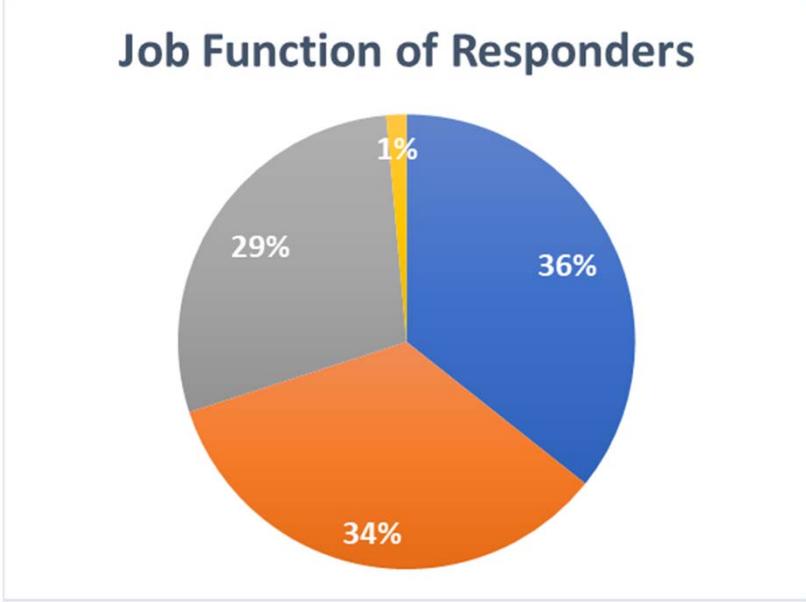
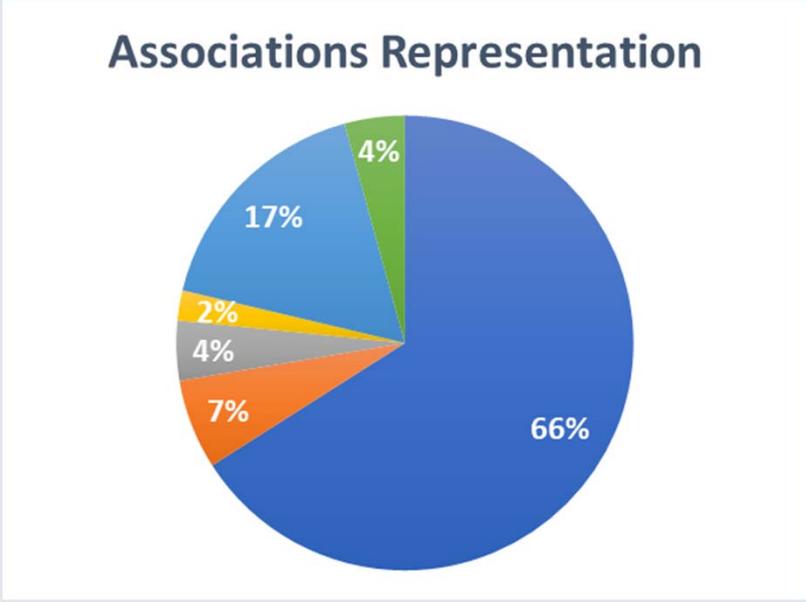
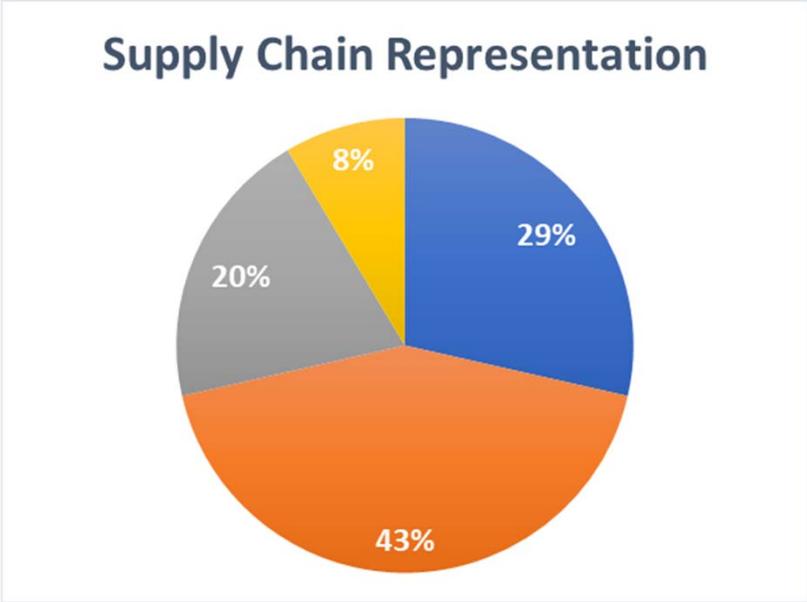
In order to better meet the needs of our customers, fluid power should seek to:

- Improve fluid power control systems (including through electrification)
- Monitor, gather and use data generated from working fluid power products to add value
- Provide greater fluid power expertise
- Improve fluid power's reliability and durability
- Increase fluid power's energy efficiency
- Increase fluid power's power density
- Reduce the environmental impact of fluid power components and systems
- Reduce lead time for fluid power components and their control elements



Survey on Customer Drivers and Capability Improvements

In February 2021, NFPA conducted a survey to rank the importance of these Customer Drivers, to determine fluid power’s current ability to meet the customer needs represented by them, to assess the usefulness of these Capability Improvements in helping fluid power meet them, and to determine if any new Capability Improvements had emerged since the time of the 2019 NFPA Technology Roadmap. The survey received responses from 70 individuals across the fluid power supply chain, including a large percentage from the NFPA Roadmap Committee.



- SUPPLIER to the fluid power industry
- MANUFACTURER of fluid power components
- Fluid power DISTRIBUTOR or system integrator
- MACHINE BUILDER that uses fluid power technology

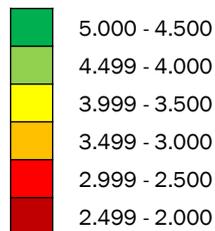
- National Fluid Power Association
- Association for High Technology Distribution
- Power Transmission Distributors Association
- Packaging Machinery Manufacturers Institute
- Association of Equipment Manufacturers
- Association for Manufacturing Technology

- Executive Management
- Sales or Marketing
- Engineering
- Human Resources



Ranked Importance of Customer Drivers

CUSTOMER DRIVERS	WEIGHTED AVERAGE	IN MARKETS SERVED BY HYDRAULICS	IN MARKETS SERVED BY PNEUMATICS
Increased availability and up-time	4.54	4.60	4.25
Increased productivity and performance	4.51	4.56	4.23
On-time delivery of the machine	4.21	4.23	4.09
Lower capital and operating costs	4.09	4.10	4.02
Compliance with environmental and safety regulations and machine directives	4.04	4.06	3.93
Easier and more predictable maintenance	3.90	3.89	3.93
Increased energy efficiency	3.78	3.80	3.70
Increased use of integrated data and connected intelligence	3.72	3.72	3.70
Decreased lead time in getting the machine	3.65	3.63	3.75
Weight reductions and increased power density	3.32	3.39	2.93
Autonomous functions and operation	3.23	3.23	3.23



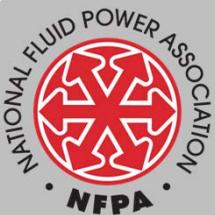
Survey participants were first asked to rank how important each of the customer drivers are for machine builders in markets typically served by HYDRAULICS and in markets typically serve by PNEUMATICS.

The scoring scale was: 5 = Extremely important; 4 = Very important; 3 = Somewhat important; 2 = Not so important; 1 = Not at all important.

Results are shown at left.

The weighted average reflects that, according to NFPA's latest data, hydraulics represent 84% and pneumatics represent 16% of all fluid power component sales.

When asked to identify additional customer drivers that would have ranked as extremely important or very important, survey participants had two concrete suggestions: (1) Easier implementation of new technologies; and (2) Reduced noise.



Hierarchy of Customer Drivers

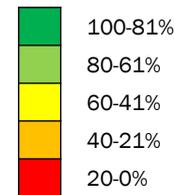
Survey participants were then asked to identify when efforts to address one customer driver could also serve as a method for addressing the needs represented by other drivers. A summary of the percentages of participants identifying such a relationship for each pair of drivers is shown at right.

Focusing on instances where 81% or more of participants responded, it may be more appropriate to classify:

- Autonomous functions and operations as a method for delivering increased productivity and performance;
- Weight reductions and increased power density as a method for delivering increased energy efficiency;
- Decreased lead time in getting the machine as a method for ensuring the on-time delivery of the machine; and
- Increased use of integrated data and connected intelligence as a method for delivering increased productivity and performance and for delivering easier and more predictable maintenance.

In making these changes, we are more clearly separating “what the user wants” from “how the OEM is going to deliver it to them.”

THESE CUSTOMER DRIVERS...	...ARE AN EFFECTIVE METHOD FOR ACHIEVING THESE CUSTOMER DRIVERS										
	Increased availability and up-time	Increased productivity and performance	On-time delivery of the machine	Lower capital and operating costs	Compliance with environmental and safety regulations and machine directives	Easier and more predictable maintenance	Increased energy efficiency	Increased use of integrated data and connected intelligence	Decreased lead time in getting the machine	Weight reductions and increased power density	Autonomous functions and operation
Increased availability and up-time		72%	26%	61%	9%	54%	22%	30%	26%	4%	7%
Increased productivity and performance	41%		0%	71%	17%	43%	65%	26%	0%	15%	13%
On-time delivery of the machine	54%	26%		41%	3%	13%	13%	5%	56%	0%	3%
Lower capital and operating costs	32%	77%	13%		6%	32%	61%	26%	10%	16%	10%
Compliance with environmental and safety regulations and machine directives	20%	26%	6%	46%		17%	63%	23%	3%	11%	9%
Easier and more predictable maintenance	87%	76%	2%	76%	20%		37%	39%	2%	2%	9%
Increased energy efficiency	24%	63%	0%	76%	61%	9%		15%	2%	28%	7%
Increased use of integrated data and connected intelligence	67%	89%	4%	52%	37%	85%	70%		4%	7%	65%
Decreased lead time in getting the machine	36%	19%	83%	36%	2%	2%	7%	5%		2%	0%
Weight reductions and increased power density	5%	62%	2%	57%	19%	5%	86%	0%	0%		2%
Autonomous functions and operation	50%	88%	0%	62%	29%	31%	57%	64%	0%	10%	



Final Customer Drivers

A final list of Customer Drivers for the 2021 NFPA Technology Roadmap would therefore look like this, prioritized in order of importance:

Customer Drivers

Fluid power's machine builders want to provide their customers with machines that offer:

1. **Increased availability and up-time**
2. **Increased productivity and performance**, including through efforts to provide autonomous functions and operations, and to use integrated data and intelligence
3. **On-time delivery of the machine**, including through efforts to decrease lead time in getting the machine
4. **Lower capital and operating costs**
5. **Compliance with environmental and safety regulations and machine directives**
6. **Easier and more predictable maintenance**, including through efforts to use integrated data and intelligence
7. **Increased energy efficiency**, including through efforts to reduce weight and increase power density



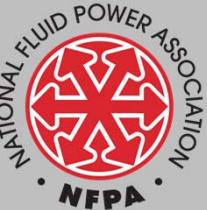
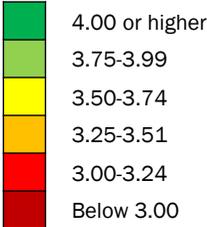
Alignment with Fluid Power

CUSTOMER DRIVERS	WEIGHTED AVERAGE	FREQUENCY HYDRAULICS IS USED TO DELIVER BENEFITS	FREQUENCY PNEUMATICS IS USED TO DELIVER BENEFITS
Increased availability and up-time	3.84	3.88	3.62
Increased productivity and performance	4.29	4.38	3.79
On-time delivery of the machine	3.38	3.38	3.38
Lower capital and operating costs	3.65	3.66	3.62
Compliance with environmental and safety regulations and machine directives	3.47	3.44	3.65
Easier and more predictable maintenance	3.49	3.48	3.56
Increased energy efficiency	3.71	3.76	3.44
Increased use of integrated data and connected intelligence	3.12	3.12	3.12
Decreased lead time in getting the machine	3.16	3.14	3.24
Weight reductions and increased power density	3.60	3.66	3.29
Autonomous functions and operation	3.06	3.06	3.03

Survey participants were next asked how often HYDRAULIC and PNEUMATIC technologies are used by machine builders when delivering each of the following benefits to the buyers and users of their machines.

The scoring scale was: 5 = Always; 4 = Usually; 3 = Sometimes; 2 = Rarely; 1 = Never.

We have focused our analysis on the seven most important customer drivers. The weighted average reflects that, according to NFPA's latest data, hydraulics represent 84% and pneumatics represent 16% of all fluid power component sales.



Gap Between Importance and Alignment

It is often helpful to look at the gap between the importance of a customer driver and the frequency with which fluid power is used by machine builders to deliver its benefits to their customers.

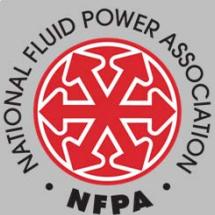
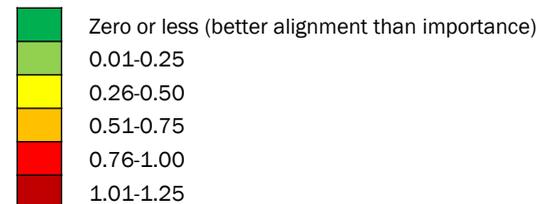
We have focused our analysis on the seven most important customer drivers. The weighted average reflects that, according to NFPA's latest data, hydraulics represent 84% and pneumatics represent 16% of all fluid power component sales.

For all seven, the gaps between importance and use of fluid power are positive numbers, meaning that the frequency of fluid power use scored lower than the importance of the driver. The customer drivers can be ordered from largest to smallest gap like this:

1. On-time delivery of the machine (0.83)
2. Increased availability and up-time (0.71)
3. Compliance with environmental and safety regulations and machine directives (0.57)
4. Lower capital and operating costs (0.43)
5. Easier and more predictable maintenance (0.40)
6. Increased productivity and performance (0.22)
7. Increased energy efficiency (0.08)

This suggests that fluid power should focus on capability improvements that would help address the top drivers on this list.

CUSTOMER DRIVERS	GAP BETWEEN IMPORTANCE AND ALIGNMENT		
	WEIGHTED AVERAGE	HYDRAULICS	PNEUMATICS
Increased availability and up-time	0.71	0.72	0.63
Increased productivity and performance	0.22	0.18	0.44
On-time delivery of the machine	0.83	0.85	0.71
Lower capital and operating costs	0.43	0.44	0.40
Compliance with environmental and safety regulations and machine directives	0.57	0.62	0.28
Easier and more predictable maintenance	0.40	0.41	0.37
Increased energy efficiency	0.08	0.04	0.26
Increased use of integrated data and connected intelligence	0.60	0.60	0.58
Decreased lead time in getting the machine	0.49	0.49	0.51
Weight reductions and increased power density	-0.28	-0.27	-0.36
Autonomous functions and operation	0.17	0.17	0.20



Helpfulness of Existing Capability Improvements

Survey participants were then asked to rank how helpful each of the 2019 Capability Improvements would be in improving the ability of hydraulic and pneumatic systems in allowing machine builders to provide the benefits described by each customer driver.

The scoring scale was: 5 = Extremely helpful; 4 = Very helpful; 3 = Somewhat helpful; 2 = Not too helpful; 1 = Not at all helpful.

		CUSTOMER DRIVERS													
		Increased availability and up-time		Increased productivity and performance		On-time delivery of the machine		Lower capital and operating costs		Compliance with environmental and safety regulations and machine directives		Easier and more predictable maintenance		Increased energy efficiency	
CAPABILITY IMPROVEMENTS	WEIGHTED AVERAGE	HYD	PNE	HYD	PNE	HYD	PNE	HYD	PNE	HYD	PNE	HYD	PNE	HYD	PNE
Improve fluid power control systems (including through electrification)	3.65	3.96	3.53	4.38	4.21	1.95	2.12	3.85	4.03	3.55	3.38	3.75	3.87	4.15	4.03
Monitor, gather and use data generated from working fluid power products to add value	3.81	4.24	4.06	4.15	4.13	1.95	2.12	3.95	3.87	3.63	3.66	4.71	4.56	4.10	3.94
Provide greater fluid power expertise	3.52	3.80	3.67	3.90	4.06	2.85	2.97	3.51	3.50	3.33	3.47	3.78	3.87	3.43	3.38
Improve fluid power's reliability and durability	3.65	4.59	4.29	4.05	4.09	2.12	2.13	4.17	4.09	2.88	2.91	4.60	4.52	3.18	3.30
Increase fluid power's energy efficiency	3.50	3.42	3.25	3.83	3.79	1.80	1.97	4.37	4.22	3.38	3.25	2.80	2.87	4.93	4.79
Increase fluid power's power density	2.92	2.96	2.86	3.73	3.50	1.90	2.03	3.33	3.34	2.50	2.41	2.36	2.42	3.67	3.62
Reduce the environmental impact of fluid power components and systems	2.77	2.82	2.83	2.43	2.50	1.83	2.00	2.55	2.65	4.69	4.50	2.38	2.42	2.58	2.88
Reduce lead time for fluid power components and their control elements	2.58	3.40	3.42	2.23	2.41	4.17	4.26	2.30	2.29	1.56	1.68	2.53	2.65	1.75	1.88

We have focused our analysis on the seven most important customer drivers. The weighted average reflects that, according to NFPA's latest data, hydraulics represent 84% and pneumatics represent 16% of all fluid power component sales.

These results show that each capability improvement would be extremely or very helpful in improving fluid power's ability to help meet the customer needs expressed by at least one of the customer drivers.

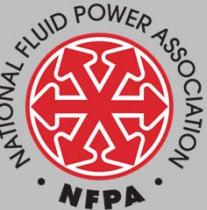


Suggestions for New Capability Improvements

	SUGGESTIONS FOR CAPABILITY IMPROVEMENTS	
CUSTOMER DRIVERS	HYDRAULIC SYSTEMS	PNEUMATIC SYSTEMS
Increased availability and up-time	Origin of supply chain manufacturing Proper distribution strategy Real time oil monitoring Easily maintained Distributors stocking product more Availability of service parts	Origin of supply chain manufacturing Proper distribution strategy Easily maintained Distributors stocking product more Availability of service parts
Increased productivity and performance	Noise/vibrations Use of new technology like IoT or similar	Use of new technology like IoT or similar
On-time delivery of the machine	Improved fabrication capability - flexibility and throughput Better distributor involvement Local support from hydraulic suppliers	Better distributor involvement Local support from hydraulic suppliers
Lower capital and operating costs	Identify actual operating costs so they can be targeted	Identify actual operating costs so they can be targeted
Compliance with environmental and safety regulations and machine directives	Better knowledge of published directives and compliance	Better knowledge of published directives and compliance
Easier and more predictable maintenance	Clear and precise technical documentation Embrace new technology that monitors machine performance Supply chain consistency	Clear and precise technical documentation Embrace new technology that monitors machine performance Supply chain consistency
Increased energy efficiency	Better data to see how to improve efficiency	Better data to see how to improve efficiency
Increased use of integrated data and connected intelligence	Break down trust barriers to network security	Break down trust barriers to network security
Decreased lead time in getting the machine	Distribution strategy Stable or short supply chains	Distribution strategy Stable or short supply chains
Weight reductions and increased power density		
Autonomous functions and operation	Local programming support from suppliers Training necessary to support this technology	Local programming support from suppliers Training necessary to support this technology

In addition to ranking the helpfulness of the existing Capability Improvements, participants were also asked to suggest any additional Capability Improvements that they would have ranked as “Extremely Helpful” or “Very Helpful” for each Customer Driver. A summary of the responses received is shown at left.

Many of these suggestions would require market-based rather than technology-based improvements in order to be effective, and therefore may not be appropriate for incorporation into a technology development roadmap.



Discussion of Suggested Capability Improvements

The following table lists the suggested Capability Improvements that seem technology-based, and offers a list of proposed actions for how to best incorporate them in the new technology roadmap. The NFPA Roadmap Committee will discuss these actions during its meeting on March 4, 2021. The goal of the discussion will be to finalize a list of Capability Improvements, from which the remainder of the 2021 NFPA Technology Roadmap can be built.

Related Customer Driver	Suggested Capability Improvement	Proposed Action
Increased availability and up-time	Real-time oil monitoring	Include as a possible research area under the existing Capability Improvement: “Monitor, gather and use data generated from working fluid power products to add value.”
	Easily maintained	Include as a possible research area under the existing Capability Improvement: “Improve fluid power’s reliability and durability.”
Increased productivity and performance	Noise/vibrations	Include as a possible research area under the existing Capability Improvement: “Reduce the environmental impact of fluid power components and systems.”
	Use of technology like IoT or similar	Include as a possible research area under the existing Capability Improvement: “Improve fluid power control systems (including through electrification).”
On-time delivery of the machine	Improved fabrication capability – flexibility and throughput	Include as a possible research area under the existing Capability Improvement: “Reduce lead time for fluid power components and their control elements.”
Easier and more predictable maintenance	Embrace new technology that monitors machine performance	Include as a possible research area under the existing Capability Improvement: “Monitor, gather and use data generated from working fluid power products to add value.”
Increased energy efficiency	Better data to see how to improve efficiency	Include as a possible research area under the existing Capability Improvement: “Increase fluid power’s energy efficiency.”

Capability Improvements

In order to better meet the needs of our customers, fluid power should seek to:

- **Improve fluid power control systems (including through electrification)**
- **Monitor, gather and use data generated from working fluid power products to add value**
- **Provide greater fluid power expertise**
- **Improve fluid power's reliability and durability**
- **Increase fluid power's energy efficiency**
- **Increase fluid power's power density**
- **Reduce the environmental impact of fluid power components and systems**
- **Reduce lead time for fluid power components and their control elements**



Selection of Working Groups

Following discussion by the Roadmap Committee, this list will be revised and finalized.

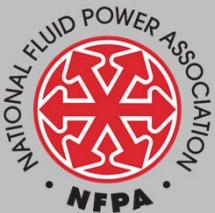
2021 NFPA Technology Roadmap

Capability Improvements

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1. Improve fluid power control systems (including through electrification)
2. Monitor, gather and use data generated from working fluid power products to add value
3. Provide greater fluid power expertise
4. Improve fluid power's reliability and durability
5. Increase fluid power's energy efficiency
6. Increase fluid power's power density
7. Reduce the environmental impact of fluid power components and systems
8. Reduce lead time for fluid power components and their control elements

Once finalized, Roadmap Committee members will be asked to volunteer to serve on a working group that will focus on the need research areas and needs for one of the Capability Improvements.



Wrap-Up and Next Steps

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