

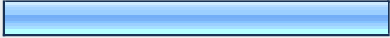






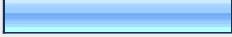








Future of Sensors

1. Have you had any experience or familiarity with sensors within the past 5 years?			
		Response Percent	Response Count
Yes		95.5%	447
No		4.5%	21
<i>answered question</i>			468
<i>skipped question</i>			0

2. Who has been your primary employer within the past 5 years?			
		Response Percent	Response Count
University		42.3%	184
Industry, business		46.0%	200
Government, municipal, and public services		6.4%	28
Military		1.6%	7
Other (please specify)		3.7%	16
<i>answered question</i>			435
<i>skipped question</i>			33

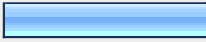
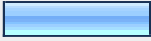
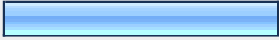
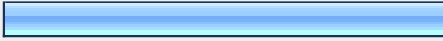



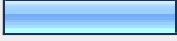

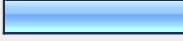
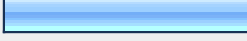
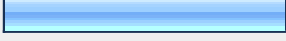
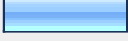

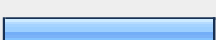


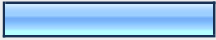



3. What has been your primary type of work in the past 5 years?


		Response Percent	Response Count
University research, teaching, instruction		40.6%	173
Industrial research		11.3%	48
Design, development		25.1%	107
Manufacturing		3.3%	14
Installation, technical support, maintenance		5.2%	22
Marketing		6.3%	27
Administration, monitoring, contracts		1.4%	6
Consulting		4.2%	18
Other (please specify)		2.6%	11
		<i>answered question</i>	426
		<i>skipped question</i>	42


















4. What has been your predominant involvement with sensors over the past 5 years?

		Response Percent	Response Count
developing custom sensors (< 10 sensors/year)		18.2%	74
developing custom systems containing sensor(s) (< 10 systems/year)		34.7%	141
manufacturing or selling sensors (> 10 sensors/year)		7.9%	32
manufacturing or selling mass-produced equipment containing sensors (> 10 products/year)		4.7%	19
installing and maintaining sensors		8.6%	35
monitoring or managing sensor acquisition		14.0%	57
Other (please specify)		11.8%	48
		answered question	406
		skipped question	62

5. In what fields of application have you encountered or used sensors? Check ALL that apply.

		Response Percent	Response Count
Aerospace (including military aerospace vehicles)		22.2%	87
Agricultural machinery, vehicles		15.8%	62
Automotive		30.1%	118
Basic scientific research		48.5%	190
Buildings, structures, HVAC		19.4%	76
Business and financial systems		1.5%	6
Civil infrastructure, municipal services		14.3%	56
Consumer products		18.9%	74
Ecology, biology		11.2%	44
Food, pharmaceutical - factory, process control, distribution		19.6%	77
Manufacturing, OEM, assembly		26.8%	105
Medicine, healthcare		30.9%	121
Military (NOT including military aerospace vehicles, see aerospace)		13.3%	52
Mining		8.9%	35
Petroleum, natural gas, chemical - drilling, pumping, refining, distribution		23.0%	90
Power generation and distribution		22.7%	89
Security - homeland, local (e.g. police and fire)		14.8%	58
Test facility, metrology, compliance		23.0%	90
Transportation - trucking, railroad		16.3%	64
Transportation - ships, boats, barges, ferries		11.2%	44
Warehousing, logistics, distribution		9.2%	36

Other (please specify)		8.4%	33
		answered question	392
		skipped question	76

6. Pick the ONE field of application that you have the MOST familiarity, expertise.			
		Response Percent	Response Count
Aerospace (including military aerospace vehicles)		6.5%	25
Agricultural machinery, vehicles		1.6%	6
Automotive		6.8%	26
Basic scientific research		20.3%	78
Buildings, structures, HVAC		1.6%	6
Business and financial systems		0.0%	0
Civil infrastructure, municipal services		2.3%	9
Consumer products		2.6%	10
Ecology, biology		1.8%	7
Food, pharmaceutical - factory, process control, distribution		3.4%	13
Industrial machinery, vehicles		7.0%	27
Manufacturing, OEM, assembly		5.2%	20
Medicine, healthcare		7.0%	27
Military (NOT including military aerospace vehicles, see aerospace)		2.3%	9
Mining		1.0%	4
Petroleum, natural gas, chemical - drilling, pumping, refining, distribution		7.5%	29
Power generation and distribution		4.9%	19
Security - homeland, local (e.g. police and fire)		2.3%	9

Test facility, metrology, compliance		4.9%	19
Transportation - trucking, railroad		2.3%	9
Transportation - ships, boats, barges, ferries		0.5%	2
Warehousing, logistics, distribution		1.6%	6
Other (please specify)		6.5%	25
answered question			385
skipped question			83

7. Rate each of these characteristics for sensors in the field of application that you chose in question 6.					
	very important	important	low importance	not important	Response Count
Dependability	57.8% (208)	35.6% (128)	5.6% (20)	1.1% (4)	360
Cost	32.8% (120)	48.9% (179)	15.6% (57)	2.7% (10)	366
Power consumption	33.4% (121)	34.3% (124)	26.5% (96)	5.8% (21)	362
Size, volume, mass	26.4% (96)	53.6% (195)	18.4% (67)	1.6% (6)	364
Environmental extremes	34.3% (123)	40.7% (146)	21.2% (76)	3.9% (14)	359
Ease of diagnostics	28.5% (103)	50.8% (184)	17.7% (64)	3.0% (11)	362
Security of data	22.0% (80)	33.3% (121)	33.1% (120)	11.6% (42)	363
Installed longevity	41.7% (150)	45.0% (162)	11.4% (41)	1.9% (7)	360
Comments					10
answered question					371
skipped question					97







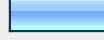

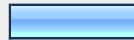











8. Predict how these sensor parameters will change within the next 5 years.							
	0%	+10%	+20%	+50%	+100%	>+100%	Response Count
Speed	7.2% (26)	25.3% (91)	22.8% (82)	28.1% (101)	8.4% (30)	8.1% (29)	359
Accuracy/resolution	3.5% (13)	19.3% (71)	31.3% (115)	28.1% (103)	12.0% (44)	5.7% (21)	367
Conservation of power (reduced consumption)	3.9% (14)	10.8% (39)	24.3% (88)	34.3% (124)	15.5% (56)	11.3% (41)	362
% decrease in size	3.0% (11)	15.2% (55)	25.4% (92)	34.0% (123)	13.0% (47)	9.4% (34)	362
Comments							10
answered question							369
skipped question							99

9. Predict how sensor networks will change within the next 5 years. (The numbers and types of sensors are per system, as is the total bandwidth.)							
	0%	+20%	+50%	+100%	+200%	>+200%	Response Count
Numbers of sensors	1.8% (6)	21.6% (72)	25.5% (85)	26.7% (89)	11.4% (38)	12.9% (43)	333
Types of sensors	4.8% (16)	32.7% (110)	27.4% (92)	23.5% (79)	7.1% (24)	4.5% (15)	336
Network bandwidth	3.9% (13)	19.9% (66)	29.6% (98)	29.6% (98)	9.7% (32)	7.3% (24)	331
Secure transmission	5.2% (17)	24.6% (81)	32.2% (106)	25.2% (83)	7.9% (26)	4.9% (16)	329
Comments							11
answered question							338
skipped question							130

10. What will be the rate of increase in numbers of sensor networks?							
	0%	+20%	+50%	+100%	+200%	>+200%	Response Count
Wired	8.4% (28)	51.7% (172)	25.5% (85)	9.6% (32)	2.7% (9)	2.1% (7)	333
Wireless	1.5% (5)	10.7% (36)	26.1% (88)	27.0% (91)	19.6% (66)	15.1% (51)	337
Optical	8.5% (28)	33.5% (110)	29.6% (97)	18.6% (61)	6.1% (20)	3.7% (12)	328
Other (please specify)							9
answered question							339
skipped question							129

11. This completes the predictive portion of the survey. Do you wish to tell us about your application?			
		Response Percent	Response Count
Yes, I'll answer more questions		48.1%	168
No, end the survey		51.9%	181
answered question			349
skipped question			119

12. Please select ONE sensor type with which you have recent or the most experience.

		Response Percent	Response Count
electric field		1.1%	2
voltage, current		6.5%	12
magnetic field		3.2%	6
electromagnetic		2.2%	4
proximity, occupancy, motion		2.2%	4
position, displacement		5.4%	10
velocity, acceleration		10.3%	19
force, strain, mass		3.8%	7
temperature		13.5%	25
pressure		13.5%	25
humidity, moisture		3.8%	7
fluid level		0.5%	1
mass, fluid, gas flow		2.7%	5
acoustic, ultrasonic		4.9%	9
radar, microwave - transmitted, reflected		2.2%	4
optical - transmitted, reflected, fiber optic		9.2%	17
optical - imaging		3.2%	6
radiation		0.0%	0
chemical		5.4%	10
biological		2.2%	4
Other (please specify)		4.3%	8
		answered question	185
		skipped question	283

13. What are the sampling speeds for this particular type of sensor? Even if the sensor operates asynchronously, give your best estimate in samples per second (sps) -----

	<1	1	10	100	1K	10K	100K	1M	10M	100M	1G
Minimum	22.2% (36)	17.9% (29)	14.8% (24)	11.7% (19)	13.6% (22)	8.0% (13)	7.4% (12)	0.6% (1)	2.5% (4)	0.6% (1)	0.6% (1)
Average	8.1% (13)	11.9% (19)	14.4% (23)	16.9% (27)	15.6% (25)	15.0% (24)	7.5% (12)	6.3% (10)	1.3% (2)	1.9% (3)	0.6% (1)
Maximum	5.6% (9)	5.0% (8)	11.3% (18)	10.6% (17)	16.9% (27)	13.8% (22)	15.0% (24)	7.5% (12)	5.6% (9)	2.5% (4)	3.1% (5)
Sensor speed not defined in samples per second											
<i>an</i>											

14. What is the range of accuracy for this particular type of sensor? ENOB = effective number of bits Approximate relation of ENOB
 10 bits / 62 dB 18 bits / 110 dB 4 bits / 26 dB 12 bits / 74 dB 20 bits / 122 dB 6 bits / 38 dB 14
 8 bits / 50 dB 16 bits / 98 dB 24 bits / 146 dB -----

	pulse/contact closure	2	4	6	8	10	12	14	16	18
Minimum accuracy	7.9% (11)	6.5% (9)	5.8% (8)	8.6% (12)	25.9% (36)	19.4% (27)	16.5% (23)	2.2% (3)	4.3% (6)	0.7% (1)
Average accuracy	2.9% (4)	2.2% (3)	7.2% (10)	3.6% (5)	8.7% (12)	18.8% (26)	29.0% (40)	8.7% (12)	11.6% (16)	2.9% (4)
Maximum accuracy	3.0% (4)	3.0% (4)	1.5% (2)	3.0% (4)	5.2% (7)	5.9% (8)	20.7% (28)	6.7% (9)	21.5% (29)	8.1% (11)
Sensor accuracy not defined in bits										

15. What is the bandwidth of this particular sensor? Even if the data transmission is not continuous, give your best estimates of the bandwidths. ----- Bandwidth (Bytes/sec) -----

	pulse/switch closure	<1	1-100	100-1K	1K-10K	10K-100K	100K-1M	1M-10M	10M-100M	100M-1G
Minimum	4.5% (6)	7.6% (10)	31.1% (41)	18.9% (25)	21.2% (28)	9.8% (13)	1.5% (2)	3.0% (4)	1.5% (2)	0.8% (1)
Average	2.2% (3)	2.2% (3)	19.3% (26)	17.8% (24)	25.9% (35)	16.3% (22)	8.1% (11)	3.0% (4)	2.2% (3)	1.5% (2)
Maximum	2.3% (3)	1.6% (2)	10.9% (14)	13.2% (17)	19.4% (25)	20.2% (26)	15.5% (20)	7.8% (10)	3.1% (4)	1.6% (2)

Sensor bandwidth not defined in bytes/sec (please

answered question

skipped question

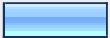
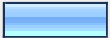
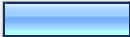
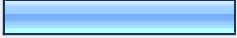




16. What is the power consumption of this particular sensor? Even if the level of power consumption is not fixed, give your best estimates of the average levels of power consumption. (uW = microwatt, mW = milliwatt, W = watt)

	<1 uW	1-10uW	10-100uW	100uW-1mW	1-10mW	10-100mW	100mW-1W	1-10W	>10 W	Response Count
Minimum	8.9% (12)	11.1% (15)	19.3% (26)	19.3% (26)	20.0% (27)	10.4% (14)	8.1% (11)	2.2% (3)	0.7% (1)	
Average	1.4% (2)	7.1% (10)	12.1% (17)	17.1% (24)	24.3% (34)	17.9% (25)	13.6% (19)	5.7% (8)	0.7% (1)	
Maximum	0.8% (1)	3.8% (5)	9.2% (12)	7.6% (10)	23.7% (31)	20.6% (27)	22.1% (29)	8.4% (11)	3.8% (5)	

Other (please specify)


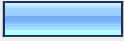
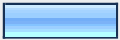


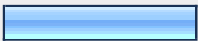




answered question

skipped question

17. For this particular sensor, what is the general size (volume) of the sensor (includes the transducer)?		Response Percent	Response Count
<0.03 ml (3 mm x 3 mm x 3 mm)		11.0%	17
<0.1 ml (5 mm x 5 mm x 5 mm)		11.0%	17
<1 ml (1 cm x 1 cm x 1 cm)		13.6%	21
<10 ml (2.2 cm x 2.2 cm x 2.2 cm, or about 1 cubic inch)		25.3%	39
<100 ml (5 cm x 5 cm x 4 cm or about 8 cubic inches)		23.4%	36
<1 liter (10 cm x 10 cm x 10 cm or about 32 cubic inches)		5.8%	9
> 1 liter		3.9%	6
Other (comment on varying sizes if applicable)		5.8%	9
answered question			154
skipped question			314

18. For this particular sensor, what is the range of distances from the transducer to the data collection module or computer?									
	<20 cm	20-50 cm	0.5-1 m	1-2 m	2-5 m	5-10 m	10-50 m	>50 m	Response Count
Minimum	33.6% (46)	13.9% (19)	17.5% (24)	8.0% (11)	8.8% (12)	7.3% (10)	5.8% (8)	5.1% (7)	137
Average	13.3% (19)	11.9% (17)	11.2% (16)	16.1% (23)	7.7% (11)	15.4% (22)	14.0% (20)	10.5% (15)	143
Maximum	10.5% (14)	6.8% (9)	5.3% (7)	7.5% (10)	13.5% (18)	9.0% (12)	15.0% (20)	32.3% (43)	133
Other (please specify)									5
answered question									149
skipped question									319





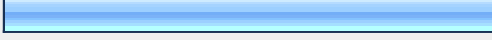

19. For your chosen sensor and field of application, what format is the data transmission from the sensor to the data collection module or computer?

		Response Percent	Response Count
Digital - wired		33.8%	53
Digital - wireless		12.7%	20
Digital - combination of wired and wireless		12.1%	19
Digital - optical		2.5%	4
Current loop		5.7%	9
Raw analog signal - wired		21.0%	33
Raw analog signal - wireless		5.1%	8
Raw analog signal - combination of wired and wireless		2.5%	4
Raw analog signal - optical		1.9%	3
Other (please specify)		2.5%	4
		answered question	157
		skipped question	311

20. How many different TYPES of sensors are typically incorporated into a system?

	1	2	3	4	5	6 - 10	>10	Response Count	
Minimum/system	56.3% (80)	16.2% (23)	13.4% (19)	4.9% (7)	3.5% (5)	3.5% (5)	2.1% (3)	142	
Average/system	14.6% (22)	27.2% (41)	22.5% (34)	11.9% (18)	10.6% (16)	7.9% (12)	5.3% (8)	151	
Maximum/system	8.4% (12)	8.4% (12)	13.3% (19)	15.4% (22)	15.4% (22)	20.3% (29)	18.9% (27)	143	
Other (please specify)								1	
								answered question	152
								skipped question	316

21. How many TOTAL sensors are typically incorporated into a system?									
	1	2	3-5	6-10	11-20	21-50	50-100	>100	Response Count
Minimum/system	41.7% (58)	19.4% (27)	17.3% (24)	7.9% (11)	5.8% (8)	4.3% (6)	2.2% (3)	1.4% (2)	139
Average/system	9.7% (14)	12.4% (18)	25.5% (37)	20.7% (30)	11.0% (16)	7.6% (11)	9.7% (14)	3.4% (5)	145
Maximum/system	5.1% (7)	5.1% (7)	15.9% (22)	14.5% (20)	13.8% (19)	13.8% (19)	11.6% (16)	20.3% (28)	138
Other (please specify)									3
answered question									148
skipped question									320

22. Are any security measures used in the data transmission from the sensor to the data collection module or computer?			
		Response Percent	Response Count
Highly sophisticated encryption with hardened enclosure and restricted physical access		5.8%	9
Hardened enclosure and restricted physical access		9.7%	15
Restricted physical access only		20.8%	32
Encryption only		7.8%	12
None		53.9%	83
Other (please specify)		1.9%	3
answered question			154
skipped question			314

23. What is the environment that this particular sensor must endure in this particular field of application? Office: - Temperature ranges from 0 to 50 C - Mild vibration and shock (drop to concrete floor from 1 m) - Humidity ranges from 10% to 80% - Pressure from sea level to 5000 m - EMI is nominal, power drops and brown outs, surges, spikes, ESD Medical: - Temperature ranges from 0 to 50 C - Mild vibration and shock (drop to concrete floor from 1 m) - Humidity ranges from 0% to 100% condensing, sometimes immersion - Corrosion in implanted devices - Pressure from sea level to 5000 m - EMI can be moderate, power drop outs, surges, spikes, ESD, RFI, reversed battery leads Industrial: - Temperature ranges from -40 to 85 C - Potentially severe vibration and shock - Humidity ranges from 0% to 100% condensing, sometimes immersion - Corrosion in caustic liquids and gases - Potentially volatile gases or liquids - Pressure from multiple atmospheres to near vacuum - EMI can be severe, power drop outs, surges, spikes, ESD, RFI Military: - Temperature ranges from -40 to 125 C - Potentially severe vibration and shock - Humidity ranges from 0% to 100% condensing, sometimes immersion - Corrosion in caustic liquids and gases - Pressure from multiple atmospheres to near vacuum - EMI can be severe, power drop outs, surges, spikes, ESD, RFI, Extreme (any or all of the following): - Temperature ranges much greater than from -40 to 125 C - Severe vibration and shock - Humidity ranges from 0% to immersion - Corrosion in caustic liquids and gases - Volatile gases or liquids - Pressure from many atmospheres to vacuum - EMI is severe, power drop outs, surges, spikes, ESD, RFI - Ionizing radiation, high energy particles and rays

	Office	Medical	Industrial	Military	Extreme	Response Count
Least severe	56.6% (82)	8.3% (12)	27.6% (40)	4.8% (7)	2.8% (4)	145
Typical, predominate	9.4% (14)	16.1% (24)	58.4% (87)	10.1% (15)	6.0% (9)	149
Most severe	5.6% (8)	9.0% (13)	28.5% (41)	27.1% (39)	29.9% (43)	144
				Other (please specify)		4
	answered question					152
	skipped question					316