Follow-up Need Analysis Survey
Tempus-Edunano project

Torino Meeting 19-20/9/16

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Follow-up analysis of the nano industry employment and training needs in order to provide future students, teachers and industry professionals the most relevant skills and competencies in this field.

Methodology

1. The 2014 survey was updated.

1. New knowledge fields that were raised by the respondents of the 2014 questionnaire were added.

2. The survey encompasses: 41 learning outcomes of 15 courses.

3. The Israel Venture Capital (IVC) database were used for update of the Israeli Nano companies mailing list.

4. The survey was distributed via Opinio (on-line survey tool) to 116 Nano companies CTO's, CEO's or managers.

Methodology

5. The EduNano partners were asked to distribute the survey among their colleagues in the academia and industry.

6. We also asked several key executives in the Industrial firms to distribute the survey to the relevant people.

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Survey Results

We have collected 46 answers.

20 respondents (43%) are from industrial companies

40% (8) general managers
25% (5) group leaders
25% (5) engineers
1 technology director and
1 researcher in a company
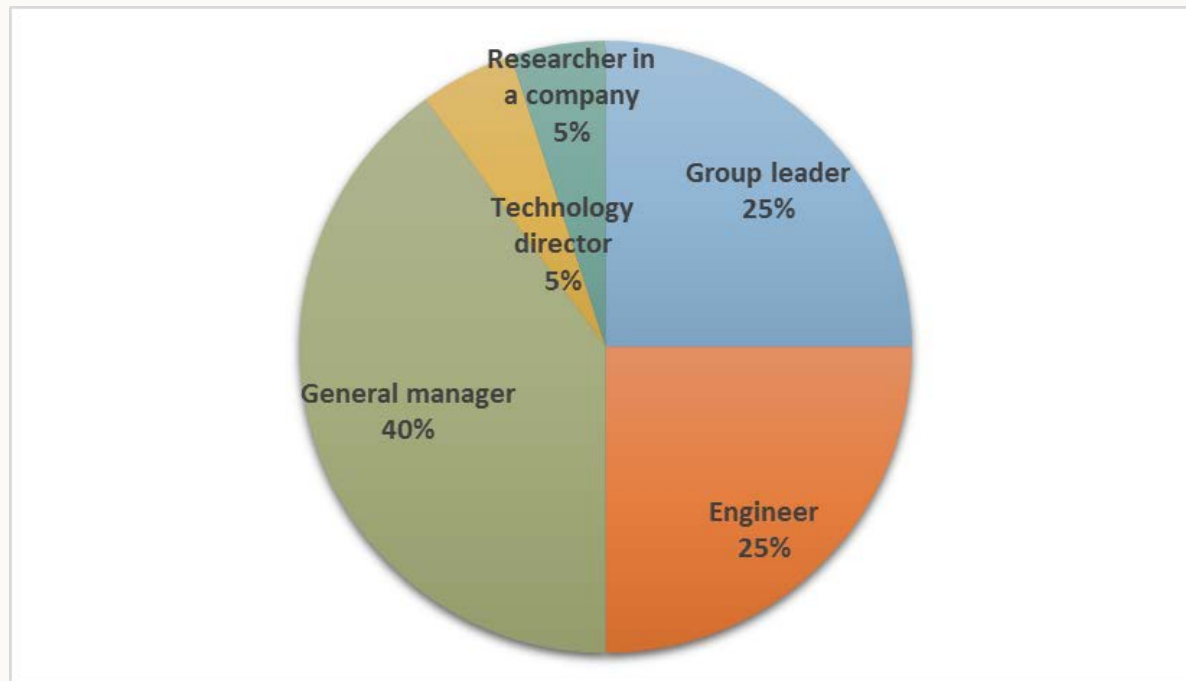
The 20 respondents from the industry are working in 17 different companies.
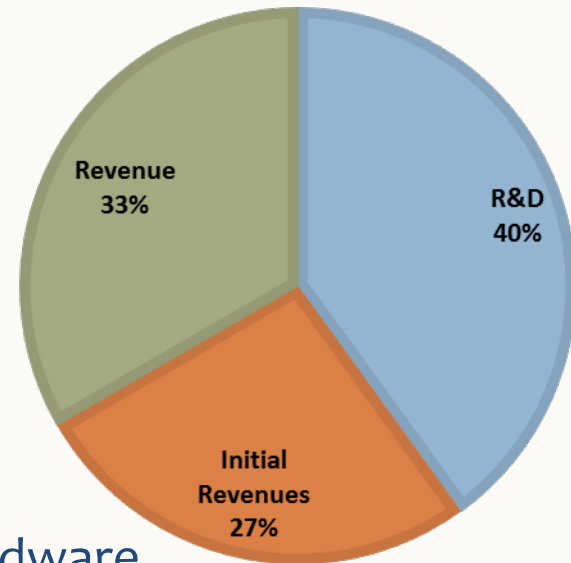
Analysis of the 15 Israeli companies
Company stage:
40% (6) R&D
27% (4) Initial Revenues
33% (5) revenue

Companies classification:
47% (7 out of 15) Miscellaneous Technologies:
Nanotechnology, Industrial Technologies or Hardware
20% (3) Semiconductors
13% (2) Life Sciences
The other: Cleantech, Communications and 1 LowTech

Year of establishment: 6 (40%) companies are well established - founded between the years 1965–1998, 5 companies were founded between 2000-2009 and 4 after 2010 (n=15).
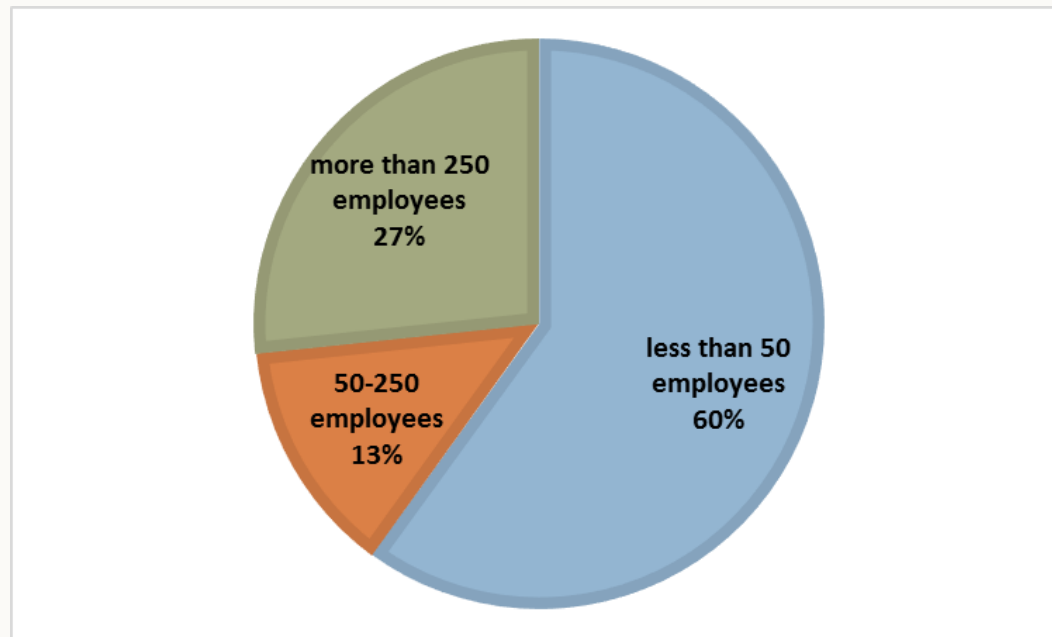
Number of employees:

9 companies (60%) are small companies with less than 50 employees.
2 companies employ 50-250 employees (13%)
and 4 companies (27%) are large companies - with more than 250 employees
(n=15).

Survey Results

23 respondents (50%) are from academic institutes

22 of them are from Israeli institutes (Tel-Aviv University, Technion, Hebrew University, Ben Gurion university, Bar Ilan university and Weizmann institute of Science).

1 is from Technical University of Sofia.

The results of this survey represent mainly the opinion of companies' senior managers and academic institute researchers.

Pie chart: Technion 35%, Tel-Aviv University 22%, Hebrew University 13%, Ben-Gurion University 9%, Weizmann Institute 9%, Bar Ilan University 4%, Technical University of Sofia 4%, university* 4%
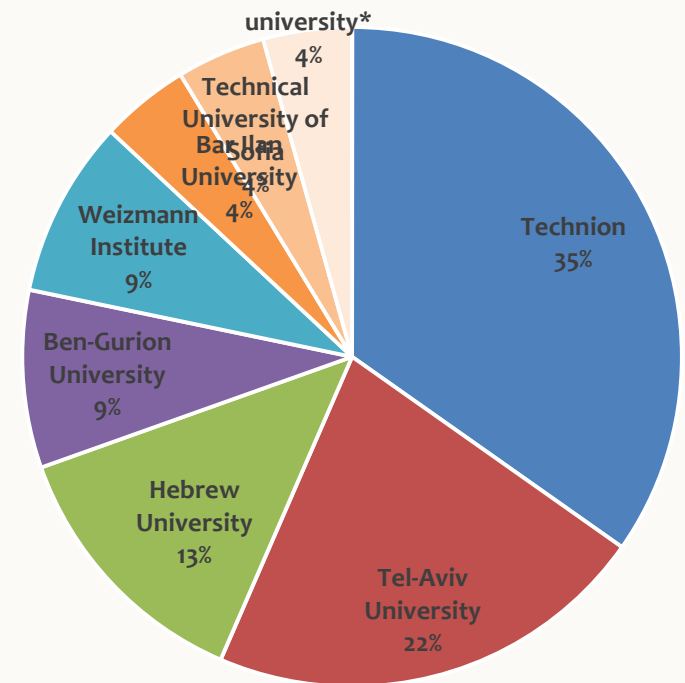
Weizmann Institute of Science courses skills and competencies
Scanning Probe Microscopy and its Applications in research in the nanotechnology Industry

■ 2014 ■ **2016**

Courses skills and competences	N	Low or very low	Average	High or Manda tory	Not relevant to my field of expertise
Analyze and Understand the results of selected characterization methods: AFM, STM, TEM, SEM, XRD, XPS	40 **46**	8% **4%**	10% **11%**	68% **76%**	15% **9%**
Predict the effect of various scanning parameters in Scanning Probe Microscopy	40 **45**	30% **18%**	18% **40%**	35% **27%**	18% **16%**
Identify analytical techniques in your work and in the work of others in Scanning Probe Microscopy	40 **46**	18% **22%**	30% **24%**	35% **39%**	18% **15%**
Decide which of the various modalities of Scanning Probe Microscopy are appropriate for a specific sample/scientific question	40 **46**	15% **15%**	33% **28%**	38% **41%**	15% **15%**
Propose standard SPM experiments for solving a scientific or technical problem	40 **42**	18% **14%**	20% **26%**	43% **38%**	20% **21%**
Perform basic image manipulation and analysis procedures (leveling, filtering, histogram adjustment, statistical and gain analysis) on SPM images	40 **43**	13% **16%**	23% **26%**	40% **47%**	25% **12%**

Bar-Ilan University courses skills and competencies

Bar-Ilan University courses skills and competencies
Nano Science and Nano technology why is "nano" different and how is it useful?

Courses skills and competences	N	Low or very low	Average	High or Mandatory	Not relevant to my field of expertise
Fundamentals of nano-science, its applications and new developments, including new optoelectronic devices, new materials and new biomedical applications	**38** **46**	**3%** **17%**	**16%** **17%**	**74%** **70%**	**8%** **7%**

Course name: Kinetics of materials

Courses skills and competences	N	Low or very low	Average	High or Mandatory	Not relevant to my field of expertise
Fundamentals of solid state diffusion	**40** **45**	**15%** **7%**	**33%** **38%**	**40%** **36%**	**13%** **20%**

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Ben-Gurion University of the Negev courses skills and competencies
Nano medicine and target drug delivery: where are we going?

Courses skills and competences	N	Low or very low	Average	High or Mandatory	Not relevant to my field of expertise
Fundamentals of nano-science in general and nano-medicine in particular	40	8%	28%	40%	25%
	46	9%	17%	59%	15%
Understand the principles and motivation for target drug delivery	40	18%	20%	25%	38%
	46	11%	20%	43%	26%
Familiarity with the tools that are used for Nano medicine studies	40	18%	23%	25%	35%
	46	13%	17%	43%	26%

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The Hebrew University of Jerusalem courses skills and competencies
Macroscopic quantum coherence in engineered nano-systems

Courses skills and competences	N	Low or very low	Average	High or Mandatory	Not relevant to my field of expertise
Understand the advantages and disadvantages of different engineered quantum nano-systems	**40** **46**	**15%** **11%**	**23%** **37%**	**48%** **33%**	**15%** **20%**
Calculate basic properties of different quantized nano systems and estimate sensitivity to noise and measurements	**39** **46**	**28%** **15%**	**33%** **39%**	**26%** **24%**	**13%** **22%**

Nanotechnology in Service of Humanity

Courses skills and competences	N	Low or very low	Average	High or Mandatory	Not relevant to my field of expertise
Know and understand the operation principles, advantages and limitations of important experimental techniques in the field of nano-science	**40** **45**	**10%** **4%**	**20%** **18%**	**65%** **76%**	**5%** **2%**

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Tel Aviv University courses skills and competencies
Introduction to Surface Science

Courses skills and competences	N	Low or very low	Average	High or Mandatory	Not relevant to my field of expertise
Familiarity with basic surface science concepts	**40**	**8%**	**20%**	**63%**	**10%**
	46	**2%**	**17%**	**78%**	**2%**

Course name: Atomistic Simulation of Materials

Courses skills and competences	N	Low or very low	Average	High or Mandatory	Not relevant to my field of expertise
Understand the capabilities and limitations of different computer simulation methods to learn about the properties of materials	**40**	**13%**	**30%**	**43%**	**15%**
	46	**20%**	**26%**	**46%**	**9%**
Know how to access state of the art simulation codes that are freely available for the study of molecules and solids as well as the resulting materials properties (know how to install them in a computer and know how to run them in parallel computers)	**40**	**33%**	**25%**	**28%**	**15%**
	45	**22%**	**33%**	**31%**	**13%**

Elbit courses skills and competencies
Advanced materials and nanotechnologies for electrochemical Energy Storage Systems

Courses skills and competences	N	Low or very low	Average	High or Mandatory	Not relevant to my field of expertise
Fundamentals of Electrochemistry	40	10%	25%	53%	13%
	45	9%	22%	58%	11%
Materials selection for Electrochemical Energy Storage	40	15%	25%	45%	15%
	46	7%	30%	41%	22%
Storage mechanisms, Materials Design, Operation Mode and performance Evaluation of Energy Storage Devices	40	15%	23%	40%	23%
	45	7%	33%	40%	20%

Technical University of Sofia courses skills and competencies
Design of Nanoscale MOS IC's

Courses skills and competences	N	Low or very low	Average	High or Mandatory	Not relevant to my field of expertise
Highly specialized knowledge on CMOS integrated circuit layout, basic technology, IC design and modeling and specific physical effects in short channel transistors	40 46	20% 9%	23% 22%	38% 39%	20% 30%

Course name: Nanomaterials for electronics

Courses skills and competences	N	Low or very low	Average	High or Mandatory	Not relevant to my field of expertise
Advanced knowledge of a field of materials for nano-electronics and their use in nano-devices fabrication	40 46	8% 7%	15% 20%	65% 57%	13% 17%

Politecnico di Torino courses skills and competencies

Bio Nano electronic devices for biosensing

Courses skills and competences	N	Low or very low	Average	High or Mandatory	Not relevant to my field of expertise
Basics of quantum mechanics useful for the design and use of nano devices in particular nano sensors	40	18%	33%	35%	15%
	44	11%	25%	48%	16%
Knowledge of the possible device production techniques of nano-systems in particular nano gap realization	40	10%	28%	43%	20%
	43	19%	23%	33%	26%

Micro interfaces for contacting the Nano World

Courses skills and competences	N	Low or very low	Average	High or Mandatory	Not relevant to my field of expertise
Design of CMOS Circuits for the management of ReadOut interfaces	40	25%	20%	30%	25%
	44	14%	20%	23%	43%
The use of CMOS Technology and post processing processes for the implantation of integrated sensors	40	20%	23%	35%	23%
	44	9%	20%	34%	36%

Grenoble courses skills and competencies
Nanostructure analysis

Courses skills and competences	N	Low or very low	Average	High or Mandatory	Not relevant to my field of expertise
Overview of the fundamentals of Scanning Probe Microscopy (SPM based nanolithography: STM, AFM, Near field optics) and of their place in the present development of nano-science and nanotechnology	39 **46**	18% **9%**	13% **20%**	56% **57%**	13% **15%**

Bio technologies

Courses skills and competences	N	Low or very low	Average	High or Mandatory	Not relevant to my field of expertise
Global overview of bioelectronics sciences and technologies	40 **45**	15% **11%**	13% **20%**	48% **42%**	25% **27%**
Study of Bioelectrical interfaces with the dual goal of monitoring physiological phenomena or biological species an of interacting with biological functions	40 **45**	20% **33%**	20% **13%**	25% **29%**	35% **24%**

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New knowledge fields that emerged from the results of the previous questionnaire

Knowledge field	N	Low or very low	Average	High or Mandatory	Not relevant to my field of expertise
Nano-optics	46	0%	15%	70%	15%
Electron microscopy for nano materials	46	2%	13%	76%	9%
Plasmonics	46	2%	26%	48%	24%
Thermal properties of nanomaterials	45	2%	24%	64%	9%
Challenges in development of CMOS devices (and nanotechnology)	46	4%	20%	46%	30%

Conclusions

- In most of the courses, at least 70% of the survey respondents rated the proposed courses skills and competencies as fulfilling average or high/mandatory needs.

- Most of the courses are relevant to at least 75% of the survey respondents.

- The survey respondents specified additional Knowledge fields that were not covered by the courses skills and competences mentioned in the survey. The additional needs can be found in the need analysis report.

- New knowledge fields that emerged from the results of the previous questionnaire were rated by most of the respondents as high need or mandatory.

Conclusions

- **The skills and competencies which were rated by more than 70% of the respondents as high need or mandatory, are:**

  - **Fundamentals of nano-science, its applications and new developments, including new optoelectronic devices, new materials and new biomedical applications (70%)**

  - **Analyze and understand the results of selected characterization methods: AFM, STM, TEM, SEM, XRD, XPS (76%)**

  - **Fundamentals of nano-science in general and nano-medicine in particular (76%)**

  - **Understand the advantages and disadvantages of different engineered quantum nano-systems (70%)**

  - **Know and understand the operation principles, advantages and limitations of important experimental techniques in the field of nano-science (76%)**

  - **Familiarity with basic surface science concepts (78%)**

  - **Nano-optics (70%)**

  - **Electron microscopy for nano materials (76%)**

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Courses skills and competences	N	Low or very low	Average	High or Mandatory	Not relevant to my field of expertise
E-Beam evaporation	39	5%	26%	44%	26%
	46	7%	33%	37%	24%
Deposition of PECVD silicon dioxide	39	8%	15%	49%	28%
	45	7%	33%	27%	33%
Reactive ion etching (RIE) of silicon dioxide	39	8%	26%	46%	21%
	45	9%	31%	36%	24%
Chip singulation – wafer cleaving	39	15%	26%	31%	28%
	45	16%	33%	24%	27%
Critical point drying (CPD)	38	18%	18%	32%	32%
	43	19%	30%	28%	23%
Profilometry (step height characterization for photoresist, silicon dioxide, metal, etc.)	39	8%	18%	54%	21%
	45	18%	36%	31%	16%
Ellipsometry (thickness measurement of PECVD silicon dioxide	39	10%	21%	54%	15%
	45	13%	36%	36%	16%
Confocal microscopy (depth measurement of silicon after DRIE)	39	8%	21%	56%	15%
	45	9%	38%	40%	16%
Wafer cleaning and photoresist stripping	38	8%	18%	47%	26%
	45	16%	24%	36%	24%