Master MIPET
industrial plant engineering and technologies

Industrial Plant Innovation Seminar:

Excellent Experiences of Industry 4.0 and R&D Innovative Technologies applied to the Real World

Simulation Team
www.simulationteam.com

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Research and Development Projects

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Research and Development

The term **R&D** (*Research and Development*) refers to a specific group of activities within a business. The activities classified as R&D differ from company to company, but there are two primary models:

- Primary function of R&D is to develop new products *(R&D staff composed by Engineers)*
- Primary function of R&D is to discover/create new knowledge about scientific and technological topics for the purpose of uncovering and enabling development of valuable new products, processes, and services *(R&D staff based on Industrial Scientists)*

R&D differs from the vast majority of a company's activities which are intended to yield nearly immediate profit or immediate improvements in operations and involve little uncertainty as to the (ROI).

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R&D Peculiarities

The Nevis cyclotron, which was constructed at Columbia University's Nevis Laboratories in Irvington, N.Y

WBS in Project Management
from **Manhattan Project**

PERT in Project Management
from **Polaris Project**

Uncertainty

- ***Difficulties in Estimating Times***
- ***Difficulties in Estimating Costs***
- ***Difficulties in Estimating Performances***
- ***Difficulties in Estimating Activity Advancement***

R&D deals with New Areas to be investigated and new Solutions to be Engineered!

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Sources for R&D

Internal R&D & Industrial Funds

Governmental Funds

- *Regional Authorities*
  - *Region Administration*
- *National Departments*
  - *Research and University*
  - *Industry*
  - *DoD or MoD*
  - *NASA*

International Organizations

- *European Community*
- *World Bank, Asian Development Bank*
- *NATO, European Defense Agency*
- *United Nations*

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R&D around the World

World is sensitive to R&D in different ways

	R&D Investments	*Patents*
Sweden	*3.70% GDP*	*10'905*
Japan	*3.45% GDP*	*304'604*
Singapore	*2.84% GDP*	*2'043*
USA	*2.79% GDP*	*201'158*
Europe	*1.85% GDP*	*186'146*
Germany	*2.69% GDP*	*72'346*
France	*2.12% GDP*	*34'755*
UK	*1.79% GDP*	*18'275*
Italy	*1.21% GDP*	*16'212*
Brazil	*1.12% GDP*	*805*
China	*1.70% GDP*	*118' 857*

2008 Statistics

2012 Statistics`

World Companies Leaders in Patents

1 IBM
2 Samsung
3 Canon
4 Sony
5 Panasonic
6 Microsoft
7 Toshiba
8 Hon Hai
9 General Electric
10 LG Electronics

2012 Statistics

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Statistics Consistency: Overall R&D Investments

Wikipedia 2013 on Statistics about 2011

Rank	Country/Region	Expenditures on R&D (billions of US$, PPP),	% of GDP PPP	Expenditures on R&D per capita (US$ PPP),	Year	Source
1	United States	405.3	2.7%	1,275.64	2011	[2]
2	China	296.8	1.97%	217.69	2012	[3]
3	Japan	160.3	3.67%	1,260.42	2011	[4]
4	Germany	69.5	2.3%	861.04	2011	[2]
5	South Korea	55.8	3.74%	1,111.12	2011	[4]
6	France	42.2	1.9%	640.91	2011	[2]
7	United Kingdom	38.4	1.7%	602.78	2011	[2]
8	India	36.1	0.9%	29.07	2011	[2]
9	Canada	24.3	1.8%	688.47	2011	[2]
10	Russia	23.8[n1]	1.0%	165.62	2011	[2]
11	Brazil	19.4	0.9%	96.50	2011	[2]
12	Italy	19.0	1.1%	316.70	2011	[2]
13	Taiwan	19.0	2.3%	812.69	2011	[2]
14	Spain	17.2	1.3%	369.02	2011	[2]
15	Australia	15.9	1.7%	978.97	2011	[2]
16	Sweden	11.9	3.3%	1,232.97	2011	[2]
17	Netherlands	10.8	1.6%	641.23	2011	[2]
18	Israel	9.4	4.2%	1,153.90	2011	[2]
19	Austria	8.3	2.5%	975.91	2011	[2]
20	Switzerland	7.5	2.3%	924.53	2011	[2]

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Statistics Consistency: R&D Investments per Capita

Wikipedia 2013 on Statistics about 2011

Rank	Country/Region	Expenditures on R&D (billions of US$, PPP),	% of GDP PPP	Expenditures on R&D per capita (US$ PPP),	Year	Source
1	United States	405.3	2.7%	1,275.64	2011	[2]
3	Japan	160.3	3.67%	1,260.42	2011	[4]
51	Luxembourg	0.67	1.62%	1,247.67	2007	[6]
16	Sweden	11.9	3.3%	1,232.97	2011	[2]
26	Singapore	6.3	2.2%	1,166.84	2011	[2]
25	Finland	6.3	3.1%	1,155.37	2011	[2]
18	Israel	9.4	4.2%	1,153.90	2011	[2]
5	South Korea	55.8	3.74%	1,111.12	2011	[4]
15	Australia	15.9	1.7%	978.97	2011	[2]
19	Austria	8.3	2.5%	975.91	2011	[2]
20	Switzerland	7.5	2.3%	924.53	2011	[2]
60	Iceland	0.3	2.3%	921.18	2011	[2]
27	Denmark	5.1	2.4%	906.31	2011	[2]
4	Germany	69.5	2.3%	861.04	2011	[2]
28	Norway	4.2	1.6%	822.07	2011	[2]
13	Taiwan	19.0	2.3%	812.69	2011	[2]
9	Canada	24.3	1.8%	688.47	2011	[2]
17	Netherlands	10.8	1.6%	641.23	2011	[2]
6	France	42.2	1.9%	640.91	2011	[2]
21	Belgium	6.9	1.7%	619.82	2011	[2]

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Statistics Consistency: R&D Investments per GDP

Wikipedia 2013 on Statistics about 2011

Rank	Country/Region	Expenditures on R&D (billions of US$, PPP),	% of GDP PPP	Expenditures on R&D per capita (US$ PPP),	Year	Source
18	Israel	9.4	4.2%	1,153.90	2011	[2]
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51	Luxembourg	0.67	1.62%	1,247.67	2007	[6]

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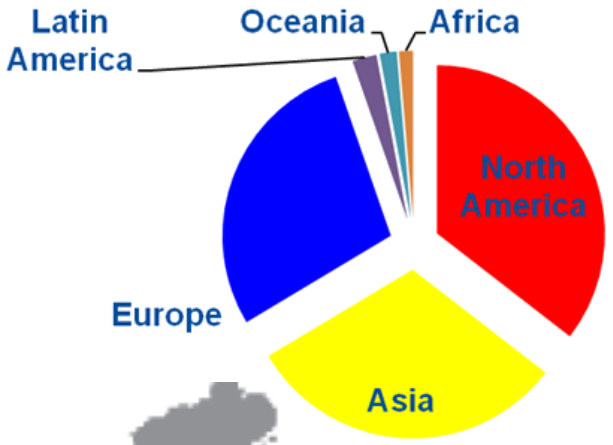
R&D over World Regions



North America
$393 (35.5%)

Europe (Western, Central, Eastern)
$313 (28.2%)

Asia (East, South, West)
$343 (31.0%)

Africa & Middle East $15 (1.3%)

Latin America & Caribbean
$26 (2.4%)

Pacific
$18 (1.6%)

R&D 2007 Investments in US billions based on NSF Estimations

World total = $1,107

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Patents in Countries and over the Regions along last Years

	Office	Office (code)	Origin	2006	2007	2008	2009	2010	2011	2012
1	Asia	R2	Total	365143	404315	392031	415546	461474	544008	638606
2	North America	R5	Total	188742	175833	176475	186846	238734	245267	274974
3	United States of America	US	Total	173770	157283	157772	167349	219614	224505	253155
4	China	CN	Total	57786	67948	93706	128389	135110	172113	217105
5	Europe	R3	Total	160576	145654	157603	164951	160033	152667	158282
6	Oceania	R6	Total	12838	14839	15067	15822	18904	22587	24002
7	Latin America and the Caribbean	R4	Total	16526	16302	17104	15457	15349	17757	19879
8	France	FR	Total	13788	12112	10811	10529	9899	10213	12913
9	Germany	DE	Total	21034	17739	17308	14435	13678	11719	11332
10	Africa	R1	Total	3110	3104	3525	2866	7776	8979	9015
11	United Kingdom	GB	Total	7907	5930	5360	5428	5594	7173	6864
12	Singapore	SG	Total	7393	7478	6286	5609	4442	5949	5633
13	Italy	IT	Total	5560	6508	7318	18277	16106	6380	5625

WIPO Statistics

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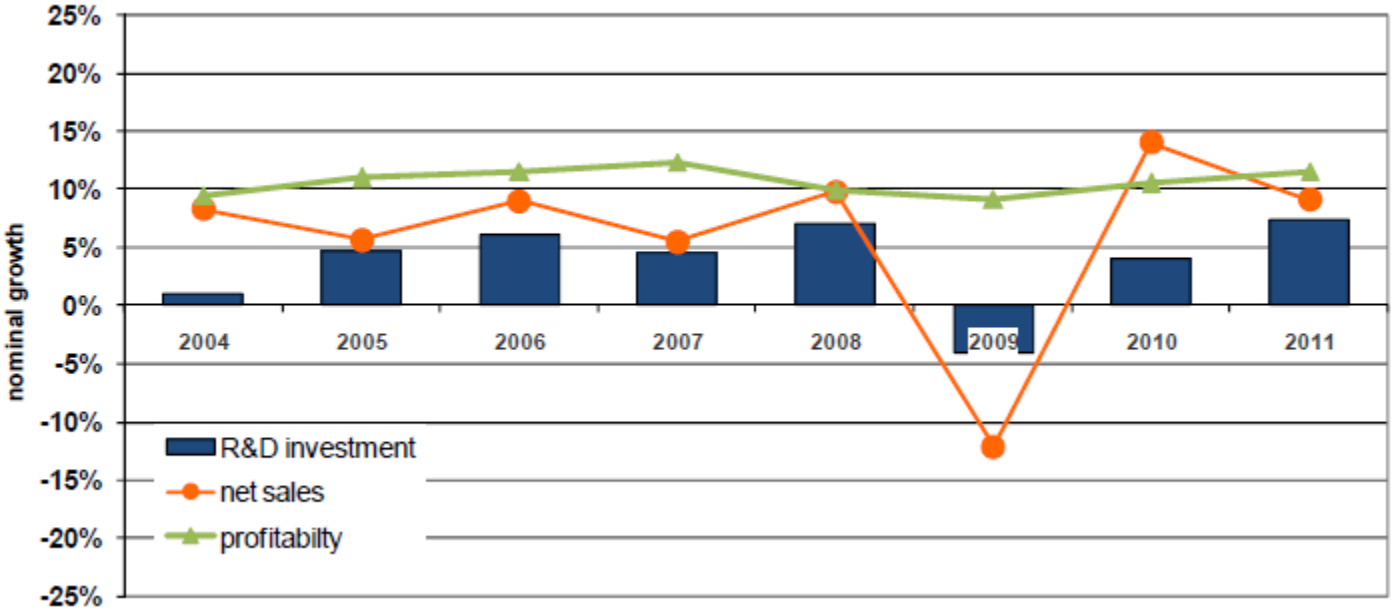
R&D Investments, Profits and Net Sales in EU Companies



2012 EU Industrial R&D Report

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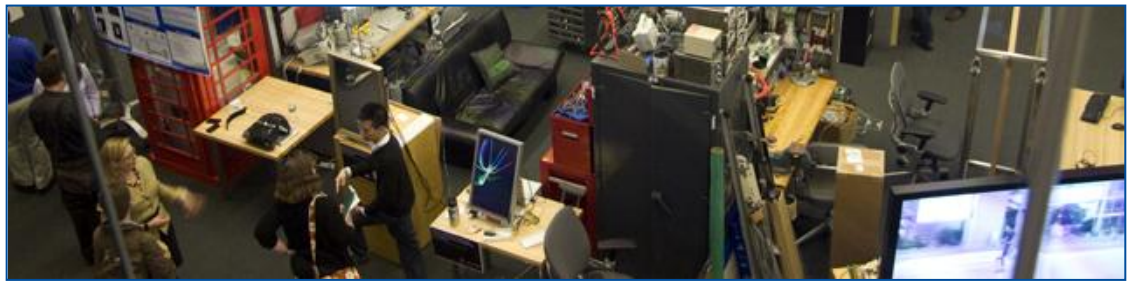
R&D Investments, Profits and Net Sales in USA Companies



2012 EU Industrial R&D Report

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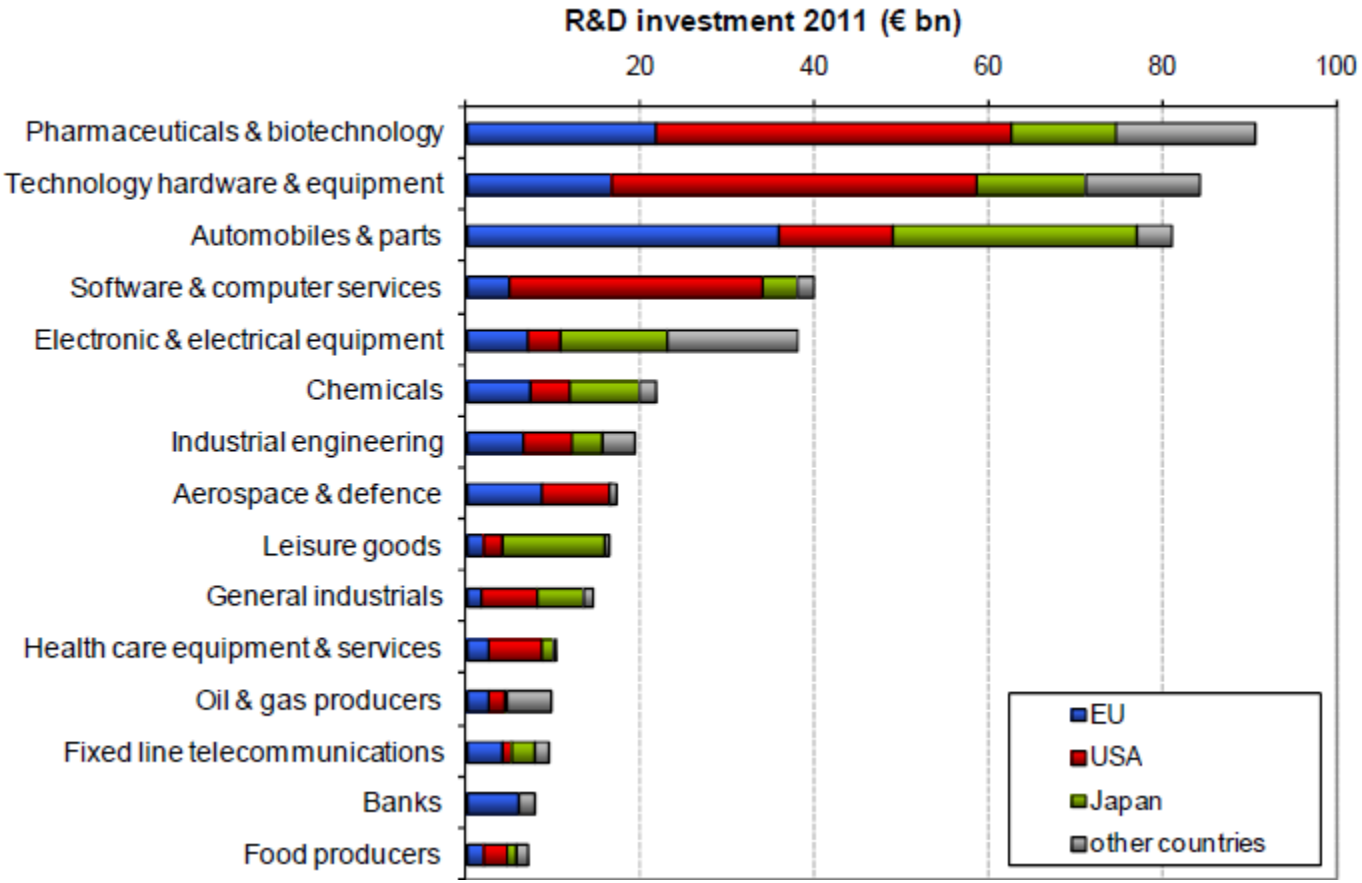
R&D Over Different Business Sectors

Investments over first 1500 Companies based on EU



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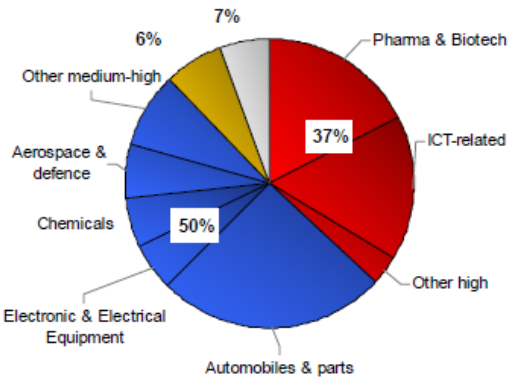
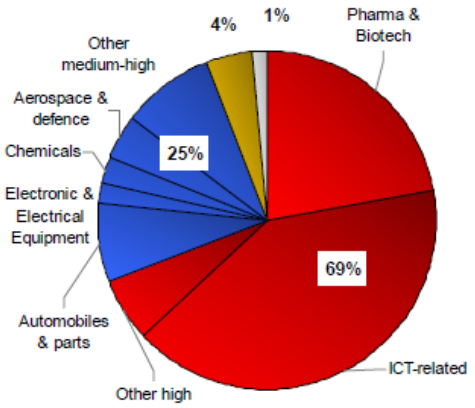
R&D Investment in EU and US: Area Shift over Last Years

EU 2011



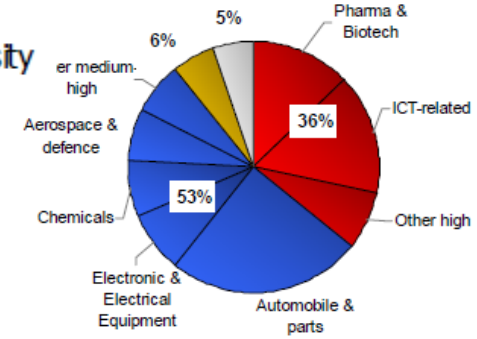
US 2011



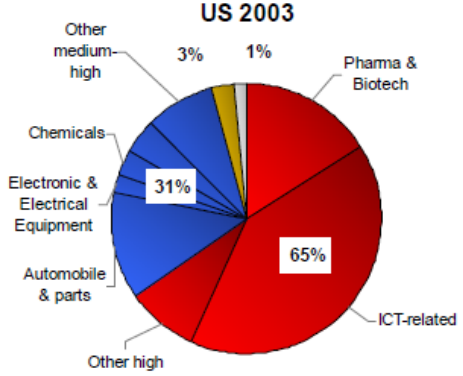
■ High ■ Medium-High

■ Medium-Low □ Low R&D intensity

EU 2003



US 2003



2012 EU Industrial R&D Report

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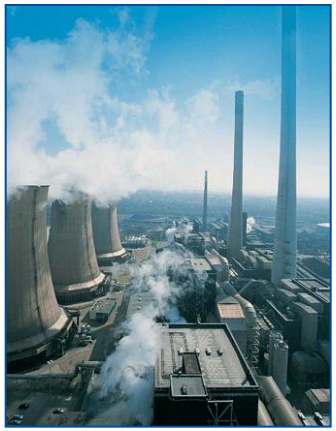
Business Sectors EU/US/Japan

Rank	Sector	Overall one-year R&D growth (%)	EU R&D change (%)		US R&D change (%)		Japan R&D change (%)	
			1 year	3 years	1 year	3 years	1 year	3 years
1	Banks	21.8	19.5	19.8				
2	Industrial engineering	16.5	15.6	6.0	20.1	7.7	7.9	0.6
3	Automobiles & parts	13.1	16.2	4.1	13.4	-3.3	9.9	-4.0
4	Software & computer services	10.9	7.8	5.0	11.6	6.2	0.0	-12.6
5	Oil & gas producers	10.4	0.0	0.1	13.6	2.3	3.5	12.5
6	Electronic & electrical equipment	10.0	5.4	4.6	16.6	6.2	3.0	-1.0
7	Technology hardware & equipment	8.3	6.2	-1.5	10.9	3.8	1.1	-4.6
8	Health care equipment & services	7.0	6.8	4.2	6.3	5.5	6.6	1.3
9	Leisure goods	4.0	4.3	3.0	-2.0	-6.0	4.6	-2.9
10	Chemicals	4.0	0.5	1.0	10.0	7.0	3.4	1.9
11	Food producers	4.0	8.7	4.2	17.5	11.2	4.3	5.8
12	Aerospace & defence	3.9	6.1	4.8	1.1	-1.5	10.5	-4.4
13	General industrials	1.5	0.3	4.3	13.4	9.1	-12.5	-6.9
14	Pharmaceuticals & biotechnology	1.5	5.4	2.3	2.1	6.9	-7.6	2.6
15	Fixed line telecommunications	-2.1	-2.4	-4.5	-5.6	12.9	-3.7	-0.4
	top 15 industries	7.5	8.8	3.2	8.6	4.5	2.4	-2.6
	Rest of 23	8.6	9.2	5.8	15.4	8.8	-6.4	-3.6
	All 38 industries	7.6	8.9	3.4	9.0	4.8	1.6	-2.7

Trends



Investments over first 1500 Companies based on EU

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Business Sectors EU/US/Japan

Absolute R&D Intensity

Rank	Sector	Overall sector R&D intensity, %	EU sector R&D intensity, %	US sector R&D intensity, %	Japan sector R&D intensity, %
1	Pharmaceuticals & biotechnology	15.1	14.7	15.3	16.3
2	Software & computer services	9.5	10.6	10.6	5.0
3	Technology hardware & equipment	7.9	14.2	8.2	6.1
4	Leisure goods	6.7	7.1	7.7	6.6
5	Health care equipment & services	5.9	3.6	7.3	6.6
6	Electronic & electrical equipment	5.1	4.9	5.0	5.9
7	Automobiles & parts	4.2	4.9	3.8	4.6
8	Aerospace & defence	4.1	6.0	3.1	6.6
9	Chemicals	3.1	3.0	2.9	4.0
10	Industrial engineering	3.1	3.5	3.0	3.0
11	General industrials	2.7	4.2	3.3	2.6
12	Banks	2.2	2.0		
13	Fixed line telecommunications	1.7	1.5	1.1	2.5
14	Food producers	1.6	2.0	1.3	1.8
15	Oil & gas producers	0.3	0.3	0.2	0.2
	Top 15 industries	3.9	3.6	4.9	4.5
	Rest of 23	1.1	0.8	2.1	1.2
	All 38 industries	3.2	2.6	4.5	3.8

Investments over first 1500 Companies based on EU

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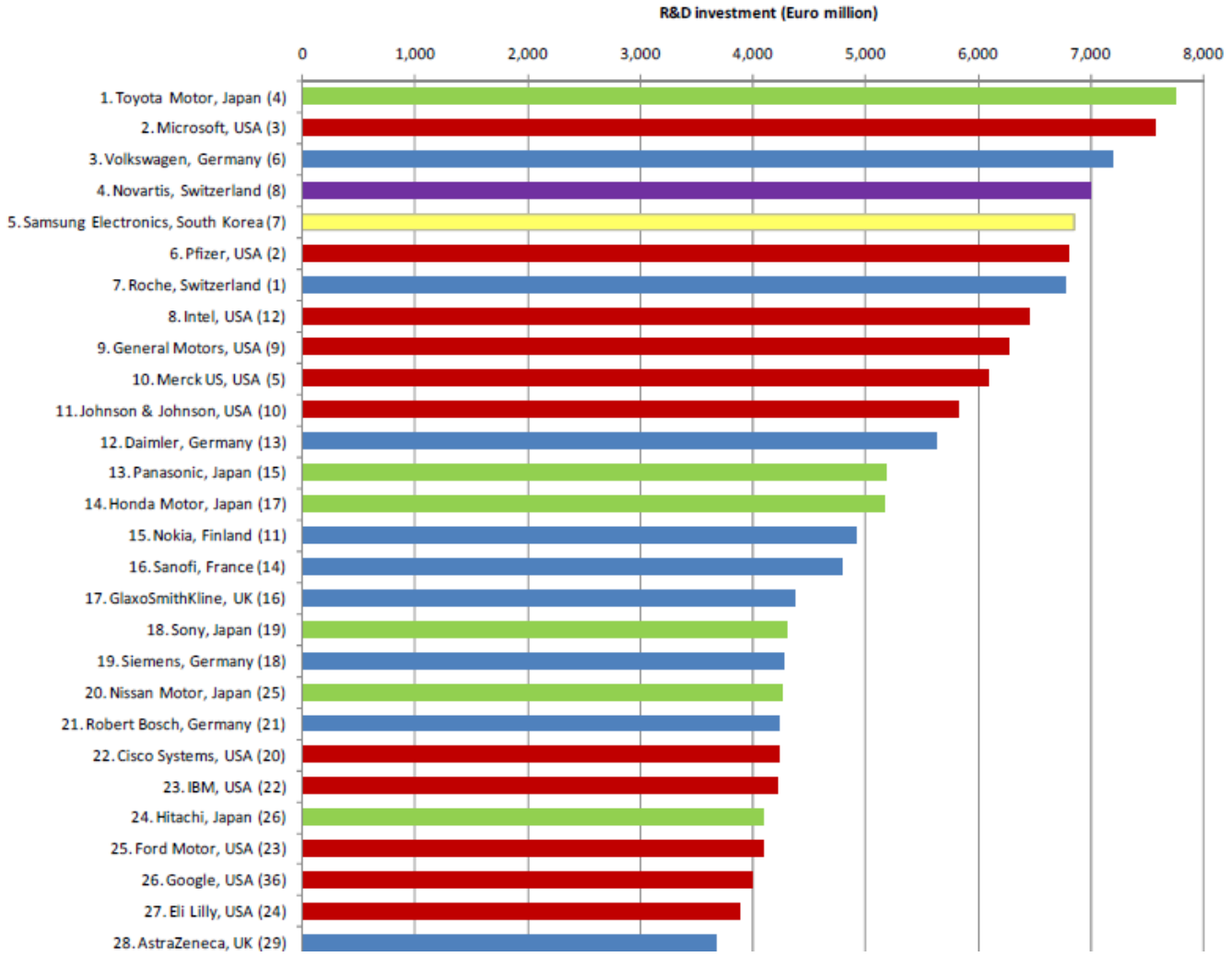
Top R&D Investing Companies



2012 EU Industrial R&D Report on Top 50 Companies

52 Fiat (Italy) 2175

54 Finmeccanica (Italy) 1960

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Top R&D Companies: Evolution

1	Toyota Motor	up 4
2	Microsoft	up 11
3	Volkswagen	up 5
4	Novartis	up 16
5	Samsung Electronics	up 28
6	Pfizer	down 4
7	Roche	up 11
8	Intel	up 6
9	General Motors	down 3
10	Merck US	up 19
11	Johnson & Johnson	up 1
12	Daimler	down 9
13	Panasonic	up 134
14	Honda Motor	up 2
15	Nokia	down 5
16	Sanofi	up 39
17	GlaxoSmithKline	down 6
18	Sony	down 3
19	Siemens	down 15
20	Nissan Motor	up 14
21	Robert Bosch	up 5
22	Cisco Systems	up 9
23	IBM	down 14
24	Hitachi	nil
25	Ford Motor	down 24
26	Google	up > 200
27	Eli Lilly	up 14
28	AstraZeneca	down 3
29	Ericsson	down 12

2011 Top Companies: Ranking and Rank Change from 2004-2011

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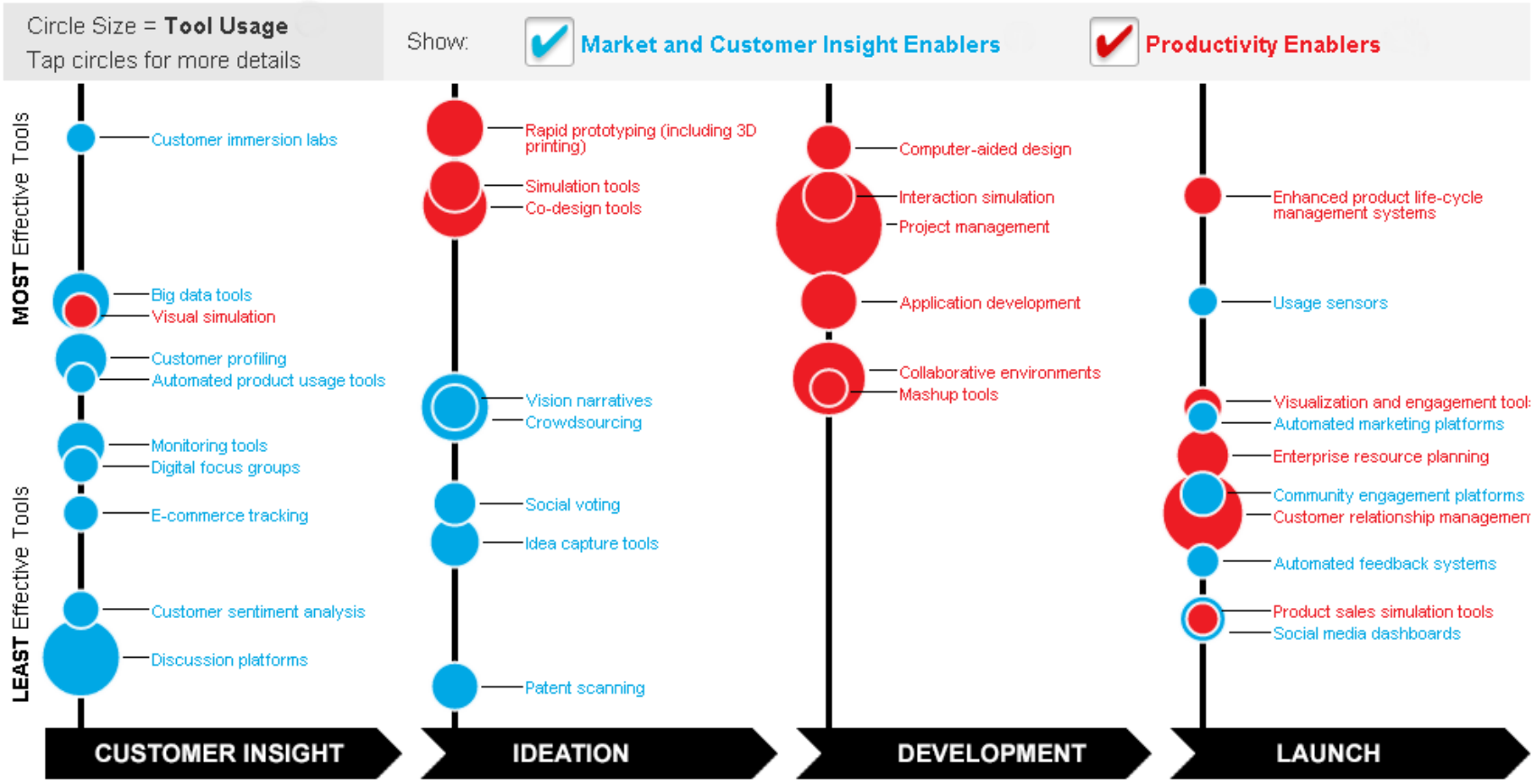
Digital Tool Landscape & R&D



Source: "The Global Innovation 1000: Navigating the Digital Future," by Barry Jaruzelski, John Loehr, and Richard Holman.

Strategy &, Formerly Booz & Company, PWC, 2013 Global Innovation 1000 Study

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Funds for Research Projects

In R&D there are interesting opportunities to obtain sponsorship by Governmental Funds therefore these funds provide partial coverage of costs:

Usually around 50% of Research Costs
Usually around 20-30% of Pre Competitive Developments

These opportunities implies usually IPR (Intellectual Proprietary Rights) for the Co-Sponsors that need to be evaluated

Call for Proposals need to be evaluated with Attention

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Solicited and Unsolicited Proposals

In order to get benefits from R&D Funds it is possible to set up proposals, these could be summarized in different main categories:

Solicited
Unsolicited

Fixed Deadlines
Open Calls

Usually there are R&D Programs addressing some specific areas for instance EU was active with FP7 and establish currently the new Program Horizon 2020 (2014-2020) 80 Billions Euro open to World Participants

24 billions for Science
18 billions for Industrial Leadership
31 billions for Shortfalls (i.e. Mobility, Environment, renewable energy, etc.)

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R&D Project Types

There are different project types possible to be defined:

- **Network of Excellence**
- **Exchange Programs**
- **Research Grants**
- **R&D Projects**
  - **Pilot Projects**
  - **Development Projects**
  - **Advanced Projects**

Pilot Project 6 Months 50-100 kUSD

R&D Project 1 year 0.5-1 MUSD

Full Project 1-2 year 1-5 MUSD

Example inspired to DoD

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R&D Timeline for most EU Projects

Call for Proposal, Bidder, R&D Program Activation

Application ⇒ 10-100 pages within 1-6 months

Evaluation ⇒ feedback within 6-12 months (5-20% success rate)

Final Negotiation ⇒ 1-3 months (possible budget reduction)

Execution ⇒ 12-36 months

Exploitation ⇒ 1-6 months

Usual for common EU Projects

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International Partnership

International Partnership is usually important in R&D proposal applying for International Agencies or Entities

The number of Countries is usually limited (i.e. maximum number of partners n), with constraints for not supporting national prevarication (i.e. largest country shares less than 50% of project)

Some countries are usually preferred to receive funds, so it could make sense to involve Entities in these countries and to establish there the majority of the efforts: i.e. Pilot Plant

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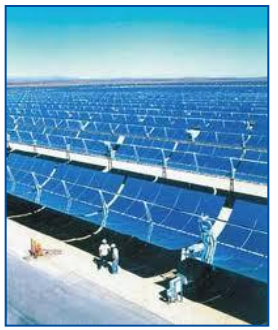
R&D Project Participants

In R&D Projects it is possible to have different Stakeholders

Partners funded directly by the Sponsors

Partners funded indirectly based on framework agreements with sponsors

Observers



All these subjects should have usually their Legal Representative signature on the Project or on Endorsement Letter.

Constraints could restrict funding respect partners status (i.e. percentage of their sale turnover)

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R&D Partnership

Strong Project Partnership is usually very important for the success of R&D proposals and R&D Projects.

Usually it is critical to involve:

- **Major Industries**
- **Small Medium Size Enterprises**
- **Academia and Research Centers**

Institution and Agencies could provide added value

This should include both:

- **R&D Developers**
- **User Industries or Institutions**

It is critical to identify the total number of participants considering that Increasing the Participants the Project Management is more complex

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R&D Funds for Projects

Funds could be provided based on different criteria:

Congruity Analysis of Proposed Costs

Actual Costs Controlled based on Cash Payments and Workload Records

Funds could be produced by sponsors as:

Refundable Contracts
Money Transfer
Tax Reduction Policies
Low/No Interest Financing
Barter and Benefits

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R&D Budget Items

R&D Costs and Budget Items usually could include:

- *Researcher Activities*
- *Major Equipment*
- *Equipment*
- *Networking*
- *Computational Efforts*
- *Consumables*
- *Consultancy (often limited to 10-20% of overall costs)*
- *Travelling and accommodation*
- *Exploitation*
- *Industrial Margin (rarely accepted)*
- *Overheads (often 20%-80% with analytical report or flat-rate)*

If the project is co-funded normally no profit is accepted

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R&D Not Allowed Budget Items

Depending of the Sponsor the following Items could be not eligible for refunds:

Profits

Commercial Costs

Promotional Activities

Subcontracting is usually limited and should be approved through an explicit acceptance by the sponsor

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Example of R&D: CAPRICORN

ID	Description	Start	End	Duration
WP000	**PROJECT MANAGEMENT**	0	28	28
WP010	Project Management	0	28	28
WP100	**SIMULATION AND CGF APPLICATION IN OPERATIONAL PLANNING TASKS**	0	12	12
WP110	Collection of Italian Requirements on Simulation and CGF for Operation Planning	0	6	6
WP120	Collection of French operational Requirements on Simulation and CGF for Operation Planning.	0	6	6
WP130	Collection on European Union Requirements: Joint Requirements for Simulation and CGF in Non-Article 5/San Petersburg Crisis Management Operations Planning Tasks (Peace keeping, Peace Enforcement, Peace Making)	4	12	8
WP140	Objective System Specification for CAPRICORN Project including metrics and performance to be realized and system requirements.	6	12	6
WP200	**CAPRICORN TECHNIQUES, MODELS AND ALGORITHMS**	4	22	18
WP210	Models & Techniques evolving from PIOVRA and HBM in a CIMIC and PSYOPS context	4	12	8
WP220	New Models and Techniques proposed for CAPRICORN	6	22	16
WP300	**CAPRICORN DEMONSTRATOR DEVELOPMENT**	6	26	20
WP310	CAPRICORN System Specification	6	19	13
WP320	CAPRICORN SubSystem Specification	12	19	7
WP330	CAPRICORN Architecture Specification	12	19	7
WP340	Definition of Metrics and Validation, Verification Plans	12	19	7
WP350	Capricorn Developments & User Manual	15	26	11
WP360	Validation, Verification Reports	15	26	11
WP400	**CAPRICORN EXPERIMENTATION AND ASSESSMENT**	0	28	28
WP410	Uses-Cases Definition	4	12	8
WP420	Experimentation Definition	0	24	24
WP430	Experimentation Execution	20	26	6
WP440	Results & Lesson Learned	23	28	5

CAPRICORN Project is devoted to develop Decision Support for Planning Civil Military Co-operations In South Asia: i.e. Construction of new Wells, Water Treatments, Roads, Buildings, Schools, Hospitals

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Deliverable List

Delverable	Description			
D_010_5	Project Quality Management Plan	WP010	3	DIPTEM
D_010_6	Intellectual Proprietary Right Planning	WP010	4	DIPTEM
D_010_1	Central & National Project Progress F	WP010	6	DIPTEM
D_110_1	Italian Requirements on Simulation a	WP110	6	MAST
D_120_1	French Requirements on Simulation a	WP120	6	LSIS
E_010_1	Workshop in Italy for Presentation	WP010	6	DIPTEM
E_010_2	Workshop in France for Presentation	WP010	12	LSIS
D_010_2	Central & National Project Progress F	WP010	12	DIPTEM
D_130_1	EU MS Requirements Joint Requirem	WP130	12	LSIS
D_140_1	Objective System Specification for C	WP140	12	DIPTEM
D_140_2	CAPRICORN Paper for Exploitation	WP140	12	LSIS
D_210_1	Review of Methodologies and technol	WP210	12	DIPTEM
D_210_2	State of the art for Human Behavior M	WP210	12	DIPTEM
D_410_1	Uses-Cases Definition	WP410	12	LSIS
D_310_1	CAPRICORN System Specification	WP310	19	LSIS
D_320_1	CAPRICORN SubSystem Specificati	WP320	19	MAST
D_330_1	CAPRICORN Architecture Specificati	WP330	19	LSIS
D_340_1	Definition of Metrics and Validation, V	WP340	19	LSIS
D_010_3	Central & National Project Progress F	WP010	22	DIPTEM
D_220_1	New Models and Techniques	WP220	22	LSIS
E_360_1	Integration Tests	WP360	24	LSIS
D_360_2	Reports about the Validation, Verifica	WP360	24	MAST
D_420_1	Experimentation Definition	WP420	24	MAST
E_350_1	Developments	WP350	24	MAST
D_350_2	User Manual	WP350	26	MAST
E_430_1	Experimentation Execution	WP430	26	MAST
D_360_3	CAPRICORN Brochure	WP360	26	MAST
E_430_2	CAPRICORN Execution on Site Italy	WP430	26	MAST
E_430_3	CAPRICORN Execution on Site Fran	WP430	26	LSIS
S_350_2	CAPRICORN Demonstrator	WP350	26	MAST
D_010_4	Central & National Project Progress F	WP010	28	DIPTEM
D_440_1	Results & Lesson Learned	WP440	28	DIPTEM
E_010_3	Workshop in Italy for Exploitation	WP010	28	DIPTEM
E_010_4	Workshop in France for Exploitation	WP010	28	LSIS
FR	Final Report	WP010	28	DIPTEM
ES	Executive Summary	WP010	28	DIPTEM

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Time Planning

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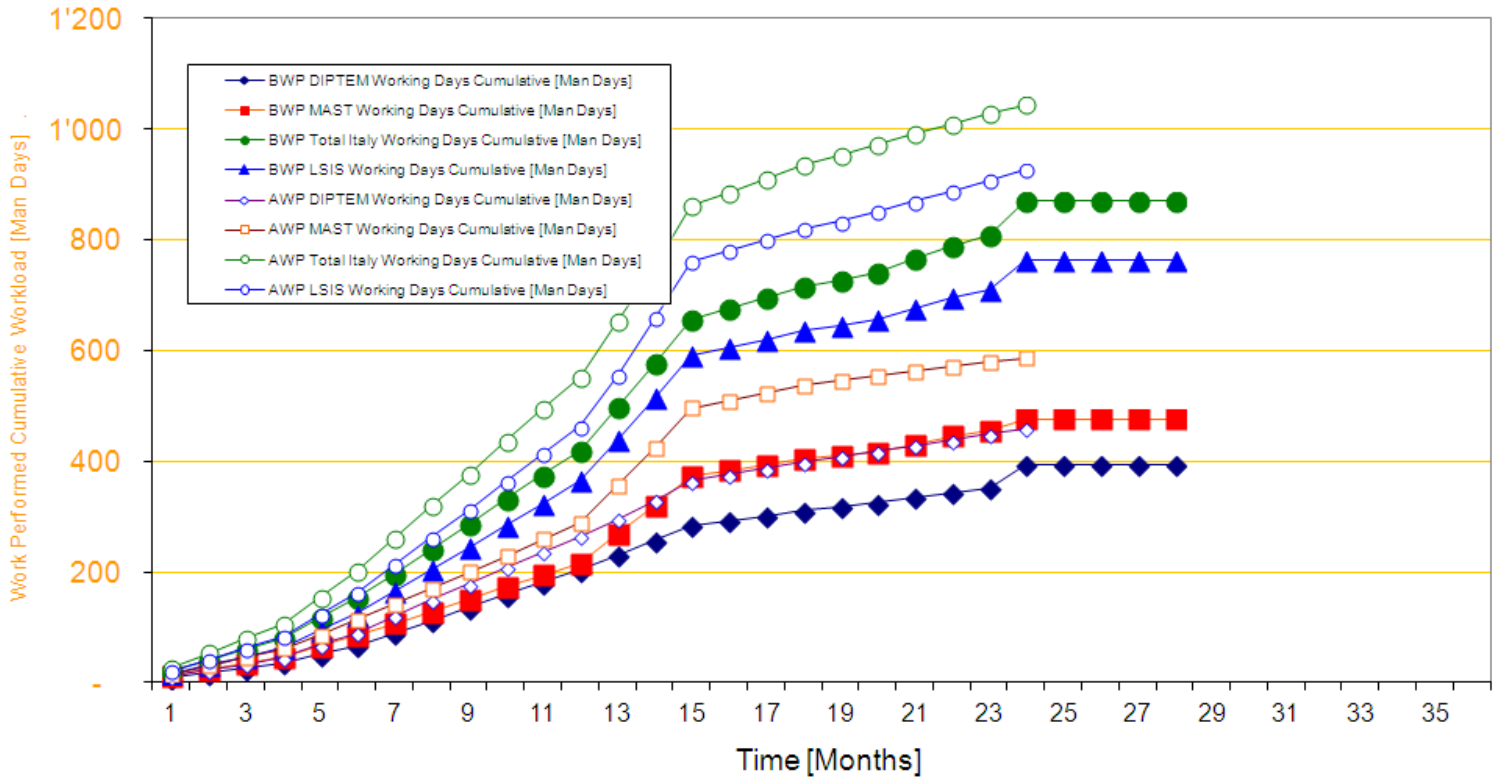
Efforts

Budget Work Performed (BWP)
Cumulative Workload



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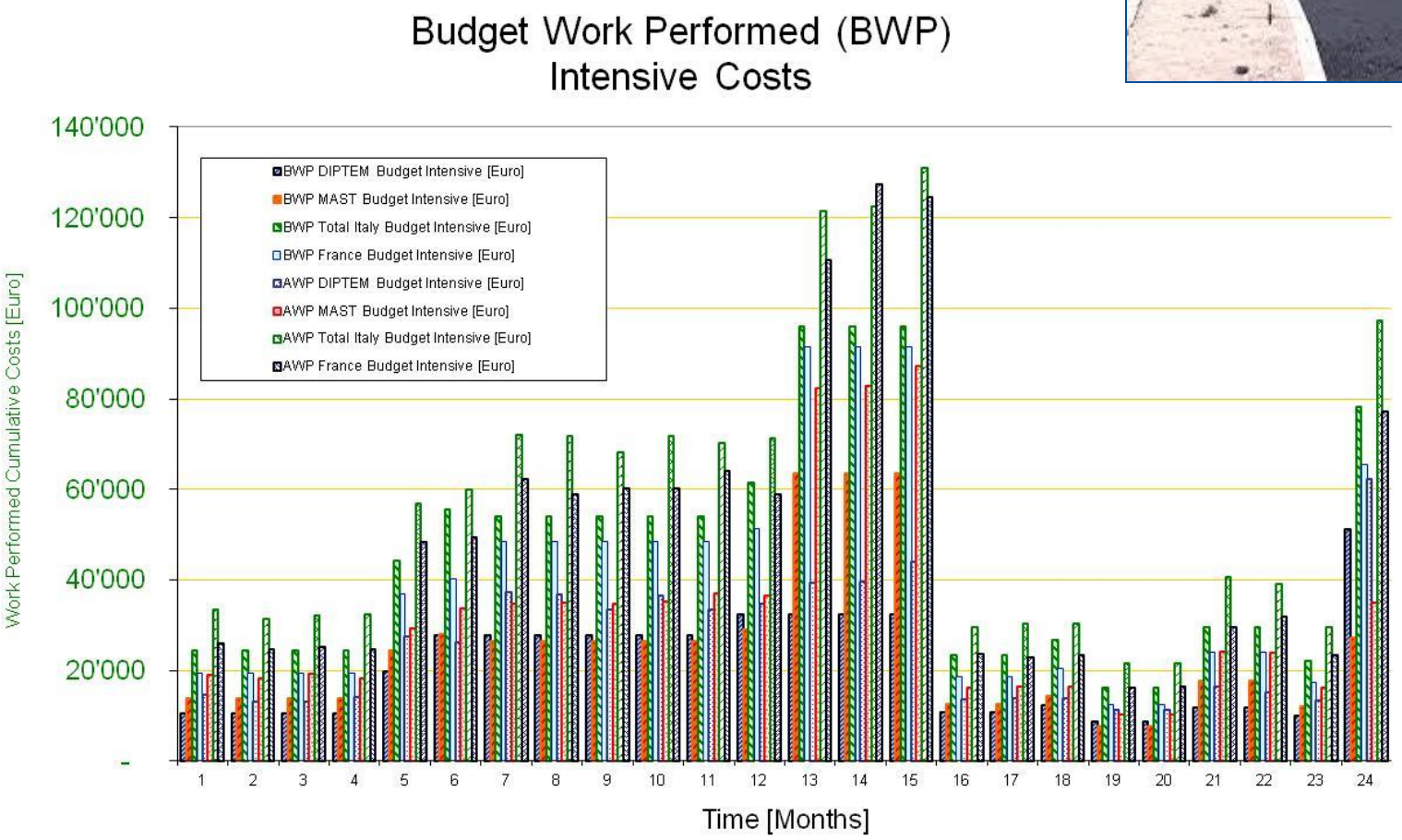
Budget Reporting



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Make Yourself the R&D Project: a Basic Experience

Finalizing the Subject of the R&D of Interest:

Project Description, R&D Results, R&D Activities

Identify the Funding Sources

Identify Countries & Partners

Finalizing the Budget and share among Partners

Establishing major Elements: WP, Deliverables, Schedule, RAM, IPR

Finalizing Details: Exploitation Plan, Exchanges, etc.

RAM: Responsibility Assignment Matrix

IPR Intellectual Propirtary Rights

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