

# SCIENTIFIC RESEARCH METHODOLOGIES AND TECHNIQUES

## Unit 3: LITERATURE REVIEW

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PDEEC - PhD Program on Electrical and Computer Engineering

## 1. PURPOSE





- Brings **clarity and focus** to your research problem
  - Helps you understanding the subject
  - Helps you to conceptualize your research problem
  - Helps identifying relationships with existing body of knowledge
- Improves your research **method**
  - How the others have approached the problem
  - Which methods others have used and which difficulties they faced
- Broadens your **knowledge base** in your research area
  - You need to know where we are and where the gaps are
- Helps identifying **trends**
  - It is convenient to know what are the hot research topics in the area
  - Also what are the assessment criteria in use
- **Contextualizes** your findings
  - How your results fit into the existing body of knowledge
  - How do your results differ from others

**For a while you'll be (very) confused !**



Diversity of opinions,  
agreements, disagreements,  
perspectives, partial relation  
to your work, diversity of  
terminology (specially in new  
areas), ...

**Build a conceptual  
framework**  
(on your mind first)



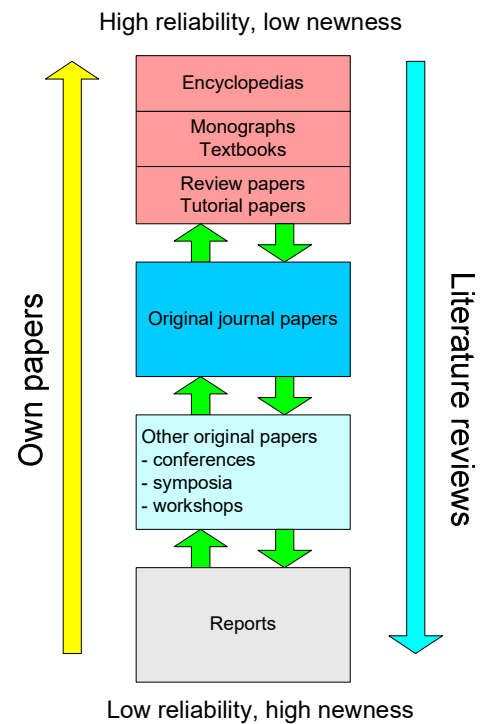
- Your work won't be accepted for publication without a proper study of and comparison with related work.
- Used ideas, results, ... from others must be **properly referenced**
  - Facilitate contextualization
  - Ethical issue – Plagiarism, reputation

## 2. SOURCES

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### Traditional sources

- Books
- Journal papers
- Conference papers
- Technical reports



[Mämmelä, 2006]

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- Most publishers are making their products accessible online (subject to subscription)
- Reference databases are also available online
- Some scientific associations give online access to their publications for subscribers / members
- There is a trend in Universities to **subscribe packages** guaranteeing access to contents from multiple publishers.

**Example:**  
In Portugal the **b-on** initiative offers a collective package of on-line subscriptions (table)

**... also the open access movement !**

Publisher	Nº of titles
Academic Search Complete	9791 total 5795 periodicals
American Chemical Society	34 periodicals
American Institute of Physics	12 periodicals
Annual Reviews	32 periodicals
Association for Computing Machinery	6 periodicals 10 magazines 28 transactions 256 proceedings 56 newsletters 24 affiliated pubs
Association for Computing Machinery	c. 1 million records
Business Source Complete	4056 total 3166 periodicals
Current Contents (ISI)	n.a.
Derwent Innovation Index (ISI)	n.a.
Elsevier	1961 periodicals
Essential Science Indicators (ISI)	n.a.
Eric	n.a.
IEEE	280 periodicals 10093 proceedings 1004 standards
Institute of Physics	36 periodicals
ISI Proceedings	n.a.
Journal Citation Reports	n.a.
Royal Society of Chemistry	34 periodicals
Sage	66 periodicals
Society for Industrial and Applied Mathematics	14 periodicals
Springer	1132 periodicals
Taylor & Francis	1221 periodicals
Web of Science	n.a.
Wiley	477 periodicals
Zentralblatt	n.a.

An example of technical publisher

Springer

- > Access to journals
- > Access to some proceedings (e.g. Proceedings from IFIP conferences)
- ... "Readers room"

The screenshot shows the SpringerLink interface. At the top, there's a search bar with 'LNL - Reitoria' entered. Below the search bar, there are navigation tabs for 'Journal', 'About', and 'Business and Economics'. The main content area displays the 'Journal of Intelligent Manufacturing' page, including a list of articles with titles like 'Production planning optimization for manufacturing and remanufacturing system in stochastic environment' and 'Designing an integrated driver assistance system using image sensors'. Each article entry includes the authors, the journal issue, and a 'Download PDF' button.

An example  
of technical  
society:

IEEE

The screenshot shows the IEEE Xplore search interface. At the top, it says 'Welcome UNIVERSIDADE NOVA DE LISBOA'. Below that, there are navigation links like 'Home', 'Login', 'Logout', etc. The main search area has options to 'Browse Journals & Magazines', 'BROWSE', 'SEARCH', 'IEEE XPLORE GUIDE', and 'SUPPORT'. There are radio buttons for 'All Titles', 'IEEE Titles', and 'IET Titles'. Two options are shown: 'OPTION 1: Browse by keyword' and 'OPTION 2: Browse alphabetically'. A list of journals is displayed, including 'Advanced Packaging, IEEE Transactions on', 'Aerospace and Electronic Systems Magazine, IEEE', etc. To the right, a PDF document is open, showing the title 'A Petri Net-Based Heuristic Algorithm for Realizability of Target Refining Schedule for Oil Refinery' by Nianqi Wu, Meng-Chu Zhou, Feng-Chu, and Feng-Chu. The document includes an abstract, a list of symbols, and a note to practitioners.

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Access to papers  
available via the  
web

<http://scholar.google.com/>

The screenshot shows Google Scholar search results for 'collaborative networks'. The search bar at the top contains 'collaborative networks' and a search icon. Below the search bar, it says 'Articles About 3,310,000 results (0.07 sec)'. There are several search filters on the left: 'Any time' (Since 2021, Since 2020, Since 2017, Custom range...), 'Sort by relevance', 'Sort by date', 'Include patents', 'Include citations', and 'Create alert'. The search results list several articles, including 'Collaborative networks' by LM Camarinha-Matos, H Afsarmanesh, 'Collaborative networks: Reference modeling' by LM Camarinha-Matos, H Afsarmanesh, 'Creating and managing value in collaborative networks' by US Bittici, V Martinez, P Albores, and 'Collaborative networks: a new scientific discipline' by LM Camarinha-Matos, H Afsarmanesh. Each result includes a brief description, citation count, and a link to the full text or PDF. At the bottom, there are 'Related searches' like 'collaborative networks innovation', 'collaborative networks inside', etc., and a 'book' result 'A manager's guide to choosing and using collaborative networks' by HB Milward, KG Provan.

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● Many authors make their papers available through their web sites (found by Scholar Google)

● As having publications on-line increases the chance of being cited, many universities are promoting mechanisms to have the publications of their members online

... But there is the problem of Copyright ! (if not “open access”)

... Some tricks to solve the problem.

● Other specialized sources:  
Patents  
Standards

**NEW:**  
The European Commission, in its research programs, requires that publications generated as a result of funded projects shall be given open access!

Researchgate.net

The screenshot shows the ResearchGate profile of Luis Camarinha-Matos. The profile includes a header with navigation tabs (Overview, Research, Experience, Stats, Scores, Following, Saved List) and a blue 'Add new research' button. The 'About me' section contains an introduction with a YouTube link, languages (Portuguese, English, Spanish), and disciplines (Artificial Intelligence, Computer and Society, Electrical Engineering, Industrial Engineering, Information Systems, Business Informatics, Information Systems). The 'Skills and expertise' section lists 31 skills including Sustainability, Cloud Computing, Robotics, Production Planning, Artificial Intelligence, Electrical Engineering, Virtualization, IT Infrastructure, Industrial Engineering, and Manufacturing. The 'Stats overview' section shows 5,836 Total Research Interest, 8,901 Citations, 115 Recommendations, and 118,585 Reads. The 'Current affiliation' is Universidade NOVA de Lisboa, Faculty of Sciences and Technology, Full Professor. The 'Lab' section shows 'Luis Camarinha-Matos's Lab' with 9 members. The 'Network' section shows 68 following.

Academia.edu

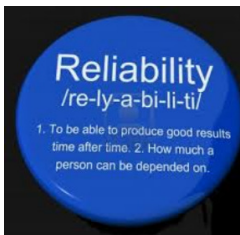
The screenshot shows the Academia.edu profile of Luis M Camarinha-Matos. The profile includes a header with navigation tabs (ANALYTICS, GRANTS, READERS, MENTIONS, PREMIUM, ADD NEW) and a blue 'Add new' button. The 'About me' section contains a biography, location (Lisbon, Portugal), department (Faculty of Sciences and Technology), and position (Full Professor). The 'PAPERS' section lists two papers: 'Analysis of Manufacturing Platforms in the Context of Zero-Defect Process Establishment' and 'A Balanced Sociotechnical Framework for Collaborative Networks 4.0'. The first paper has 763 followers, 53 following, 46 co-authors, and 28,912 total views. The second paper is by Paula Urze and Luis M Camarinha-Matos. The 'Stats overview' section shows 317 papers, 2 conference presentations, 1 book, and 2 conference papers.



When making a literature survey ...

... pay special attention to the **reliability of the sources**

- Is it coming from a prestigious journal?
- Was it presented in a serious peer-reviewed conference?
- Are there other related references?
  - Is it from a recognized group?
- Use Wikipedia with caution
  - ... A good starting point to get a general idea
  - ... But then seek more reliable and identified sources

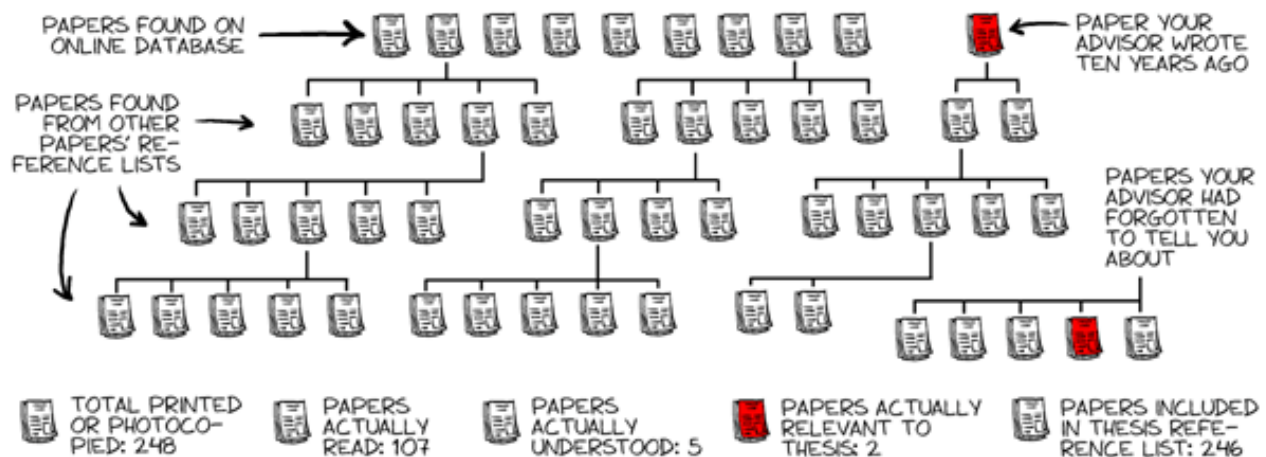


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## REFERENCES

MAKING SURE NO ONE HAS ALREADY WRITTEN YOUR THESIS

phd.stanford.edu  
JORGE CHAM © STANFORD DAILY



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**You cannot guarantee that you checked ALL relevant papers ...**

**But it is very bad if you miss some major reference !**

**What to do (besides making exhaustive search):**

- ◆ **Get some (initial) help from your supervisor (but remember, it is your responsibility !)**
- ◆ **Identify most relevant sources (journals, conferences) in your area and check them more carefully**
- ◆ **“Follow the references”  
... i.e., Follow common references indicated by several of the papers you checked**

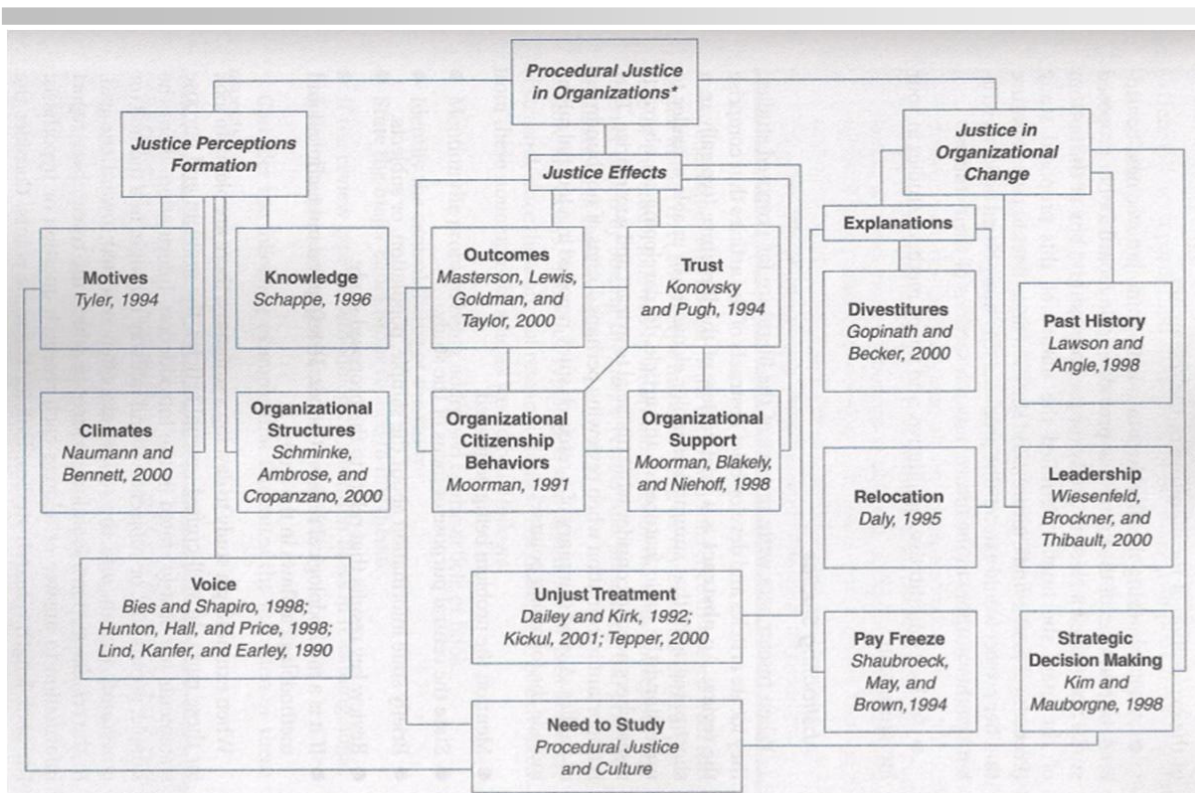
## 3. SYNTHESIS AND CRITICAL SPIRIT



1. Identify a set of **keywords** (try also synonyms) to search via Google or specialized database.
2. If you are not yet very familiar with the subject, try to identify **first surveys / overviews** (or even books) that give a general overview of the topic. Then turn to journal articles and then to conference papers.
3. Try to select a set of 40 – 50 articles in order to help you get a **first view** of the topic.
4. Do a **“fast reading”** (without spending time with details) of these articles, just trying to filter what seems useful for your work or to give you a first global **“picture”**.
5. Based on the useful literature, start elaborating a **literature map**, which gives you a visual picture of groupings of literature per sub-topic.

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## Example of literature map



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Janovec, 2001]

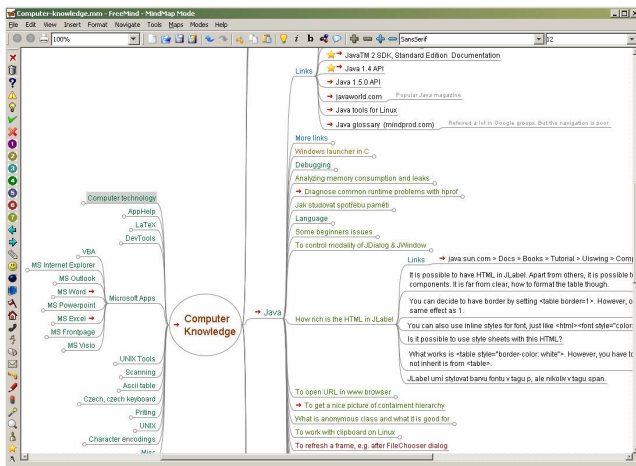
6. While organizing the **map**, prepare **short summaries** of the key ideas conveyed by each relevante article.
  - ... Use Post-It
  - ... Or Add annotations on the margins of the paper
  - ... Or use some electronic means (in this case you can also start to organize a references database, e.g. Using Endnote).
7. Use the most relevant articles to find other relevant literature (**following the references** included in those articles). Try to identify relevant groups of researchers / authors (“**schools** of thought”).
8. **Digest** all collected ideas, concepts, findings (read the most relevant articles again, **now in detail**); try to organize and **criticize** them. For specific topics consult research reports, PhD thesis, etc.
9. Try to **relate your work** to the existing literature.
10. Plan a structure for the literature review **synthesis**; think of original ways of summarizing the ideas (what can be your **added-value**).

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Perhaps one possibility to build literature maps ...

Examples:

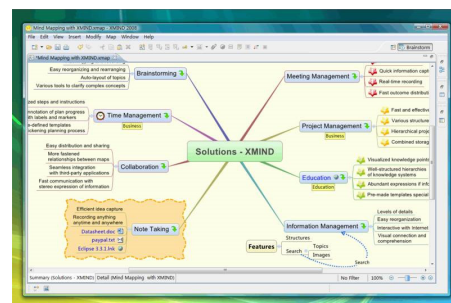
**Freemind**



[http://freemind.sourceforge.net/wiki/index.php/Main\\_Page](http://freemind.sourceforge.net/wiki/index.php/Main_Page)

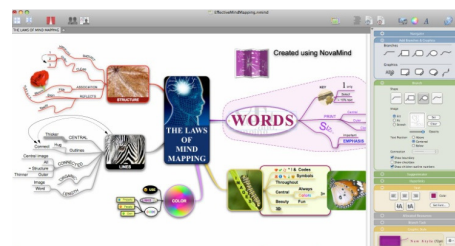
**XMind**

[www.xmind.net/](http://www.xmind.net/)



**NovaMind**

[www.novamind.com/](http://www.novamind.com/)

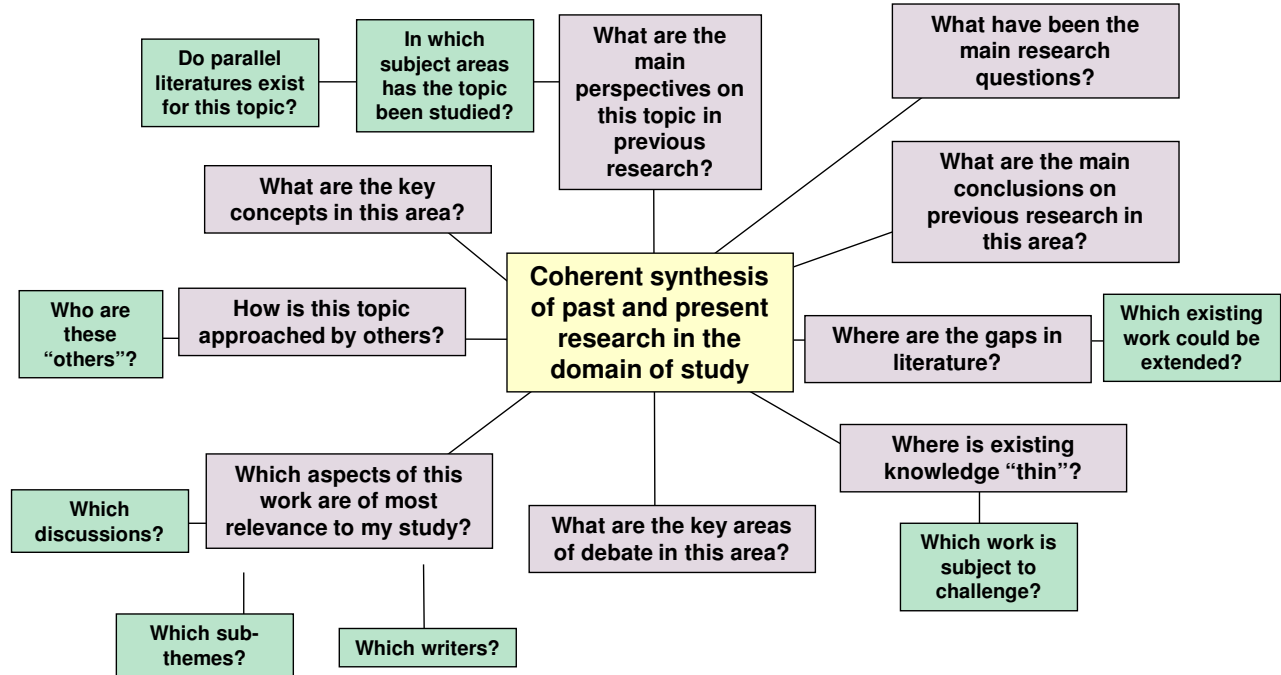


More:

[http://en.wikipedia.org/wiki/List\\_of\\_Mind\\_Mapping\\_software](http://en.wikipedia.org/wiki/List_of_Mind_Mapping_software)

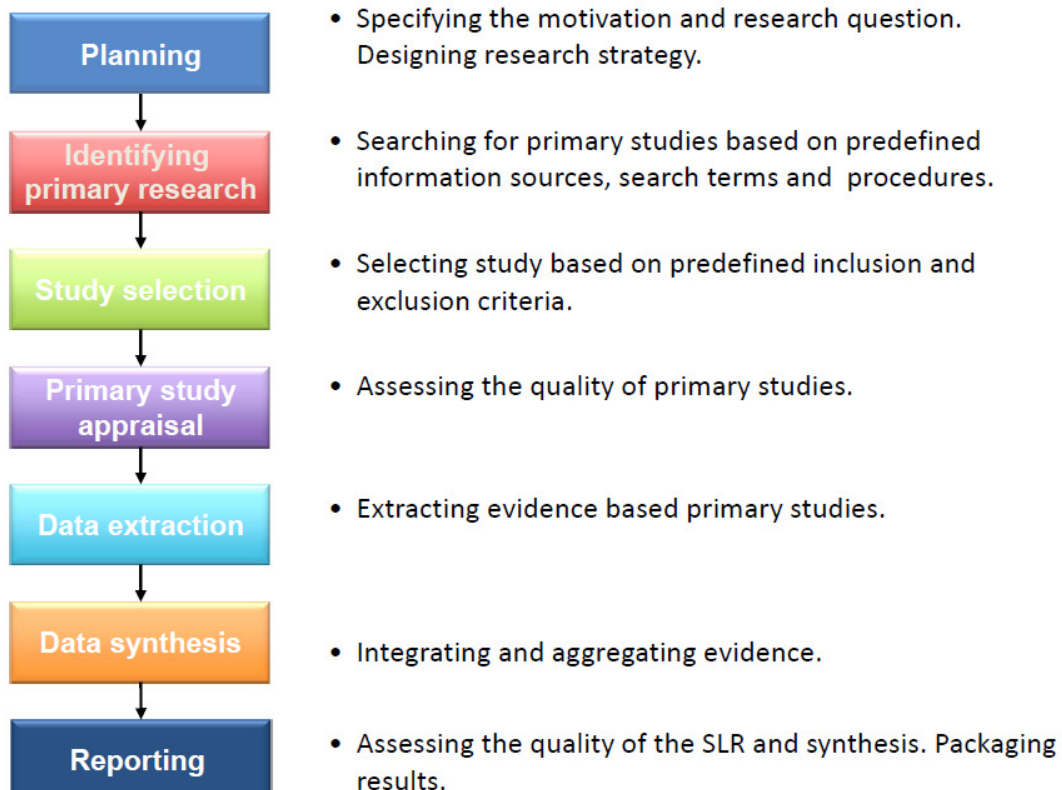
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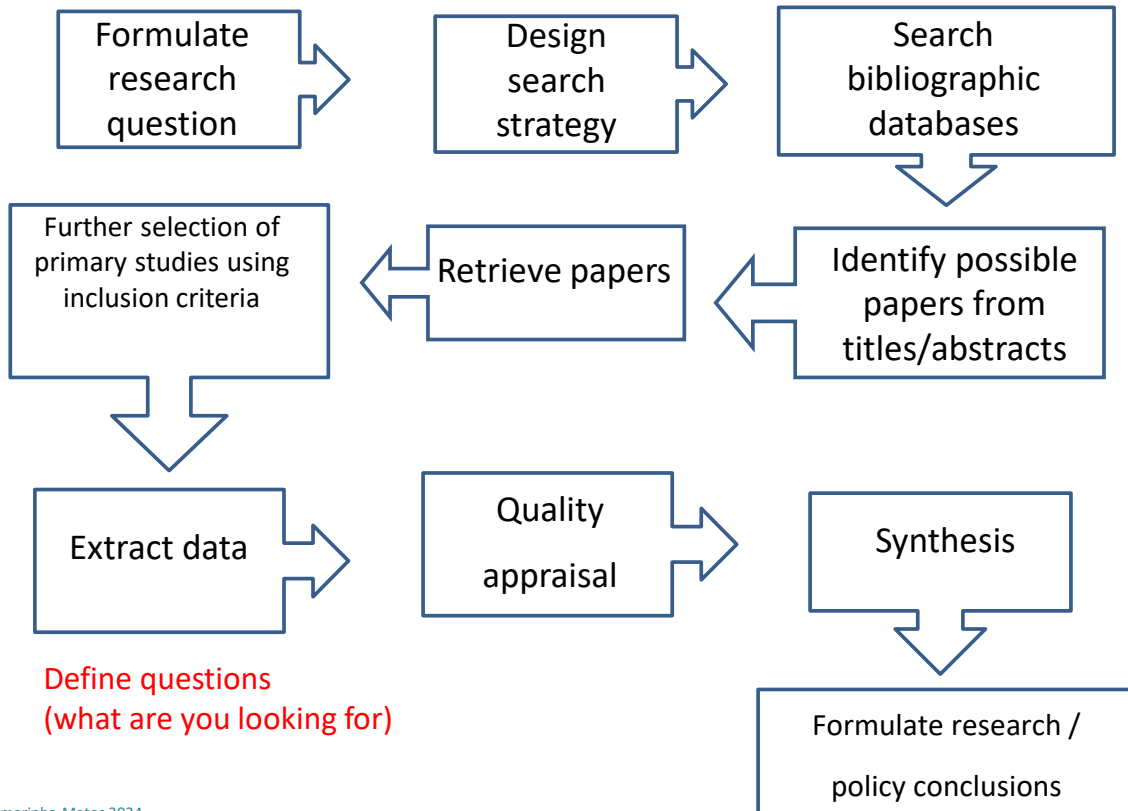
[Hall, 2009], Napier University

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## Which time interval ?

Recent ones (e.g. 5, 10 years)?

Risk of missing some key reference works?

**Towards the end of your dissertation [or paper] you will refer back to literature review**

- Do your findings **confirm** those of others?
- Does your work **extend** that of others?
- Does your work **provide new meaning** to the work of others?
- Does your work **break new ground**?
- Does your work raise **issues about the methodological choices** made in previous studies?
- Does your work **challenge existing ideas** on your subject?

[Hall, 2009], Napier University

“ The capacity for a **systematic understanding** of his / her specialization area”

“Capacity to **analyze with a critical spirit**, to **evaluate**, and to **synthesize** new and complex ideas in a context of fast technological and socio-organizational change”

[Portuguese Law]

**The literature review is one place to show these skills.**

- ✿ **Definitely not** the result of “copy & paste” !
  - Plagiarism
  - Even if properly referenced, what is the relevance?
  - Copying sentences and making small changes is not acceptable
- ✿ **Not** a simple (weakly linked) concatenation of excerpts from others !!!
  - “Author X said bla bla.... On the other hand, Y defends that bla bla ... Furthermore Z introduced bla bla .... and W agrees with ....”
- ✿ **Not** a pedagogic text book !
  - Who is your reader?
  - What is his / her background?
  - What does he / she expect?

**What is the relationship to your work?**  
**What is your added value?**

### It shall:

- **Integrate** a set of ideas that were previously dispersed and turn them into a coherent framework
- **Clarify concepts** that were only partially present in other works
- Introduce a new / original (**fresh**) **look** into the subject
- Show a **critical** perspective and some “personal touch” (how you see the current state of the art)
- Identify **gaps** / unsolved issues
- Be **synthetic** !
  - Use synthetic representations – graphics, diagrams, tables, etc
  - Focus on the essential (namely what is relevant for your work)
  - But at the same time try to give a broad perspective in order to properly “locate” your work



**LITERATURE REVIEW**

found in different organizations (ISO-9001 1993). ISO 9000, SW-CMM and CMMI (staged representation) models claim to be flexible and tailorable to the goals of each organization. However, there is no support for tailoring, thus the three improvement efforts cannot be considered **adaptive**. Another problem is that there is no guidance for how much tailoring is acceptable within the limits of the model. Nevertheless, CMMI continuous model is more flexible since process improvement is performed for each process area following the approach proposed by ISO/IEC 15504.

The ISO/IEC 15504 includes two dimensions (processes and capability) which aren't coupled and provide greater flexibility than the CMMI staged representation, because any processes can be managed at any capability level. This standard is tailorable for different software life cycle models, and it is the organization's responsibility to map the activities and tasks of the standard into the chosen model. Several experiences, such as the experiences reported by Cass et al. (Cass et al. 2002), served as examples of the adaptation of the standard for particular industrial sectors and its extension into new domains.

The main problem detected in other SPI models is that they mandate rules that might reduce flexibility and adaptation to organization needs and goals. BOOTSTRAP major challenge was therefore the integration of appropriate mechanisms for tailoring the model to the actual needs of an organization (Stienen et al. 1997). Nowadays, the model is flexible enough to account for various application areas, different organization cultures and sizes across countries. BOOTSTRAP provides guidelines to identify which process highly affect organizations goals, but does not provide any suggestion on how to prioritise process improvement. Defining priorities is up to each organization.

The SPIQ improvement model has been applied to a number of very different projects with respect to technology, people, products and processes. This shows that the model is applicable in various environments. Second, the fact that the model has been applied for 10 years shows that it is adaptable over time. As the goals of the organization change, so the improvement model does. The SPIQ model evolves according to goals based on the context. Here, adaptivity refers to evolution as well as suitability in different contexts.

ISO 9000, SW-CMM, ISO/IEC 15504, BOOTSTRAP and CMMI appraisal methods are mainly intended for people who have been trusted with the management of a large process initiative. They are important for staging and managing a successful program and represent a step towards an institutionalised Software Process Engineering system. The methods have certain strengths and weaknesses when compared to each other's. For the IDEAL, the main strength comes from the fact that it has been derived from actual industry cases, rather than being a theoretical (untested) model. It has also been applied successfully later on, as will be apparent from the industry case reports. The model lacks insights to specific multi-site SPI program issues - e.g. activity synchronisation problems

[Martins, 2008]

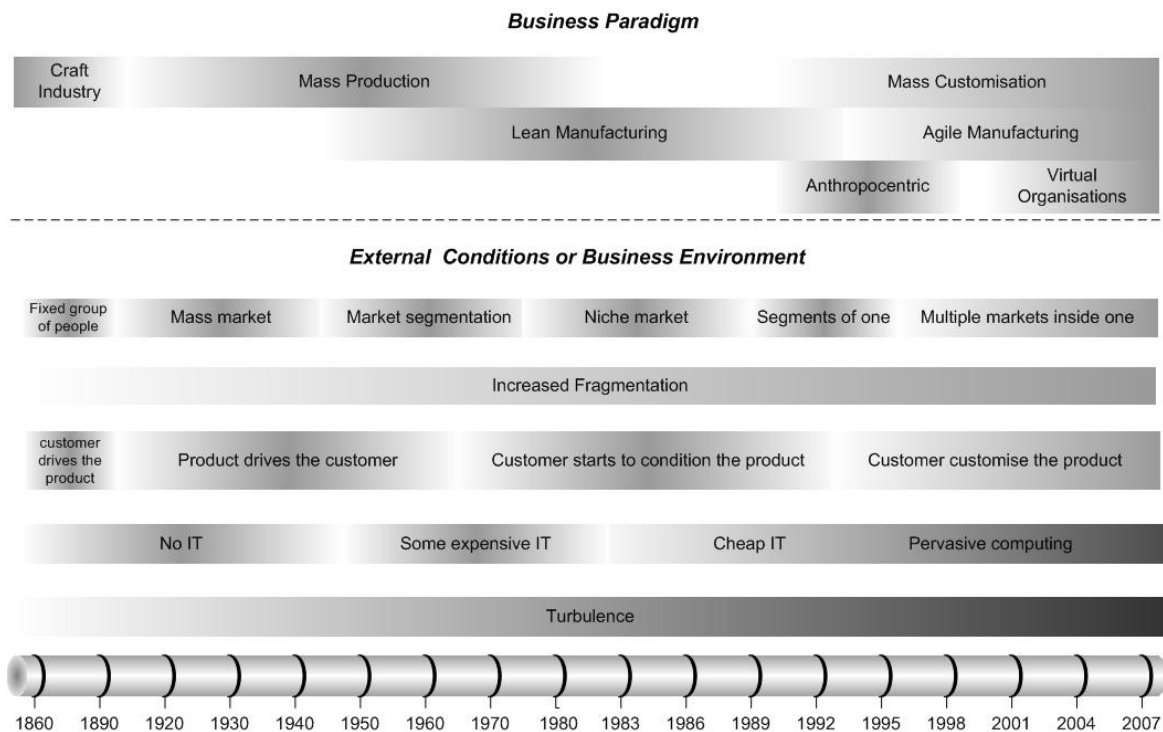
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## Using critical spirit ... Discussing ... Giving opinion ...

The SPIQ improvement model has been applied to a number of very different projects with respect to technology, people, products and processes. **This shows that** the model is applicable in various environments. Second, the fact that the model has been applied for 10 years **shows that** it is adaptable over time.

**The methods have certain strengths and weaknesses** when compared to each other's. For the IDEAL, **the main strength comes from** the fact that it has been derived from actual industry cases, ...

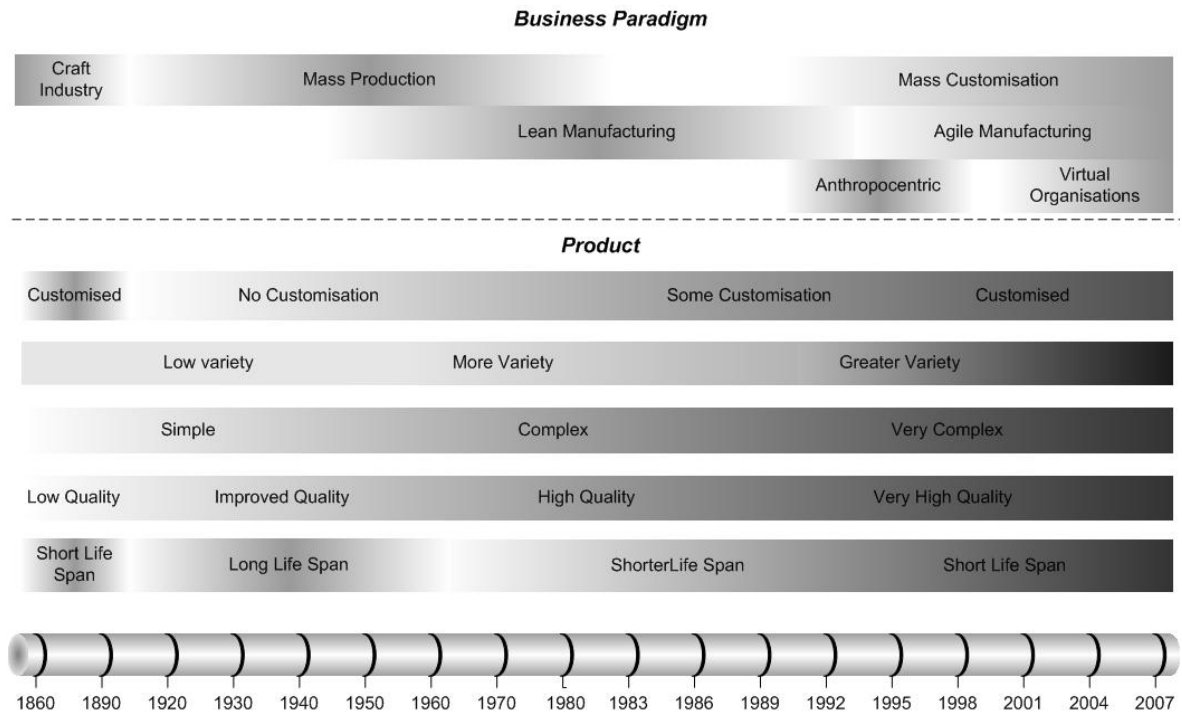
## [Manufacturing trends - business environment]



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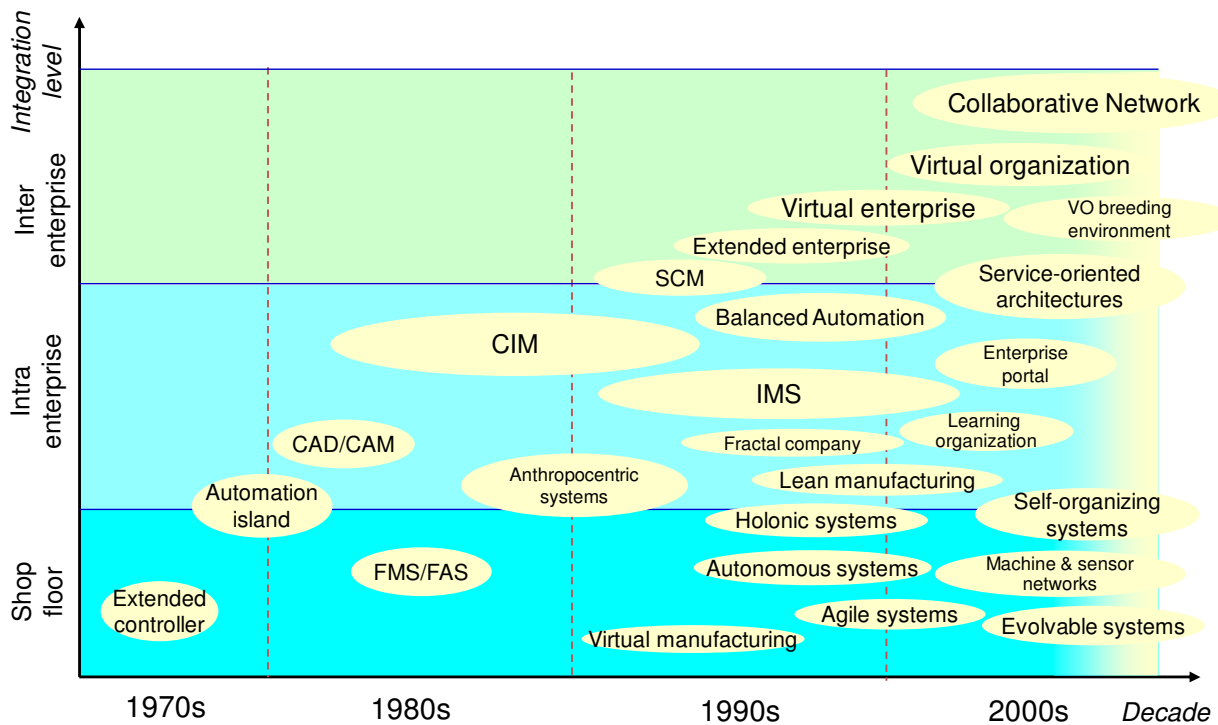
[Barata, 2003]

**[Manufacturing trends – product conditions]**



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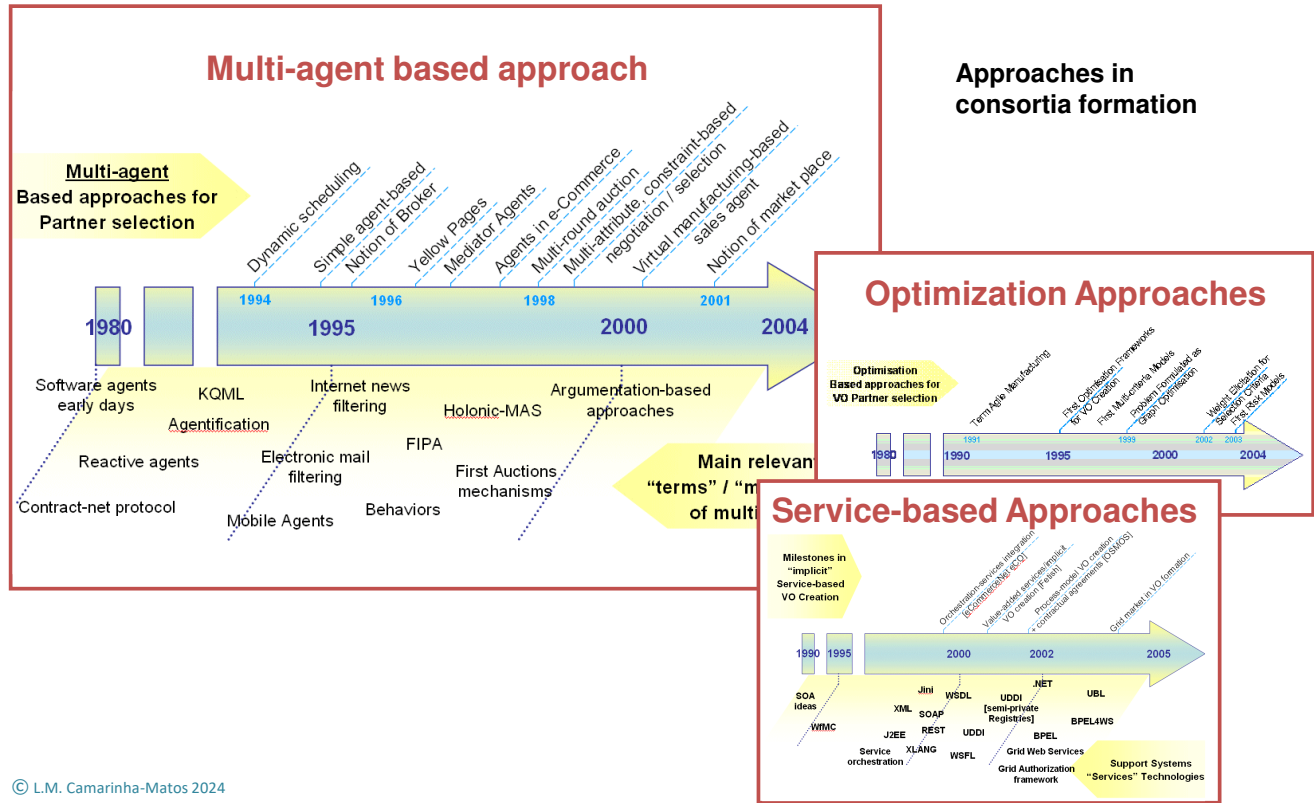
[Barata, 2003]



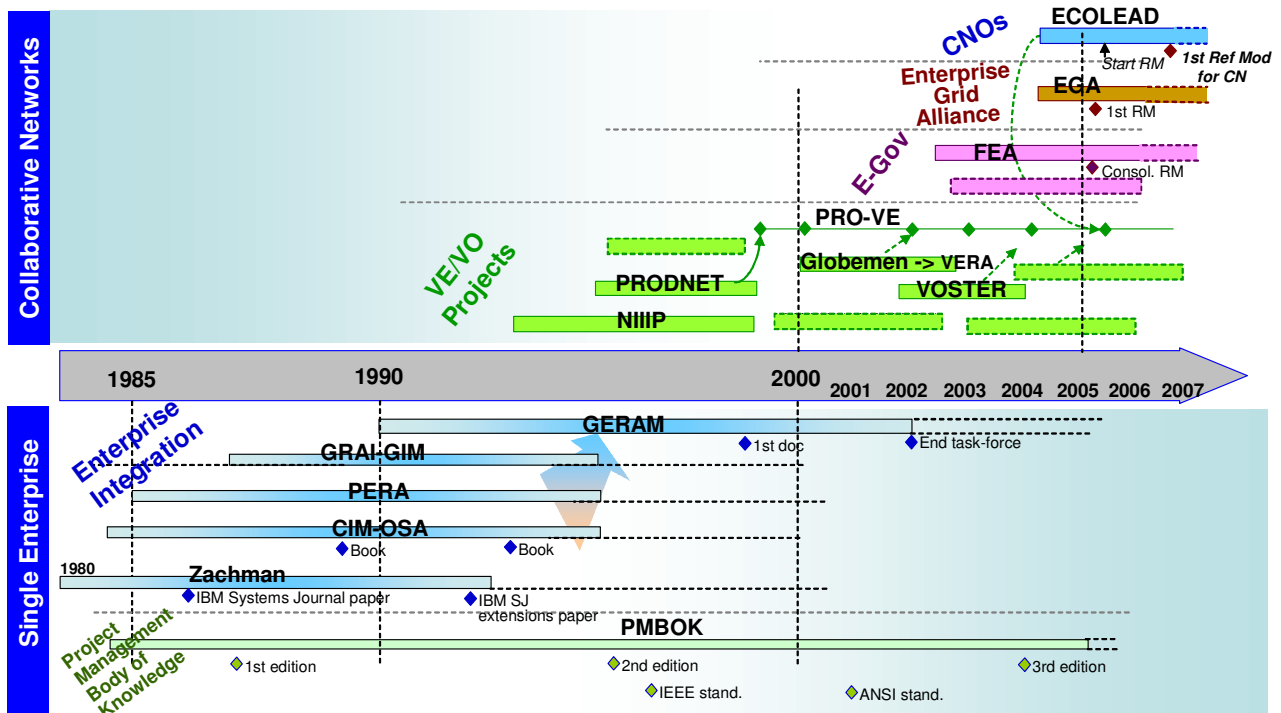
**A brief historic evolution in manufacturing systems**

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[Camarinha-Matos, 2008]



Efforts in reference modelling



Tables summarizing the main ideas / trends.

These tables can include references →  
or be accompanied by a short text where the references appear. ↓

Focus area: ICT Infrastructures		
Current issues and results	Example projects	Further challenges
Service Oriented Architecture (SOA) orientation established as the main approach for integration of distributed services	ECOLEAD ITSIBus ATHENA INPREX	<ul style="list-style-type: none"> <li>In spite of the growing importance of SOA approaches, there is a need for better standardization and design methodologies. Other aspects include: Services' semantic annotation (focused on collaboration), dynamic ("on the fly") service combination, intelligent planning, search, and integration of services, soft matching methods, etc.</li> <li>Sustainable business models for the infrastructures (one of the main current obstacles for the development of the area).</li> <li>Absorption of emerging computing paradigms.</li> <li>Grid computing has been trying to be a kind of "bandwagon" that collects / integrates ideas from other areas but still offers a limited conceptualization of VO and corresponding business model. Nevertheless it includes some potentially useful mechanisms for resource management and a collaboration between the two communities could be useful.</li> <li>As the area of mobile computing, WiMax, new mobile devices and infrastructures is developing, it is necessary to identify / create new opportunities for new pervasive collaborative environments.</li> <li>RFID (radio frequency identification) may enable better real-time management in production and logistic networks for which a holistic approach is needed.</li> <li>The Multi-Agent Systems area continues to be promising from a conceptual perspective but there is a need for more robustness in development environments for widely distributed systems.</li> </ul>
Security infrastructures including: <ul style="list-style-type: none"> <li>- Basic security mechanisms</li> <li>- Authentication mechanisms</li> <li>- Responsibility policies</li> </ul>	ECOLEAD TRUSTCOM DyVOSE	
Distributed workflow / business process modeling and execution engines	WIDE CrossFlow	
Distributed information exchange and sharing mechanisms: <ul style="list-style-type: none"> <li>- Federated systems</li> <li>- Standards for information exchange</li> <li>- Web-based document management systems</li> </ul>	PRODNET II MASSIVE	
Interoperability principles and approaches for integration of legacy systems	ATHENA ITSIBus INTEROP ECOLEAD ECOLEAD	
Base collaboration services: <ul style="list-style-type: none"> <li>- CSCW</li> <li>- Document management</li> <li>- Forum, chat, billing, etc.</li> </ul>		
Agent-based approaches: <ul style="list-style-type: none"> <li>- Agent-based enterprise modeling</li> <li>- Agent-based infrastructures</li> <li>- Agent-based simulation</li> <li>- Mobile agent infrastructures</li> </ul>	TeleCARE, SteelNet Global Automation Platform	

[Camarinha-Matos, 2007]

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However other characteristics have been highlighted on different studies and are summarised next (Table 2.1).

Characteristics	Description	References
Coordination	<p>How business processes are synchronized and managed to achieve the business goals.</p> <p>In terms of network coordination various models can be found:</p> <ol style="list-style-type: none"> <li>1) Star-like structure - a dominant company "surrounded" by a relatively fixed network of suppliers.</li> <li>2) Democratic alliance - a different organization could be found in some supply chains without a dominant company in which all nodes cooperate on an equal basis, keeping their autonomy, but joining their core competencies.</li> <li>3) Federation - once a successful alliance is formed, companies may realize the mutual benefits of having some common management of resources and skills and they may tend to create a kind of common coordination structure.</li> </ol>	(Camarinha et al., 1997), (Boudreau et al., 1998)
Duration	There are alliances made for a single business opportunity and which are dissolved at the end of such process, and long term alliances that last for an indefinite number of business processes or for a unspecified time span.	(Camarinha et al., 1997)
Flexibility	Resources can be easily reassigned to respond to shifting opportunities in global markets.	(Boudreau et al., 1998), (Martinez et al., 2001)
Heterogeneity	Components with different profiles in regard to their strengths and competencies.	(Wigand et al., 1997)
Modularity	Relatively small but manageable units with decentralised decision-making competencies and responsibilities.	(Wigand et al., 1997)
Purpose	<p>The objective of creating or joining a virtual organization.</p> <p>For instance, is it to extend its boundaries and still keeping control over its vital suppliers (for instance, in terms of quality control) or is it to complement its core competencies in order to be able to share some market opportunities? Instead of just bidding for a single opportunity in the market, is it to be involved in a consistent supply chain, from the raw materials to the end customers? Is it to increase the geographical presence or to improve the quality and responsiveness to the market opportunities?</p>	(Camarinha et al., 1997)

[Nunes, 2005]

## Where to include it? – case of papers

Case 1:

Paper Title Authors Affiliation
Abstract
<ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. <b>Literature review</b></li> <li>3. Contribution A</li> <li>4. Contribution B</li> <li>5. ...</li> <li>6. Conclusions</li> <li>7. References</li> </ol>

This approach is used in those works that employ a strong theory / literature background on which the work is rooted on

Case 2:

Paper Title Authors Affiliation
Abstract
<ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Contribution A</li> <li>3. Contribution B</li> <li>4. ...</li> <li>5. <b>Related work</b></li> <li>6. Conclusions</li> <li>7. References</li> </ol>

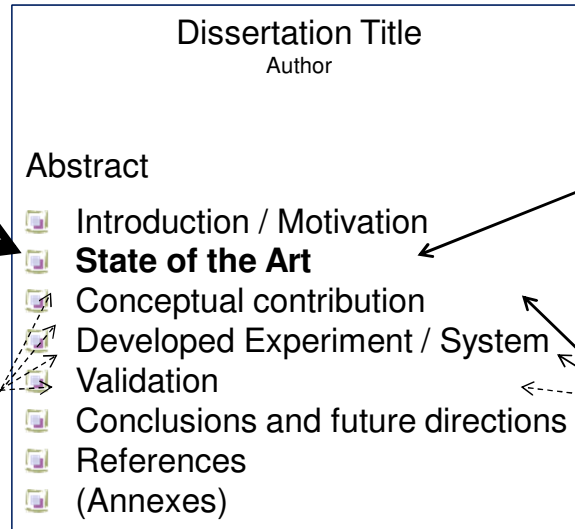
This approach is used when the idea is to provide a basis for comparing and contrasting findings of the work



**Case 1**  
(The most common)

A strong literature review / state of the art section after the introduction (1 or more chapters)

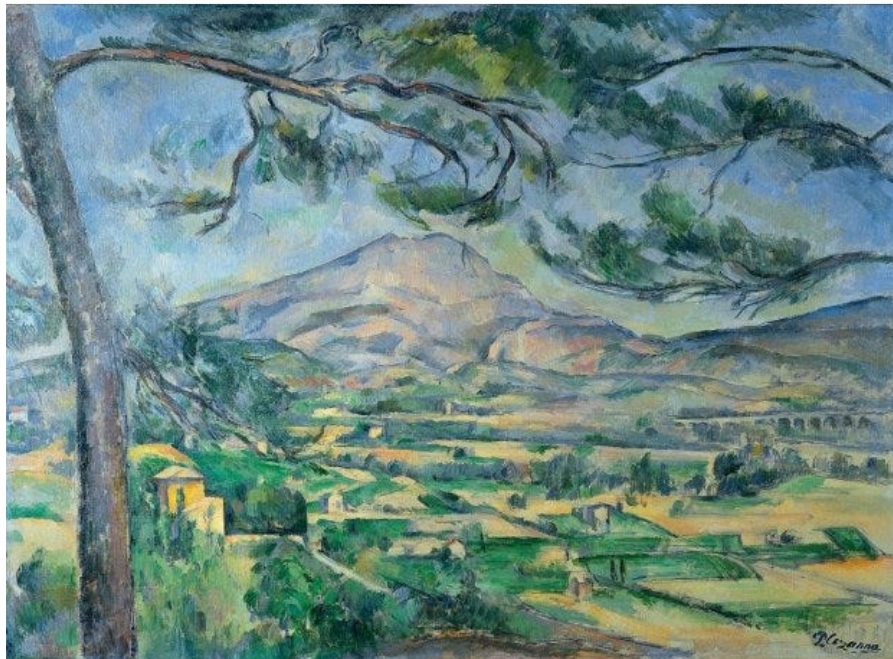
Sporadic references can also be made along the text.



**Case 2**

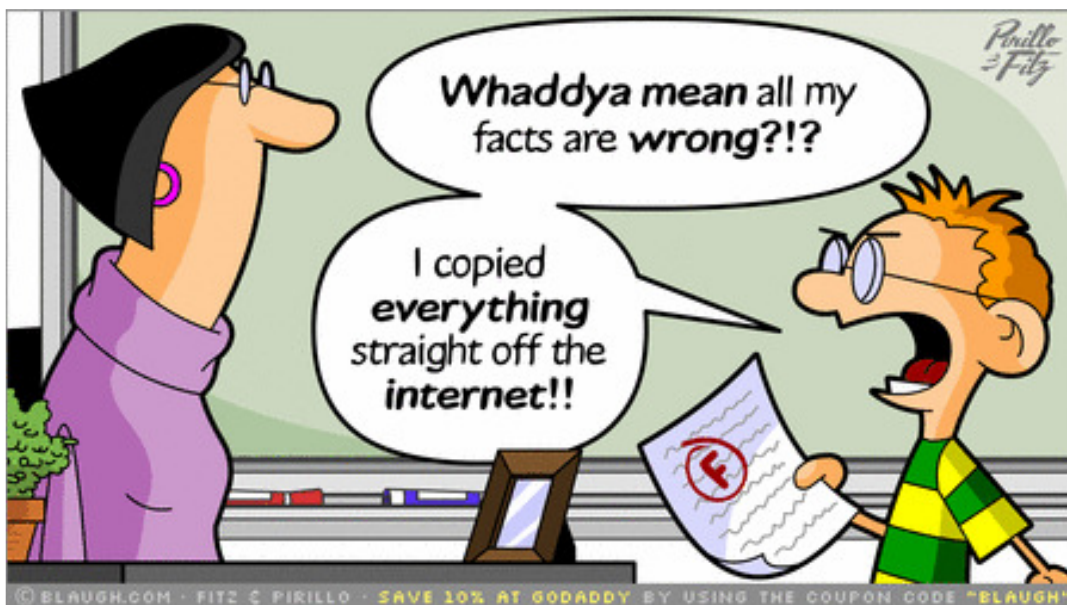
A shorter literature review / state of the art section after the introduction (1 short chapter) followed by...

Distributed sections of state of the art on different topics along the text (namely when the work involves several topics)



## 4. OTHER PRACTICAL ASPECTS

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There are several referencing styles available

**Examples:**

**APA style**

**MLA style**

**Harvard style**

**Chicago style**

<http://www.citethisforme.com/guides>

<https://pitt.libguides.com/citationhelp>

**Conferences and journals usually provide their own style !**

**A frequent case:**

WORK BY ONE AUTHOR:

The most recent study...(Author, 1995) suggests that....

WHEN THE AUTHOR'S NAME IS PART OF THE SENTENCE:

In Author's (1993) study of....

**References are then  
listed alphabetically**

WORK BY TWO AUTHORS:

Other researchers (Author1 and Author2, 1981) have suggested....

WORK BY THREE OR MORE AUTHORS:

White-lined bark beetles...(Author1 et al., 1992).

MULTIPLE WORKS BY THE SAME AUTHOR:

The circulatory system...has been described...by Author (1978, 1980, 1983).

MULTIPLE WORKS BY DIFFERENT AUTHORS:

Many different models have been proposed...(Author1, 1977, 1979; Author2, 1988; Author3, 1992).

**Another case:**

References in brackets - [4], [12]

**In the end, references are  
listed according to the order  
of referencing in the text**



Information and communication technologies (ICT), and particularly high-speed pervasive broadband connectivity, Internet of Things, cloud-computing and web-based technologies, offer promising opportunities to provide care and assistance, as well as new ways of working, facilitate social interaction and reduce limitations imposed by location and time. **During last decade**, many research projects and pilot experiments **have focused on ICT and ageing** (see, for instance, Aguilar et al. 2004; Camarinha-Matos, Rosas, and Oliveira 2004; Alexandersson 2008; D'Andrea et al. 2009; Costa et al. 2009; Vontas, Protogeris, and Moutmtzi 2009; O'Grady et al. 2010). But many of the resulting ideas and promising pilot cases, even if with a high potential, fail to scale because the adopted approaches have been excessively techno-centric. In this area, a purely technology centred approach, without consideration of the socio-organisational aspects, is likely to add only marginal value, not getting accepted by users, or not finding a sustainable business approach for wider deployment. Therefore, while designing a new conceptual architecture for an ICT and Ageing support environment, it is fundamental to also address the need for organisational and cultural change.

On the other hand, the frequent association of senior citizens with a dependent stage of life does no longer (fully) match the reality. The adoption of the concept of 'active ageing' provides a more appropriate understanding of the later phases of life (USDHHS 1997). Furthermore, the notion of 'productive ageing' (Garlick and Soar 2007) has opened new perspectives for a change in the way society often perceives older people. Thus, supporting the active ageing process is not only about creating

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## Organization of references

In case there are prescribed rules, **follow them !**

**Additional tips:**

- The list of given references is closely tied to the literature review / state of the art section of the thesis / paper.
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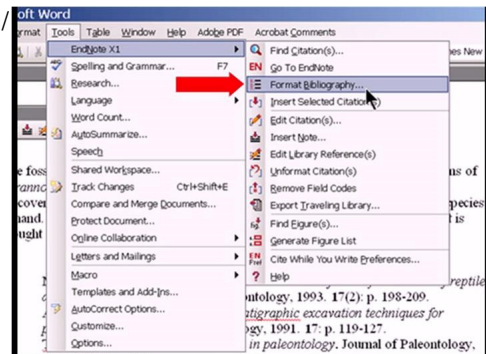
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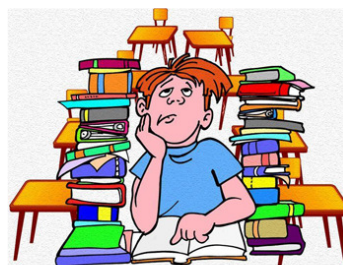
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**Roots of Collaboration: Nature-Inspired Solutions for Collaborative Networks**

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**ABSTRACT** Last decades have witnessed considerable growth in formation of collaborative networks in industry and services, as well as in the rest of society. This trend is boosted by progress in information and communication technologies, and more specifically by ubiquitous access to computing and fast move toward the hyper-connected world. But, this growth has also raised fundamental questions regarding its effectiveness and sustainability of networks. On the other hand, nature is full of examples of successful collaborative processes, both intra- and inter-species. Hence, we consider learning from nature to provide a promising strategy toward both better understanding of collaboration and more effective designing of networks with sustained collaboration. As such, a systematic literature survey is conducted on recent works originated in nature-related disciplines with a focus on collaboration. As a result, a set of important organizational models, collaborative behavior patterns, and collaboration facilitation mechanisms are identified and categorized. Furthermore, our analysis results on potential contribution of such aspects to more intelligent and optimized collaborative networks area are briefly outlined.

**INDEX TERMS** Collaboration, biometrics, collaborative behavior, collaboration mechanisms, collaborative networks.

**1. INTRODUCTION**  
The importance of collaboration is widely recognized in industry and services. From the long-term strategically established business communities such as those manifested as business ecosystems, to the dynamic goal-oriented virtual organizations such as those found in manufacturing and even in disaster rescue initiatives, there is a very wide spectrum of cases of organizational structures and co-working forms relying on the collaboration among their members [1]-[3]. The topic has therefore attracted considerable attention during the last decades in a number of different communities, including the computer science, management, engineering, economy, sociology, and psychology, among many others. The need to integrate multiple perspectives into an interdisciplinary view has led to the emergence and consolidation of Collaborative Networks (CN) as a new discipline [4], and the efforts towards CN reference modeling [5]. Of particular relevance is the contribution of the information and communication technologies (ICT) as an enabler and facilitator of the collaboration processes. The exponential increase of connectivity, and the move toward the so-called hyper-connected world, has led to complex collaborative environments, wherein humans, organizations, smart devices and sensors, and intelligent agents co-exist and act together. On the other hand, the vastly growing number of turbulent disruptions at the market and societal levels re-enforces adopting collaboration as a sustainability pillar for the involved organization players.

Main research efforts on CNs have so far focused on three main streams: (i) How to operationalize (enable and manage) collaboration, (ii) How to measure collaboration, and (iii) How to promote collaboration. Vast amount of literature, accumulated knowledge, and support tools exist in this area [1], [3], [6]. And yet when it comes to practice, it is reported by various authors that many of the collaborative alliances fail, sometimes in excess of 50% [7]-[10] and this is observed not only in business partnerships but also in R&D partnerships [11]. A few recent studies present different numbers, depending on the analysed sectors and sample data [12]-[14], but all show that a significant number of partnerships fail their objectives. Nevertheless, and surprisingly, we observe that only a few works have studied and addressed the nature, sources, and treatment of conflicts

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**Collaborative smart grids – A survey on trends**

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**ABSTRACT**  
Smart grids are the result of a dynamic co-evolution process that leverages the integration of new technological advances in the energy systems and information and communication technologies. This process is accompanied by changes in business models, organizational structures, roles, and operating practices. In this context, collaboration among multiple entities becomes a crucial element, justifying the term Collaborative Smart Grid. The purpose of this article is to systematically review recent literature with a view to identifying trends, opportunities, and challenges regarding the application of models, approaches, and tools from collaborative networks to the energy domain.  
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