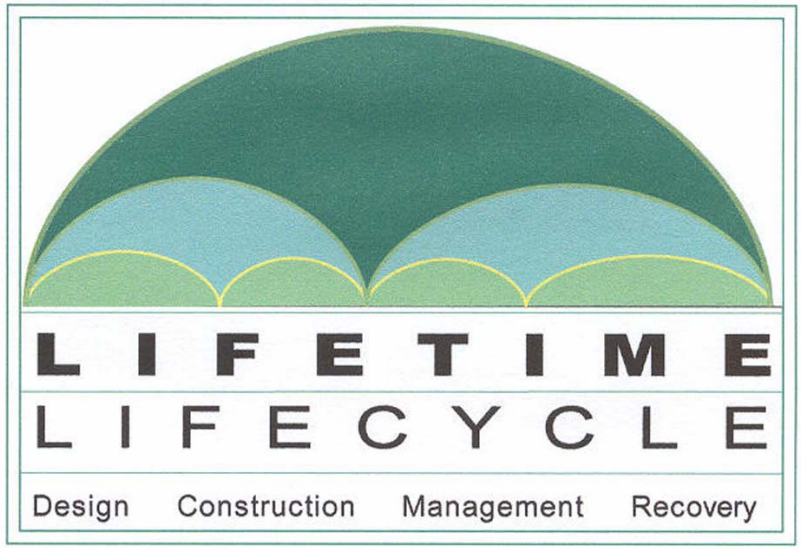


# WP3: *Exploring, analysing and benchmarking of technical and methodological contents of*

# *lifetime engineering*

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# Objectivesof WP3

- Technical knowledge support to stakeholders for developing and implementing lifetime principles and methodology into their everyday practice.
- a special role to raise the knowledge of the Network partners to the technical systematics and content of the life time engineering of buildings, civil and industrial infrastructures

# General features and trends in the field of Lifetime Engineering

- The content of the issues is broadening towards integrated lifetime engineering:
  - Life Cycle Costing is the odldest area of Lifetime Engineering;
    - LCC was treated already in 1930`s in the industry in USA
    - applied increasingly in 1950`s as Total Cost (incl. functions in use) in the industry and defence in USA
    - In 1961 Building Research Institue (USA) hold first conference in "Methods of Building Cost Analysis"
    - In 1970`s uniform LCC systems were presented
    - In 1994 ASTM Standard Oractice E 917-94: "Measuring Life-Cycle Costs of Buildings and Building Systems" was approved and published in 1995
  - Value Engineering was developed in 1970`s
    - management tool for seeking  best value for money in facilities design

# General features and trends in the field of Lifetime Engineering (continued)

- In the begin of 1990`s as Environmentlal Impact Analysis; called Life Cycle Analysis (LCA)
  - first framework report: Life-Cycle Impact Assesssment: A conceptual Framework, Key Issues, and Summary of existing Methods. United States Environmental Protection Agency (EPA), Report EPA-452/R-95-002, July 1995
  - ISO Standard 14000 series in 1996
- Durability issues have been treated since 1960`s in individual research works,
  - collected in DBMC Symposia since 1970`s, and
  - systemtised in ISO/DIS 15686 standards, starting in 1998 and continuing in 2000`s
  - statistical and safety factor methods have been introduced and systematised in durability design in 1990`s:
    - RILEM TC 130 SLD, [Sarja, Asko & Vesikari, E.(1996) (Editors and author group chair and secretary). Durability design of concrete structures. RILEM Report of TC 130-CSL. RILEM Report Series 14. E&FN Spon, Chapman & Hall, 165 pp.]
    - Duracrete, [Schiessl et al., DuraCrete: Brite EuRam III Project BE95-1347, Reports 1-9, 1998 -2000]

# General features and trends in the field of Lifetime Engineering (continued)

- System engineering for multi-attribute optimisation and decision making:
  - linear and dynamic programming and optimisation: 1950-1960
  - MADA (Multi-Attribute Desicion Aid). 1970-1970
  - QFD (Quality Function Deployment Method): 1960-1970
  - Risk Analysis
- ISO is working out standards on environmental management, service life planning and design and life cycle costing.

# General features and trends in the field of Lifetime Engineering (continued)

- Integrated life cycle design systemised [SARJA, Asko,(2002) "Integrated Life Cycle Design of Structures". Spon Press, London 2002, 142 pp.],
  - Framework,
  - Process
  - Methodologies and procedures
  - Methods

- Predictive and optimising Design and Management of buildings, civil and industrial infrastructures
  - Lifetime Cluster Projects [2000-2005]: LIFECON, INVESTIMMO, EUROLIFEFORM, LICYMIN, CONLIFE
  - Thematic Network Lifetime [2002 - 2005]
- Lifetime Responsibility Procurement (Lifetime Contracting)
  - 1990`s -

# CONTENT OF THE INTEGRATED LIFETIME ENGINEERING

- Lifetime investment planning
- Integrated lifetime design
- Integrated lifetime procurement and construction
- Integrated lifetime management and maintenance planning
- Rehabilitation and modernisation
- End-of Life Management:
  - Recovery, Reuse
  - Recycling and
  - Disposal

# The hierarchy of technical information

[Dr. Hywel Davies, Review of Standards and associated literature on technology and lifetime economy]

# Key European Union Directives relating to Lifetime Engineering

[Dr. Hywel Davies, Review of Standards and associated literature on technology and lifetime economy]

| Directive | Act | Date of entry into force | Final date for implementation in the Member States |
|---|---|---|---|
| Construction Products | Directive 89/106/EEC | 27.12.1998 | 27.06.1991 |
| | Directive 93/68/EEC | 02.08.1993 | 02.08.1993 |
| Energy Performance of Buildings | Directive 2002/91/EC | 04.01.2003 | 04.01.2006 |
| Framework Directive in the field of water policy | Directive 2000/60/EC | 22.12.2000 | 22.12.2003 |
| | Decision No 2455/2001/EC | 16.12.2001 | - |
| Framework Directive on waste disposal | Decision 96/350/EC | 28.05.1996 | |
| | Directive 96/59/EC | 16.09.1996 | |
| Integrated pollution prevention and control: IPPC Directive | Directive 96/61/EC | 30.10.1996 | 30.10.1999 |
| Public works contracts, public supply contracts and public service contracts | Directive 2004/18/EC | 31.04.2004 | 31.01.2006 |
| Public procurement in the water, energy, transport and postal services sectors | Directive 2004/17/EC | 31.4.2004 | 31.01.2006 |

# State of the Art: some features

- There are already knowledge: concretised systems, methodologies, methods and standards on several fields available
- Applications also exist already
  - they are usually not very comprehensive, but quite limited
  - General guides are existing, for eaxample:
  - **EU: Buying green!** – A handbook on environmental public procurement: http://europa.eu.int/comm/environment/gpp/guidelines.htm
- Most active early developments have been in the fields of:
  - Durability and service life of materials and structures
  - Life cycle costing LCC: ASTM E 917-94 (published in 1994)
  - Decision Analysis (MADA) in investment planning: ASTM E 1765-98 (year 1998)
  - Environmental Management and LCA (Life cycle Environmental Analysis) (ISO 14000 series)

# ISO Standards TG59: "Buildings"

[Dr. Hywel Davies, Review of Standards and associated literature on technology and lifetime economy]

- **ISO 15686-1 Buildings and constructed assets – Service life planning – General principles(ISO/TC59/SC15)**
- **ISO 15686-2 Buildings and constructed assets – Service life planning – Service life prediction procedures (ISO/TC59/SC15)**
- **ISO/DIS 15686-5 Buildings and constructed assets – Service life planning – Whole life costing (ISO/TC59/SC15)**
- **ISO 15686-6 Buildings and constructed assets – Service life planning – Guidelines for considering environmental impacts (ISO/TC59/SC15)**
- **ISO/DIS 15686-8 Buildings and constructed assets – Service life planning – Reference service life and service life estimation (ISO/TC59/SC15)**
- **ISO/AWI 15686-9 Buildings and constructed assets – Service life planning – Service life declarations (ISO/TC59/SC15)**
- **ISO/DIS 21930 Building construction - Sustainability in building construction – Environmental declaration of building products (ISO/TC59/SC17)**
- **ISO/TR 21932 Building construction - Sustainability in building construction – Terminology (ISO/TC59/SC17)**
- **ISO/TS 21931 Building construction - Sustainability in building construction – Framework for environmental performance of buildings (ISO/TC59/SC17)**
- **ISO/WD 15392 Building Construction – Sustainability in building construction – General Principles (ISO/TC59/SC17)**
- **ISO 6707-1 Building and civil engineering – Vocabulary – General terms (ISO/TC59/SC2)**

# Standards of CEN

- EN 1990: 2002: Eurocode - Basis of structural design. CEN: European Committee for Standardisation. Ref. No. EN 1990:2002 E. 87 pp..
- Several standards in each of the following TC`s:
  - CEN/TC89 “Thermal performance of buildings and building components”,
  - CEN/TC156 “Ventilation for buildings”,
  - CEN/TC169 “Light and lighting”,
  - CEN/TC228 “Heating systems for buildings” and CEN/TC 247 “Building automation and building management”

# **Lifetime Responsibility Procurement** (Lifetime Contracting)

- Innovations in public sector:
  - Private Finance Initiative (PFI) and
  - Public Private Partnership (PPP).
- PFI/PPP are efficient and effective ways of delivering services to the public sector
  - the responsible contractor has real interest in optimised lifetime costs and
  - the client defines the requirements and criteria for lifetime quality
  - is applied both in building and civil engineering sector
  - usual contract time period 20 - 25 years
  - Variations of Lifetime Contract process:
    - “Design, Build and Operate” (DBO),
    - “Design, Build, Finance and Operate” (DBFO),
    - “Build, Own, Operate, Transfer” (BOOT)

# Adopting the Lifetime Engineering into practice

- Renewal of processes of investment planning, design, MR&R, End-of Life management
- Adopting new methods  multiple requirements optimisation and decision making
  - LCC, LCE, QFD, MADA, Risk Analysis etc.
  - Management of usability against obsolescence
  - Service life design with degradation models
- Computer tools of methods
- Data on indicators and variables of lifetime properties
- New creative organisational solutions and consortia
  - PPP consortia etc.
- Demonstration building projects
- Education and training

# Some features of the trends in different regions

- USA:
  - investment planning (Value Engineering), life cycle economy and multi-attribute decision making.
  - Several ASTM standards on these issues have been published in 1990`s.
- Canadia: "Green building"
- Japan:
  - Service life planning and design,
  - lifetime quality
  - standards and guidelines have been published
- China and Southeast Asian countries:
  - facility management and condition assessment

# Lifetime Engineering in The sixth Framework Program of EU Commission XII GDL

Sub-programs of sixth Framework Program include several subjects on lifetime engineering:

- New production processes and devices (1.1.3.iii)
  - (b) systems research needed for sustainable waste management and hazard control in production and manufacturing, including bio-processes, leading to a reduction in consumption of primary resources and less pollution;
  - (c) development of new concepts optimising the life cycle of industrial systems, products and services.
- Sustainable energy systems (1.1.6.1)
  - (ii) energy savings and energy efficiency, including those to be achieved through the use of renewable raw materials;

# CONCLUSIONS

- The knowledge in R&D results, standards and guidelines in the field of Lifetime Engineering is already vaste and is growing rapidly
- The challenge of research and practice is to get a comprehensive and systematic figure, and to apply the knowledge into own concepts and systems
- Systematic knowledge on Lifetime Engineering should be distributed increasingly in education and training cources
- Practical management, planning, design and building concepts, which are supported by lifetime principles and methods have a high potential in the building market
  - Lifetime Engineering can be a source for new and creative solutions