Structural design in the 21th century

The role of software applications

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Standardized structural design – history

- ~1900s – Appearance of structural design codes
  - First obligatory rules for all structural design providers
  - Consistent methods for comparison defining minimum safety
  - Practice oriented: simple, clear procedures

- ~1950s – Increasing role of engineering research
  - More scientific people involved in the code development
  - More content, wider application field, more refined rules

- ~1970 – New calculation tools for design offices
  - Appearance of numerical methods, desktop computers and software products
  - Significantly extended calculation capacity
  - More complexity (more economy and safety) in the design rules

Standardized structural design – recent situation

Basic example: Structural Eurocodes

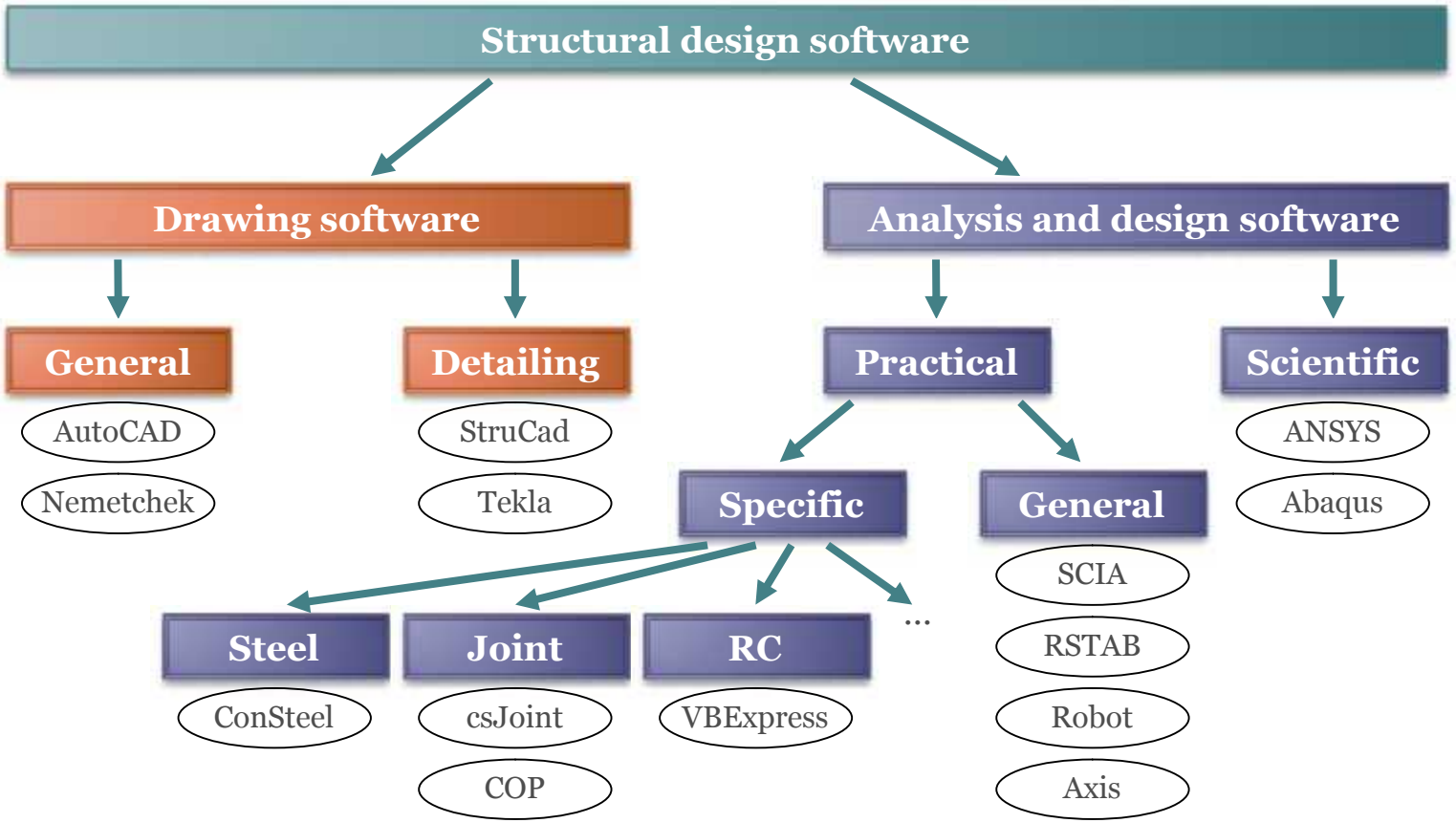
- The body responsible for the development of structural standard: almost entirely researchers, professors and scientists
- The standard rules are knowledge based containing the latest research results
- The complete standard is quantitatively huge
- The methods are usually complex and specific, hand calculation is not possible
- Several background documents, commentaries and refined tools needed for the efficient use

Structural design software – history

- ~1970s – Appearance of structural design software (SDS)
  - Use of numerical methods
  - Provides results for mechanical analysis of structures
  - Cumbersome modeling (limited to creation directly the mechanical model) and large calculation time
- ~1980s – Significant development of CAD modeling technology
  - Appearance of object-oriented modeling
  - Possibility for creation and analysis of 3D structural models
  - Spread of PCs with increasingly growing memory and calculation speed applicable for analysis of larger models
- ~2000s – SDS based design
  - The structural design workflow is substantially based on the use of SDS applications

Structural design software – recent situation

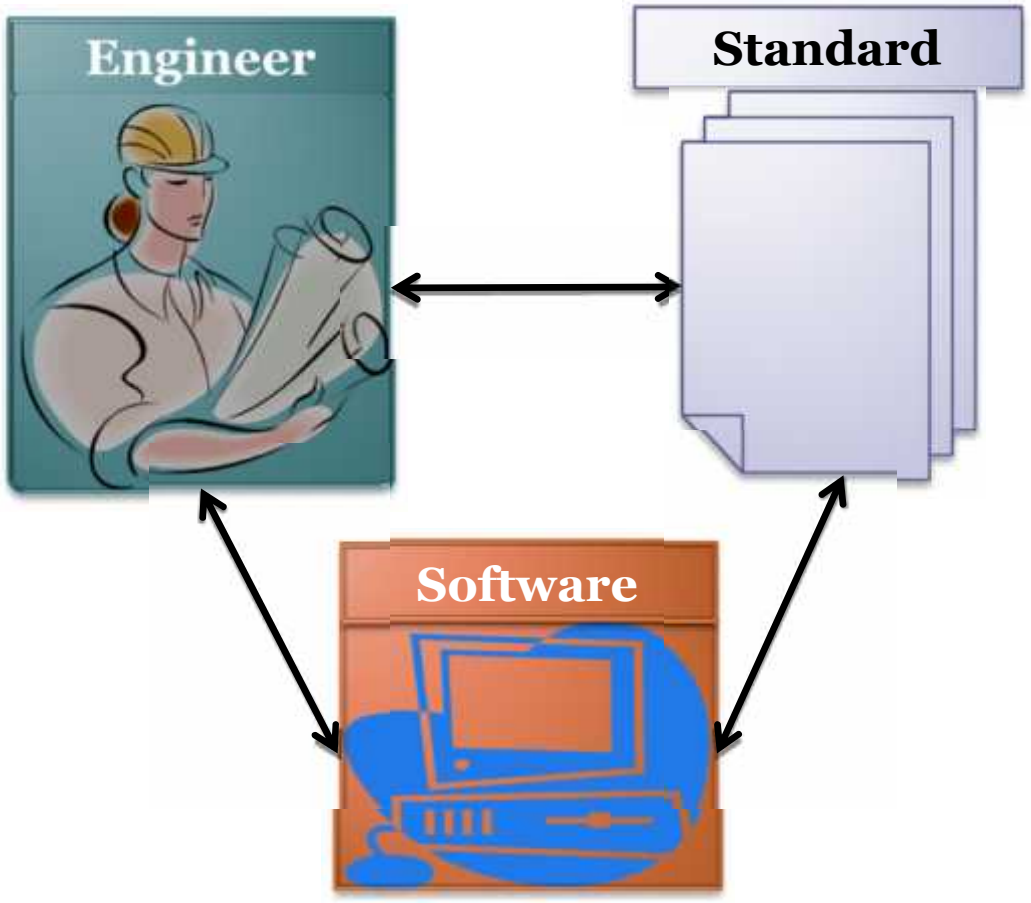
- Several specific software products are available for different type and level design purposes



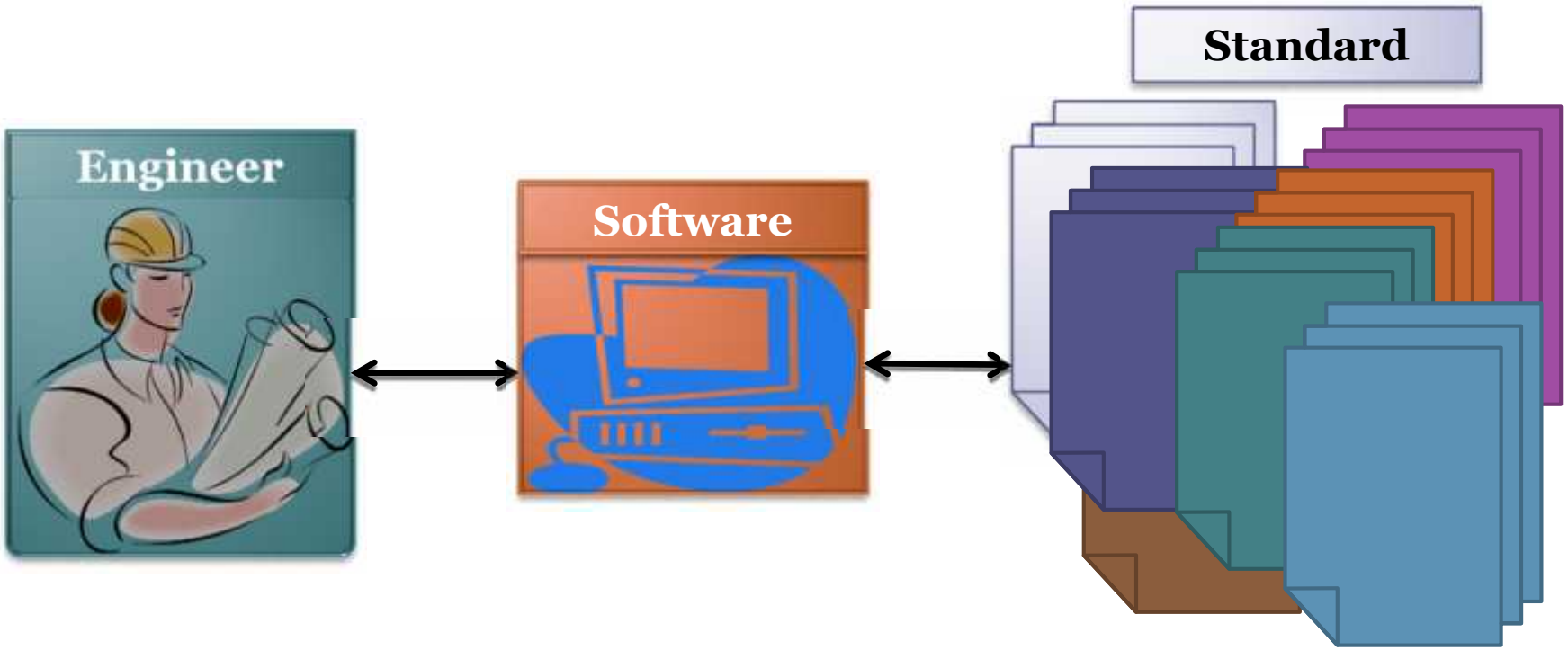
Structural design software – recent situation

- Primary and essential tool for the modern, efficient structural design
- Attempts to implement all the standard procedures provideing all the necessary evaluation tools
- The developments provide higher and higher level automation for the whole design process
- The use of SDS increases considerably the efficiency of the design – accelerates the work and reduces the costs

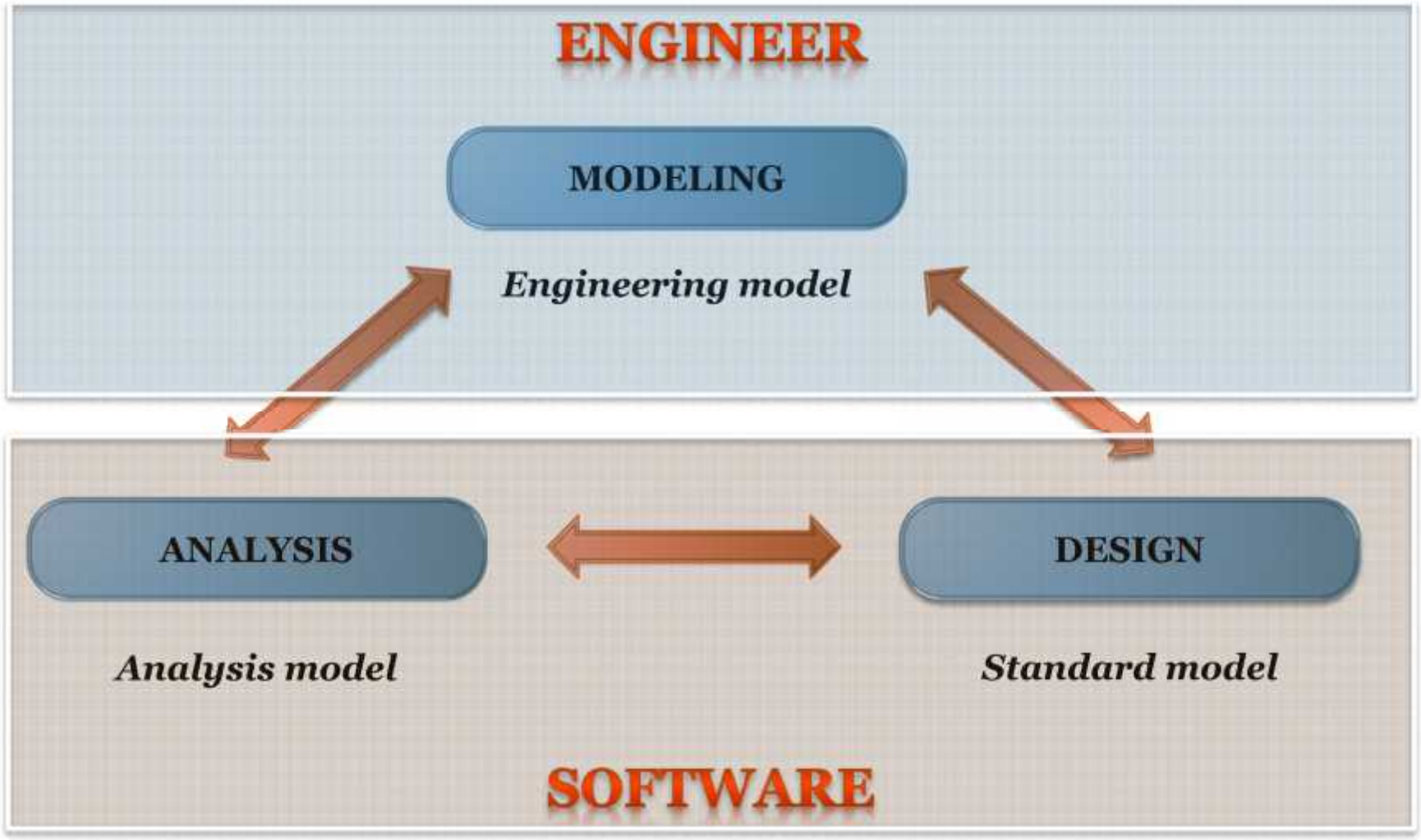
Change of design workflow



Change of design workflow



Basic design stages



Basic design stages

*** - controlling actor
** - assistant actor
* - irrelevant actor

Activity		Engineer	Standard	SDS
Modelling	Global geometry	***	*	**
	Supports, releases	***	*	**
	Cross sections	***	*	**
	Material	***	*	**
	Load cases	***	*	**
	Load combinations	***	*	**(*)
	Load placement	***	*	**(*)
Analysis	Developing analysis model	*	*	***
	Mathematical description	*	**	***
	Analysis types	*	**	***
	Performing analysis	*	*	***
	Evaluate results	***	*	**(*)
Design	Definition of design situations	**	**	***
	Selection of relevant checks	*	**	***
	Definition of design parameters	***	*	**(*)
	Performing checks	*	**	***
	Selection of dominant cases	*	**	***

General conclusions

- Role of the engineer
  - primary role is the creation of the suitable computer model of the structure
  - the appropriate evaluation and interpretation of the results is very important
  - the engineer use the standard methods generally only through the SDS
- Legal issues
  - none of the SDS products take the responsibility for its calculations
  - the engineer is usually not able check rigorously the results, but still he is fully responsible for them
- Standard issues
  - Accreditation system needed for the SDS products
  - Differentiation should be made by multilevel rules serving the simple hand oriented and complex software oriented work

Thank you for your attention