spectives have potential for use for certain areas, although this often varies relative to concrete needs in the domain for representing particular aspects (such as topological aspects which in many cases might not be relevant). In particular some of the less traditional approaches appear to have large untapped potential for a richer more appropriate representation of what we term processes and business processes.

3.5 Applying Several Modelling Perspectives in Concert

We have above presented different perspectives towards conceptual modelling. If we follow a social construction theory, we cannot claim that the general features of the world to exist a priori. According to this belief one might wish to go to the other extreme; an approach without any presumptions at all. However, this is impossible. Any methodology and any language imply some presumptions. Thus, having an approach totally free of presumptions would mean to have no approach at all, inventing a new one fit for the specific problem for every new development and maintenance task. For philosophers this might be acceptable, but engineers are expected to adapt to certain demands for efficiency. Inventing a new approach for every development and evolution effort would not give us that efficiency, neither is it likely that it will give better CIS-support for the organisation. Developing and maintaining a CIS without any fixed ideas about how it should be done would be tedious and unsystematic and make communication difficult between those involve in the work. As stated by (Boehm 1988), the ad hoc methods used in the earliest days of software development were much worse than those used today. So clearly one needs to make some presumptions. What is necessary is to find a point of balance: making enough presumptions for the approach to be systematic and efficient, but not so many that its flexibility and applicability is severely reduced. We can become aware of some of our presumptions, and in that way emancipate ourselves from some of the limits they place on our thinking, but we can never free us from all presumptions.

As we have illustrated in this chapter, there are a number of different approaches to conceptual modelling, each emphasising different aspects of the perceived reality. Towards the end of the eighties and early nineties several researchers claimed that one perspective is better, or more natural, than others:

- (Sowa 1983) bases his language for conceptual graphs on work on human perception and thinking done in cognitive psychology, and uses this to motivate the use of the language. It seems safe to say that even with his convincing discussion, his approach applying conceptual graphs have had a very limited influence on conceptual modelling

practices and the development and evolution of CISs in most organisations, even if it has received much attention within computer science research.

- Many authors have advocated object-oriented modelling partly based on the claim that it is a more natural way to perceive the world (Loy 1990, Wilkie 1993). The view that object-orientation is a suitable perspective for all situations have been criticised by many; see e.g. (Bryant and Evans 1994, Høydalsvik and Sindre 1993, Jacobs et al. 1994.) The report on the First International Symposium on Requirements Engineering (Jacobs et al. 1994) said it so strongly that “requirements are not object-oriented. Panellists reported that users do not find it natural to express their requirements in object-oriented fashion". Even if there are cases where a purely object-oriented perspective is beneficial, it does not seem to be an appropriate way of describing all sorts of problems, as discussed in (Høydalsvik and Sindre 1993). As stated by (Meyer 1996), "Object technology is not about modelling the real world. Object technology is about producing quality software, and the way to obtain this is to devise the right abstractions, whether or not they model what someone sees as the reality".
- In Tempora (1988), rules were originally given a similar role in that it was claimed, “end users perceive large parts of a business in terms of policies or rules". This is a truth with modification. Even if people may act according to rules, they are not necessarily looking upon it as they are as discussed by (Stamper 1987). Rule-based approaches also have to deal with several deficiencies, as discussed earlier in the chapter.
- Much of the early work on conceptual modelling that has been based on a constructivistic world-view has suggested language/action modelling as a possible cornerstone of conceptual modelling (Goldkuhl and Lyytinen 1982, Klein and Lyytinen 1991, Winograd and Flores 1986) , claiming that it is more suitable than traditional “objectivistic" conceptual modelling. On the other hand, the use of this perspective has also been criticised, also from people sharing a basic constructivistic outlook. An overview of the critique is given in (Michelis and Grasso 1994):
    - Speech act theory is wrong in that it assumes a one-to-one mapping between utterances and illocutionary acts, which is not recognisable in real life conversations.
    - The normative use of the illocutionary force of utterances is the basis for developing tools for the discipline and control over organisations

  - member's actions and not supporting cooperative work among equals.
  - The language/action perspective does not recognise that embedded in any conversation is a process of negotiating the agreement of meaning.
  - The language/action perspective misses the locality and situatedness of conversations, because it proposes a set of fixed models of conversations for any group without supporting its ability to design its own conversation models.
  - The language/action perspective offers only a partial insight; it has to be integrated with other theories.

- As discussed earlier in this chapter, also functionally and structurally oriented approaches have been criticised in the literature (Opdahl and Sindre 1994).

Although the use of a single perspective has been criticised, this does not mean that modelling according to a perspective should be abandoned, as long as we do not limit ourselves to one single perspective. A given language according to a specific perspective emphasise a specific way of ordering and abstracting ones internal reality. One model in a given language will thus seldom be sufficient. With this in mind more and more approaches are based on the combination of several modelling languages. There are four general ways of attacking this:

1. Use existing single-perspective languages as they are defined, without trying to integrate them further. This is the approach followed in many existing modelling tools.
2. Refine common approaches to make a set of formally integrated, but still partly independent set of languages.
3. Develop a set of entirely new integrated conceptual modelling languages.
4. Create frameworks that can be used for creating the modelling languages that are deemed necessary in any given situation.

A consequence of a combined approach is that it requires much better tool support than a single-perspective approach to be practical. Due to the increased possibilities of consistency checking and traceability across models, in addition to better possibilities for the conceptual models to serve as input for code-generation, and to support validation techniques such as execution, explanation generation, and animation the second of

these approaches has been receiving increased interest, especially in the academic world. Basing integrated modelling languages on well-known modelling languages also have advantages with respect to perceptibility, and because of the existing practical experience with these languages. Also many examples of the third and fourth solution exist, together with work on so-called meta-modelling systems supporting domain specific modelling e.g. (Kelly and Tolvanen 2008). Work based on language-modelling might also be used to improve the applicability of approaches of all the other types

Having discussed the weaknesses of fixed orientation above, the fundamental goals for a modelling approach that attempts to avoid orientation can be identified:

- Perspective freedom: It should enable the modeller to choose to capture any *kind of aspect* of a problem-domain phenomenon, and any *kind of dependency* between aspects. To the extent possible, *the choice of what to* represent *and when to* represent *it should be left to the modeller* contingent on the problem domain and the problems at hand.
- Perspective co-representation: Whenever several aspects of the same phenomenon are relevant to describe the problem domain, it should be possible to capture them *simultaneously as* well as structurally and semantically close *to* one *another in the model* instead of having to use several isolated modelling constructs and several isolated partial models.
- Perspective integration: If several aspects of the same phenomenon are *semantically related,* this should be reflected in the problem domain model.
- Perspective extensibility: As new kinds of aspects are recognised as relevant to the problems at hand during analysis, it should be possible to *extend* the modelling language to account for them. Also, it should be possible to visualise perspectives freely based on the already recognised kinds of aspects that are represented in a model.

These are the four main characteristics of what in (Opdahl and Sindre 1995) was introduced as the *facet-modelling ap*proach. We will present another language of this sort (GEMAL) later in this section. We will also look at other multi-perspective languages made according to approach 2, UML being rooted in object-orientation, but also found useful for modelling according to other perspectives, and EEML, rooted on transformations, but also able to cover the other perspectives for the use in enterprise modelling with a focus on process modelling in particular.