

Hierarchical breakdown structures

Anastásios Perdicoulis

Assistant Professor, ECT, UTAD (<http://www.tasso.utad.pt>)
 Affiliate Researcher, CITTA, FEUP (<http://www.fe.up.pt/~tasso>)

Abstract

Hierarchical structures can be explored, visualised, and understood through appropriate decomposition — or ‘breakdown’ — and graphical representation, as practised in the domain of project management.

1 Introduction

Hierarchy — *ιεραρχία* [Gk], the function of *ιεράρχης* [Gk], sacred ruler — indicates a rank or order of holy or sacred beings, starting with heavenly entities such as angels (*Oxford Dictionary of English*, 2010) and extending to the government of church (*Webster’s Revised Unabridged Dictionary*, 1913). Across various cultures, it is this particular term that is chosen to identify any ranking or order in almost every context — from the military to academic institutions, to civil society, to information technology. Common graphical representations of hierarchy can be found, for instance, in the form of organisational charts to display administrative ranks, and computer filesystems to display directory ranks and pathways — Figure 1.

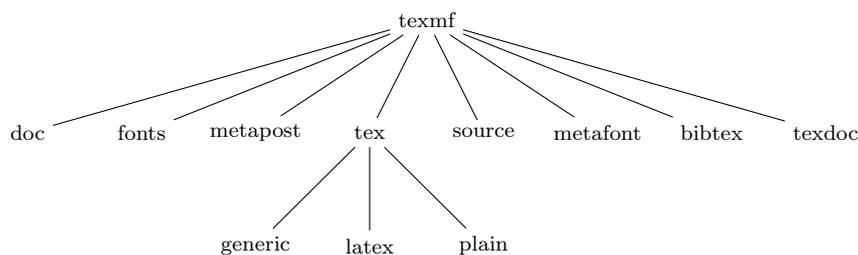


FIGURE 1 Hierarchical structure of a \TeX filesystem in three tiers

2 Tree typology

Practically, hierarchical breakdown structures are ‘trees’, or non-directed graphs — although alternatively they can be directed graphs (also known as ‘digraphs’) such as concept maps (Perdicoulis, 2012a) and reverse blueprints (Perdicoulis, 2012b). Tree diagrams can be visualised with various techniques, which may be chosen on the grounds of aesthetics, space availability, tradition, or facility of visualisation. The following examples illustrate common styling options: Figures 2 to 5 are alternative visualisations of a common tree structure, while Figure 6 is merely a tree lookalike.

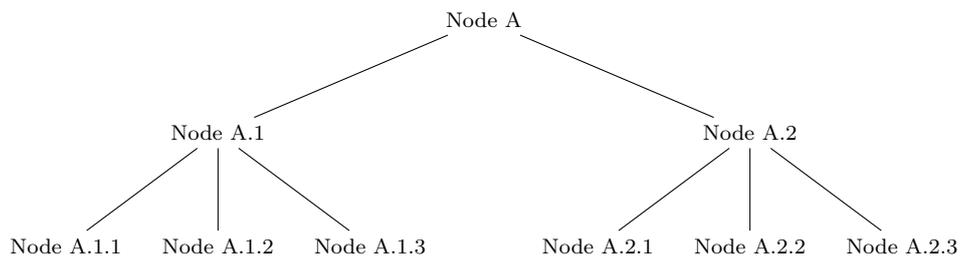


FIGURE 2 Hierarchical tree with straight edges

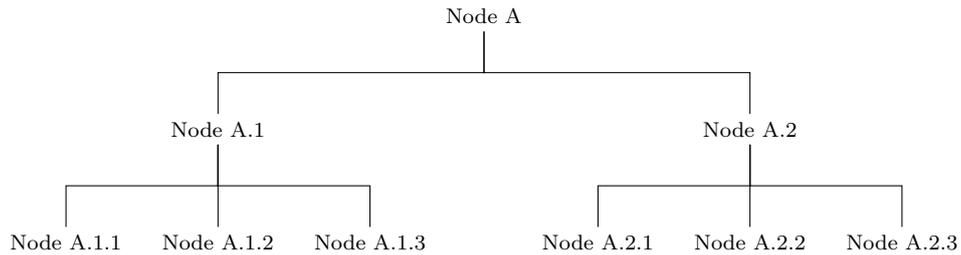


FIGURE 3 Hierarchical tree with bent edges

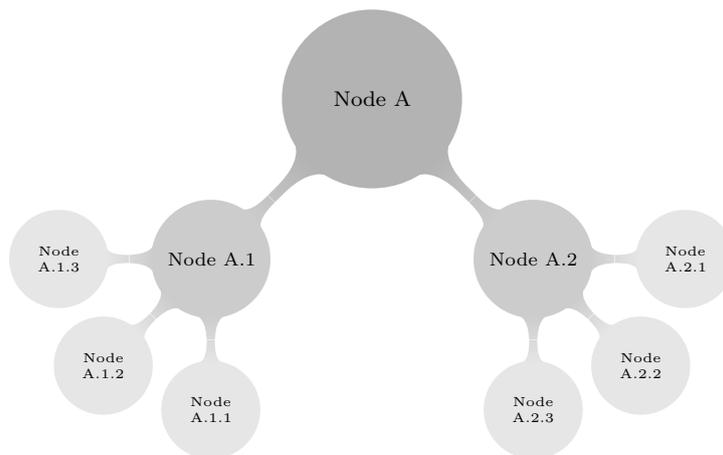


FIGURE 4 Hierarchical tree in the style of a mindmap

Technically, a nested list is not a tree, as it has no edges: the hierarchical relationships between the

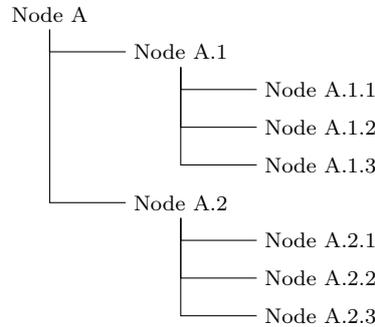


FIGURE 5 Hierarchical tree in the style of a file directory

‘nodes’ are implicit — Figure 6.

- Node A
 - Node A.1
 - * Node A.1.1
 - * Node A.1.2
 - * Node A.1.3
 - Node A.2
 - * Node A.2.1
 - * Node A.2.2
 - * Node A.2.3

FIGURE 6 Nested lists in lieu of a hierarchical tree

3 Breakdown structures in project management

Explicit reasoning and communication requires the representation of the information regarding hierarchical structure: the system elements, their order, and their links — often after a preparation through exploration, analysis, or decomposition.

Project management has developed an interesting variety of diagrams through the decomposition — or ‘breakdown’ — of hierarchical structures. Adoption by practice tends to make these *de facto* standards, focussing on aspects such as work, risk, product, and organisation (Project Management Institute, 2013).

3.1 Work (WBS)

The work breakdown structure (WBS) is a hierarchical representation of the work to be executed by the project team, usually represented in a ‘top-down’ orientation — Figure 7. Thus, higher levels of the WBS represent more general information, while lower levels represent increasingly detailed definition of the project work (Project Management Institute, 2013, p.125). The deliverables and work-packages of the WBS organise information to be used in the Gantt chart (Perdicoulis, 2013).

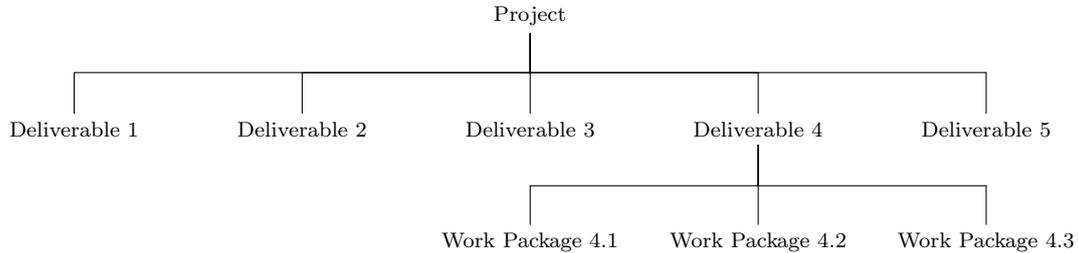


FIGURE 7 Sample WBS with three tiers: P–D–WP

The branching of a WBS varies to suit the complexity of each project, and/ or the needs and preferences of each project team. Some of these breakdown variations include the sequences indicated in Table 1, involving combinations of distinct semantic categories.

TYPOLGY	CONTENT
P–D–WP	project, deliverable, work package
P–Ph–D–WP	project, phase, deliverable, work package
P–SP–D–WP	project, sub-project, deliverable, work package
P–D–D–WP	project, deliverable, deliverable, work package

TABLE 1 Variations of WBS structures

3.2 Risk (RiBS)

The risk breakdown structure (RiBS) is a hierarchical representation of the aspects of the project that may be the cause of potential risks (Project Management Institute, 2013, p.325), although the risks themselves may not be expressed as such — Figure 8. Practically, the preparation of a RiBS helps to be systematic in the identification, organisation, and display of the risk sources (Perdicoulis, 2015). As with all the other breakdown structures, the configuration and content of the RiBS must be decided by the project team.

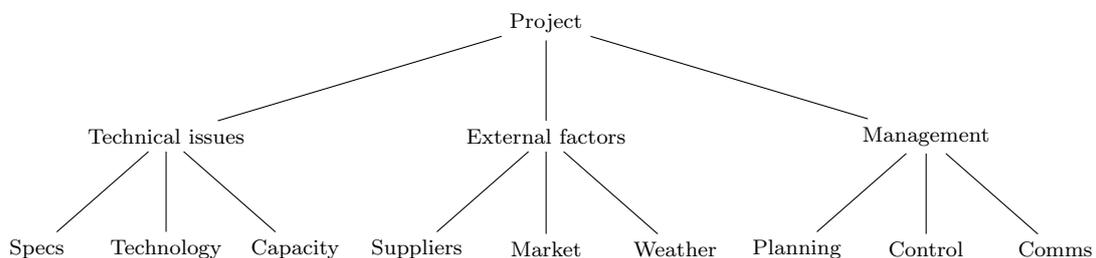


FIGURE 8 Sample RiBS ending with the ‘risk sources’

3.3 Resources (ReBS)

The resource breakdown structure (ReBS) is a hierarchical representation of the resources likely to be required in a project. This may or may not include human resources — see § 3.5. The ReBS hierarchy generally contains categories and subcategories, thus giving varying levels of detail regarding the project resources such as materials, equipment, and supplies — Figure 9.

The value of ReBS lies in the varying aggregation of the resources, ranging from global views to fairly detailed views. This information can be complemented by resource calendars for acquisition, assignment, etc., and resource requirement lists, similar to ‘shopping’ lists (Project Management Institute, 2013, p.164).

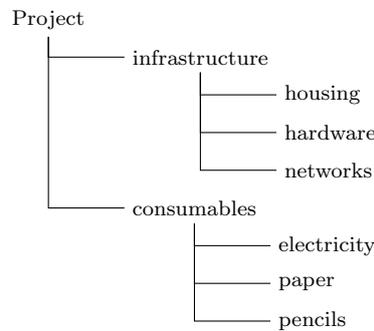


FIGURE 9 Sample ReBS tree in a vertical orientation

3.4 Products (PBS)

The product breakdown structure (PBS) is a hierarchical representation of the outcomes of a project, which may be physical products and/ or services (Project Management Institute, 2013, p.122). The hierarchy permits an aggregation–detailing of the product (and, practically, also of the services), of value similar to that of ReBS (Figure 10), which can also help identify the deliverables for the WBS (Figure 7) and the Gantt chart (Perdicoulis, 2013).

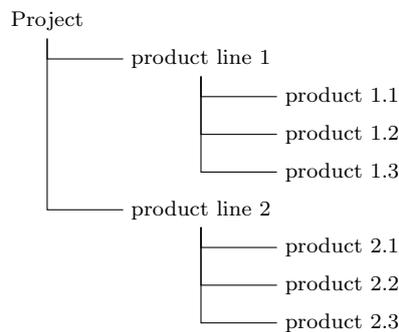


FIGURE 10 Generic PBS tree

3.5 Organisation (OBS)

‘Organisation’ may refer to just about anything, but organisational trees (or diagrams, charts, or ‘organigrams’) traditionally refer to human resources — *cf.* § 3.3. Thus, the hierarchical tiers of organisational breakdown structures (OBS) typically expand through departments, units, teams, and individuals (Project Management Institute, 2013, p.21), showing positions or functions and their relationships — Figure 11. This information can be complemented by roles and responsibilities, typically delivered in the form of text, tables, or matrices.

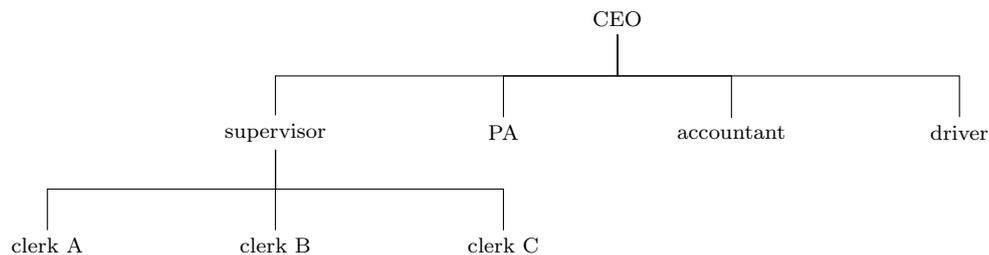


FIGURE 11 Sample OBS of a small enterprise

4 Discussion

The visualisation of hierarchical structure is a *sine qua non* interface of reality. To get to know the risks of a particular project, for instance, we must at least know their sources and their relative position or importance in the total set of possible risks. Then — and *only* then — we can start doing the really important work of risk assessment and mitigation. The same applies for all aspects of project management — namely, tasks, resources, and products or services.

The styling of tree visualisation may make a difference in the perception and understanding of the relative importance, context, and relations of system elements. Further experimentation with spatial arrangements of tree diagrams can be sought with specialised graph visualisation software such as [GraphViz \(website\)](#) or [Omnigraffle \(website\)](#).

5 Conclusion

Hierarchy can be expressed graphically as styled ‘trees’, or non-directed graphs, to facilitate the organisation of information, reasoning, and communication. This has applications in project management through the perspectives of work, resources, risks, and products.

References

[Graphviz \(website\) http://www.graphviz.org](http://www.graphviz.org)
[Omnigraffle \(website\) http://www.omnigroup.com/products/omnigraffle/](http://www.omnigroup.com/products/omnigraffle/)
Oxford Dictionary of English, 3rd ed. (2010). Oxford: Oxford University Press.
Perdicoulis, A. (2013) Project timeline views. *Systems Planner*, **26**.

Perdicoulis, A. (2012b) Detective work. *oestros*, **4**.

Perdicoulis, A. (2012a) Concept maps and CPDs. *Systems Planner*, **3**.

Perdicoulis A. (2015) *Risks*. Perdicoulis Publishing: Folio Division, Technical Collection.

Webster's Revised Unabridged Dictionary (1913) — public domain

Project Management Institute (2013) *A Guide to the Project Management Body of Knowledge* (5th ed). Newtown Square, PA: Project Management Institute.

