

A Teleological Explanation of the Major Logic Path in Classic FAST



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ABSTRACT

The concepts of function in technology can be explained and described within models using etiological (causality and determinism) and teleological (intentionality) view. The function explains the prevalence and (or) persistence of object types by citing their contributions and relationships in the artefact or system. Function Analysis System Technique (FAST) is a technique for analysing the functional structure used in Value Methodology. Therefore, this paper describes the relationships between function, goals and the purpose of a system as represented in the HOW-WHY logic of Classic FAST's 'Major Logic Path'. Meanwhile the other paper at this conference explains etiological function in the WHEN logic path of Classic FAST. A teleological function is that which needs to be done in order to achieve a purpose. In other words, what an object brings about in a system needs to serve its purposes and goals of the system in order to be called a teleological "function." To optimise at the detailed level only may undermine value at the purpose level and how the teleological functional theory has been selected from the intentional design of an agent (manufacturer). The focus of this paper is on the horizontal arrangement of functions in the HOW-WHY direction. The reason such articulation is needed is to enable the use of Classic FAST to be taken into High Technology projects that require greater alignment of engineering and scientific thinking. The underlying theory is an adaptation of Aristotle's "Teleological cause". The HOW-WHY logic path comprises functions that need to be done in order to achieve a purpose and is a feature of how engineers develop practical expectations that underpin invention. It is this means-end logic that makes it teleologic. The need to combine engineering intentionality with scientific knowledge in an explicit form provides Value Engineering an advantage because Classic FAST can represent the link between practical and theoretical intelligence. This paper uses teleological functions as the way in which the Major Logic Path structures purposive decision-making and so aids engineers to think more clearly about what needs to be done. It is a different logic from the accompanying paper at this conference (Woodhead & Berawi, 2004) which discusses etiological functions in the When direction of Classic FAST.

INTRODUCTION

There have been many long debates around functional theories for many years (Preston, 1998). Similarly, there are still problems in formulating functional theories in accordance with the expectations of scientific explanation and the need for corroborative phenomena (Godfrey-Smith, 1993). We will argue that phenomena referred to in a Classic FAST diagram in the How-Why logic path are cognitive and reside inside the world of ideas. This paper is a step towards unifying the relationship between a FAST Model and scientific explanation but is by no means complete; we ask that it is seen as work in progress.

This paper will explain an approach to functional theory used in the design and development of technological artefacts; for example, a chair (see figure 1). The function of an object (e.g. a chair) cannot be specified without also establishing the context in which the system (e.g. chair and person sitting on it) is analysed. Just as the function of a teacher cannot exist without the function of a student, and the function of a door cannot exist without the function of a wall, we must make the interconnectedness of functioning objects explicit. That is, when it comes to functional explanations, we must take into account 'developmental constraints' that are the conditions in which alternative uses/functioning may exist. We must accept that the drive to achieve a purpose brings with it a bounded rationality (Simon, 1997). Functional explanations as set within the major logic path may explain the reason why an object, such as a chair's armrest, exists in a certain system, but the way the function is performed via a physical artefact (e.g. a purple armrest made from bundled wires) may have additional value that it is unexpected (e.g. an accidental function that enables us to pass electric current through the armrest for some additional purpose to the armrest's original reason for being there).

FUNCTIONAL THEORY

In previous work we have cited Mahner and Bunge's (2001) work and believe their taxonomy is an important contribution that the world of VE will move closer to. Given the brevity needed in conference papers here we limit ourselves to one philosopher that deals with issues pertinent to this paper and is a mark of the fact this research is on going. Achinstein (1977) describes three accounts of function which involve different ways of viewing a means-end relationship and the idea of design, or use or benefit. He argues that functional doctrine can be classified into:

- (1) **The good-consequence doctrine:** the function x (resident in object S) is linked to function y if and only if x does y (in S) and doing y (in S) confers some good (upon S , or perhaps upon something associated with S). For example, the function of a heart (x) in a human (S) is to 'Pump Blood' (x in this case is 'pump blood') is linked to the function 'Distribute Oxygen' (This is function y) if and only if pumping blood (x) does distribute oxygen (y) in a human (S) confers some good. In science this is also known as 'Aptation' from which the more commonly known word 'adaptation' comes from.
- (2) **The goal doctrine:** the function of x (in S) is to y , if and only if, x does y (in S) and doing y (in S) is or contributes to some goal which x (or S) has, or which the user, owner, or designed of x (or S) has. So for example, the pumping of blood enables the distribution of oxygen that leads to electrons passing through cell walls via protein pumps so that energy is transferred; the goal here then is 'transfer energy'
- (3) **The explanation doctrine:** the function of x is to y , if and only if, x is there because it does y , and y is a consequence of x 's being there. Here we must pause for this is how the Classic FAST uses functions during the creativity stage. If the goal/purpose is to Transfer Energy to billions of cells inside the human body and this is done through the distribution of oxygen enabled by the pumping of blood enabled by the process of a beating heart, then we can either seek another methodology to distribute oxygen or swap a beating heart for a mechanical heart that pumps blood via a rotary pump.

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Making theories explicit allows us to move beyond a craft based approach to the formation of the major logic path and closer to union with scientific approaches. Furthermore, Achinstein distinguishes three types of function: design functions, use functions and service functions. This could be seen alongside Miles' views of 'use functions and 'aesthetic functions' not so much as a challenge but as a refinement that opens greater possibility for the role FAST diagramming can play in the Knowledge Economy. Achinstein explains that doing y – or that y is done- is an end with which x's function can be associated if one or more of the following conditions is satisfied:

- (1) x was designed (produced, created, established, appointed, etc.) to be or to serve as a means of doing y (design functions views)
- (2) x is used as a means of doing y (use functions views)
- (3) y is in fact done by means of x and either (1) or (2) or y's being done confers a good (service functions views)

This can also be considered alongside Mahner and Bunge's (2001) view of intrinsic and extrinsic functions. The important thing is that all types of function are not so much what we would see written on a single sticky note, but the meaning they convey about the relationships across and within functions on the major logic path. One only has to see Kaufman's (1998) view of a function in relation to its goal and its method to see the way we think about functions on the major logic path is in two stages; first the individual function and then the function in the means-end chain.

As we argue that the function on a major logic path is free from any solution or way it should be performed (i.e. technique) we must make it clear that it must therefore be the intention we the designers want to be achieved. Let us take a chair in the room as an example to make the link between intentionality and implementation explicit. Suppose that a chair has the proper function of supporting the weight of a seated person (see Figure 1). Note how a preconceived view of usage, that is seated person, has been established and with this purpose comes a limit on what we consider. But at the same time the chair can be used to hold the door open, as a step-up to take something from high cupboard, so on so forth. When articulating the functions on a major logic path we thus exclude consideration of co-incidental usage. This is why the major logic path needs to be generic and apply to all types of 'thing'. The major logic path is thus the central part of how a certain thing comes to have a certain identity such as a chair is for sitting on, a watch is for telling the time and so on. If analysing an existing product or thing, we need to be able to explain why and when the thing (e.g. a chair) can be used in relation to its function. The starting point is to establish the purpose of the thing which Heidegger argues comes from the way it is used; we thus see everything in the modern era as resources to be used (Heidegger, 1926). Next we need to untangle the design team's intentionality and why various things end up in the solution that in this instance is a chair. To do this, we have to consider how the designers thought about the chair's structure, material, its loading, and direction at the time it has been used. Here we are using the full set of Aristotle's four causes (Woodhead and McCuish, 2002):

Material Cause: why is this girder strong? Because it is made of steel.

Formal Cause: why is this piece of metal a key? Because its shape opens a lock.

Efficient Cause: why is the riverbed smooth? Because the water has eroded the rough edges.

Teleological Cause: why does the sunflower turn its head to the sun? Because it functions in such a way to achieve goals that ensures maximum sunlight capture to achieve its purpose of converting energy to survive and prosper.

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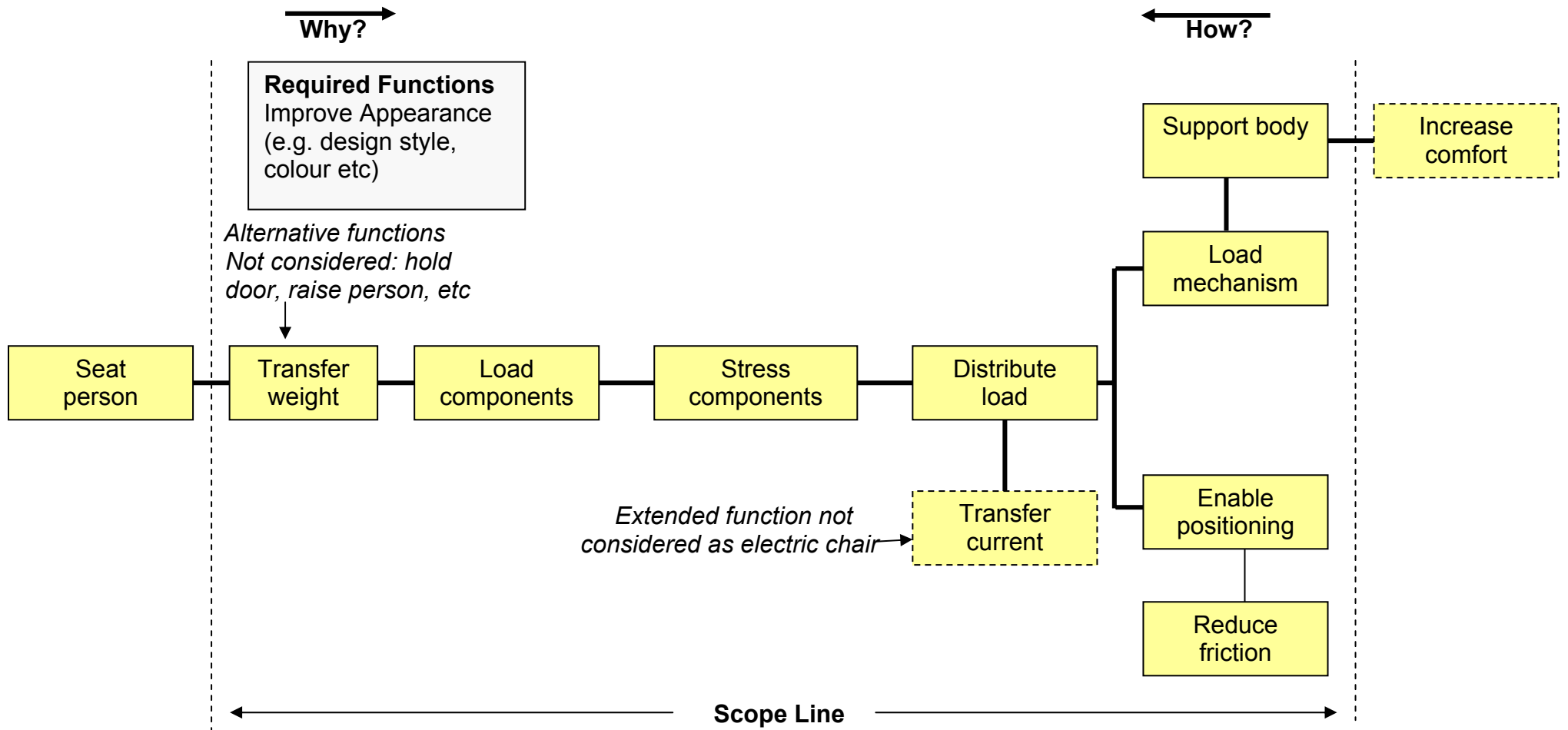


Figure 1, FAST DIAGRAM of a CHAIR

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In addition to theories of necessity we must also link them up to the real world in which the laws of the universe are not subservient to the will of man. For example, we have to know about the law of gravitation, the properties of materials, Newtonian mechanics and the like; the stuff of science and observable phenomena. These theories of science enable us to model the behaviour of reality under given situations. They represent the physical structure of an object, and are ‘controlled conditions’ that are in reality our interpretation of certain aspects of reality, such as the law of gravitation, the theory of aerodynamics, provide ‘general rules.’

The ‘controlled conditions’ describe anticipated events that might happen at a certain time and place, and general rule(s) connect these ‘controlled conditions’ to the functional explanandum -why and when the chair can be used- by the statement that, whenever events of one kind occur, events of the other always occur (Refer to Achinstein’s ‘good consequence doctrine’ and to his ‘goal doctrine’ above). It can be stated in the following formulation as shown at Table 1.

Line Number	Source of Truth	Argument
1	1	There is intention in agent forethought
2	2	There is a purpose in that we are considering.
3	3	There is a set of conditions that we are considering.
4	1,2	There exists a purposes in the agent’s intention
5	2,3	There exists a purposes in order to characterise the condition
6	6	There is a set of rules in explaining the condition.
7	3,6	There are instances when both the conditions and the rules are logically united
8	1,2,3,4,5,6,7	Every function explanation is such that if conditions and rules coincide then it is an explanation

Table 1, Logic Deduction Formulation of Function Explanation

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If I have certain conditions such as a person weighing less than X Kg and a chair designed within rules so that it can resist crushing, buckling, shear, gyration and overturning for loads of less than Xkg we have a means of manipulating reality. However, it has no value unless this know-how leads to something that is useful.

TELEOLOGICAL FUNCTIONAL THEORY IN VE

As we argue that the concept of function is an abstract set of processes, therefore, the Classic FAST concept is about the modeling relation (teleology), conditioned by causality and determinism (etiology).

So far in this paper we have distinguished between a real artefact and a FAST diagram's major logic path and the process by which the major logic path is made. This enables us to examine statements made during the development of the FAST diagram. We can see that functional representation and physical implementation are two things that mutually operate on two different levels of thinking. On one level we talk about the functions to be performed in order to achieve a purpose. On top of this level we talk of the methods or techniques or solutions selected to perform the function.

The challenge is thus to link the explicit intentionality within the major logic path to represent the way we want reality to work. If we also see intentionality as a product of investigation and the way humans construct explanation such a move would bring VE closer to high technologies.

It is because the intentionality must not inhibit the search for alternative solutions that functions in the major logic path should comprise an active verb operating on an abstract noun as is common practice in VE. For example, if the function "move chair" was in the major logic path it would fail because;

1. It has a specific noun
2. It does not convey the underlying intentionality
3. As it can be perceived in the everyday world it is a process or solution to some underlying intention.

The value of function in an artefact can be explained by our purposes, goals and technologies, because the successful artefact must always serve some good of ours in a better way than alternatives (Woodhead, & Downs, 2001). Additional value is achieved when the parts of an artefact not only carry out their respective functions, but other functions if something about the object and the system it's in changes (e.g. a chair is used to prop open a door).

Artifacts are generally the result of a selection process; intentional design of an agent with forethought. They are idiosyncratic functions. The different aspects of the cognitive apparatus (intentionality) could have different purposes; different parts or aspects of a design plan, and could be aimed at different ends or goals.

Agents' intentionality is determined within etiological structures (external condition and physical structure) or developmental constraints in which they are embedded. It's an explained account of what it is to do something intentionally. Intentional action is purposive action, and purposes can

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originate either inside or outside of a specific agent's will. Intentional facts may become social facts by collective intentionality. It can be stated as shown at Table 2.

Line Number	Source Of Truth	Argument
1	1	The first premise is that there exists a set of conditions that we are considering.
2	2	The second premise is that there exists a set of Rules by that we are considering as a means to characterise the conditions
3	1&2	The third premise is that there are instances when there is both the conditions and the rules are logically united
4	1,2 &3	Every scientifically valid explanation is such that if conditions and rules coincide then it is a valid scientific explanation
5	5	There is a purpose in the world of intentions
6	6	There is a function in the world of intentions
7	5,6	In order to achieve the purpose the function must be performed
8	8	Value is achieved when a purpose is performed in the real world
9	1 to 8	Every form of value is such that if the relevant purpose is achieved by performing the relevant function and Every scientifically valid explanation is such that if conditions and rules coincide then it is a valid scientific explanation

Table 2, Combining intention, design and science

CONCLUSION

A teleological function is that which needs to be done in order to achieve a purpose. In other words, what an object brings about in a system needs to serve its purposes and goals of the system in order to be a "teleological function". To optimise at the detailed level only may undermine value at the purpose level and how the teleological functional theory has been selected from the intentional

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design of an agent (manufacturer). The challenge in FAST is thus to link the intentionality, made explicit, within the major logic path. If we see intentionality as a product of investigation and the way humans construct explanation then the intentionality must not inhibit the search for alternative solutions that functions in the major logic path enable management planning to co-ordinate other theories of function such as etiological perspectives. The reason such articulation is needed is to enable the use of Classic FAST to be taken into High Technology projects that require greater alignment of engineering know how and scientific knowledge.

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