The Logic of Definition

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1   Introduction

Voltaire's admonition to "define your terms" has become a bedrock maxim of science, whether in the physical, social or military sciences. Why do we as Defence Scientists attach such importance to the process of definition? First and foremost, definitions (ideally) provide semantic clarity, clarifying ambiguous and vague terms[1] and, hence, mitigating terminological confusion, a critical imperative particularly in combined or multinational (and multilingual) military operations. Moreover, standardized terminology can enhance situational awareness, to the extent that it assists in identifying and describing features of the strategic, operational and/or tactical environment in commonly understood language.

Finally, univocal terms and concepts (that is, terms and concepts that have only one meaning or sense) are the building blocks of the defence scientific enterprise. Precise definition is necessary if these terms are to be applied to extant phenomena without question or doubt. Moreover, as Robinson points out, "science requires universal agreement…on the inferences that can be drawn from those terms when they are combined into propositions. Safe and agreed inferences are possible only with precise and unambiguous terms" (Robinson 1950: 70)[2].

What follows in this Technical Note is a discussion of the logic of definition, illustrating some of the basic terminology, types and methods used in this essential intellectual activity.

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[1] A term is *ambiguous* when it has more than one distinct meaning, and it is unclear from the context of its use which meaning or sense is intended. A term is *vague* when there are marginal cases to which it may or may not apply.

[2] As will be discussed later in this Note, words and concepts do not need to be absolutely precise in order to be useful. Indeed, in the social sciences, it is often impossible to approach the degree of conceptual and terminological precision achieved in the "hard" sciences.

2   What is a Definition?

"[A] man that seeketh precise truth had need to remember what every name he uses stands for, and to place it accordingly; or else he will find himself entangled in words, as a bird in lime twigs" – Thomas Hobbes, Leviathon (1651), Ch.IV.

Paradoxically, there is no agreed-upon definition of the term 'definition'. Aristotle considered a definition to be "a phrase signifying a thing's essence" (Aristotle 1994). John Stuart Mill maintained that "[t]he simplest and most correct notion of a Definition is, a proposition declaratory of the meaning of a word; namely, either the meaning which it bears in common acceptation, or that which the speaker or writer, for the particular purposes of his discourse, intends to annex to it" (Mill 1974: Book I, Ch.VIII). Rudolf Carnap characterized a definition as "a rule for mutual transformation of words in the same language" (Carnap 1934: 39)[3]. For the purposes of this Note, 'definition' is understood as an intellectual activity setting out the meaning of symbols or, more specifically, words (that is, utterances or their written representations). As Robinson describes it, it is "a process either of equating two symbols or of reporting or proposing a meaning for a symbol" (Robinson 1950: 191).

2.1   Terminology

Before proceeding further, certain technical terms need to be introduced. In a definition, the **definiendum** is the symbol being defined, whereas the **definiens** is the symbol or group of symbols explaining the meaning of the definiendum. Formal definitions are written as follows (using the Oxford English Dictionary (hereafter OED) definition of 'adversary' as an illustration):

> 'Adversary' (noun) $=_{df}$ 'one who, or that which, takes up a position of antagonism, or acts in a hostile manner; an opponent, antagonist; an enemy, foe.'

'$=_{df}$' is the standard symbol representing the phrase "is by definition". The term to the left of this symbol is the definiendum. The expression to the right is the definiens. Thus, a definition is an assertion or proposition that the definiendum has the same meaning as the definiens.

The **extension** (or **denotation**) of a term is the *class of objects* sharing common attributes or characteristics to which the term is correctly applied. For example, to define the word 'ocean', one could list the Pacific, Atlantic, Indian, Southern (or Antarctic) and Arctic bodies of water.[4] The **intension** (or **connotation**) of a term, on the other hand, is the *set of attributes* or defining

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[3] These definitions are examples of the essentialist, linguistic and prescriptive approaches to definition, respectively. In general terms, essentialists maintain that definitions provide (or should provide) a causal explanation of the thing defined; linguists view definitions as historical reports of word usage; and prescriptivists see definitions as syntactic or semantic rules for assigning names to things (the nominalists), or abbreviating strings of symbols (the formalists). For a discussion of these different general positions, see Abelson (1967).

[4] Only recently has the extension of the word 'ocean' been expanded to five. The International Hydrographic Organization delimited the Southern/Antarctic Ocean as the fifth world ocean only in the spring of 2000.

characteristics shared by that class of objects to which we apply the term. Returning to our example, one possible intension of the word 'ocean' would be 'those bodies of salt water with an area greater than five million square miles'. The class of objects so defined – i.e., the five above-named oceans – corresponds exactly with that of the extensional definition of the word. To put it simply, extension = objects, whereas intension = attributes.

All general terms have both intensional and extensional meanings. Moreover, it is commonly held among logicians that the intension determines the extension of the term, that is, the attributes define the class of objects to which the term applies[5]. The reverse, however, does not hold. The extension does not determine the intension, since different intensions may have the same extension. For example, the extension of the word 'ocean' corresponds to the above-mentioned attribute – 'bodies of salt water with an area greater than five million square miles'. However, it also corresponds to the intension 'bodies of salt water with a volume greater than four million cubic miles'. Simply listing the extension of the word 'ocean' does not enlighten us as to what particular attribute or characteristic is common to the specified class of objects.

Adding attributes to the intension – or increasing the intension – generally decreases the extension. To illustrate, refer to the OED definition of 'adversary' above. If we add the condition 'towards Canada', such that the resulting intensional definition reads,

> 'Adversary' $=_{df}$ 'one who, or that which, takes up a position of antagonism, or acts in a hostile manner towards Canada'

the extension or class of agents thereby described is clearly (or hopefully) much smaller than that determined by the original intension.

Proliferating terms in the intension, however, will not necessarily shrink the size of the extension. Conditions that are logically implied or logically equivalent to those already present in the intension, for instance, will have no effect on the extension. Let us, for the moment, redefine 'adversary' as follows:

> 'Adversary' $=_{df}$ 'a state that takes up a position of antagonism, or acts in a hostile manner'.

Incorporating the adjective 'organized' to modify the noun 'state' – to create the phrase 'organized state' – will not reduce the extension of the term 'adversary' since 'state' already implies some degree, however minimal, of institutional organization. In this instance, the additional attribute 'organized' is redundant and superfluous to the intensional definition.

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[5] See, for example, Copi & Cohen 2005: 106. Robinson takes exception to this, observing that this is, at best, a description of the *ideal* or *rational* relation between connotation and denotation, not of the *actual* relation in every case (Robinson 1950: 115).

3   Types of Definition

There are many types of definition[6]. Three prominent types are **lexical**, **stipulative** and **precising** definitions.

A **lexical** definition is an historical assertion reporting, oftentimes in a dictionary, how a term is actually spoken or written (i.e., its usage[7]) within a certain linguistic community.

The definition of 'adversary' presented above, for example, is a lexical definition, taken from the OED. Swartz maintains that such dictionary definitions, especially "if the dictionary is published by a prestigious firm and is compiled by competent and respected lexicographers" (Swartz 1997a), may assume a normative or regulatory function. In other words, they may be employed as the standard against which to judge the correct or incorrect use of a term[8]. However, rather than repositories of timeless linguistic excellence, dictionaries are, in effect, records of the dialect of a community's preferred or privileged class (Robinson 1950: 36-37). Moreover, given that "literary and academic uses of words lag behind changes in a living language…[dictionary] definitions that report meanings accepted by some intellectual aristocracy are likely to be out of date" (Copi & Cohen 2005: 100).

A **stipulative** definition deliberately assigns meaning to a new term (or to an old term used in a new way). It is proposal or a request, rather than an assertion, that this term be understood as having a certain meaning. As it involves the arbitrary assignment of meaning, a stipulative definition has no truthvalue – it is neither true nor false. Contrast this with a lexical definition, which may be true or false depending on the accuracy or inaccuracy of its report on a word's usage.

A **precising** definition stipulates additional features so as to increase the precision of a term's meaning, thereby eliminating the ambiguities and vagueness characterizing the common usage of the term. Though there is an element of stipulation, a precising definition is not a "pure" stipulative definition. It must remain connected to established usage – one is not free to assign whatever meaning one chooses to the term. However, a precising definition is not a mere report

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[6] Apart from the three discussed here, other types of definitions include theoretical, operational, recursive and persuasive. See Swartz (1997a).

[7] Ryle draws an interesting distinction between 'use' and 'usage'. A term's use is the way people *should* speak or write that term. For example, the word 'adversary' is a noun that is properly used in a grammatical sentence according to certain syntactic rules. A term's usage, on the other hand, is "a custom, practice, fashion or vogue. It can be local or widespread, obsolete or current, rural or urban, vulgar or academic." In other words, it is how people *actually* speak or write a term. Usage (as opposed to use) is neither correct nor incorrect; quite simply, it is what it is. As Ryle notes, "there cannot be a misusage any more than there can be a miscustom or a misvogue" (Ryle 1953: 173-174).

[8] Swartz tempers this view somewhat in the latter part of his essay. He notes that mistakes often "creep in" to dictionary definitions; that, though there are many first-rate dictionaries, no one is considered authoritative; and that, while providing "helpful hints" on how the educated classes speak and write a language, dictionaries, no matter how respected, cannot be expected to resolve philosophical or policy debates (Swartz 1997a).

of common usage. It goes beyond lexical definition in that it incorporates additional attributes in the definiens so as to narrow the scope of the term's meaning.

4   Methods of Definition

There are several methods of definition[9], three of which are **denotative**, **synonymous** and **analytical**.

Denotative definition (a technique of extensional definition) is a method in which the meaning of a word is conveyed by citing examples taken from the class of objects to which the word is applied. For example, as discussed above, to define the word 'ocean', one could list the Atlantic, Pacific, Indian, Arctic, and Antarctic bodies of water. A serious limitation with this method is that it is often impossible to denote all members of the class – 'ocean' is one of the few instances where complete enumeration is possible. In most cases, we must settle for partial enumeration. However, most phenomena have attributes that could place them in the extensions of many different terms. Consider, for example, these Toronto landmarks: First Canadian Place, Scotia Plaza and BCE Place – Canada Trust Tower. These could be part of the extension of "tallest buildings".[10] Yet, they could also be part of "tourist attractions of Toronto" or "urban Canadian eyesores" (depending upon one's taste in architectural design). The problem here is that we cannot be sure to which term this partial enumeration of examples refers (this reinforces the point made earlier that extension does not determine intension). Thus, the use of this method can leave the meaning of the term we wish to define uncertain.

Synonymous definition (a technique of intensional definition) is a method in which another word is provided having the same general sense as the definiendum and with which the learner is already familiar. This is the commonest method of definition used in dictionaries. For example, the OED offers the words 'opponent', 'antagonist', 'enemy', and 'foe' as synonyms for the term 'adversary'. The principal advantage of this method is that it is concise and straightforward. Its disadvantage is that it assumes prior understanding of the meanings of the words provided as synonyms. If one does not know what 'opponent', 'antagonist', 'enemy' or 'foe' mean, then they will shed no light on the meaning of 'adversary'. Moreover, synonyms are broadly similar rather than exactly alike in meaning. They carry different shades of meaning that can mislead the learner. Accordingly, dictionaries often list several partial synonyms "in the hope that the false in each will be cancelled by the others" (Robinson 1950: 95).

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[9] Other methods of definition include the synthetic, implicative, ostensive and regular methods (see Robinson 1950: 93-148).

[10] According to the Council on Tall Buildings and Urban Habitat (CTBUH), these three buildings rank 37th, 59th and 83rd, respectively, on the list of the top 100 tall buildings in the world. An intensional definition of 'tall buildings', derived from CTBUH criteria, might read as follows:

> 'Tall building' $=_{df}$ 'a structure that has floors and whose design, use or operation, whether for residential, business or manufacturing purposes, is influenced by some aspect of "tallness"'

The weakness of such a definition is, of course, its circularity – a 'tall building' is one influenced by 'tallness'. See CTBUH (2007).

Analytical definition or connotative definition (also a technique of intensional definition) is a method in which the phenomenon with which the meaning of the term is connected is broken down into its constituent elements. The advantage of this method is that it not only conveys the meaning of the word but also gives an analysis of the characteristics of the phenomenon itself. The disadvantage is that it is a more involved method of definition, certainly when compared with the simplicity of the synonymous method. For example, it is easier to define 'adversary' as "an enemy" than to set out the attributes (not all of which may be generally agreed) that distinguish an adversary.

This method is also known as definition by *genus* and *differentia*, acknowledging its roots in the Aristotelian method of classification. To define a term, one begins by naming the larger group (*genus*) with which the phenomenon shares a common characteristic, then stating the specific difference (*differentia*) or attribute that sets off the phenomenon from members of other sub-groups (species). For example, the OED definition of 'adversary' sets out the genus as agent[11] ("one who, or that which") and the differentia – that is, the attribute which distinguishes an adversary from other agents – as enmity or ill will ("takes up a position of antagonism, or acts in a hostile manner").

Copi and Cohen maintain that intensional definition is superior to extensional definition, and that the genus and differentia method is usually the "most effective and most helpful" of all intensional definition methods (Copi & Cohen 2005: 117). Some go even further, maintaining that the analytical method is, indeed, the only acceptable method. John Stuart Mill wrote: "[a] name [i.e., a word or term], whether concrete or abstract, admits of definition, provided we are able to analyze, that is to distinguish it into parts, the attribute or set of attributes which constitutes the meaning both of the name and of the corresponding abstract" (Mill 1974: Book I Ch.VIII). Others counter that it is unreasonable to restrict definition to the analytical (or, for that matter, any other single) method. Indeed, the OED definition of 'adversary' employs two methods: the analytical and synonymous. Robinson argues that exclusive reliance on the analytical method is justified only if the purpose of a definition is not solely to teach the meaning of a word, for which many equally valid methods are available, but also to provide an analysis of the thing meant by the word (Robinson 1950: 97).

In analytical definition, the definiens sets out the individually necessary and jointly sufficient conditions for the correct application of the definiendum (Swartz 1997b). Let us clarify what we mean by necessary and sufficient conditions before proceeding further. Recall, "if p is a necessary condition of q, then q cannot be true unless p is true. If p is a sufficient condition of q, then given that p is true, q is so as well" (Blackburn 2005: 71).[12] To illustrate, consider the following definition of a "triangle":

> 'Triangle' $=_{df}$ 'a closed figure with three sides which are straight line segments linked end-to-end' (Page 2007).

X is said to be a triangle if it satisfies the three conditions set out in the definiens:

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[11] An 'agent' is an actor with "the capacity for willed (voluntary) action" (Scott & Marshall 2005: 9).

[12] For a detailed discussion of these concepts, see Swartz (1997b).

- X is a closed figure.

- X has three sides.

- X has linked straight-line sides.

Each of these conditions is individually necessary. X cannot be a triangle, for instance, unless it is a closed geometric figure (condition 1). Yet, this condition is not sufficient in and of itself for X to be a triangle; any polygon satisfies the condition of being a closed geometric figure. Rather, the total set of three conditions is jointly sufficient for a triangle. In other words, if a polygon satisfies all these conditions taken together, then it is a triangle (see Box 1 below for a discussion of necessary and sufficient conditions in the context of the definition of 'strategic victory').

Box 1. Is Tactical Success Necessary and/or Sufficient for the Definition of Strategic Victory?

Consider the question whether tactical success is a necessary and/or sufficient condition for strategic victory. With respect to the Vietnam War, for example, many Americans, military and civilian, have maintained since the war's end that U.S. forces never lost a tactical battle against their Vietnamese enemy. Yet, most would concede that the U.S. lost the war. Apparently, tactical success was not a necessary condition for the Communists' strategic victory. North Vietnam and its southern allies could lose every tactical engagement with U.S. combat forces, yet ultimately emerge victorious. Nor, conversely, was tactical success a sufficient condition for U.S. strategic victory. Its forces purportedly won all their tactical engagements, yet the U.S. still lost the war. Were we to propose an intensional definition of the term 'strategic victory' based on the Vietnam experience, we would not include the condition of tactical success since it does not appear to have been either a necessary or sufficient condition for victory. (Indeed, we may need to rethink our concept of tactical success – for instance, taking into account the broader psychological impact of tactical engagements on the overall war effort rather than focusing narrowly on measures of physical effects such as relative body counts, as was the prevailing practice at the time – or, alternatively, debunk the post-war myth of U.S. tactical dominance.)

5   Sufficiency Definitions

Swartz sets out what he describes as the two principal tenets of the Classical Theory of Definition:

- "[A] 'proper' intensional definition states in the definiens the logically necessary and sufficient conditions for the application of the definiendum".

- "[T]here are intensional definitions for each of the class of terms (e.g. "horse", "house", "musical instrument", "educated person", etc.) which we use" (Swartz 1997a).

The first has already been discussed above. The second holds that it is possible to set out the necessary and sufficient conditions for the application of every definiendum. This proposition has not gone unchallenged. Wittgenstein, in his Philosophical Investigations (1953), observed that, for many phenomena, there are no necessary conditions common to all members of a class. For example, the term "games" includes board-games, card-games, ball-games, Olympic games, etc. What is the common feature – or necessary condition – that distinguishes these activities as "games"? he asks. There is, in fact, nothing common to them all but, rather, a series of relationships, "a complicated network of similarities overlapping and criss-crossing: sometimes overall similarities, sometimes similarities in detail" (Wittgenstein 1953: §66, p.27[e]). Wittgenstein refers to these overlapping similarities as "family resemblances" (Ibid., §67, p.27[e]). Few, if any, of these similarities are necessary, and something less than all together are jointly sufficient in order to define an activity as part of the "family" of "games".

The implication of Wittgenstein's argument is that, contrary to the Classical Theory of Definition, there are terms for which it may be difficult to construct a precise intensional definition or, to put it differently, for which "the extension of the concept is *not* [original emphasis] closed by a frontier" (Ibid., §68, p.28[e]). We may, through a rigid intensional definition, draw a boundary on the concept for our own special purposes (that is, we may resort to stipulative definition). But this is not necessary for the concept to be usable. Indeed, as Wittgenstein says, sometimes "a concept with blurred edges" (Ibid., §71, p.29[e]) is exactly what we need.

This is the logic underlying the notion of a "cluster concept" (see Gasking 1960). Cooper describes the "essential characteristic" of a cluster concept in these words:

> "[W]hile it is possible to list sufficient conditions for the applicability of a cluster concept term, it is not possible to list any necessary conditions for its applicability" (1972: 496).

Relating this to definitions, he draws a distinction between the **normal form** of definition and what he calls sufficiency definitions. The normal form is structured as follows:

> 'A' =$_{df}$ 'Something having the properties X, Y, and Z' (Ibid.: 495).

A **sufficiency definition**, on the other hand, takes the form:

> 'A' $=_{df}$ 'Something having *sufficient of* [original emphasis] the properties X,
> Y…N' (Ibid.).

The key difference between the two is that the normal form sets out the necessary and jointly sufficient conditions for a term to be applied. A sufficiency definition, on the other hand, consists of a number of conditions that are not singly necessary and are jointly oversufficient (Swartz 1997a).[13]

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[13] Not all authors agree with Cooper's notion of sufficiency definitions, nor with the use he makes of them in defence of "certain traditional philosophical theses against some rather fashionable objections" (Cooper 1972: 495). For two critiques, see Boër (1974) and Shafer, Jr., J.J. (1975).

6   Conclusion

The definition of terms is the first task that must be tackled in the TIF Project. It is essential that we clarify the key constructs – in particular, culture, worldview, ideology, and identity – upon which the conceptual framework will be built.

Much intellectual effort in many academic disciplines has been devoted to elaborating these constructs. However, consensus on their exact meaning remains – and will likely remain – elusive. In this Project, we will not presume to resolve the ongoing debates over the essence of these constructs. Rather, we will limit our ambitions to fashioning **precising definitions** that serve the narrower purposes of the Project. In other words, while drawing upon the many and varied meanings that previous thinkers have ascribed to these terms, we will attempt to *precise* or *particularize* their meanings within the bounded context of the conceptual framework of which they will be integral parts. What is important here is not that we succeed in contriving definitions upon which everyone in the scholarly community can agree (an impossible task). Rather, what is essential is that we be clear *in our own minds* – and make clear to those to whom we will communicate the fruits of our labours – what we mean when we use these terms in the context of this Project.

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