



Thesis – Military Theory, 15 hp

<i>Author</i> Major Jonas Andersson	<i>Course</i> ChP 07/09
<i>Tutors</i> Kersti Larsdotter Truls Gustavsen	
<h3>Center of Gravity Analysis – an Actual or Perceived Problem?</h3> <p><i>Abstract</i></p> <p>Centers of Gravity (CoGs) analyses deliver vital input to the operational design. However, there are a great number of theories regarding the phenomenon which can create a certain degree of confusion. The diversity in theories may lead to misdirected mental energy where the focus is to discuss theories instead of using the theories at hand efficiently. The question is if the diversity in theory is an actual problem or if it just perceived as such?</p> <p>This research identifies the similarities and differences in the theories of Milan Vego and Joseph Strange & Richard Iron regarding CoGs, their sub elements and methods for analysis. The impact of the differences on the practical result is then surveyed by implementing the theories on a delimited phase of the Falklands War, in order to conclude if the differences have a decisive impact on the product of the CoG analysis.</p> <p>The result of this thesis indicates that the diversity in theory is a perceived problem. The identified divergence does not reflect crucially on the CoG analysis and the variation of the input provided to the operational design is minor. The CoGs and the critical vulnerabilities identified are the same or at least similar, no matter which of the two theories was used in this research.</p> <p>Key words: Centers of Gravity, Military Theory, Operational Art, Operational Design, Milan Vego, Joseph Strange, Richard Iron, Falklands War</p>	

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1. Introduction

1.1. Background

In order to succeed with a military mission and to attain the objectives given by the higher echelon a skillful employment of forces with a logical balance and connection between *ends*, *ways* and *means* is argued for. The skill to accomplish this, to have the creativity and imagination to plan and execute a mission and to balance the influence of *time*, *space* and *forces* is the bedrock of **operational art**. During the planning process operational art is used when formulating the intent for the operation, when determining the linkage between employment and objectives, when building lines of operation and when formulating how and with what to reach the end-state. All this is essential for the development of the operational design.

The **operational design** gives the “overarching idea” for the operation based on the situation estimate, the mission analysis and the intent given by the commander. An operational design is developed by using a variety of concepts and tools in conjunction with operational art. The design is vital to the operational planning and therefore operational art requires understanding of the tools connected to the design. The toolbox consists of a great number of terms and concepts such as *end-states*, *objectives*, *centers of gravity*, *critical capabilities*, *critical vulnerabilities*, *decisive points*, *lines of operation*, *branches/sequels* and *conflict termination*.

All terms and concepts mentioned above are defined in the Guidelines for Operational Planning (GOP)¹, but are nonetheless objects of frequent debates and misunderstanding. A reason for this could be the shallow definition which gives room for different viewpoints that are built upon a variety of theories and doctrinal diversities.

Within the academic sphere these diversities are taken as a challenge and triggers further studies and discussions, but for a professional officer active in an operation they can be a source of frustration. When the tools are used in a context where the operational plan will lead to a maintained high level of force protection and operational success or a high number of casualties and operational failure the diversities form a liability instead.

If not most important, the determination of Center of Gravity (CoG) is probably one of the most important factors when the operational design is developed. CoG is a phenomenon and concept that was originated by Carl von Clausewitz in the 19th century.² The connection between the concept of CoG and operational art is fundamental, since the analysis of CoG can provide information on what is decisive in an operation and usually decisive actions are connected to a CoG. The efforts are either directed towards weaknesses connected to CoG or specifically towards the CoG, although an experienced practitioner aims to concentrate the

¹ Supreme HQ Allied Power Europe (2005). *Guidelines for operational planning (2005) NATO Restricted*

² In order to study the theory, see Clausewitz, Carl von (1976). *On war*. Princeton, N.J.: Princeton U.P.

effects to exploit the identified weaknesses.³ To find these weaknesses within the framework of the indirect approach the professional soldier has to view the CoG concept as a system with different sub elements connected to each other and the CoG. The result of the CoG analysis provides input for what objectives and decisive points that should be accomplished and how to use the forces in order to reach the desired end-state.⁴

An operation that is focused on a mistaken CoG will be more time consuming, cost ineffective and/or mean overall failure.⁵ Unfortunately the definition of CoG, its sub element and the methods to analyze the phenomenon are faced with a great diversity. Since the original theory of Clausewitz CoG reached the public it has been an object of frequent and intense debates. There are a large number of interpretations and understandings of the phenomena including how it should be implemented in military operations. Brigadier General Gunnar Lundberg reinforces this and according to him there is a variety of opinions and interpretations about what Clausewitz really meant by CoG and during operational planning there will be discussions on this matter.⁶

In the US there are a large amount of different studies and theories on the phenomenon of CoG, where the theories by Milan Vego, John Warden, Antulio Echevarria and Joseph Strange and Richard Iron can exemplify this some of this diversity. Due to the American influence on both NATO allies and NATO partners these discussions both indirectly and directly affect the debate in the Swedish Armed Forces.

Since 2000 the discussion in Sweden has intensified as a result of the implementation of GOP and the introduction of the doctrinal hierarchy, and even though there has been a progress in instruction concerning CoG there is still confusion amongst the officers in the Swedish ranks. There are even factions amongst both academics and professional officers that strongly question the utility of CoG in modern conflicts. This is interesting, but not too fruitful for the professional officer since the dominant and influential military power of today still believes in the concept. Instead of fighting the system the professional officer needs to become comfortable with the CoG phenomenon and its utility in operational planning.

1.2. Problem statement

When the professional officer is confronted with the concept of CoG and the methods of its analysis, the great variety of theoretical approaches can cause a practical problem and the essential work of operational planning can be hampered because of this. Vego states that, despite the importance, inadequate attention is paid to the phenomenon.⁷ This is unfortunate since the result from the CoG analysis deliver the vital input mentioned earlier, needed to produce the operational design and the decisive points tied to it.

³ Strange, Joe & Iron, Richard (2005). *Understanding centers of gravity and critical vulnerabilities*. Stockholm: Department of War Studies, Swedish National Defence College: pp. 30 – 33

⁴ *DGemO doktrin för gemensamma operationer*. (2005). Stockholm: Försvarsmakten: pp. 63 – 66

⁵ Vego, Milan (2008). *Joint operational warfare: theory and practice*. 1. ed. Stockholm: National Defence College: p. III-26

⁶ Introduction by Brigadier General Gunnar Lundberg, Strange & Iron, p. 7

⁷ Vego, p. VII-13

The different understandings and interpretations of the concept are as stated of concern for the professional officer conducting operational planning but is this concern based upon an actual problem or is it just perceived as such? What are the differences in the modern theories regarding CoG and what impact will these differences have on the products? Will different theories when applied in operational planning produce results that reflect the diversity or will the result be similar? Will the identified CoG, strengths and weaknesses be different when using different theories?

Are the differences in theories regarding the modern Center of Gravity framework an actual or perceived problem? What differences can be identified in modern theories on CoG and will these differences have a crucial impact⁸ on practical operational planning?

1.3. Purpose

In order to use the concept of CoG during operational planning the professional officer needs to have confidence in and knowledge of the tool. The purpose of this research is to create some necessary conditions needed to establish this. By comparing two of the dominant modern theories on the subject, identifying the differences between them and analyzing if the differences will have a crucial impact on the results in an operational planning, this research will clarify if the confusion and lack of confidence is founded on an actual or perceived problem. Will there be contradictory input to the operational design or is the choice of theory to implement irrelevant when the final result is concerned?

The reason for conducting a research on this subject is derived from an urge to enrich the knowledge of Center of Gravity and its utility in operational planning. By clarifying the definitions and elucidating the relevance of differences this research will try to provide the professional officer with a clearer view of the phenomenon and its utility. Hopefully this may lead to a tendency to focus on the contents and result of the method instead of questioning the method itself. Importantly, the utility of CoG in operational planning will not be questioned.

1.4. Research questions

In order to solve the defined problem and to arrive at the purpose of this thesis, the following research questions need to be answered.

- What similarities and differences can be identified in modern military theory regarding Centers of Gravity definitions and their sub elements?
- What similarities and differences can be found in modern military theory concerning methods to identify and analyze Centers of Gravity?
- What impact can the differences in theory have on the products of the CoG analysis when applying it to a conflict such as the Falklands War?

⁸ A *crucial impact* is according to this research, if the identified CoGs and vulnerabilities are so diverse that the effort of an operation will be directed in divergent directions.

1.5. Preceding research

The subject of CoG is, as mentioned, a branch in military theory that has been, is and will be the object of frequent research and debate. When observing the research area the reader will identify a number of tendencies and levels in the academic debate. On the first level there are surveys that identify and describe different viewpoints and on the next level the theories are analyzed using case studies in both historical and modern contexts in order to substantiate or falsify the relevance. When observing the higher level of research the CoG theory is exposed to a deeper clarification and adjustments to new contexts or attempts to entirely rebuild the understanding of the concept.

In the international arena there are a number of modern theories that have had more impact than others in the military sphere and they all act on the higher level of research in reference to the levels described. They are without exception connected to the US armed forces and their doctrines which amplify the international influence these theories have.

John Warden is known for his involvement in the air campaign during the first Gulf War in 1990-91 and for his theories on viewing the opposing force as a system described in a five layer circle. He claims that CoG is useful in planning operations since it “describes the point where the enemy is most vulnerable and the point where an attack will have the best chance of being decisive”.⁹ The point that Warden makes is built upon the original theories of Clausewitz, even though he to some extent confuses the concept with vulnerabilities.

Robert Leonhard claims that the CoG is the enemy’s vulnerabilities and not his strengths. He makes a comparison to both a game of chess and amusingly to a personal battle with fire ants in Georgia. Leonhard identifies that in order to win you need to attack the vulnerabilities instead of the strengths, i.e. the king of chess and the queen of fire ants.¹⁰ Leonhard as well as Warden has a practical approach to the theories which serves the professional officer well.

Antulio Echevarria represents another branch in the theories on CoG and a more modern one where new types of wars are included in the analysis. He asserts that CoG is not the strength, not the source of strength and not a weakness. According to Echevarria CoG is what holds the enemy’s force together. CoG is the “*focal point*” that holds the system together, but only exists if there is a certain degree of connection.¹¹ Echevarria has some inspiring theories that will improve the area of research and his contribution to the debate will hopefully take it closer to an applicable consensus.

Before leaving the international focus there are two additional main theories that will help in surveying the research area. The theories of **Milan Vego** and **Joseph Strange & Richard Iron** claim that CoG in its essence belongs to the strengths in the system. However, this introduction

⁹ Warden, John. *The Air Campaign* (toExcell Press: USA, 2000), p. 7

¹⁰ Leonhard, Robert R. (1991). *The art of maneuver: maneuver-warfare theory and airland battle*. Novato, CA: Presidio Press: pp. 20 – 24

¹¹ Echevarria, Antulio J (2003) “*Reining in*” the Center of Gravity Concept” in *Airpower journal [Electronic resource]*. (1999-). Maxwell AFB, Ala.: AU Press
Available on Internet: <http://www.airpower.maxwell.af.mil/airchronicles/apje.html>

will not elaborate on the last two theories any further, since they will be the main ingredient of this research. The survey of preceding research will instead shift focus to the Swedish research situation.

In general Swedish research on CoG is mainly found in the first two levels outlined above. The researchers Widén & Ångström have given the area a thorough research on the subject with the main effort set on conducting a survey on the different existing main theories.¹² This book serves as a base for further studies in an exemplary manner, but none of them clarifies if there is a relevant practical difference in the product when using the varied theories.

When focusing on the delimited topic of this thesis the preceding research is limited. In 2002 a student at the Swedish National Defence College (SNDC) conducted research aiming at a survey of a broad variety of theories concerning CoG and the analysis methods in order to identify if there is a valid and reliable method to determine the CoG.¹³ Unfortunately, he didn't find a method fulfilling those criteria due to the complexity. His research touched the area of this thesis when comparing different theories, but since it was not part of his purpose he didn't cover if the problem mentioned earlier was perceived or actual.

Before finalizing the preceding research its worth mentioning that there is research currently being conducted by LTC Anders Palmgren at the SNDC which undoubtedly will provide both the national and international field with deeper knowledge in connection to the tendency described on the higher levels of research.

1.6. Delimitation

Since this thesis concerns theories and their impact on practical issues, the delimitations is mainly made around what theories to research and why certain theories are delimited. All theories in the subject are connected to the original theory of Carl von Clausewitz and therefore this thesis does not elaborate on the original theory, unless it is referred to in the context of the modern theories analyzed. This might seem like too narrow a delimitation to the reader, but the focus is on modern theories and what impact their different views on the subject will have in a practical context.

The effective Swedish doctrines¹⁴ and the guidelines given in GOP are for the time being emphasizing that CoGs is connected to strength, either the source of strength or the strength itself. This research does not strive to reevaluate this standpoint and therefore authors like Echevarria, Leonhard and Warden will not be covered any further. This research is instead using the theories of Milan Vego and Joseph Strange & Richard Iron. There are a number of reasons why these theories are chosen, but the decisive factors are that they both view CoG as connected to strength and that they are frequently referred to in the curriculum of SNDC. Instead of comparing theories with great diversity this research is trying to identify what frictions could appear even when only minor differences appear to exist.

¹² Widén, Jerker & Ångström, Jan (2005). *Militärteorins grunder*. Stockholm: Försvarsmakten

¹³ Ohlsson, Ulf (2002). *Metod för fastställande av Center of Gravity*. Stockholm: National Defence College

¹⁴ The Swedish doctrines referred to consists of a hierarchy covering the strategic, operational and tactical levels.

Since this research cannot cover classified material it does not refer to GOP in detail. There are sections where the research refers to that document in general terms so that personnel with clearance are able to update themselves on the relevance in connections and conclusions presented. The reliability and validity of this research is not jeopardized even though the GOP is not available.

The phenomenon of CoG and the different sub elements are reviewed without limitations regarding levels of war, but the comparison and analysis of the definitions are only conducted on the operational level. This is also the case when the methods of analysis are reviewed and compared. Therefore, even though the other levels of war are covered in some way, the focus of this research is on the operational level.

1.7. Research methodology and disposition

The base of this research is built upon a comparison of a delimited number of theories concerning the phenomenon of Center of Gravity. The focus of the research is the comparison of the analysis method given by the reviewed theories, but in order to gain understanding of the theories, their definitions of different elements need to be analyzed.

When using a comparative method the empirical material is compared systematically and explicitly. One major reason for using this type of method is the fact that unlike in physical sciences, it is troublesome to devise precise experiments.¹⁵ Within social science there are three major types of comparative analyses; individual case studies, studies of a limited number of objects and global studies based on statistics.¹⁶ This research is based on the second variant where two cases, the two theories, are compared systematically in a *focused study*.

Focused studies involve an intense comparison of a limited number of objects. In all they try to explain a situation of one aspect, the *dependent factor*, which is at the center of the research. In order to identify what impacts the dependent factor there are *independent factors* involved in the analysis. Further, there are two forms of focused studies which in general differ in the level of similarity between the objects; the *most similar systems design* and the *most different systems design*. The idea behind the most similar systems design is to identify differences between the objects studied in order to explain the differences in the dependent factor. This means that all differences are potential explanations to the dependent factor. However, it can be problematic to decide what differences have the crucial impact, but the more similar the objects are the easier it is to accomplish this.¹⁷

This research uses the *most similar systems design* due to the nature of the two theories chosen. The *dependent factor* consists of the result derived from the two CoG analyses methods, while the *independent factors* are identified as the theory differences during the initial comparison of the two theories. Hence, these *independent factors* are mentioned further on in the research, before concluding the situational analysis of the dependent factor.

¹⁵ Mackie, Tom & Marsh, David. *Quantitative Methods* in Marsh, David & Stoker, Gerry (red.) (2002). *Theory and methods in political science* . 2. ed. Palgrave Macmillan: p. 173

¹⁶ Miller, p. 176

¹⁷ Denk, Thomas (2002). *Komparativ metod: förståelse genom jämförelse* . Lund: Studentlitteratur: pp. 42 – 43

The research is conducted in four phases: Theory Review – Comparison and Problem Assessment – Validity Test – Discussion and Conclusions.

The first phase is a review of the two theories and how they define CoG, what sub elements they claim belong to the phenomenon and how these sub elements are defined. This phase also includes a review of the methods the two theories profess for the identification and analysis of CoG. The purpose of this phase is to build the foundation for the comparison by forming a summary of the two theories.

During *the second phase*, the theories are compared in order to identify the *independent factors*. These differences are identified both by comparing the definitions and meaning of the variety of elements and by comparing the methods of CoG analysis. These independent factors are then used in a theoretical discussion to assess what impact these differences could have on the *dependent factor*, which is the result of a practical CoG analysis.

When moving into *the third phase*, a timeslot of the Falklands War in 1982 is used as an object for a CoG analysis conducted using the two different methods. The results are then exposed to the independent factors in order to test the validity of the previously made assessments. Moreover, the Falklands War was chosen due to the fact that it represents a proper example of a joint operation within a relatively easily defined framework.

In *the fourth phase*, the result of the validity test is discussed in order to conclude if the diversities in theory are an actual or perceived problem. This phase also includes a short reflection on the practical impact of the diversity in an operational environment, the human factor impact and how the comprehensiveness of the theories may be improved. The research is finalized by providing suggestions for further research.

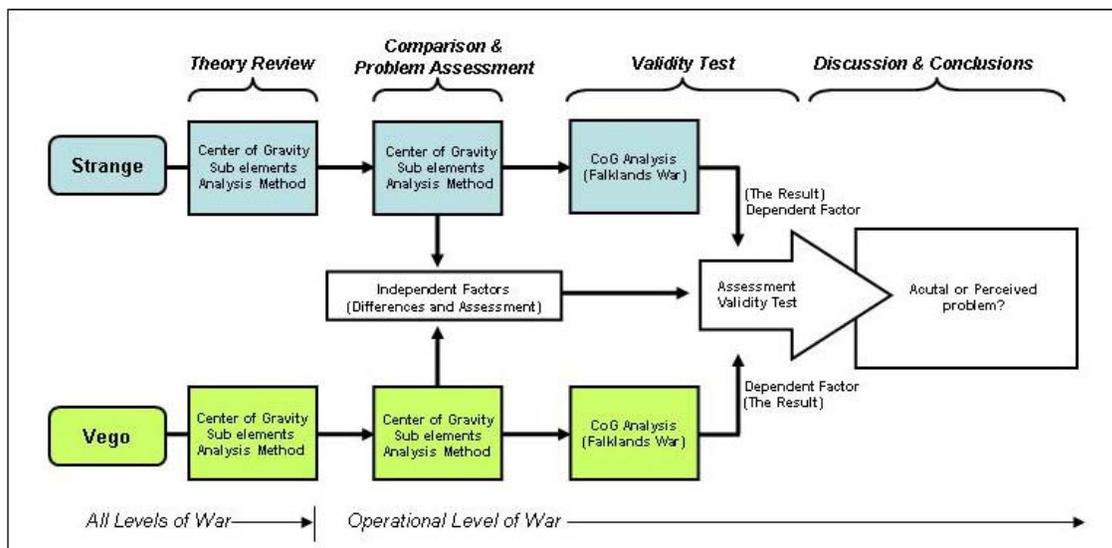


Figure 1: Graphical description of the research methodology

1.8. Validity and Reliability

Validity concerns the degree of measurement of what is intended to measure, while reliability is concerned with if the measurement is done in a correct way.¹⁸ In other words, validity shows to what degree a study supports the conclusions drawn from the results. If the research is reliable, an independent research using the same instrument will give similar scores.

Since this research is about theories concerned with components of the operational art, the level of *subjective input* is quite extensive where the researcher's personal experiences, preconceived ideas and intuition plays a large role.¹⁹ The theories at hand are also emphasizing the officers' knowledge, understanding and intuition, and the impact these factors have when implementing the theories. In addition to this, the theories and their methods of CoG analyses are not scientifically based, and the trail of thought is many times only implied. Due to this, there are some concerns regarding the validity and reliability of this research, which are reviewed by phase below. This research is aware of the problem, and due to this, the research manages the issue by elaborating and describing the conduct of each step, and by identifying factors, motivating them and implementing them as filters in the research.

Initially, during the theory review, this research provides with a summary of the two theories. The displayed result is based on the researcher's interpretation of the theories, and another research might highlight other parts of the theories due to a different understanding. However, the reliability of this part of the research is increased by following a determined flow of study, where each theory is reviewed and summarized in the same strict manner, in order to be as objective as possible.

When comparing the theories, identifying differences serving as independent factors and assessing the effect these will have on the dependent factor, the impact of the subjectivity is present again, where the researcher's knowledge and understanding is used to a high extent. Decisions made during this phase may be different if a research with divergent knowledge and understanding conducts the same comparison. However, this part of the research uses a number of factors identified from the theory review that forms a framework for the comparison and problem assessment, which increases the reliability of this phase.

During the validity test, the assessed impact of the independent factors is analyzed, by using a phase of the Falklands War, summarized by the researcher. The summary and the operational factors derived from the literature are, as the summary of the theories, built upon the researcher's view of the scenario and what factors are deemed important for the upcoming implementation of the theories. Both theories are depending on the knowledge, understanding and intuition of the officer implementing their methods, which in this case will be the researcher's current prerequisites. Importantly, a CoG analysis is not limited by the subjective nature; it requires a high degree of knowledge and understanding. Moreover, the analyses conducted, are due to their iterative and brainstorming nature, difficult to recapitulate in words,

¹⁸ Thurén, Torsten (2007). *Vetenskapsteori för nybörjare . 2.*, [omarb.] uppl. Stockholm: Liber: pp. 26 – 27

¹⁹ In this research, *subjective* refers mainly to the preconceived knowledge, understanding and intuition of the person or group of people conducting the research and/or implementing the theories at hand.

which to some extent will limit the view of the trail of thought. Since the results of the CoG analyses both derive from the previous phases in the research and the subjective view of the researcher, the reliability of the dependent factor can be questioned. However, by being faithful to and following the theories proclaimed methods strictly and as objectively as possible, the reliability of this validity test is increased.

In all, both the independent and dependent factors identified and analyzed during this research are products of an analysis where a combination of the theories and subjective factors plays an important role. The reliability concerning the detailed result of each step is limited, but despite this piecemeal limitation, a research conducting the same steps is likely to derive at a similar conclusion. The divergence in theory is deemed not to derive at a crucial difference in the result of a CoG analysis, when built upon a specific set of subjective values. In this research, the subjective values are founded on an officer competence formed by 18 years of active service, from which 8 years have been focused on tactics and operational art, both in practice and in theory. Finally, the validity of this research is believed to be fulfilled, despite the reliability issues, and the conclusion made is supported by the result of the research.

The issues above are not emphasized further in the following chapters, without some exceptions, in order to enable a focus on the content of the research and the present trail of thought.

1.9. Definition of terms

Operational level of war: “level at which military and nonmilitary sources of power are employed to accomplish a single military-strategic or theater-strategic objective through the planning, preparation, and execution of a single campaign; sometimes the same objective can be accomplished by conducting a major joint or combined operation; this level of war is conducted in a given theater of operations.”²⁰

Objective: “a tangible (“concrete”) or intangible (“abstract”) purpose of one’s efforts; military and nonmilitary objectives are differentiated.”²¹

Mission: “The task, together with the purpose, that clearly indicates the action to be taken and the reason therefore.”²²

In conjunction with the phenomenon of CoG, Milan Vego uses the term *objective* while Strange & Iron use the term *mission*. Strange & Iron are active at the US Marine Corps War College which makes it suitable to use the definition of that service. Vego’s definition of objective is quite similar to the Marine Corps’ definition, and therefore this research will view them as one, where the purpose is their major linkage. When defining the operational level of war, the definition of Vego is chosen. This definition only serves as a framework for the upcoming comparison of theories and it has no impact on the result of the comparison.

²⁰ Vego, p. GL-14

²¹ Vego, p. GL-12

²² US Marine Corps (1997). *FM 105-1-1 Operational Terms And Graphics*. Washington DC: p. 1-102

1.10. Literature review and criticism of the sources

When reviewing the literature and criticizing the sources the principles defined by Thurén²³ have formed the filter. If the source is *genuine* it is what it claims to be and if the source is *independent* it does not build upon transcripts or summaries of other sources. *Freedom of tendencies* is another principle that means that the message should not give a false picture of reality due to personal, economical or other interests. Finally, the principle of *connection in time* is important since if the time gap between the event and the description is too large there are reasons to doubt the relevance of the source.

This research has tried to identify problems when it comes to the theories of Milan Vego and Joseph Strange & Richard Iron, but without any great success. They are genuine and independent event though their starting point on the subject comes from the theories of Carl von Clausewitz, and even though they both aim at building their own theories upon this foundation. The connection in time is not so relevant in this case, since they try to establish general principles in military theory. There could be tendencies in both cases, but this research has not identified any that would interfere with the quality of this work.

When researching the Falklands War there are a great amount of literature that can provide the researcher with both a broad and deep understanding of the conflict. This research is not evaluating the conflict itself; it only uses the conflict as a filter when analyzing the two theories. Therefore, the research uses a limited number of sources for fact finding, but they have nevertheless been exposed to criticism. In general, the literature has a British perspective which in some cases can put some overcast on the principle of *independence* and *freedom of tendencies*. However, this is assessed to have no decisive negative impact on the research itself.

One of the main sources used to describe the conflict, the book *Krigen under kalla kriget*²⁴, is written in Swedish. However, Professor Gunnar Åselius has derived his information from literature available in English. If the reader wishes to enter deeply into the subject, it is recommended to follow the professor's sources; Max Hastings²⁵, Lawrence Freedman²⁶, Jeffrey Ethell²⁷, Anthony Cordesman²⁸, Sandy Woodward²⁹, Martin Middlebrook³⁰ and Robert Scheina³¹.

²³ Thurén, Torsten (2005). *Källkritik* . 2., [rev. och utök.] uppl. Stockholm: Liber: p. 13

²⁴ Åselius, Gunnar (2007). *Krigen under kalla kriget* . Stockholm: Medström

²⁵ Hastings, Max & Jenkins, Simon (1983). *The battle for the Falklands* . London: Pan

²⁶ Freedman, Lawrence (2005). *The official history of the Falklands campaign. Vol. 2, War and diplomacy* . London: Frank Cass

²⁷ Ethell, Jeffrey & Price, Alfred (1983). *Air war South Atlantic* . London

²⁸ Cordesman, Anthony H. & Wagner, Abraham R. (1990). *The lessons of modern war. Vol. 3, The Afghan and Falklands conflicts* .

²⁹ Woodward, Sandy. & Robinson, Patrick (2003). *One hundred days: the memoirs of the Falklands Battle Group Commander* . Fully rev. and updated. Hammersmith, London: HarperCollins

³⁰ Middlebrook, Martin (1989). *The fight for the 'Malvinas': the Argentine forces in the Falklands war* . London: Viking

³¹ Scheina, Robert L. (1987). *Latin America: a naval history, 1810-1987* . Annapolis, Md.: Naval Institute Press

2. Theory Review

In order to build the foundation for the upcoming comparison this research now gives a review of the two modern theories chosen according to the *most similar systems design*. Individually, the two chosen theories and their view on CoG, the different sub elements and the method for CoG analysis are given in a summarized and explanatory manner.

Military theory can be viewed as both normative and explanatory, with ambition to find guidelines for how to conduct war in order to win or just an attempt to explain factors determining the outcome.³² This research has an explanatory ambition by comparing already recognized normative theories and by trying to establish clarity in perceived or actual confusion. The modern theories of Center of Gravity and methods to analyze this phenomenon, provided by Milan Vego and Joseph Strange & Richard Iron, form the theoretical bedrock of this research.

The theories are studied and reviewed following a determined pathway. First the CoG definitions, compositions and nature are surveyed combined with the authors view on the original source. Second, the sub elements are identified and their definitions and nature are reviewed together with their connection in between and towards CoG. Third, the proposed methods for CoG analysis are reviewed, in order to identify the different steps and their interrelation.

2.1. Joseph Strange & Richard Iron

2.1.1. A handbook for officers

Dr Joe Strange has been a Professor of Strategic Studies at the Marine Corps War College in the US since 1990. Dr Strange has had numerous different positions in the US and they have been mainly connected to history in the military sphere. Colonel Richard Iron has had wide operational experience as an officer in the UK and he is currently commanding the UK Army Doctrine Branch in the Directorate of Land Warfare.³³ Both have written a number of articles which have had a broad influence on the subject throughout the western world, even though their theories have not been implemented as a whole. For instance, some elements of their theory are implemented in the GOP which is used by the Swedish Armed Forces during operational planning. When choosing literature on this theory, this research focused on the referred book, and did not take into consideration the numerous articles published, mainly because the chosen book is new and updated and gives the most modern view of their theories.

There are many reasons why this research uses the theories of Joe Strange and Richard Iron (Strange/Iron). First, their view on CoG as connected to strength is compatible with the view of the Swedish Armed Forces. Second, their theories have had an obvious impact on the planning tools used by the Swedish Armed Forces. Third, the curricula at the Swedish National Defence College emphasize the theory as one of the major theories on the subject of CoG. Fourth, when

³² Widén & Ångström, pp. 9 – 10

³³ Strange & Iron, p. 55

exposed to this theory the author of this research felt comfortable due to its comprehensible character.

Joe Strange & Richard Iron (Strange/Iron) agree on the problem that there are contradictions and ambiguity between different theories on CoG, even though there has been progress in modern time.³⁴ Strange/Iron argue that the contradictions causes a loss of valuable time that is used on “*fruitless discussion*” instead of planning.³⁵ Their theory is an attempt to clarify the misconceptions and to provide the planner (civilian or military) with a clear definition of CoG and a comprehensible model for the analysis of CoG.³⁶

Overall, they succeed in their intent and the theories regarding CoG are concise and easily understood. Moreover, the method of analysis is comprehensible and exemplified which will help the professional officer conducting operational planning. There are some unresolved issues in their theory, but it is served as a tangible handbook for officers.

2.1.2. Centers of Gravity

Strange/Iron strongly question the existing American and NATO doctrines and their definitions of CoG. They claim that the understanding of CoG is incorrect in connection to the original theory of Clausewitz and that many definitions confuse CoG with the requirements that support the actual CoG.³⁷ Moreover, the definitions have left the original meaning where a CoG is a strength that can deliver a decisive blow on the opponent, even if the given examples many times are just of that sort.³⁸

“**Centers of Gravity (CG)** are physical or moral entities that are the primary components of physical or moral strength, power and resistance. **They don’t just contribute to strength; they ARE the strength.** They offer resistance. They strike effective (or heavy) physical or moral blows. At the strategic level, they are usually leaders and populations determined to prevail. At operational and tactical levels they are almost invariably specific military forces.”³⁹

When reviewing the phenomenon on an operational level, Strange/Iron believe the discussion on CoG is clear and that there should be no misunderstanding. According to their view, a CoG is to be found where a force’s main power is situated and it is of a physical nature.⁴⁰

However, Strange/Iron believe to have identified where the misunderstanding and confusion comes from. Many of the quotes used on CoG originate from the part of Clausewitz’s theory which covers the strategic level, and due to improper choices in translation and due to the lack of contextual understanding, the original essence is lost in many cases.⁴¹

³⁴ Strange & Iron, p. 11

³⁵ Strange & Iron, p. 18

³⁶ Strange & Iron, p. 27

³⁷ Strange & Iron, pp. 11 – 14

³⁸ Strange & Iron, p. 21

³⁹ Strange & Iron, p. 35

⁴⁰ Strange & Iron, pp. 13 – 14

⁴¹ Strange & Iron, pp. 14 – 15

While elaborating on the contextual deficiency Strange/Iron find support for the connection between CoG and the physical forces of the army. They illustrate that even on the strategic level the army is functioning as CoG, they identify that even if a capital could perhaps be viewed as a CoG, the army will always be the crucial factor. In all, they recognize the phenomenon of CoG clearly connected to the main body of the army, in other words the strength.⁴²

Parallel to the text taken out of context, they also point out that there are unfortunate choices in the translations of the original. Insignificant though important differences have increased the distance between modern definitions and conceptions from the original idea of CoG. Strange/Iron even argue that the modern implementations of the phenomenon are unnecessarily more complicated than the original. When they elaborate on this issue they emphasize that CoGs are physical and that they can strike the opponent.⁴³

Even though Strange/Iron continuously claim a CoG as something physical, they also relate to more abstract CoGs in their theory. On the strategic level, there will likely be one or more moral CoGs that enable a continuous spirit of resistance. They refer to Clausewitz's examples of moral CoGs; the capital, the shared interest in an alliance, the leader and the population, but at the same time they raise doubt about their roles as CoGs. Is the capital itself the CoG or is the CoG what is in the capital. In all, Strange/Iron claim that the moral CoG in some way is linked to the people and the will to fight and that the ability to command the resources connects the three categories – the leader, the ruling elite and a strong-willed population. In order to win the peace and not only the war, both the physical and moral CoG need to be identified and defeated since they are active agents that attempt to destroy the capability and will of the opponent.⁴⁴

The theory of Strange/Iron claims that its viewpoint is faithful to the original conception of CoG; therefore CoGs should be viewed as dynamic, positive and powerfully active agents that can strike effectively. Furthermore, CoGs are obvious even though the moral type is somewhat unsubstantial.⁴⁵ They exist at all levels of war when a combat mission is given and there are several CoGs on each level.⁴⁶ However, CoGs do not exist without a relation to an opponent and there will be no opposing CoG if there is no threat of overrunning the objectives of the other side.⁴⁷

2.1.3. Sub elements

The theory of Strange/Iron identifies a number of different sub elements that are connected to the CoG. The model they give the planner consists of four different elements/concepts all together, including CoG. Below the three sub elements of CoGs will be reviewed and analyzed.

⁴² Strange & Iron, pp. 15 – 19

⁴³ Strange & Iron, pp. 18 – 19

⁴⁴ Strange & Iron, pp. 21 – 26

⁴⁵ Strange & Iron, p. 26

⁴⁶ Strange & Iron, p. 31

⁴⁷ Strange & Iron, p. 20

According to Strange/Iron there are factions that within the framework of a maneuverist approach want to categorize CoGs as weaknesses as an alternative to strengths, but instead of confusing the original meaning of CoG, Strange/Iron recognize that even strengths most times have weaknesses. The weaknesses, that Strange/Iron name Critical Vulnerabilities (CV), need to be identified and exploited in order to achieve success.⁴⁸ Further below the concept of CV will be elaborated, but the elements of Critical Capabilities and Critical Requirements need to be reviewed first so the CV can be placed in a proper context.

“Critical Capabilities (CC): every center of gravity has some primary ability (or abilities) that makes it a center of gravity in the context of a given scenario, situation or mission – including phases within campaigns or operations.”⁴⁹

Critical Capabilities are directly connected to CoG and describe what the chosen CoG can accomplish that could jeopardize the opponent’s mission. The CC shows what potential a CoG has in relation to the opponent. When defining a CC, the key word is a *verb* which Strange/Iron exemplify plentifully in different case studies, i.e. it can *destroy, block or prevent* something.⁵⁰

“Critical Requirements (CR): are conditions, resources and means that are essential for a center of gravity to achieve its critical capability.”⁵¹

In order for a CoG to have the possibility to maintain or establish the capabilities described as CC, there are always some essential prerequisites. Strange/Iron faithfully exemplify the CR, as well as the other elements in conjunction with the case studies. They mention CR such as intelligence, C2 and logistics, which enable the CoG to reach the CC required for it to be a CoG.⁵²

As mentioned earlier Strange/Iron believe that most strengths have weaknesses and an important part of the operational planning is to identify these factors in order to find the decisive actions needed. In this theory these weaknesses are called Critical Vulnerabilities.

“Critical Vulnerabilities (CV) are those critical requirements, or components thereof, that are deficient, or vulnerable to neutralization or defeat in a way that will contribute to a center of gravity failing to achieve its critical capability.”⁵³

Strange/Iron claim that a CoG has both intrinsic and external weaknesses and that they can be of many types including technical, geographical or more abstract factors such as national psyche. Interestingly, a weakness in one context can be a strength in another, which means that the “window of opportunity” is many times based on time as an essential factor. When defeating a CoG there are, according to Strange/Iron three primary ways to react which are all focused on the exploitation of identified CV. Either the plan focuses on making the CoG

⁴⁸ Strange & Iron, p. 33

⁴⁹ Strange & Iron, p. 35

⁵⁰ Strange & Iron, pp. 35 – 37

⁵¹ Strange & Iron, p. 35

⁵² Strange & Iron, p. 37

⁵³ Strange & Iron, p. 35

irrelevant, on denying it the needed support or on defeating the CoG by exploiting system weaknesses, and it is in these three areas the search for CV should centre.⁵⁴ However, it is rare that one identified and neutralized CV will bring success. Usually, in order to achieve success, the operation needs to neutralize a number of CV in a sequence and produce the decisive result by a cumulative effect. Instead of a “silver bullet” a CV is usually a “led bullet”.⁵⁵

2.1.4. Method for Analysis

Strange/Iron provide the planner with an analytic model to be used on strategic and operational level where the identified CoG is dissected in order to find what could be decisive in an operation.⁵⁶ However, the theory of Strange/Iron does not provide the planner with a tool for identifying the actual CoG, even though it offers a sequence of questions to determine true or false moral CoGs on the strategic level.⁵⁷

Strange/Iron point out that the antagonistic nature of CoGs is truly important and that there doesn't exist a CoG without the relation to an opponent. Moreover, they emphasize that the CoG might be different if viewed from two different perspectives or opponents. This is exemplified with Operation Iraqi Freedom, where the Republican Guard was accepted as the Iraqi operational CoG, even though the true strength and obstacle in relation to the coalition was the Fedayeen, while the Republican Guard could maintain the title of CoG from a Kurdish perspective.⁵⁸

In all, the planner is not provided with a tool that helps to identify the CoG of neither the opponent or of one's own forces. The model is focused on analysis of an already identified CoG that fills the requirements given in the CoG definition. Still, when studying the theory the planner will find indirect guidelines that can assist in this process.

When giving examples of CoG on different levels during the Gulf War in 1991 the connection between the mission and the CoG on that level is quite clear and the CoG can be interpreted as the active agent that stands in the way for mission success.⁵⁹ This is enforced when Strange/Iron, during a review of critique aimed at the same conflict emphasize the importance of the *de facto* objective when identifying the CoG.⁶⁰

Just as the recognized shortage connected to the identification of CoGs, the theory misses a comprehensible description of how the CC should be found. When reviewing the examples given by Strange/Iron, it seems like an iterative process where the planner identifies the CoG and the capabilities simultaneously and continuously in relation to the mission or objective given.⁶¹

⁵⁴ Strange & Iron, p. 34

⁵⁵ Strange & Iron, p. 36

⁵⁶ Strange & Iron, pp. 29 – 30

⁵⁷ Strange & Iron, p. 24

⁵⁸ Strange & Iron, p.20

⁵⁹ Strange & Iron, p. 32

⁶⁰ Strange & Iron, p. 48 (footnote 52)

⁶¹ Strange & Iron, pp. 37 – 38, 40 – 45 and 49

However, when the CoG and its CC are identified the model becomes more comprehensible and clear again. When conducting planning the professional officer needs to “*conduct two side-by-side*” CoG and CV analyses, one for each antagonist. Strange/Iron suggest the planner makes a list of all CR associated with the chosen CoG and CC that are relevant in the present context. The next step is to analyze the identified CR and find known, probable and possible CV connected to each of them.⁶²

In order to make the analysis easier to conduct and view, they propose that the model is used in a four column format. The format including the connection between CoG, CC, CR and CV is exemplified in the table below.

Centers of Gravity	Critical Capability	Critical Requirement	Critical Vulnerabilities
German U-boat fleet	Disrupt/retard passage of US military personnel and equipment to UK.	At-sea logistics to extend range and time at sea...	Re-supply rendezvous points comprised by breaking ENIGMA code.

Table 1: The Strange/Iron four column format for CoG analysis.⁶³

Finally, Strange/Iron claim that the CoG analysis and the model they provide is applicable to any conflict or situation. They exemplify this by showing an analysis on the War Against Terrorism. Interestingly, an end-state is given here for the first time, which provides the reader with a better contextual understanding even though the connection to the conducted analysis is somewhat thin.⁶⁴

⁶² Strange & Iron, p. 39

⁶³ For more examples of the format and different contents, see Strange & Iron, pp. 36 – 37

⁶⁴ Strange & Iron, pp. 48 – 49

2.2. Milan Vego

2.2.1. Opus Magnum

Milan Vego (Vego) is active at the U.S. Naval War College. He is a professor of Joint Military Operations and holds a B.Sc. and M.Sc. from Belgrade University and a PhD. from George Washington University. He has written books and numerous articles on military matters.⁶⁵ Vego also frequently gives lectures at the Swedish National Defence College. This research focuses on the updated book referred to, and disregards the articles published, since the articles published in most cases derive directly from the book itself.

When it comes to the theories of Vego, this research derives the empirical material from Vego's *Joint Operational Warfare*. In this book, Vego tries to provide the professional officer with a description and analysis of the most important aspects of operational warfare and he aims to fit this all into one volume. Vego is aware of the fact that not everything can be covered, but his intention is to deliver a synthesis on the subject based on a large amount of theoretical and practical aspects.⁶⁶ His book is a heavy one, both in weight and content, and Vego presents operational warfare in a logical sequence starting with the basic fundamentals. It is an achievement of great value that offers the professional officer a deep and wide understanding of operational warfare, amplified with numerous historical examples. This is not a handbook to carry in the field, it is an opus magnum.

The theories of Milan Vego were chosen for this research because of different reasons. First, just as Strange/Iron, Vego views CoG as connected to strength which is in conjunction with the belief of the Swedish Armed Forces. Second, the curricula at the Swedish National Defence College are increasingly viewing Vego's theories as substantial. Third, compared to Strange/Iron the theories of Vego have a wider perspective and a depth that this research believes could increase the knowledge of the phenomenon. Fourth, when given the book *Joint Operational Warfare* the author of this research felt that this theory could provide a personal challenge due to the mentioned depth.

Vego believes that the plan for an operation or campaign depends on proper determination of both friendly and enemy CoGs. He claims that many professional officers do not give the concept the attention it deserves and that due to different circumstances it is ignored, despite the importance. Vego believes, similarly to Strange/Iron, that the misconceptions connected to the concept of CoG derive from mistranslation of the original term of *Schwerpunkt*.⁶⁷ However, Vego claims that despite the misunderstanding of the original, the [modern] concept of CoG is highly useful.⁶⁸ In all, Vego develops and explains the concept of CoG in a comprehensive manner and he provides the reader with a depth that is hard to find in other sources besides in the work of Clausewitz.

⁶⁵ Military Review (January – February 2007), Downloaded from
<<http://usacac.army.mil/CAC/milreview/English/JanFeb07/Vego.pdf>> 2008-12-27

⁶⁶ Vego, p. xvii

⁶⁷ Vego, p. VII-13

⁶⁸ Vego, p. VII-26

2.2.2. Centers of Gravity

According to Vego, the concept of CoG is not that complicated. The professional officer has to accept the fact that an objective will be accomplished if the main effort is directed at the enemy's dominant strength, while the source of the friendly dominant strength is protected.⁶⁹ Using the concept of CoG increases the chance of accomplishing the objective and this is the key to success.⁷⁰ Moreover, the CoG identification process might be as important as the product itself.⁷¹

Unfortunately there are many misconceptions on the concept and Vego tries to falsify these. Vego states that a common error is confusing physical objectives with CoG and thereby focusing the efforts in the wrong direction. For instance, a geographical location like a port has no strength, but the source of strength that maintains control of that location could have. Vego also points out that decisive points should not be confused with CoGs even though they to some extent can be a source of strength, however small in size and power. CoGs include elements for integration, protection and sustainment, but these elements are usually potential weaknesses and should therefore not be mixed up with the CoGs. Vego also contests the theory that views a CoG as a "focal point" that holds the enemy together as a factor of balance. According to Vego, a CoG cannot be viewed with this type of mechanical lens, since there are always both tangible and intangible elements included in the source of strength.⁷²

“center of gravity—a source of “massed” strength—physical or moral—or a source of leverage, whose serious degradation, dislocation, neutralization, or destruction would have the most decisive impact on the enemy's or one's own ability to accomplish a given military objective; tactical, operational, and strategic (theater-strategic and national/alliance/coalition) centers of gravity are differentiated; each center of gravity is related to the corresponding military objective to be accomplished.”⁷³

Vego argues that there can be both military and nonmilitary CoG including the mentioned tangible and intangible elements. On higher levels of war and when the objectives are nonmilitary, the CoGs will usually be nonmilitary and consist of more intangible factors in comparison with lower levels than when the objectives are purely military. Civilian leadership and his/her will to fight could exemplify a nonmilitary CoG and an intangible element that is hard to measure or quantify. In contrast, a mechanized division could illustrate a military CoG and a tangible, measurable element.⁷⁴

CoGs do not exist on by themselves. The objective to be accomplished and the current situational factors decide what a CoG consists of and not the opposite. If CoGs fail to be linked with the objective, the ends, ways and means might be mismatched. For every objective there is

⁶⁹ Vego, p. VII-29

⁷⁰ Vego, pp. VII-13 – 14

⁷¹ Vego, p. VII-14

⁷² Vego, pp. VII-29 – 33

⁷³ Vego, p. GL-4 f

⁷⁴ Vego, p. VII-13

a CoG.⁷⁵ There are examples of a multitude of CoGs for a single objective, however this is rare.⁷⁶

CoGs exist on all levels of war, but since the number of CoGs is related to the amount of objectives to be completed, there are fewer CoGs on the higher levels. Hence, on the tactical level the number of objectives and corresponding CoGs will be plentiful, but at the same time the analysis will be less complex due to fewer involving factors. However, Vego claims that on the lowest tactical level the need for identifying CoGs is very low.⁷⁷

CoGs have specific features that cannot be found amongst objectives, locations or decisive points. On the strategic level the tangible elements of a CoG have the ability to threaten the opponent's strategic CoG, and on the levels below the CoG, they can physically endanger the opposing CoG.⁷⁸

Vego states that a CoG is composed of an inner respectively an outer core. The main source of power of a CoG is situated in the inner core while elements providing integration, protection and sustainment are placed in the outer core. Importantly, the two cores need to be viewed as a whole and the inner core cannot function well if the outer core is deficient.⁷⁹

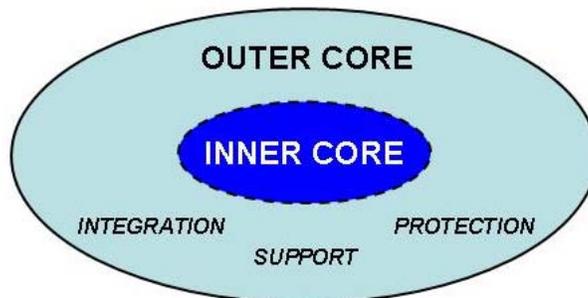


Figure 2: Composition of a Center of Gravity⁸⁰

On the nonmilitary, national level, the CoG integrating and unifying elements could be exemplified with the political system, culture and social traditions, while in the military variant, the command structure, common doctrines and C4 systems are the unifying factors. Parallel to the unifying factors, the CoG inner core needs to be protected. On the national level it is the armed forces, the police and other organizations with the task of protecting the society that form the protecting elements. In the outer core of a military CoG, the protecting elements could be air defense, operational security and force protection. The outer core also contains elements that support and sustain the performance of the CoG inner core. On the national level these elements could be diplomacy, economy and public support. In a military CoG the support is usually represented by intelligence, logistics and fire support.⁸¹

⁷⁵ Vego, pp. VII 24 – 25

⁷⁶ Vego, p. VII-21

⁷⁷ Vego, p. VII-25

⁷⁸ Vego, p. VII-21

⁷⁹ Vego, p. VII-17

⁸⁰ A simplified version of the graphs given by Vego, pp. VII-18 – 19

⁸¹ Vego, pp. VII-17 – 19

The inner core constitutes the main source of power of a CoG. In a nonmilitary CoG, this inner core could consist of the will to fight, a democratic leadership, ideology and/or legitimacy. When it comes to a military CoG, the inner core is primarily built upon firepower, maneuver and leadership.⁸²

Finally, the professional officer needs to know that the preconditions constantly change, and the identified strengths and weaknesses may change as the operation proceed, which might imply a change in CoG on either or both sides of the conflict even when the same objectives are active. Therefore, a continuous follow-up and reassessment during the operation is necessary.⁸³

2.2.3. Sub elements

Vego frequently states the importance of the military situation and the objectives to be accomplished. They are principal ingredients when finding a solution for the military problem. When analyzing the information, the professional officer needs to identify what is essential to reach the specific objective. Physical and tangible or abstract and intangible aspects that are essential are called *critical factors*. Tangible, critical factors range from geographical features to military forces or resources such as economy, while intangible factors could be morale, public support or the will to fight. It is in these critical factors that CoG and the different sub elements below will be found.⁸⁴

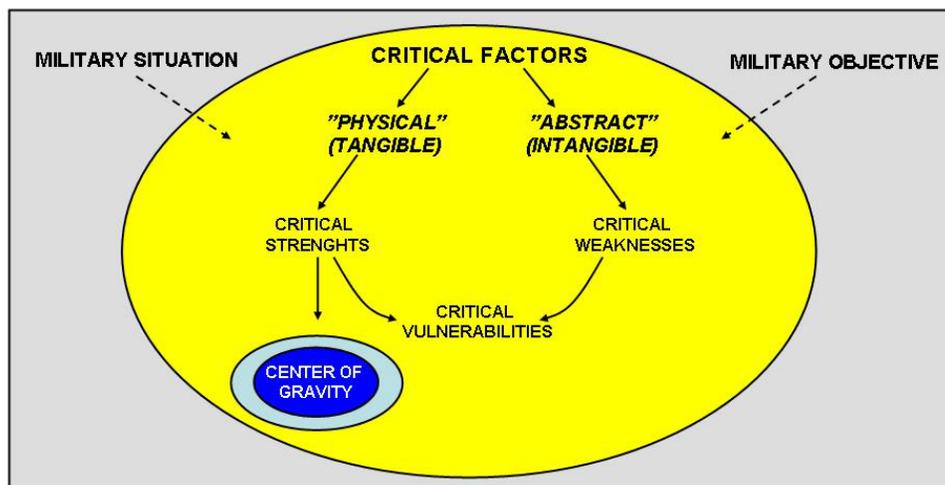


Figure 3: Concept of Critical Factors and Center of Gravity⁸⁵

In an ever changing environment, the critical factors are constantly subject to changes. The professional officer has to understand the situation and what impact it will have on the factors.

⁸² Vegp. pp. VII-18 – 19

⁸³ Vego, p. VII-22

⁸⁴ Vego, pp. VII-14 – 15

⁸⁵ A simplified version of the graphs given by Vego, p. VII-15. Take note that the figure itself can be misleading, since it states that critical strengths only are derived from tangible factors and critical weaknesses only from intangible factors. Strengths and weaknesses can of course be found in both of these areas.

When analyzing the situation and the different actors a key for success is to avoid mirror-imaging and to understand the impact of both the objective and the level of war will have on the factors. Critical strengths and weaknesses may be the opposite on different levels with a variation in objectives to attain.⁸⁶

“critical strengths—those military and nonmilitary capabilities considered essential to the accomplishment of one’s or the enemy’s military objective(s); the most important among the critical factors of a force is the center of gravity (COG).”⁸⁷

Since one of the critical strengths will compile the CoG, the examples given on CoGs above are relevant as critical strengths as well. When it comes to military factors, the critical strengths consist of physical or moral power as well as those elements that protect, integrate and support the combat power. In the nonmilitary arena critical strengths could be legitimacy, national leadership or ideology.⁸⁸ Importantly, a critical strength can, due to actions by the antagonist, become undermined and shift to a critical weakness.⁸⁹

“critical weaknesses—military and nonmilitary capabilities that are considered essential to the accomplishment of one’s or the enemy’s military objectives but are, in terms of quantity or quality or both, insufficient or inadequate to perform their intended functions.”⁹⁰

A critical weakness could on the national, nonmilitary level be a low population morale or loss of unity of effort in an alliance. Inadequate firepower and mobility or poor force protection could be a critical weakness in a military force. When reviewing the examples given by Vego from the North African Campaign in 1943, they mostly exist due to a comparison with the opponent.⁹¹

“critical vulnerabilities—those critical weaknesses (and sometimes critical strengths) open to the enemy’s attack or exploitation.”⁹²

Critical vulnerabilities are in general connected to the critical weaknesses, but as mentioned above, a critical strength can become a critical vulnerability. This could for instance happen if the logistical support for a unit temporarily is limited due to organizational issues. A critical vulnerability could be the weakest member in a coalition or the unwillingness of a nation to sustain a high number of casualties.⁹³ However, a critical vulnerability only exists if the other party has the potential to exploit it.

⁸⁶ Vego, p. VII-17 and p. VII-22

⁸⁷ Vego, p. GL-6

⁸⁸ Vego, p. VII-15

⁸⁹ Vego, p. VII-16

⁹⁰ Vego, p. GL-6

⁹¹ Vego, p. VII-16

⁹² Vego, p. GL-6

⁹³ Vego, p. VII-16

When neutralizing the enemy CoG, it could be done either directly or indirectly. A direct attack can be described as a punch with your strengths on the opponent's strengths. This might be costly in personnel and resources so an indirect attack on the CoG through the linked critical vulnerabilities is many times preferred.⁹⁴ In order to achieve any of the methods, the CoG and the sub elements need to be identified. Vego's analytical process for this purpose will now be reviewed below.

2.2.4. Method for Analysis

The identification of CoG is a complicated process and if a faulty CoG is chosen this may endanger the entire effort. Vego states that objectives could be accomplished without neutralizing the opponent CoG if the forces you possess are superior to the opponent's, but that operational success will, without doubt, be jeopardized.⁹⁵

According to the theory of Vego there are eight general steps to walk through when determining the friendly and enemy CoG, excluding the proposed validity questions. Below, in the following overview, each step will be accounted for followed by Vego's proposed validity questions. Importantly, since the results from the process are two opposing CoGs, each step needs to be viewed from two perspectives.

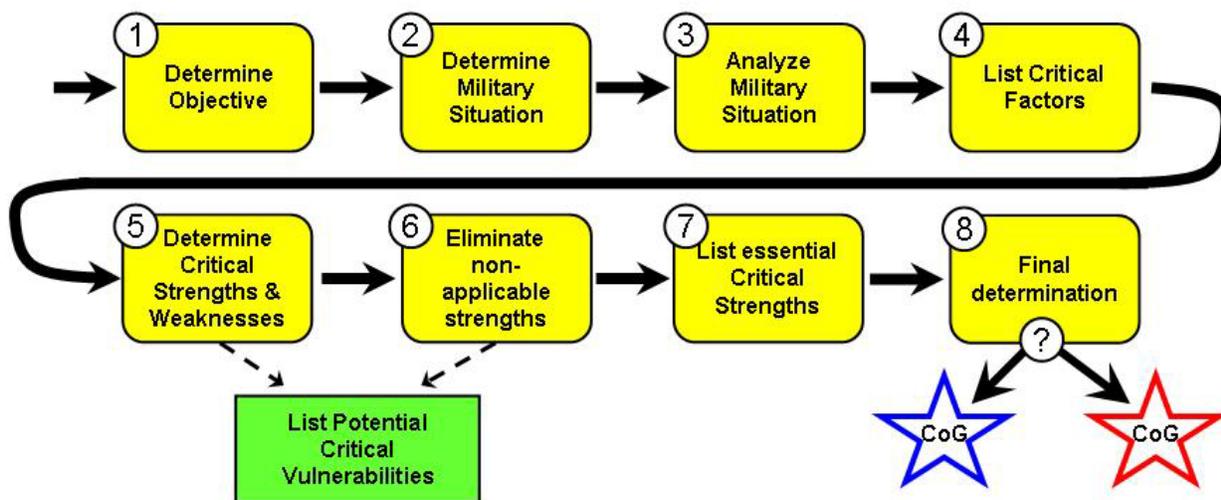


Figure 4: Process of Determining Center of Gravity⁹⁶

First, the professional officer needs to determine what objective to accomplish. Second, based on the objective, the situation is determined. Third, the corresponding situation is analyzed in regards to space and forces. Fourth, a list of critical factors will be derived, i.e. tangible or intangible elements considered essential for the accomplishment of the objective.⁹⁷

⁹⁴ Vego, p. VII-109

⁹⁵ Vego, p. IX-92

⁹⁶ A simplified version of the graph given by Vego, p. IX-91

⁹⁷ Vego, p. IX-91 and p. VII-14

Fifth, the critical factors will be used to identify both friendly and enemy critical strengths and critical weaknesses. Sixth, all listed critical strengths will be analyzed further in order to delimit those which cannot be candidates for CoGs. Integrators, protectors, sustainers, factors related to space, elements of the outer core and power that cannot threaten the opposing CoG will be left for further analysis. These factors will assist when identifying methods of protecting the friendly CoG or indirectly attacking the enemy CoG. The outcome of step five and six also provides the planner with ingredients to identify potential critical vulnerabilities, i.e. critical weaknesses (or strengths) that are open to exploitation. Seventh, from the previous step, the critical strengths that can deny the enemy and friendly objectives are listed separately.⁹⁸

Eighth, during the last step a final determination of the *most critical strength* is conducted. The essential critical strength chosen on each side is the CoG.⁹⁹ However, before making the last crucial decisions, there are questions to answer in order to control the validity of the proposed CoG. Will the destruction or neutralization of the selected opponent's CoG prevent the opponent from accomplishing his objectives? Are my forces capable of destroying or neutralizing the selected opponent's CoG? These questions need to be asked from both perspectives and the answer should be a positive one or the previous identified critical factors need to be reassessed.¹⁰⁰

Finally, although Vego provides the professional officer with an analytical process to identify CoGs he clarifies that this is not enough. The key to the process is the professional officer's knowledge, understanding, judgment and wisdom.¹⁰¹ There are many unquantifiable factors involved and the risk of mirror-imaging is great. Therefore, time consuming thinking and discussion need to take place.¹⁰²

⁹⁸ Vego, p. IX-91

⁹⁹ There is a contradiction in this last step compared to the described composition of CoG. This research proclaims and assumes that the most critical strength identified will serve as the inner core of CoG and not the CoG itself. This is further explained in chapter 3.3. *Clarification* and implemented in chapter 4.3. *Milan Vego Analysis*.

¹⁰⁰ Vego, pp. IX-91 – 92

¹⁰¹ Vego, p. VII-14

¹⁰² Vego, pp. IX-91 – 92

3. Comparison and Problem Assessment

Now, since the two theories have been reviewed, this research moves into the second phase, where the theories are compared in order to identify the differences. The comparison is done in two steps, where the two first research questions are answered. The identified differences are then used for an assessment on what possible impact they have on the dependent factor, which is the result of a CoG analysis in practice. As mentioned earlier, the comparison is conducted on the operational level only.

The comparison and problem assessment in this chapter is guided by a number of factors identified when reviewing the theory summaries above. When comparing CoGs and their sub elements, the factors of *definitions*, *relation* and *composition* are used. The definitions are analyzed due to their sometimes perceived abstractness, while the relations in between different elements need comparison due to the required understanding of each system. The compositions are compared, as part of the system understanding and the interrelating impacts they may have.

When comparing the methods the following factors are identified and implemented. The *relation to the objective and the opponent* is crucial, since if this is disregarded or misunderstood, the efforts may be misdirected in an operation. *Directions of analysis* are compared in order to identify to what extent the analysis might impose a loss of tempo and what impact the intuition has. *Complexity* is compared due to the fact that time constraints and frictions many times demand a simplistic approach in operational planning.

3.1. Theory Comparison

3.1.1. Definitions, relations and composition

The definition and meaning of CoG are similar in many ways. Both theories claim there is a connection to the primary or most essential strength and they agree that the number of CoGs increase on the lower levels. Regarding their view on physical and moral CoGs they both claim that the latter is more common on the strategic level and that the majority of CoGs on the operational level are of a physical nature. However, Vego seems more open to abstract elements acting as CoG on the operational level. This could mean that a Peace Support Operation might well include an operational CoG based on the will of the people. In general, Vego covers the abstract factors as part of the CoG nature in a more open way compared to Strange/Iron who clearly focus on the physical elements.

The definitions of CoG given by the two theories are filled with nuances, which could lead to misinterpretation if the professional officer does not study the whole theory. This occurs more so in Vego's definition than in Strange/Iron's, where there is a risk that the word "*source*" could be interpreted in the wrong way, which for instance could give a harbor the title of a CoG.

When comparing the theories' relation to the opponent and the objective (mission), they both emphasize the importance of these two factors when CoGs are discussed. Regarding the objective (mission), both theories claim the existence of CoGs for every objective. At the same

time, there will be no CoGs if there is no opponent trying to hinder the other side from reaching their objective, which means that there is also a clear relation to the opponent. This relation is also clarified further when the theories state that the process of identifying and analyzing CoGs needs to be conducted in an iterative process, with both opponents included at the same time. Hence, in connection to each objective, at least two different CoGs will therefore exist and a conflict between them will take place. In general the theory of Vego is clearer on this matter compared to Strange/Iron's theory. Vego includes the connection with the objective in the definition, in the step-by-step process and he finalizes the identification with a validity test that includes the relation to objective and opponent.

It is when comparing the two theories' views on the composition of CoGs that the first major differences can be identified. Since Strange/Iron claim that CoGs are the primary component of strength, this research believes the CRs and CVs are mainly found outside of the actual CoG, even though there are obvious connections in between these elements. This means that the requirements and vulnerabilities could be both external and internal, but they are in direct or indirect relation to the CoGs. Hence, the CRs and CV could be found on the same level as the CoG, on a lower level or on a higher level of war. If this view of Strange/Iron is implemented as a transparent layer on the theories of Vego, it gives that the Strange/Iron CoG is equal to the inner core of Vego's composition. Vego's theory places a capsule, the outer core, around all critical factors that have an impact on the pertaining objective and the situation connected to it. Vego's approach is, in general more systematically oriented, where all parts are to be viewed together as a whole on a specific level of war, though connected to the other levels.

In all, the CoG composition varies between the two theories, but despite this, the opinions regarding the connected vulnerabilities and their nature are very similar. It is mainly in the space between the primary strength and the vulnerabilities the next major differences appear. The Critical Capabilities according to Strange/Iron have no equivalent defined by Vego, but Vego states that CoG have specific features that can threaten the opponent's CoG and he poses a number of questions to test the validity of the chosen CoG. The Critical Requirements also lack a corresponding definition in Vego's theory, since he instead identifies and distributes critical factors as critical strengths or weaknesses, mainly placed in the outer core as protecting, integrating or supporting elements. The critical strengths, acting as these elements, can to some extent be equaled to Strange/Iron Critical Requirements, but the critical weaknesses have no defined counterpart in the theory of Strange/Iron.

Both theories frequently refer to the dynamic nature of conflict and the impact this can have on different factors. Vulnerabilities can change and become untouchable while situational factors may expose former strengths as vulnerabilities open to exploitation. The theories are convinced that there are weaknesses that the other part cannot influence in a certain context. However, the theory of Vego has a decisive advantage in regards to this matter when defining critical weaknesses. Critical weaknesses are disadvantages presently unreachable to the opponent's actions that might become exploitable if the situation changes. When formalizing this phenomenon, as Vego does, a more systematic follow-up is attainable.

3.1.2. Method for analysis

The two theories and their methods of analysis emphasize that the process has to be done in an iterative manner where both opponents are analyzed parallel to each other. However, in order to identify CoGs and the different sub elements, the theories have one major difference. Strange/Iron first identify the CoGs and then dissect them in order to find the Critical Requirements and the Critical Vulnerabilities. Vego, on the other hand, claims that the ultimate way is to approach the analysis from the other direction. Vego starts with determining the objective, defining the situation and then by analyzing listed critical factors the CoG will be identified. The importance of the objective or the mission in relation to the identification process can be found in Strange/Iron's theory, but the connection is not as clear as in the theory of Vego.

In order to identify CoGs in accordance with the theory of Strange/Iron, the commander (or the staff members) decides what the primary strength is. This decision is based upon the experience, knowledge, understanding and intuition of the officers. Moreover, there is no given method for this identification, even if there are some indirect guidelines that can help. The same circumstances prevail when the Critical Capabilities are to be identified.

Even though the method proclaimed by Vego works the opposite direction, the officers' ability and intuition plays a major role, but it is played differently. Initially, the intuition and experience will have an impact when identifying and analyzing the critical factors and the final influence will take place when the most critical strength is to be determined. Hence, both theories include intuition, but the decision seems to be built on a firmer and more careful foundation in Vego's theory, which of course relies on a larger number of officers involved in the process or more time appointed for the process.

When focusing on simplicity, which could be required in a complex and time limited context, the theories of Strange/Iron appear more comprehensible. When the CoG and its Critical Capabilities are decided, the identification of Critical Requirements and Critical Vulnerabilities follows a precise format that gives the officers a lucid idea of the result and where it comes from. In contrast to this, the theory of Vego is more complex and detailed, and it involves some contradictory steps in relation to Vego's idea of the CoG composition, as mentioned earlier. A great advantage of Vego's theory is the division between critical weaknesses and critical vulnerabilities, even though this process is not described.

Finally, the theory of Vego in difference to the theory of Strange/Iron provides the professional officer with a series of questions to conduct a needed validity check when the CoG identification is done. This test could be improved by extending it with questions concerning the identified critical vulnerabilities and their validity in connection to the chosen CoG.

3.2. Clarification

To clarify the theories' view of CoGs, the different sub elements and the connection between them, this research provides the reader with graphical suggestions based on the understanding of the theories reviewed above. First, since Strange/Iron do not offer such a description at all, the picture below may improve the understanding of the theory significantly.

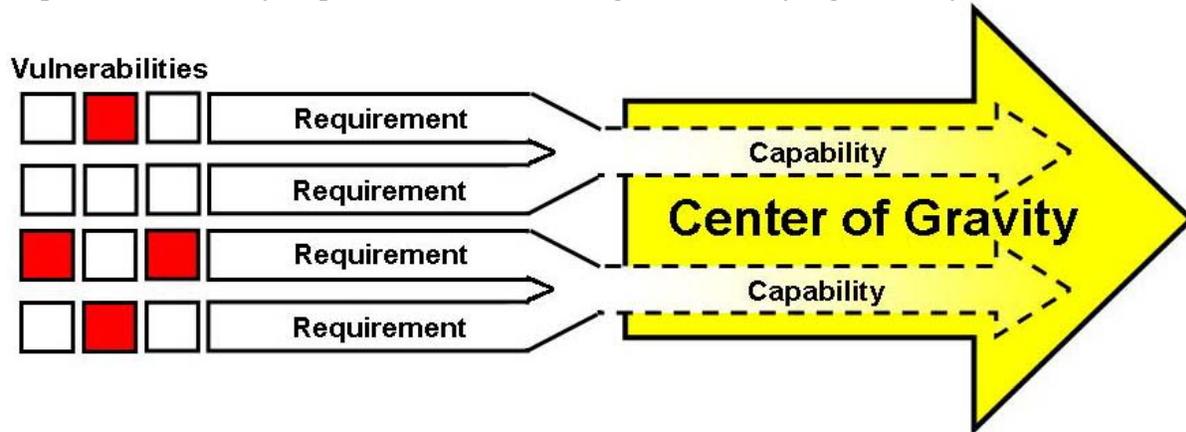


Figure 6: *Strange/Iron* – suggested graphic description of the elements and their connection.

Second, in contrast to Strange/Iron, the theories of Milan Vego are frequently reinforced with graphical descriptions. However, as mentioned earlier, when comparing the given composition of a CoG with the method for analysis, the connection between the CoG, the inner core and the outer core is somewhat contradictory. Therefore, this research assumes that when Vego claims the most critical strengths to be CoGs, the theory actually means that these strengths should compose the inner core of the CoGs. In order to clarify Vego's meaning of the different elements and their connection to the cores of CoG, the diagram below is recommended.

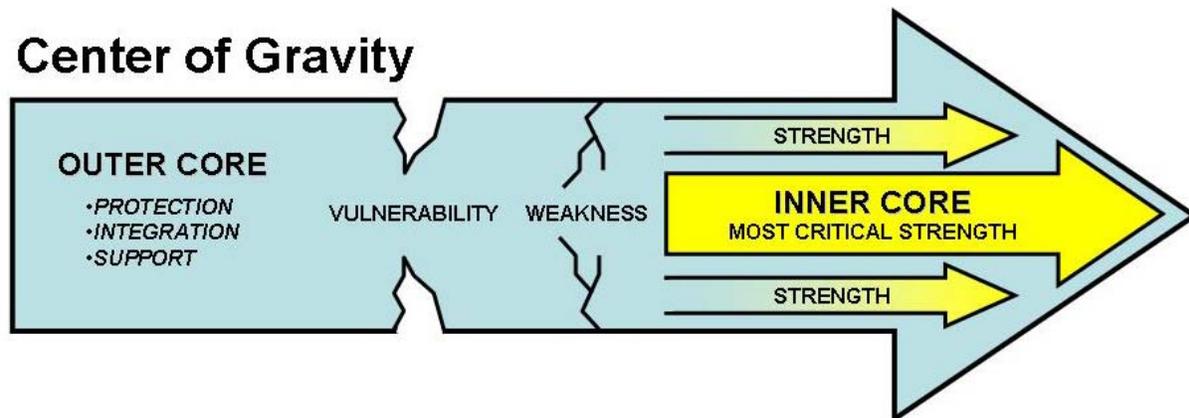


Figure 7: *Milan Vego* – suggested graphic description of the elements and their connection.

These two contributions will assist when following the process and result of the validity test below. Hopefully, it will also assist the professional officers who choose to study and implement one or both of the theories at hand.

3.3. Problem Assessment

The identified differences, also referred to as independent factors, are listed below including an assessment on what impact these differences may have on the dependent factor, the result of a practical CoG analysis. This part of the research begins to answer the third research question, which is finalized in the validity test. The differences stated are not alone, but these are chosen due to the fact that they can have a crucial impact on the result.¹⁰³ By crucial impact, this research refers to the risk of identifying CoGs and critical vulnerabilities, so diverse that the effort and energy in an operation is divergent when comparing the two results. When conducting the validity test in the following chapter, the results from the practical CoG analyses is viewed through these filters.

○ *CoG composition divergence*

The different views of the general composition of CoGs imply diversity in the size of CoGs due to what is included in the phenomenon. Where Vego's approach is more systematically oriented, embracing more factors as inherent elements, the theory of Strange/Iron is shielded around the primary component of strength. As mentioned, the theories are in some way transparent when comparing the Vego inner core and the CoG of Strange/Iron, but what impact could this disparity have on the practical result of a CoG analysis?

One concern regarding this is that a CoG identified with the theory of Vego might comprise of such a wide amount of elements that it will be complex and perhaps even perceived as belonging to a higher level of war. This is more or less reversed when assessing the impact of Strange/Irons theories, where the CoG might be too narrow for the current level of war where the analysis is conducted. Moreover, due to the fact that a commander can choose a direct approach to neutralize the opponent's CoG, using the theory of Vego might increase the risk of dispersing the efforts.

○ *Clarity in the connection to objectives*

When identifying CoGs, the objective is of utmost interest in order to avoid a misdirected focus. Vego's theory is, as mentioned earlier, emphasizing this factor in the CoG definition and he is also implementing the objective as the first crucial step in the method for analysis. Since Strange/Iron have chosen not to state the importance regarding the objective as clearly as Vego, this research is concerned that when using the Strange/Iron theory the identification process might be misdirected.

○ *Lack of defined weaknesses*

Since Strange/Iron, in contrast to Vego, have not defined critical weaknesses in their theory, it is a concern that weaknesses, deficient factors not yet open for exploitation, could be overlooked when using the Strange/Iron theory. This will limit both the systematic documentation and the continuous situational review, and when weaknesses turn into vulnerabilities, the professional officer might miss out on the opportunity.

¹⁰³ There were two other differences identified; *risk for misunderstanding due to nuances in the definitions* and *lack of clarity in the result display*. None of these differences were, according to this research, crucial enough to have an impact on the dependent factor.

○ *Existence of morale factors on the operational level*

Both theories state that CoGs on the operational level and below in the majority of situations are of a physical character. But, even though abstract factors such as morale itself do not constitute CoGs on the operational level, there ought to be moral factors that are of vital importance for the CoGs to maintain their strength. It is therefore of concern that when using the theory of Strange/Iron important abstract factors may be disregarded, despite their possible impact on the different sub elements.

○ *Direction of analysis*

There could be a tendency that when using Strange/Iron the process is more commander driven, which means that it is his experience, knowledge and intuition that form the starting point for the remaining analysis. The direction of Strange/Iron may increase the tempo and it may improve the ability towards a rapid focus in one direction, correct or not. While using Vego, the commander's abilities and intuition play a role as well, but the impact of the broad mass of staff officers and analyzed factors will assist him in his decision. This may decrease the tempo and increase the effort, but at the same time it can ensure that the direction chosen is more likely to be correct. Regarding this, it is of concern that when using the theory of Strange/Iron a wide range of alternative CoGs might be disregarded, due to the fact that the influencing factors are not listed and analyzed systematically before the decision is made.

In order to summarize the assessment, this research is still uncertain what impact the differences in theory will have on the result, which makes the upcoming validity test interesting indeed. Are the differences in theory an actual or perceived problem when put into a practical context? Will the identified CoG be the same no matter what theory is used; will the identification of vulnerabilities end up with the same result or will the theories' practical result differ on one or both of these branches?

4. Assessment Validity Test

In order to examine if the assessment made in the previous phase is valid, the two theories are now exposed to a practical context. The result derived from the CoG analyses below is compared and differences in the practical products are identified. When the research moves into the next chapter, the recognized practical differences are compared with the earlier assessment.

During this implementation a delimited part of the Falklands War in 1982 is used for a CoG analysis. The phase chosen covers the time period from the 2nd of May to the 27th of May, since this provides a clearly defined framework for the analysis. The Argentinean ship General Belgrano was sunk by a British submarine on the first date and on the latter date the operations shifted character from air and sea to land operations.

However, before the actual CoG analyses are conducted, a short summary of the war is given, followed by a survey of important operational factors acting as input for the analysis. The summary is based on the researcher's view of the literature and the important events that took place in the conflict. There might be situations this summary leaves out that could have increased or perhaps even changed the understanding of the scenario, but what is given is believed to fill its purpose. When it comes to the operational factors further below, they are derived mainly due to the input the theories require for their analysis. The factors are grouped in eight subdivisions and chosen by the research, which means that neither the summary nor the operational factors are based on an objective view, but both theories are implementing the exact same factors.

Regarding the analyses conducted with the two theories, this research struggles with the necessity of being faithful to the theories, despite the deficiencies, and the necessity to enable the reader of this research to follow the trail of thought. This research has tried to fulfill both these necessities, but the focus had to be placed on being faithful to the theories at hand.

4.1. Falklands War

4.1.1. A short summary of the War

The military junta ruling Argentina was facing an increasing domestic opposition. In order to unite the nation the junta wanted to recapture the Falkland Islands from Great Britain. The operation was supposed to start in September, after the severe winter storms, but was initiated five months earlier. After some incidents on the island of South Georgia, forces from Argentina occupied Port Stanley, the capital of the Falkland Islands, on the 2nd of April 1982. The junta anticipated a diplomatic struggle, but instead observed a determined Great Britain forming an expeditionary corps with the purpose of retaking the lost British territory.¹⁰⁴

In the middle of April, the British expeditionary force formed around the two carriers, *HMS Hermes* and *HMS Invincible* and began its journey southwards. Due to the upcoming winter

¹⁰⁴ Åselius, pp. 341 – 343

storms on the southern hemisphere the British were on a tight time schedule. The planned amphibious assault to recapture the islands had to be finalized at the latest on the 25th of May, in order to enable a month of land operations before weather conditions forced a British withdrawal.¹⁰⁵

On 12th of April, the British indirectly prevented Argentinean navy units from operating in the proximity of the Falkland Islands by imposing a Maritime Exclusion Zone (MEZ) stretching in a radius of 200 miles from the Islands. This zone was turned into a Total Exclusion Zone (TEZ),¹⁰⁶ which came into effect on the 30th of April.¹⁰⁷

After retaking South Georgia, the Falkland Islands' air strips in Port Stanley and Goose Green were attacked on the 1st of May. A *Vulcan* bomber, starting from Ascension Island, destroyed the Port Stanley air strip, disallowing it to be used by Argentinean *Skyhawks* or *Super Étendards*, followed up with attacks from *Sea Harriers* and naval bombardment. The *Vulcan* raid made the Argentines withdraw their *Mirage III* from the area to defend the mainland bases, which took away some threat from the British.¹⁰⁸ The following day, the Argentinean cruiser *Belgrano* was sunk by a British submarine, which in turn forced the Argentinean navy to stay outside the Falklands area, including the carrier *25 de Mayo*. The Argentinean forces on the Falkland Islands now had to rely on airborne re-supply.¹⁰⁹

It was now mainly up to the Argentinean air force to stop the British, which when only comparing quantity, should have been a task possible to accomplish. The Argentines had approximately 200 fighter aircraft compared to the 28 *Sea Harriers* of the British force. However, the relative quality was in favor for the latter force.¹¹⁰

On the 4th of May, the British destroyer *HMS Sheffield* was sunk by an Argentinean air attack, which caused the British to hasten their time table for the amphibious landing on the Falkland Islands. When evaluating different alternatives, the British decided to use the bay of San Carlos for this assault. This position would offer protection from counter attacks from both Argentinean ground and air forces. Due to the absence of sea mines and the weather obstructing Argentinean intelligence gathering, the British amphibious force could move into the chosen position on the 21st of May. The air space was covered by *Sea Harriers*, but just as the Argentinean air force, the British faced the challenge of short combat time in the area due to the radius of action from the bases.¹¹¹

¹⁰⁵ Åselius, p. 344

¹⁰⁶ Area declared by a state in which conditions are imposed on the passage of ship and aircraft. MEZ is focused on military vessels, while TEZ covers civilian traffic as well.

¹⁰⁷ Secretary of State for Defense (1982). *The Falklands Campaign: The Lessons*. London: Her Majesty's Stationary Office: p. 5

¹⁰⁸ Freedman, Lawrence (2005). *The official history of the Falklands campaign. Vol. 2, War and diplomacy*. London: Frank Cass: pp. 278 – 281

¹⁰⁹ Åselius, pp. 344 – 345

¹¹⁰ Åselius, p. 345

¹¹¹ Åselius, pp. 346 – 347

During this day and the days that followed, the Argentines conducted a number of air attacks on the British forces with varied results. On the 25th of May, the national day of Argentina, a final massed attempt to destroy the British forces was made.¹¹² In order to support the forces in the bay of San Carlos, the carriers had to move closer, which made them visible on the Argentinean radars in Port Stanley. Now the valuable Super Eténdard fighters were sent to destroy the carriers, but instead of engaging these targets the Argentines sank the *Atlantic Conveyor*, the cargo ship carrying vital equipment and helicopters for the land forces. Again, a temporary set back, which instead made the British more focused. The land forces began their movement towards Port Stanley by foot and when they reached the outskirts of the capital the end of the war was close. On the 14th of June the Argentinean general Menéndez capitulated.¹¹³

4.1.2. Operational Factors

Objectives and missions

On the 27th of April the planning directive sent to Woodward gave him the mission “to prevent enemy operations in the TEZ”. Some of the purposes of this mission were to cut off the supplies to the Argentinean garrison and to provide local sea and air control for the upcoming main landing on the Falkland Islands.¹¹⁴

The Argentinean objective is harder to find in the literature, but it’s likely that General Crespo, commanding the temporary *Southern Air Force*, was given the primary mission of attacking the British fleet and ensuring logistical sustainment for ground forces on the Falkland Islands.

Command and Control

The British chain of command created for this operation meant that there was no unifying commander on-the-spot. Admiral Fieldhouse based at Northwood acted as the Task Force Commander of the Carrier Battle Group, the Amphibious Group, the Landing Group and the South Georgia Group. Rear Admiral Woodward commanded the carrier group consisting of two carriers and a number of destroyers and frigates. Interestingly, the submarines took orders from Fieldhouse rather than from Woodward.¹¹⁵

The Argentinean junta set up a complicated command system that did not simplify the coordination of the different arms and units. Vice Adm Lombardo, the theater commander was in control of naval units and the Falklands garrison, while his subordinate Brig Gen Menendez commanded all units deployed to the Falkland Islands. To complicate it even more, General Crespo commanded the air force outside the control of Lombardo.¹¹⁶ The air operations, controlled from the mainland, depended largely on the information given by the long range radar in Port Stanley.¹¹⁷

¹¹² Åselius, pp. 347 – 349

¹¹³ Åselius, pp. 352

¹¹⁴ Freedman, p. 417

¹¹⁵ Freedman, pp. 29 – 31

¹¹⁶ Corum, S. James, Dr (2002). *Argentine Airpower in the Falklands War – An Operational View* . Article in *Airpower journal [Electronic resource]* . (1999-). Maxwell AFB, Ala.: AU Press
Available on Internet: <http://www.airpower.maxwell.af.mil/airchronicles/apje.html>: pp. 60 – 61

¹¹⁷ Anderson, Duncan (2002). *The Falklands War 1982* . Oxford: Osprey: p. 32

Geographical factors

Due to the location of the Falkland Islands in relation to the respective nations, different challenges appeared. The distance from the Falkland Islands to Ascension Island is 3,500 miles and to Great Britain it is 8,000 miles. This can be compared with the distance of 400 miles to the Argentinean mainland.¹¹⁸

At this time of year, the southern hemisphere only experienced daylight 9 hours a day, which made it easier for the British carriers to hide from the Argentines.¹¹⁹ Throughout the month of May the weather was unfavorable to attacking forces, no matter what side they were on. Many days the weather did not permit flying, which provided protection for the British task force but also enabled the Argentines to come through the blockade.¹²⁰

The landing site chosen, the San Carlos bay, offered good cover against submarine attacks and the hills surrounding the inlet made it harder for the Argentinean air force to conduct attacks, especially with the Exocet missile.¹²¹

Navy Forces

The Argentine navy was an effective force, but was not assessed to pose a major threat to the modern British task force. Most vessels were elderly and vulnerable to air attacks due to some outdated air defense systems.¹²² However, the *Belgrano* and her escorts armed with Exocet missiles could seriously threaten the British task force, but when she was sunk, the Argentinean warships stayed in close proximity to the Argentine coast and created no further threat. Despite this, the Argentinean submarines continued to pose a threat to the British.¹²³

The British Carrier Battle Group that arrived in the operational area on the 1st of May consisted of two aircraft carriers, five destroyers and eleven frigates. Three submarines had raced ahead to uphold the MEZ and to destroy Argentinean submarines.¹²⁴ The British nuclear-powered submarines played an important role by posing a continuous threat to which the Argentines could not respond. The exclusion zone could be monitored effectively and the intelligence provided by the submarines was valuable to the task force.¹²⁵

Air operations

The British task force brought 28 Sea Harriers and 14 RAF Harriers to the operational area. The latter variant was converted from a primary air-to-ground role into an instrument for air defense by arming it with *Sidewinder*.¹²⁶ The Argentinean air-to-air missiles were a generation older than the British *Sidewinder*, which allowed the Harrier pilots a more flexible approach.¹²⁷

¹¹⁸ Secretary of State for Defense, p. 6

¹¹⁹ Åselius, pp. 343 – 344

¹²⁰ Freedman, p. 435

¹²¹ Secretary of State for Defense, p. 7

¹²² Freedman, p. 73

¹²³ Secretary of State for Defense, p. 7

¹²⁴ Anderson, p. 27

¹²⁵ Secretary of State for Defense, p. 17

¹²⁶ Secretary of State for Defense, p. 19

¹²⁷ Corum, p. 62

The Harrier had a short combat range in comparison to the Argentinean air craft, but could patrol over the fleet for up to an hour, compared to the few minutes the Argentinean pilots had in order to find and engage targets before they were forced to head back.¹²⁸

For air defense, the British task force relied on a mixture of systems. Electronic detection, fighter aircraft, electronic counter measures, medium and short-range missiles together with different point defense systems created a shield hard to penetrate for the Argentinean air forces. Interestingly, the Sea Dart air defense missile forced the Argentinean aircraft to fly at a low altitude and thereby exposing them to other systems. Dropping bombs at low altitude also prevented the Argentinean bombs from detonating. However, since the British task force lacked an AEW system, the low level Argentinean air craft were hard to detect and therefore the interception of aircraft carrying the Exocet before they launched the missile was problematic.¹²⁹

The British Special Forces were operating in advance of the land forces by gathering intelligence and by confusing the Argentine forces with several raids.¹³⁰ Moreover, the utility of these types of forces was proven when conducting the raid on Pebble Island to destroy the light attack aircraft deployed there, who could have jeopardized the landing at San Carlos.¹³¹ This type of operation was also attempted on the mainland of Argentina, in order to decrease their air capability. The priority targets were the Super Eténdards stationed at Rio Grande airfield, but this mission failed due to bad weather.¹³²

The Argentinean air force had a quantitative advantage regarding air crafts. However, of the 200 aircraft about 60 of them were of the *Pucara* and *Aeromacchi* type; light ground attack aircraft that cannot be used against the task force at sea. The *A-4 Skyhawks* were slower in comparison to Sea Harriers and were lacking modern target acquisition radar. *Mirage III* and *Dagger* had similar disadvantages to the Sea Harrier and the Argentineans only had five *Super Eténdards*, a modern jet capable of carrying the Exocet missile.¹³³ The Exocet missiles were a big threat to the British Task Force, even though counter measures such as chaffs were used with success.¹³⁴ The Exocet flew just above the waves at almost Mach 1 and it was very difficult to take out once it was locked on a target.¹³⁵

Due to the navy being held close to the mainland of Argentina, aircraft from both the air force and the navy had to operate from the mainland. The distance of about 1,000 miles to the Falkland Islands therefore forced them to head back after only a couple of minutes in the target area.¹³⁶ The two Argentinean tanker aircraft were only capable of supporting one four aircraft

¹²⁸ Corum, p. 65

¹²⁹ Secretary of State for Defense, pp. 20 - 21

¹³⁰ Secretary of State for Defense, p. 18

¹³¹ Woodward, Sandy. & Robinson, Patrick (2003). *One hundred days: the memoirs of the Falklands Battle Group Commander*. Fully rev. and updated. Hammersmith, London: HarperCollins: pp. 302 – 306

¹³² Freedman, pp. 432 – 435

¹³³ Åselius, pp. 345 – 346

¹³⁴ Secretary of State for Defense, p. 21

¹³⁵ Corum, p. 68

¹³⁶ Åselius, p. 345

operation at a time. The Mirage and Dagger escort fighters could not, due to the fuel problem, use their Mach 2 speed, which took away an advantage in relation to the Harriers.¹³⁷

Intelligence

The British task force had to work within the range of enemy aircraft without the assistance of airborne early warning.¹³⁸ This was a severe handicap especially when operating at San Carlos where high land surrounded the landing site. Due to the fact that Argentinean air craft could approach undetected, the British carriers had to operate east of the Falkland Islands to increase the chance of detecting low flying air craft over the sea. Unfortunately, this precaution limited the British aircraft patrol time.¹³⁹ It is possible the US provided the British with satellite coverage over Argentina mainland, which could enable a certain control of the activities on mainland air bases.¹⁴⁰

The Argentinean forces had air warning radars positioned in the area of Port Stanley. There was much effort by the British to locate and destroy these mobile and frequently moved radars.¹⁴¹ These radars were effective and could plot flight patterns, which enabled the crews to determine the approximate position of the fleet. Distance from the mainland, weather conditions and the Argentinean daylight requirements limited the usage of this information. However, the radars provided the Argentinean pilots with the location of Harriers when attacking the British fleet. Besides the excellent radar, the long-range intelligence could only be conducted using two elderly propeller planes, *P-2 Neptune*.¹⁴² There were Argentinean attempts to gather intelligence through other sources. They requested satellite pictures from the US and due to civilian factors these were given. However, since the weather conditions weren't ideal, the pictures showed nothing.¹⁴³

Logistics

The British task force needed to be self sufficient because of the distance from the mainland. The establishment of a joint forward operating base at Ascension Island together with a massive logistical effort made air and sea operations to the Falklands possible, without having to return for provisions.¹⁴⁴ The Argentinean logistics need on the Falkland Islands depended on the small air field of Port Stanley and on a small transport force compiled of seven C-130, few Fokker F-27s and some civilian aircraft.¹⁴⁵ Despite the establishment and reinforcement of the TEZ, the transports continued by night, in and out of Port Stanley.¹⁴⁶

¹³⁷ Corum, pp. 62 – 66

¹³⁸ Secretary of State for Defense, p. 18

¹³⁹ Secretary of State for Defense, p. 21

¹⁴⁰ Corum, p. 67

¹⁴¹ Freedman, p. 435

¹⁴² Corum, pp. 62 – 67

¹⁴³ Freedman, pp. 384 – 385

¹⁴⁴ Secretary of State for Defense, p. 6

¹⁴⁵ Corum, p. 63

¹⁴⁶ Corum, p. 75

Morale

The personnel facing each other during this phase of the operation were highly capable. Argentinean pilots acted with high morale and aggressiveness even though they suffered dearly.¹⁴⁷ The British service men were professional volunteers who showed skill, stamina and resolution.¹⁴⁸

4.2. Strange/Iron Analysis

The theory of Strange/Iron does not provide the planner with a tool for identifying the CoG or the connected Critical Capabilities. Before or during an operation the commander and his staff continuously view the available factors and the objective/mission in an iterative process. By viewing the mission and what the opponent can do to endanger the success in a specific context, the professional officer can distillate the components of power and resistance, in order to identify the primary component, the CoG.

Due to the iterative and brainstorming nature of the Strange/Iron method the process is hard to provide in detail. The process is initiated by an iterative brainstorming, summarized below, where CoGs and their CC are identified, which forms the foundation for CR and CV identification. When continuing the analysis, each CC is tracked backwards to identify what is required to maintain that capability and to identify possible vulnerabilities connected these requirements. The graphical clarification given before may assist the reader when reviewing the results below. In order to differentiate between the deficiencies and exploitable vulnerabilities under the heading CV, this research choose to begin deficiencies with “if” and vulnerabilities open for opponent exploitation with “ARG” or “GB”. To maintain a traceable trail of thought, fields are created, to show the CV connection to the respective CR.

There were in general two threats to Woodward’s mission, the Argentinean navy and the Argentinean air force. However, when the junta decided to withdraw the navy the main threat left was the air force. The primary component of the air force that stood in the way for Woodward’s success was the high speed fighter and attack air craft based on the mainland. These aircraft had the capability to neutralize British ships, prevent amphibious landings and support air transports to the Falkland Islands.

On the other hand, there were a number of threats to the Argentinean side when their navy was still at large. Submarines, destroyers, frigates and air craft were all major obstacles initially. However, when the navy was brought out of the picture and the future lay in the hands of the Argentinean air force, it was different. Now, the primary component that endangered the success was the two British carriers and their Harriers. They were capable of establishing local air and sea control around the Falkland Islands, protecting the British forces and preventing Argentinean sea and air transports to the islands.

¹⁴⁷ Corum, p. 72

¹⁴⁸ Secretary of State for Defense, p. 16

Great Britain – CoG analysis

<p>Center of Gravity The carriers <i>HMS Hermes</i> and <i>HMS Invincible</i></p>	<p>CC – Critical Capabilities</p> <ul style="list-style-type: none"> • Establish and maintain local air and sea control. • Protect the British Task Force as a whole. • Prevent Argentinean Sea and Air transports to the Falkland Islands.
<p>CR - Critical Requirements</p> <ul style="list-style-type: none"> • Freedom of action with sufficient number of <i>Harriers</i> equipped with <i>Sidewinder</i>. <ul style="list-style-type: none"> - RAF <i>Harriers</i> converted to air-to-air role. - Enough combat range and endurance in patrol and target areas. - Rapid interception on detected threats. - High level of readiness during daylight hours. 	<p>CV – Critical Vulnerabilities</p> <ul style="list-style-type: none"> • If <i>Sidewinders</i> cannot be supplied. • If the turnover rate on the carriers is too low. • If high numbers of <i>Harriers</i> are destroyed. • ARG¹⁴⁹ posing a continuous threat towards the carriers, they will be forced further away from the target areas. • ARG acting so <i>Harrier</i> CAP coverage has to be stretched - the advantage in combat range lessens.
<ul style="list-style-type: none"> • Air control and air intelligence <ul style="list-style-type: none"> - Intelligence on the mainland by Special Forces and/or satellite - Continuous combat air patrols by <i>Harriers</i> - Forward, offensive patrols with surface ships equipped with radars and air defense 	<ul style="list-style-type: none"> • If Special Forces are not allowed to act on Argentinean main land. • If the US does not provide satellite intelligence. • ARG establishing strong ground defense on the mainland air bases • ARG only repositioning aircraft during overcast which limits satellite coverage. • ARG approaching on low level can avoid detection due to lack of AEW.
<ul style="list-style-type: none"> • Sea control of and sea intelligence <ul style="list-style-type: none"> - Nuclear powered submarines - Freedom of movement with surface ships - Anti submarine warfare helicopters/ships. 	<ul style="list-style-type: none"> • ARG approaching targets with submarines during weather conditions not suitable for rotary wings or synchronized with air attacks.
<ul style="list-style-type: none"> • Cover and Concealment for the Carrier Group <ul style="list-style-type: none"> - Carriers' location undetected - Neutralization of Long Range Radar in Port Stanley - Early interception of Super <i>Étendards</i> carrying the <i>Exocet</i> missile. - Defense in depth with mixed air defense. 	<ul style="list-style-type: none"> • If carrier group chooses not to reposition often. • ARG defending the radar with air defense and ground units. • ARG moving the radar frequently when air intelligence is denied due to weather.
<ul style="list-style-type: none"> • Enduring logistical sustainment <ul style="list-style-type: none"> - Secure SLOC¹⁵⁰ from Ascension Island - Self sustained Carrier Group - Capability to bunker at sea. 	<ul style="list-style-type: none"> • If rates of usage are higher than anticipated. • ARG submarine disruption of SLOC • ARG submarine or air attacks on auxiliary ships in the area of the Falkland Islands.
<ul style="list-style-type: none"> • Protection of amphibious operations <ul style="list-style-type: none"> - Escorted advance into landing site - Mine clear passages into landing site - Air Defense of landing site during landing. - Argentinean close air support neutralized. 	<ul style="list-style-type: none"> • ARG mining the canalizing passages between West and East Falkland. • ARG conducting massed attacks on landing site. • By ARG saving and protecting the light ground attack aircraft for the landing site attack.

Table 2. Strange/Iron CoG analysis on Great Britain

¹⁴⁹ Argentina

¹⁵⁰ Sea Lines of Communication

Argentina – CoG analysis

<p>Center of Gravity The offensive high speed fighter and attack aircraft based on the Argentinean mainland.</p>	<p>CC – Critical Capabilities</p> <ul style="list-style-type: none"> • Neutralize British ships • Prevent amphibious landings • Support air transport to the Falkland Islands
<p>CR - Critical Requirements</p> <ul style="list-style-type: none"> • Freedom of action with sufficient number of high speed aircraft <ul style="list-style-type: none"> - Secure and sustained bases on mainland - No basing of high speed aircraft on Port Stanley airfield due to the vulnerability. - Enough combat time in target area to engage and defeat Harriers. - Maximum use of daylight and good weather. 	<p>CV – Critical Vulnerabilities</p> <ul style="list-style-type: none"> • If one or both tanker aircraft are not in working order. • If the two tankers cannot be coordinated. • GB¹⁵¹ interception of tanker aircraft with offensive frigates or destroyers. • GB early interception with Harriers to limit their time in the target area. • GB massing Harrier efforts during daylight and good weather.
<ul style="list-style-type: none"> • Localization and identification of British fleet <ul style="list-style-type: none"> - Long Range Reconnaissance aircraft - Long Range Radar in Port Stanley 	<ul style="list-style-type: none"> • If target acquisitions are irrelevant when ARG aircraft arrive at target area. • GB localizing and destroying the aircraft and/or the radar. • GB frequent regrouping of carrier group.
<ul style="list-style-type: none"> • Protected and/or concealed air approaches. <ul style="list-style-type: none"> - Low level approach to avoid radar detection and air defense systems - Establish temporary local air superiority with escorts. - Early warning of Harriers' position from Long Range Radar in Port Stanley. 	<ul style="list-style-type: none"> • If a low level approach prevents bomb detonation. • If a low level approach severely limits the time needed for target acquisition. • GB mixing air defense systems for detection and protection. • GB destroying the Long Range Radar.
<ul style="list-style-type: none"> • Prioritized, coordinated and continuous attacks. <ul style="list-style-type: none"> - Prioritize Exocet on aircraft carriers. - Prioritize British auxiliary ships before frigates and destroyers to undermine sustainment. - Conduct serial and continuous attacks to stretch the Harrier turnover rate. - Synchronized attacks with aircraft and submarines. 	<ul style="list-style-type: none"> • If the Exocet missiles do not function. • If the chain-of-command prevents a joint effort. • GB providing screen with frigates and destroyers.
<ul style="list-style-type: none"> • Localization of and sustained resources to attack the British landing site. <ul style="list-style-type: none"> - Close Air Support capacity protected and saved for the decisive time. - Intelligence from air, sea and/or ground units. - Freedom of action to conduct massed attack. 	<ul style="list-style-type: none"> • GB destroying ground attack aircraft on the Falkland Islands with Special Forces or Naval bombardment.
<ul style="list-style-type: none"> • Continuous and safe transports to Port Stanley. <ul style="list-style-type: none"> - Escorted logistical transports. - Usage of dark hours for transports. - Sustained airfield in Port Stanley. 	<ul style="list-style-type: none"> • GB positioning ships with air defense systems close to Port Stanley approach paths during night. • GB continuous destruction of the airfield.

Table 3. Strange/Iron CoG analysis on Argentina

¹⁵¹ Great Britain

4.3. Milan Vego Analysis

In contrast to Strange/Iron the theory of Vego offers a step-by-step manual in order to identify CoG and the different sub elements. As mentioned in chapter 2.2.4. *Method for Analysis*, this research has identified a contradiction between the CoG composition and the finalizing steps proclaimed for CoG identification. When Vego states that the most critical strength identified in the final step is the actual CoG, this research strongly believes, when comparing this with the composition of a CoG, this strength should instead serve as the inner core of CoG and not the CoG itself. This assumption is implemented in the analysis below, and since it has an impact on several steps, the research clarifies this implementation by highlighting the changes and placing the original in brackets.

The analysis is built upon the inputs given earlier in this chapter, and since the method given by Vego states that the different factors should be listed, the displayed result below does not elaborate on the reason for each choice this research has made. However, when starting out from the elements' definitions, the method described and the operational factors reviewed before, the motivation and the trail of thought for each decision is considered quite clear.

The first four steps in the process have already been conducted and the results of these steps are stated in chapter 4.1. *Falklands War*. (1) The operational objectives on both sides of the conflict are determined, (2) the military situation corresponding to these objectives is determined, (3) the situation is analyzed and (4) the critical factors are listed.¹⁵²

(5) Determine critical strengths and weaknesses

British critical strengths: a) The two aircraft carriers including 42 Harriers equipped with Sidewinder, b) Long Harrier endurance in target area, c) Long range Vulcan air attacks capability, d) Three nuclear submarines providing intelligence and TEZ control, e) Naval gun support from Destroyers and Frigates, f) Air defense systems on surface ships for local air superiority or denying Argentinean freedom of action, g) Special Forces intelligence gathering and air base raids, h) San Carlos bay geographical cover against submarine and air attacks, i) Darkness 15 hours a day provides carriers with concealment, j) Access to logistical base at Ascension Island, k) Secure SLOC to the operational area, l) High level of morale and professionalism of the service men.

British critical weaknesses: a) Limited number of Harriers, b) No airborne early warning system (AEW), c) Carriers forced to operate east of the Falklands due to threat level, d) Limited patrol time for Harriers, e) Centralized control of Task Force from Northwood, f) Stretched SLOC from Ascension Island, g) Carrier Battle Group forced to be self sustained.

Argentinean critical strengths: a) Submarines capable of destroying British ships and disrupting SLOC, b) Large amount of high speed aircraft with long combat range, c) Ability to approach British fleet on low level to avoid detection, d) Five Super Étendards aircraft with Exocet missiles, e) Two tanker aircraft for air refueling, f) Long range radar in Port Stanley enabling

¹⁵² The critical factors are listed and explained as operational factors in chapter 4.1. *Falklands War*.

command and control, g) Intelligence and assessment on British activities and fleet position by long range radar, h) Two Neptune long range reconnaissance aircraft, i) Logistical transport capability to land in Port Stanley during dark hours, j) High level of morale and aggressiveness by pilots and other servicemen involved in this phase.

Argentinean critical weaknesses: a) No aircraft carrier in the Falkland Islands area, b) Poor air-to-air missiles in relation to Sidewinder, c) Limited time on target for high speed aircraft due to distance and fuel, d) Low level approach hampers bomb detonation probability, e) Light ground attack aircraft lacked ability to attack ships and fight Harriers, f) No modern target acquisition radar on high speed aircraft, g) High speed aircraft slower than Harriers or not able to use the Mach 2 advantage, h) Limited ability for massed attacks due to low number of tanker aircraft, i) Limited intelligence on British positions, j) Complicated command system that crippled the ability to coordinate the operation, k) Logistical support to the Falkland Islands depended on one airfield and a low number of cargo aircraft, j) Air Force depended on a limited number of daylight hours.

(6) Eliminate non-applicable strengths

During this step, critical strengths are analyzed and the ones acting as integrators, protectors or sustainers or those unable to endanger the opponent's objectives are put aside. This step is not shown in detail since the result is provided below. Moreover, the critical weaknesses listed in the former step and the critical strengths not acting as candidates for the **inner core** [CoG] will be analyzed in order to identify and list the critical vulnerabilities.

(7) List essential critical strengths

The British critical strengths that can prevent the Argentines from accomplishing their objective are the two aircraft carriers including the Harriers; the Special Forces with their ability to raid vital positions such as air bases; the Destroyers and Frigates with their systems of air defense and naval gun support. On the Argentinean side, the candidates for the **inner core** [CoG] are the high speed aircraft of the air force and the submarines, both capable of destroying British ships.

(8) Final Determination

Which one of the listed essential critical strengths is the *most critical strength* that will, if neutralized, lead to the failure in accomplishing the objectives? Is it possible to neutralize this essential critical strength with the forces at hand? When answering these questions on the basis of the earlier result together with some added intuition, it is the two aircraft carriers including the Harriers on the British side and the high speed aircraft based on the mainland on the Argentinean side that can carry the title of the **inner core** [CoG].

(x) Parallel to the eight steps above, the critical weaknesses together with the critical strengths have been analyzed in order to identify existing or potential critical vulnerabilities.

On the British side the following factors are open to Argentinean attack or exploitation:

- No airborne early warning system, which enables undetected low level approach to British ships with Super Eténdards carrying Exocet.

- When carriers are forced east of the Falklands, the Harrier combat endurance decreases, which can be exploited by a serial and continuous wave of Argentinean air attacks.
- The limited number of Harriers and their turnover rate can be exploited by continuous air attacks that focus on Harrier attrition.
- Stretched SLOC and strained logistics can be exploited by destroying British auxiliary ships instead of “hard” targets such as frigates and destroyers.
- The entrances to the landing site can be mined by the Argentinean navy.

When analyzing the Argentinean side the following factors are open for British exploitation:

- The limited combat endurance in the target area and the inferior air-to-air missile can be exploited by the Harriers in air combat.
- By forcing Argentinean aircraft to a low level approach, the probability of finding high value targets and achieving bomb detonation decreases.
- The airbases on the Falkland Islands and their poor ground defense can be exploited by Special Forces to take out ground attack aircraft prior to the amphibious assault.
- If the tanker aircraft are intercepted, the ability to conduct air attacks will be seriously hampered.
- The destruction of the Long Range Radar in Port Stanley will severely limit Argentinean capability capabilities.
- The Argentinean need of daylight can be used to mass Harriers at likely hours of enemy attacks.

Take note that all critical vulnerabilities listed above are connected to the ability of the inner core to accomplish the objective and to prevent the opponent's success. The critical strengths not chosen as the **inner core** [CoG] are normally a part of the outer core of CoG with a sustaining, integrating or protecting role.

From a British perspective this means that the submarines, the frigates and destroyers, the Special Forces, the auxiliary ships, the air defense systems and the long range Vulcan capacity all are a part of the Center of Gravity, but they will be found in the outer core. When viewing the Argentinean side, the outer core contains the radar in Port Stanley, the two Neptune reconnaissance aircraft, the tanker aircraft, the light ground attack aircraft, the logistical support and perhaps even the submarines.

Well aware of the fact that the intuition and preconceived ideas belonging to the author of this research might have had a decisive impact on the CoGs analyses, the research now has arrived at the validity test. The results from the practical CoG analyses above will now be viewed through the filters consisting of the theoretically assessed concerns previously made.

4.4. Validity Test

When reviewing the results from the two CoG analyses there are, as anticipated, mostly similarities, but there are also differences. Each one of the concerns regarding the differences' impact on the final result is listed and validated one by one below. The research is trying to keep the validation as objective as possible, but the subjectivity is of course present.

○ *CoG composition divergence*

First of all, there is a difference in the result due to the divergence regarding CoG composition. The actual size and character of the identified CoGs deviate as assessed, but there is no crucial risk that the phenomenon slides on the level of war scale. All identified CoGs, no matter what theory used, stayed within the operational level of war. When viewing the level of abstractness, the CoGs of Vego's theory, are more complex since they embrace a wider amount of elements. The CoGs identified with the theory of Strange/Iron, coincide with the inner cores identified with the CoGs found when using Vego's theory. Therefore, when stating that a direct approach is aimed straight at CoGs, there is a risk that the efforts will be dispersed when implementing Vego's theory. This is not the case when using the theory of Strange/Iron, since the result derived from their theory is all but complex. In sum, the assessments of complexity, size and character are valid, while the assessed friction connected to levels of war is invalid.

○ *Clarity in the connection to objectives*

When implementing the theories of Vego and Strange/Iron, the stated objectives of each side were a natural part of the process, even though Strange/Iron didn't announce it as strictly as Vego. During the initial intuitive brainstorming conducted in the Strange/Iron method, the objective (mission) is present, if not by default, at least in the mind of the officer implementing the theory. Due to this and due to the fact that Vego emphasizes the importance of the objective, none of the theories entail a misdirected process, which makes the previous assessment invalid.

○ *Lack of defined weaknesses*

In general, the critical vulnerabilities identified with the two theories are identical concerning the variants stated as open for exploitation by the opponent. However, since the result derived in the Strange/Iron analyses follows their specific definition, a combination of both deficiencies and vulnerabilities are listed under the heading of Critical Vulnerabilities. The deficiencies are similar to the critical weaknesses found when analyzing critical factors with the Vego method, but are to some extent mixed up with the exploitable vulnerabilities. Both theories, in different ways, list the weaknesses that due to the dynamic nature of conflict might evolve into exploitable vulnerabilities, which makes the assessment made on this matter invalid.

○ *Existence of morale factors on the operational level*

Regarding abstract factors such as morale, it was a concern that the Strange/Iron theory did not acknowledge the existence of this type of factor, thus the user of Strange/Iron could disregard it. This assessment proved to be valid. When using the theory of Vego, the morale of both antagonists was analyzed and listed as critical strengths. In this particular phase of the war, the

morale was equal on both sides, but it is still an important factor to identify and monitor, which the user of the Strange/Iron theory would probably have left out of account.

○ *Direction of analysis*

Finally, the level of intuition and the impact of systematically organized and analyzed factors are to a certain extent dependent on what direction the analysis is implementing in the CoG process. When using the Strange/Iron theory, the decision on CoGs was made relatively rapidly. Even though the final Strange/Iron CoGs and the inner core of CoGs identified by the Vego method are transparent, the Vego theory was open to optional inner cores for a longer time, especially when it came to the British side of the coin. Therefore, the assessment made on the risk of disregarding alternative CoGs when using the Strange/Iron theory, proved to be valid, but this validation is somewhat undermined since the results of this particular practical implementation were similar.

5. Discussion and Conclusion

In this chapter, the research is concluded on the diversities between the theories of Vego and Strange/Iron, and whether they constitute an actual or perceived problem for the professional officer. The results from the assessment and the validity test are discussed, in order to enable a final conclusion regarding the pertaining problem. This research is finalized by providing a reflection to increase the ability for the professional officer to comprehend the phenomenon reviewed in this research and by providing suggestions for further research.

5.1. Discussion

The basis for systematically approached theories is the elements incident to the system, including definitions and internal linkage. During the theory review, these factors were surveyed and hopefully a deeper understanding was attained. There is in general a certain degree of complexity in both theories, where the definitions attempt to cover a wide range of options. This tendency is perhaps more conspicuous when viewing Vego's theory, especially in his definition of CoG. Unfortunately, this ambitious complexity does not facilitate the practical usage of the theory without, at the same time, founding an opening for misunderstanding. It is likely, that the built-in nuances, lead to misinterpretation if the theories are not studied well. This is a concern of this research as well as the previous stated concerns, but due to the fact that the research itself has penetrated the meaning of each definition, a validity test on this concern was difficult to accomplish. Hopefully, the reader of this research will not interpret "the source of strength" as something it wasn't meant to be.

Centers of Gravity are defined differently by the two theories analyzed in this research. The definition divergence didn't cause any great concerns, but the difference in composition did. As stated earlier, the compositions of CoGs are diverse, mainly regarding to what factors are included in the core of the phenomenon. When viewing CoGs in the Strange/Iron theory, the practical result is focused on identifying the primary strength, the component that offers resistance and stands in the way of the opponent's success. A direct approach clash, between Strange/Iron CoGs, would in the phase chosen from the Falklands War, be formed around a direct confrontation between high speed aircraft from the Argentinean mainland and British Harriers taking off from the two carriers. If these forces are applied to the theory of Vego, this would mean a direct confrontation between *the inner cores* of the two belligerents. However, when implementing Vego's theory strictly, a direct approach between CoGs would instead be a struggle between the entire Argentinean air force and the British Carrier Battle Group. This amplifies the valid assessment concerning the differences of CoG size and complexity, as well as the invalid assessment regarding the sliding scale of the levels of war. With a point of departure in CoG composition, the efforts are likely to be focused in the correct direction, despite the general differences. However, this research proposes that Vego updates the theories regarding direct approach, to emphasize that a direct approach in his theory means an effort aimed directly at the inner core of a CoG.

The direction of effort is also dependent on other inputs delivered to the commander who is forming the operational design, including decisive points and intermediate objectives. Since the direct approach is by default not the approach of choice, unless the forces at hand are superior

in most aspects, the identification of exploitable vulnerabilities is of great concern. By finding or creating these vulnerabilities, the option to use the indirect approach is available, and this is as stated earlier, one main reason why a CoG analysis should be conducted. Regarding the two theories' ability to identify these vulnerabilities, the assessed concerns vis-à-vis the potential of Strange/Iron's theory to list what Vego defines as critical weaknesses proved to be invalid. Both theories are able to detect both the deficiencies and the vulnerabilities open for exploitation, however, the clarity between the two branches of Strange/Iron's CV could be improved by dividing them according to the theory of Vego.

If the theories themselves or the implementation of them don't take this into consideration, the professional officer using Strange/Iron will have an extensive laundry list of CV to put into action or present to the commander. Hence, when using the theory of Vego, the laundry list has changed character into a small note, since his theory only delivers critical vulnerabilities open for exploitation, a distilled result from the analysis of critical factors, ready for implementation. Therefore, if the listed weaknesses are disregarded, the result when using Vego's theory may seem limited. An officer using the Strange/Iron theory might announce to his commander that he identified ten CV, while his colleague using Vego's theory, with a shameful look on his face, can only deliver two.

In all, the actual and current critical vulnerabilities are similar in their essence, regardless of what theory the professional officer uses. However, the difference in definitions and division can be misleading when viewing the results that should provide input for the indirect path to neutralize the opponent's CoG and accomplish the objectives.

Both theories view the objective or mission as essential when identifying CoGs, since they indicate what should be accomplished and why. In this context, this is always placed in relation to an opponent, who by nature is aiming towards the opposite in some way. Even though Strange/Iron don't state the importance of the objective or mission as clearly or frequently as Vego, both theories agree on the importance. They place the objective in focus when analyzing the factors that influence the identification of one's own and the opponent's CoGs and vulnerabilities. Minor shortages in theories will not give rise to a commander neglecting the objective when conducting the CoG analysis, no matter what direction of analysis the theories suggest or the level of complexity prevailing.

The direction of analysis when using the theory of Strange/Iron is built upon a top-down perspective, where iterative brainstorming based on known factors, experience and intuition are the tools to identify the CoGs. By using this direction, a relatively low complexity and a high tempo regarding the process is enabled. However, when the CR and CV are to be identified, the complexity increases, due to the fact that there are no step-by-step guidelines provided to assist the professional officer. This means that the officer depends on his/her capacity to maintain awareness of a high quantity of factors simultaneously, which could entail a loss of tempo.

When reviewing the theory of Vego, a more complex construction is observed. However, this complexity can assist the professional officer in avoiding the type of difficulty prevailing when conducting the identification of CR and CV with the Strange/Iron theory. The step-by-step

process of Vego could therefore enable a more focused effort during the analysis. This might even lead to an overall tempo higher than or at least similar to the Strange/Iron method. Moreover, when using the theory of Vego, the CoGs are not decided in the initial phase, which enables a relatively open mind where a systematic approach assists the officer in his/her final decision. Hence, the identification of CoGs is less inclined to disregard alternative CoGs when using Vego's theory, in comparison with the Strange/Iron theory, but the need for and the impact of intuition is present. This is a crucial factor, underscored by the validity test, even though the results of the CoG analyses were similar this time.

Importantly, the commander's intuition is a part of the process and this cannot be disregarded with any justice. It does not matter how many properly analyzed factors the commander can gather, in the long run it is up to him/her to make the final decision, at least partly based on intuition and other intangible human factors.

The morale factor was also a concern exposed to the comparison and the validity test. Since man becomes an object for the same analyses as the tangible factors, the professional officer can, with some difficulty and uncertainty, identify strengths and weaknesses in regards to the human factor. The iterative process proclaimed in the two theories, may be even more important here, when analyzing abstract, unquantifiable and unpredictable factors such as human behavior. As previously assessed, the theory of Strange/Iron falls short on this matter, which could lead to an expensive success, if not a failure.

Additionally, when comparing the results of the CoG analyses, a difference in clarity can be identified. There is a divergence regarding the level of lucidity and the traceable trail of thought in the two theories' final result. Strange/Iron provide the observer with quite a clear overview by using the four-column format, but since the theory mixes the two branches of CV under one heading, the sharpness may be blurred. The theory of Vego has its advantages in connection to the step-by-step process, which provides a clear path that can be traced in both directions. Unfortunately, the step describing how to process the critical factors left out from the final CoG determination is missing, which puts a roadblock on this traceable path. However, no matter what theory is used, if the professional officer documents the analysis properly, it is possible to conduct a continuous review of the dynamic situation and to exploit suddenly exposed vulnerabilities.

5.2. Conclusion

CoG analyses deliver vital input to the professional officer building the operational design leading to mission accomplishment. However, there are a great number of theories regarding the phenomenon that create a certain degree of confusion, due to theory divergence. This may lead to mental energy being misdirected, and instead of focusing on the analysis, perhaps the method and its validity are discussed and compared with other theories during the planning process. Hence, there is a risk that the analysis is disregarded due to time consuming and often fruitless discussions, which could canalize the operation into a faulty direction.

By comparing two modern theories, this research clarifies what impact the differences will have on the practical result and thereby. This research also provides the professional officer

with a clearer view of the phenomenon and its utility during operational planning. With this clarity, the professional officer will know if the differences between theories concerning CoGs are an actual or perceived problem, and if the identified CoGs and their strengths and weaknesses will be different when using different theories.

This research identifies the similarities and differences in the theories of Milan Vego and Joseph Strange & Richard Iron regarding CoGs, their sub elements and methods for analysis. The impact of the differences on the practical result is then surveyed by implementing the theories on a phase of the Falklands War, in order to conclude if the differences have a decisive impact on the product of the CoG analysis.

The theories reviewed are built upon a great deal of subjectivity, where the researcher and his/her preconceived knowledge and intuition plays a major role in the process' result. Fully aware of the unreliable impact of the human factor, this research still believes that the result is both valid and reliable to the level allowing the below conclusion to be made.

In reference to the conducted comparison and the discussion above, this research concludes that the diversity in theory is only a perceived problem. If both theories are conducted with the same subjective conditions, the identified divergence does not reflect crucially on the result of the CoG analyses. The variation of the input to the operational design is minor, and the CoGs and critical vulnerabilities provided are the same or at least similar, no matter which of the two theories is implemented. In sum, the results of a CoG analysis are theory independent, but they are subjectivity dependent.

To elaborate on the conclusion, the differences concerning the composition of CoGs have to some extent, an impact on the result. If a direct approach towards the opponent is chosen, the user of the Vego theory may disperse the efforts, more so than the user of Strange/Iron, especially if the assessment regarding the inner core is dismissed. However, both theories are, despite this direct approach dilemma, leading the professional officer and his efforts in the same main direction. The mentioned differences concerning the identified critical vulnerabilities do not have any significant practical impact on the outcome of the CoG analysis, which implies that when focusing on an indirect approach, the choice of theory is even more unimportant.

When specifying the impact regarding the diversity concerning the factor of morale and the direction of analysis, the differences in theories induces a certain reflection on the final product of the CoG analysis, but it is not deemed crucial enough to counter proof the conclusion made. The factor of morale might be disregarded when facilitating the Strange/Iron theory, but the variation is according to this research not decisive.

Furthermore, when observing the identified risk of disregarding alternative CoGs when using the Strange/Iron theory, there are some concerns, but it is the knowledge and intuition of the professional officer that plays the final role in the decision, no matter what theory is chosen. Therefore, this research does not find any overweighing factors, which should force the

conclusion to be reconsidered, and the identified differences will not have a crucial impact on the practical operational planning.

Despite all above, there still exists a problem that will have an impact on the operational planning. Even if this research shows that the confusion built upon the theory diversity is not an actual problem, the problem is still perceived as such. The professional officer reading this research is perhaps enlightened to some extent, and this may assist him/her in avoiding the time consuming discussions. However, the number of theories on the CoG phenomenon is high, and is likely to increase, which means that the discussions will continue to challenge the professional officer and the efficiency of operational planning.

5.3. Reflection

First, the main reason for choosing the subject of this research was an urge to enrich and simplify the understanding of CoGs, to take away the aura of mystery draped around the phenomenon. When reflecting on the problem at hand, no other research reviewing this area was found and this makes the conducted work exclusive. New ground was covered and hopefully this will stimulate similar work that can assist the professional officer. This research can be criticized, since the result is derived from one person with specific prerequisites implementing the theories, leading to a limited level of scope. It is not proved, that if another research, using the same theories and tools, will attain the same results. On the other hand, there is nothing in this research that falsifies the conclusion made, which means that the result could be valid. On the positive side, the two theories are analyzed and compared in a thorough manner, where improving suggestions are made due to forced assumptions. The work is ambitious, and even includes its own validity test. Interestingly, no conclusion was made until during the final discussion. The author did not know where this research would take him, despite working with this phenomenon for a number of years.

One challenge was, due to nature of the subject, the reliability issue. The different steps conducted in this research were all exposed to this problem in one way or another, but since the issue was known, a number of narrowing factors and guidelines were implemented. Due to these measures, the author of this research feels confident in the conclusion made. It is possible that another research would come up with different results when using the two different theories on the same object, but this research shows and implies this to be unlikely. It is shown that the result is theory independent, but assumed to be subjectivity dependent. However, the question is unsolved, whether the result of CoG analyses will be diverse when two researchers, with different prerequisites, uses different theories.

Second, even though the diversity in theories don't have an impact on the result of a CoG analysis, the practical work is likely to be influenced by the perceived frictions. The commander and the professional officers manning his/her staff will face a continuous dilemma when it comes to the different theories impacting the phenomenon.

The professional officer will react negatively to the decreased tempo, the level of stress, the dispersion of staff energy and of course the small differences in the result. However, if these negatives sides are viewed from a positive perspective and if the staff is aware of the fact that

the problem at hand is only perceived as such, the dispersion and divergence above could be used to increase the quality of the staff work. Dispersion can provide the analysis with a wider perspective on the situation and enable an open mindset to different options. It is even possible, at least in theory, to divide the staff in separate sections during this part of the operational planning, where each section uses one theory, in order to maximize the possibilities of the divergence. The quality could then reach a level, where the loss of tempo in the staff work, reforms into a higher tempo in the actual operation. However, the basic principle of simplicity should rule, where one theory is chosen and implemented consistently in a staff, despite the fact that the theory diversity is only a perceived problem.

When the author of this research observes staff work conducted here in Sweden, the discussions due to diversity are frequent, even though there are doctrines guiding us. Doctrines and manuals, signed for implementation, should be simplistic enough to avoid the perceived diversity problem, but this is not the case. It is therefore worth reflecting on, how this diversity could be perceived in an international environment, where a wider range of nationalities including their viewpoints, are to be directed in one mutual direction. Despite the internationally agreed standards, a multinational staff is deemed to face, if not a higher, at least a similar level of opinion diversity as in a national staff.

In order to avoid the perceived problems, at least to some extent, there is a great burden of responsibility on the shoulders of the commander and his chief of staff. It is up to this duo to decide, which theory should be implemented and to train the members of the staff on spot. This might enable the professional officer to focus on implementing the theory and filling it with factors to analyze, instead of using energy on criticizing the theory itself during the operational planning. However, in order to enable the officers to focus their energy in the right direction, they need to be confident and experienced. These two factors are created by practical operational planning and by a foundation built upon an extensive education.

Third, there are many issues in this research connected to the reliability of the research itself and the result derived from it, due to the human factor and the subjectivity derived from it. This is natural since operational art is a contest between the will of opponents, where humans are analyzing the actions of other humans.

The commander and his staff has to use all their inherent capabilities and intuition, when attempting to sort factors of importance in a systematic structure and analyzing these factors, to identify the path that lead to success. When a commander makes a decision on CoGs too early, the human factor is indeed present, where the commander perhaps is incapable of changing his mind, even though his staff officers, with a great deal of courage, prove him wrong. This last friction might exist more so in a staff implementing the theory of Strange/Iron, which encourages a commander driven process, in comparison to the Vego theory that to a higher extent enables a staff driven process.

Furthermore, it is quite simple to quantify and analyze materialistic factors such as weapon systems, number of units and doctrinal standards, but when the analysis is directed towards the human counterpart, the analysis becomes much more complicated. The identified CoGs and

CVs might be correct when only viewing the tangible factors, but if the more abstract factors pertaining to the human features are taken into consideration, the equation becomes more complex. However, these factors are by nature difficult to analyze, which implies the importance of the preconceived knowledge and the intuition of the professional officer analyzing the clash of wills.

Fourth, when educating officers on the phenomenon of CoG and the theories connected to this, there are some pedagogical issues that this research feels the need to address. First of all, the academic institutions and the training facilities should not underestimate the competence of officers or their capacity to be exposed to complex subjects early in their education. Sometimes, there are tendencies to dismiss the capacity of younger officer and to save the “*more complex*” subjects to the education on the higher levels. This is of course a natural way of climbing the stairs of knowledge, but the young officer are likely to comprehend the phenomenon of CoG even during the first years, if it is served appropriately.

Appropriateness is built upon the rule of simplicity, which could be achieved by using a combination of pedagogical graphics and easily overviewed examples. This research made an attempt to simplify the description of CoGs’ composition and connections to their sub elements in chapter 3.2. *Clarification*. However, the saying “*a picture is worth a thousand words*” could be viewed from another perspective, where a picture needs an explanation of a thousand words. Therefore, the graphics will only provide a string to hold on to when studying the theories at hand, but it will hopefully assist in building knowledge and understanding.

In conjunction with the theories and their graphical descriptions, the education of officers must be based upon relatively simple scenarios and examples, where the educator are able to provide the student officer with a well covered solution in the end. However, officers in teaching positions are many times reluctant to deliver a “*correct answer*”, but this is not good enough. An officer, especially when manning a teaching position, needs to act as a role model, where he/she can stand up for a derived solution. It is inappropriate, if the important teacher cadre fulfills the not so positive saying, “*if you cannot do it, teach it*”.

Finally, when educating the professional officer, no matter on what level, a combination of theoretical and practical education is needed. There could be an extensive and wide basic education on different theories and their origin, but when it comes to the practical training, the pedagogic idea should follow the suggested approach of the commander given above. Decide what theory should be used in the specific course, and maintain focus on that one. The urge to enrich the officer on a wide perspective should only have an impact on the theoretical level. It is more advantageous if the officers have confidence and good knowledge of one theory, instead of having distrust to and knowledge about a wide variety of theories. This is amplified by the result of this research, since the diversity in theory does not have a crucial impact on the final result of a CoG analysis.

5.4. Future Research

During the research, a number of different suggestions came to mind, regarding future research that could improve the knowledge on the subject.

First, in order to validate or falsify the result of this research, a similar research should be conducted where the scenario acting as filter could be a conflict pertaining to modern types of operations, where abstract factors such as morale are more dominant. Will the divergence in theory still only be a perceived problem if the different CoG analysis methods are implemented in a Peace Support Operation?

Second, since the human factor including the experience and intuition of the author of this research had a certain impact on the result, a practical experiment could be conducted to validate or falsify this research further. By forming two different staffs, training each of them on one of the theories and then allowing them to implement the designated theory on the same scenario, the result could be compared within that research and to the result of this research.

Third, it would be very interesting to see if theories more diverse in their essence will provide the same result as given in the comparison of this research. Would the problem of diversity be an actual problem or a perceived problem, if comparing for instance the theory of Milan Vego with the theory of Antulio Echevarria, within the framework of a *Most Different Systems Design*?

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