Australian Government
Department of Defence
Defence Science and
Technology Organisation

The Metacapability Conceptual Framework: A framework linking C2 Agility Concepts

Donald Lowe and Simon Ng

Presenter: Dr. Jennie Clothier

Defence Science and Technology Organisation
Department of Defence, Australia

Structure

Australian Government
Department of Defence
Defence Science and
Technology Organisation

- Introduction
- The Metacapability Conceptual Framework
- An historical evaluation
- Summary and Further Work

Introduction

Australian Government
Department of Defence
Defence Science and Technology Organisation

- C2 Agility is increasingly important
- Multiple frameworks offered
- Definitional inconsistencies and coherence problems should be resolved
- A more formal ontology is required
- This should build upon the extensive work previously done

Our Intentions and Approach

Australian Government
Department of Defence
Defence Science and Technology Organisation

Establish a framework that:

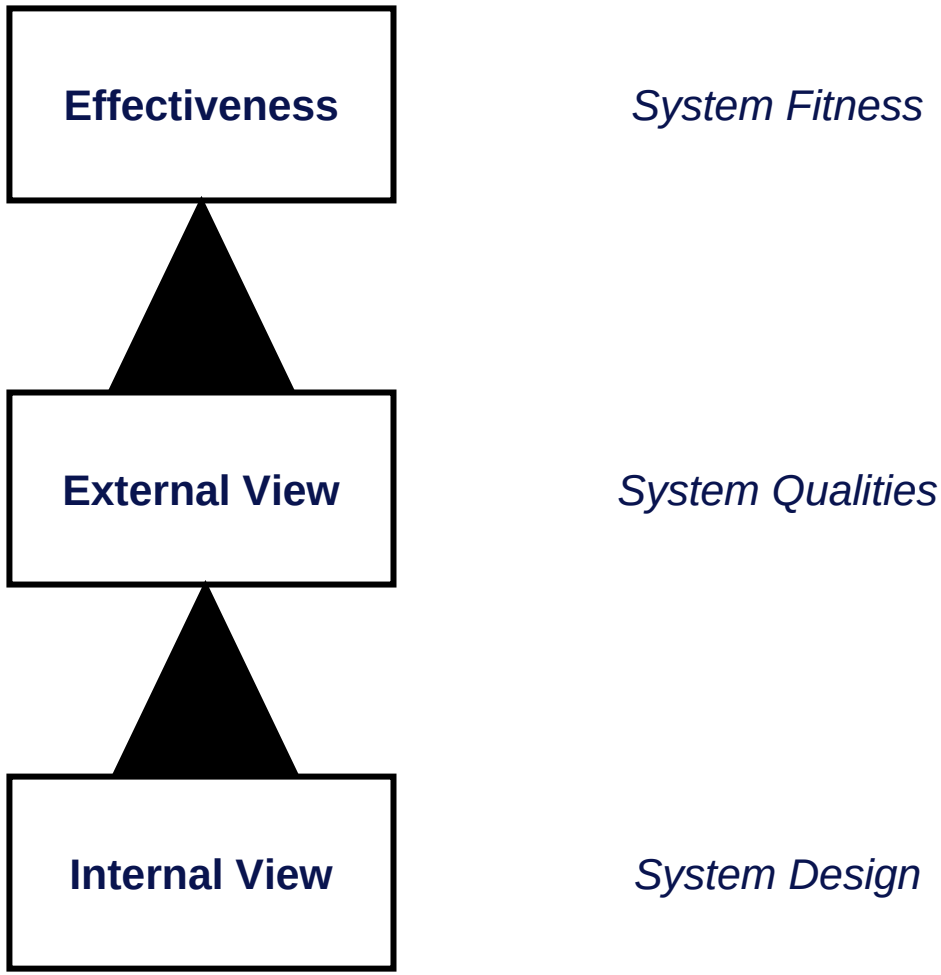
- Can support organisational design and analysis
- Is robust and comprehensive

Build upon the work of others by:

- Addressing definitional challenges
- Defining a formal ontology
- Evaluating the definitions and ontology using historical case studies

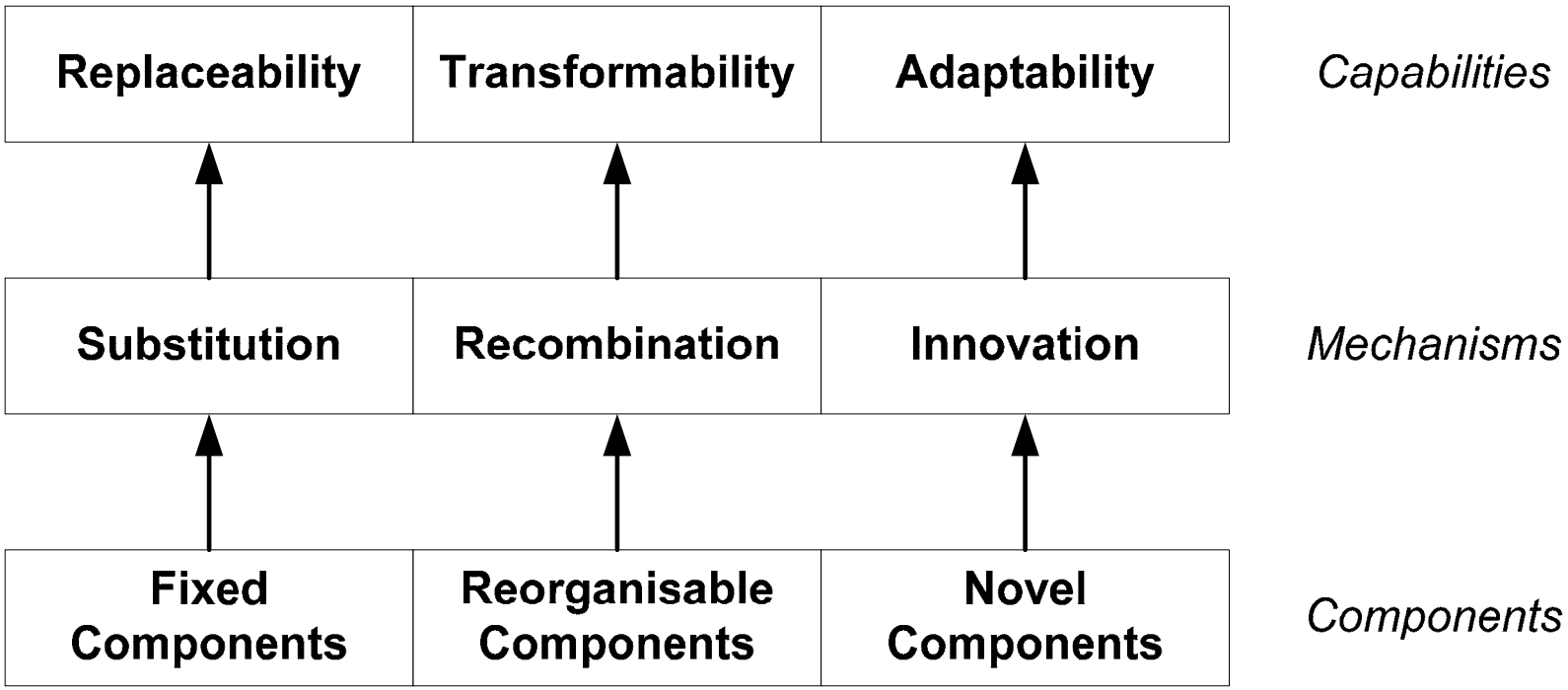
The Metacapability Conceptual Framework: An overview

Australian Government
Department of Defence
Defence Science and Technology Organisation



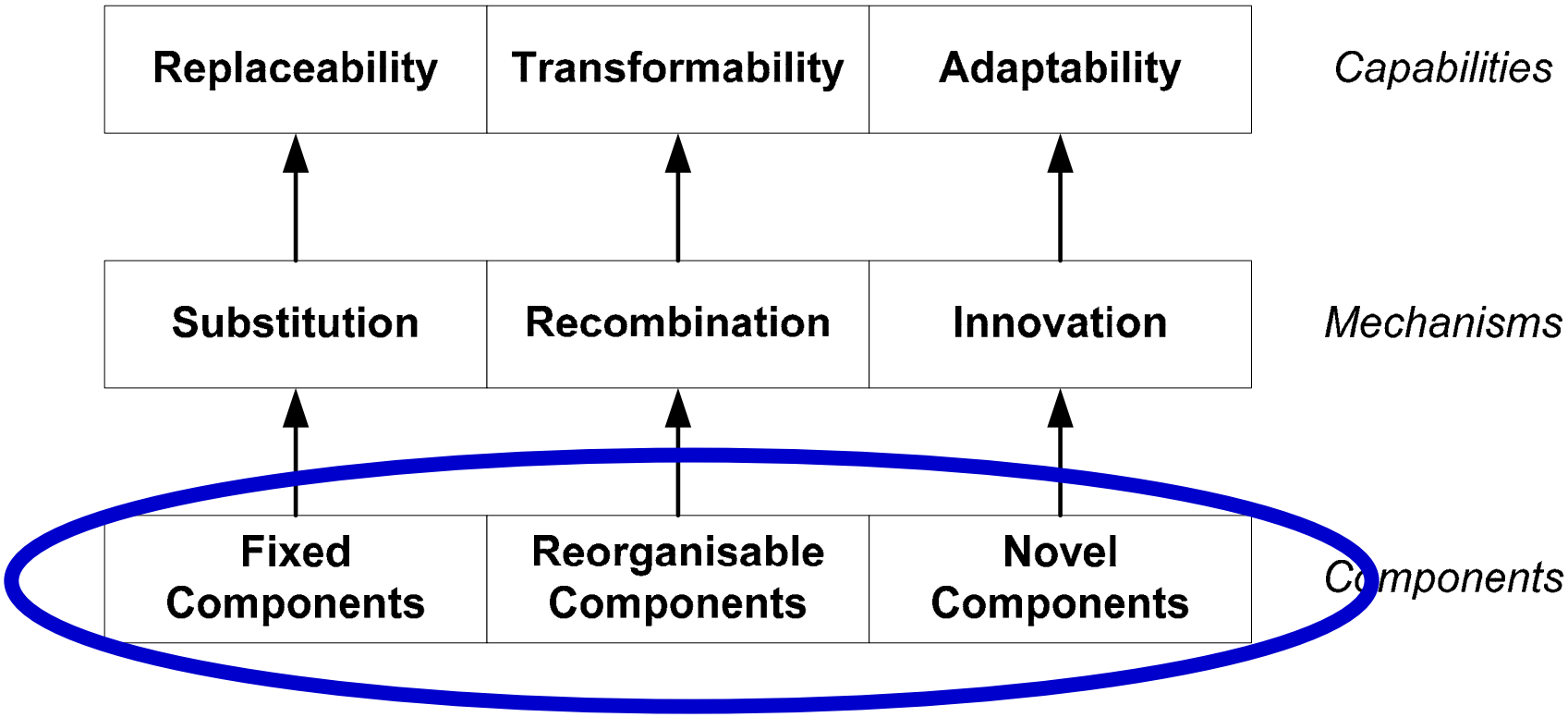
The Metacapability Conceptual Framework: The Internal View

Australian Government
Department of Defence
Defence Science and Technology Organisation



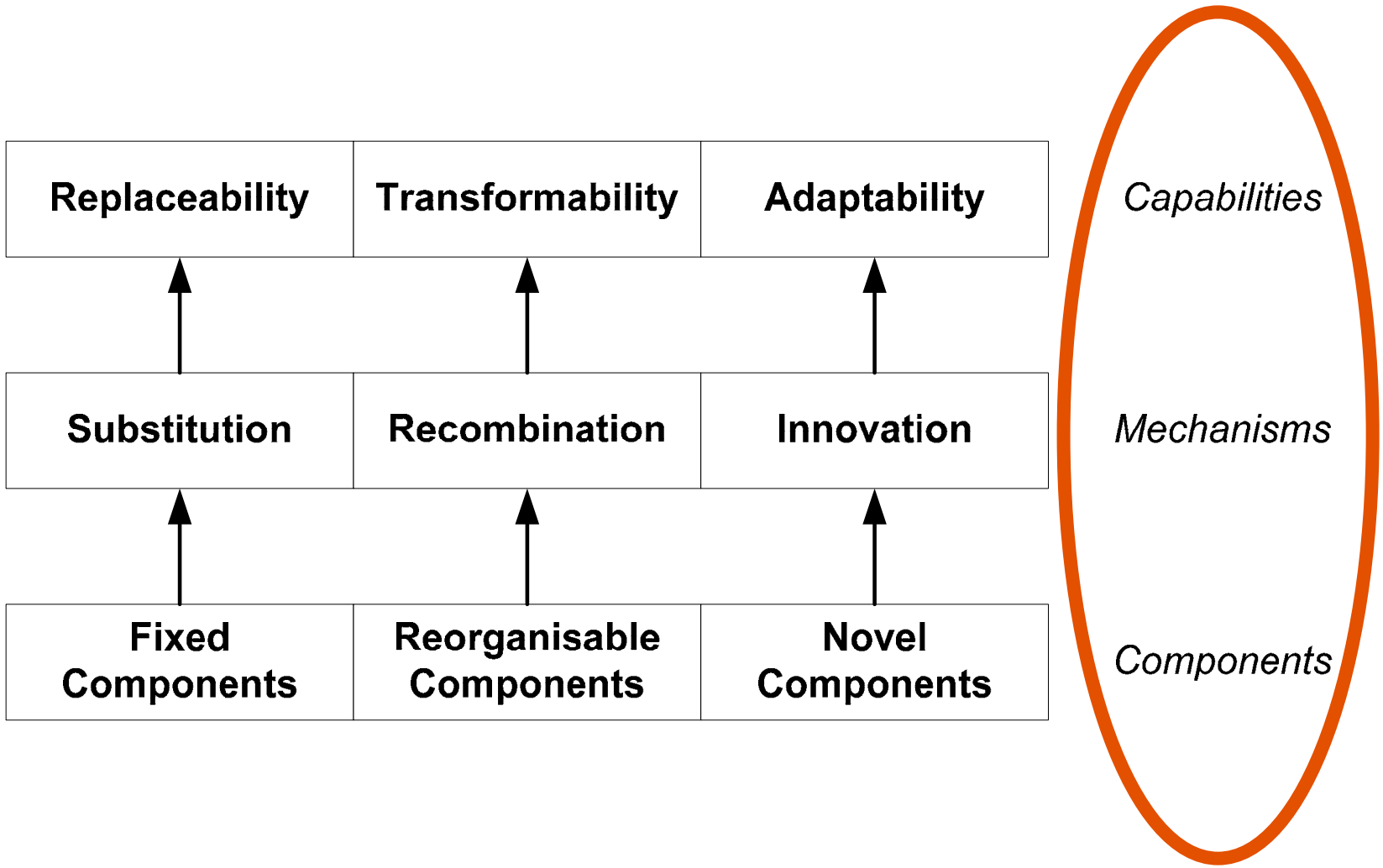
The Metacapability Conceptual Framework: The Internal View

Australian Government
Department of Defence
Defence Science and Technology Organisation



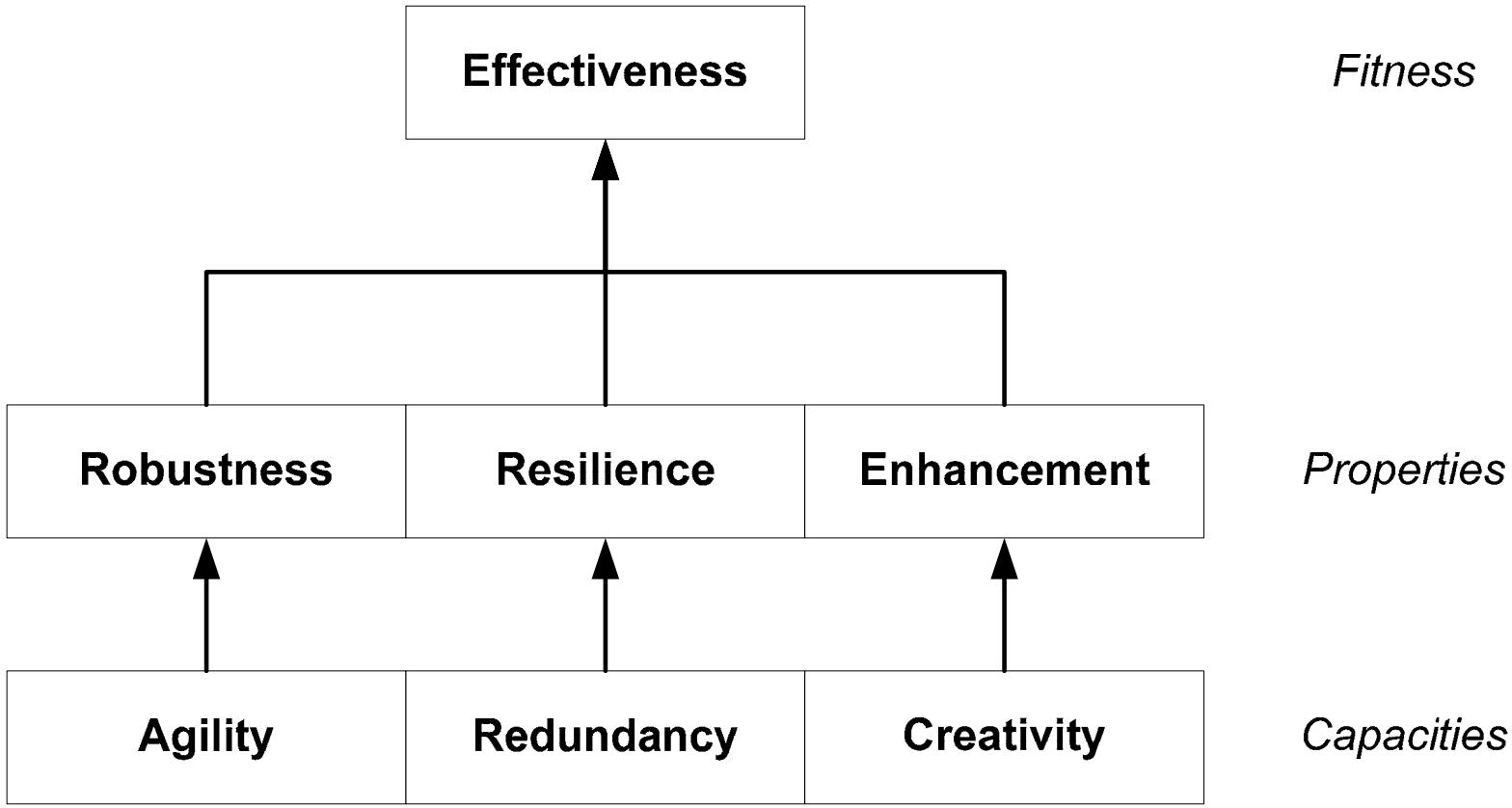
The Metacapability Conceptual Framework: The Internal View

Australian Government
Department of Defence
Defence Science and Technology Organisation



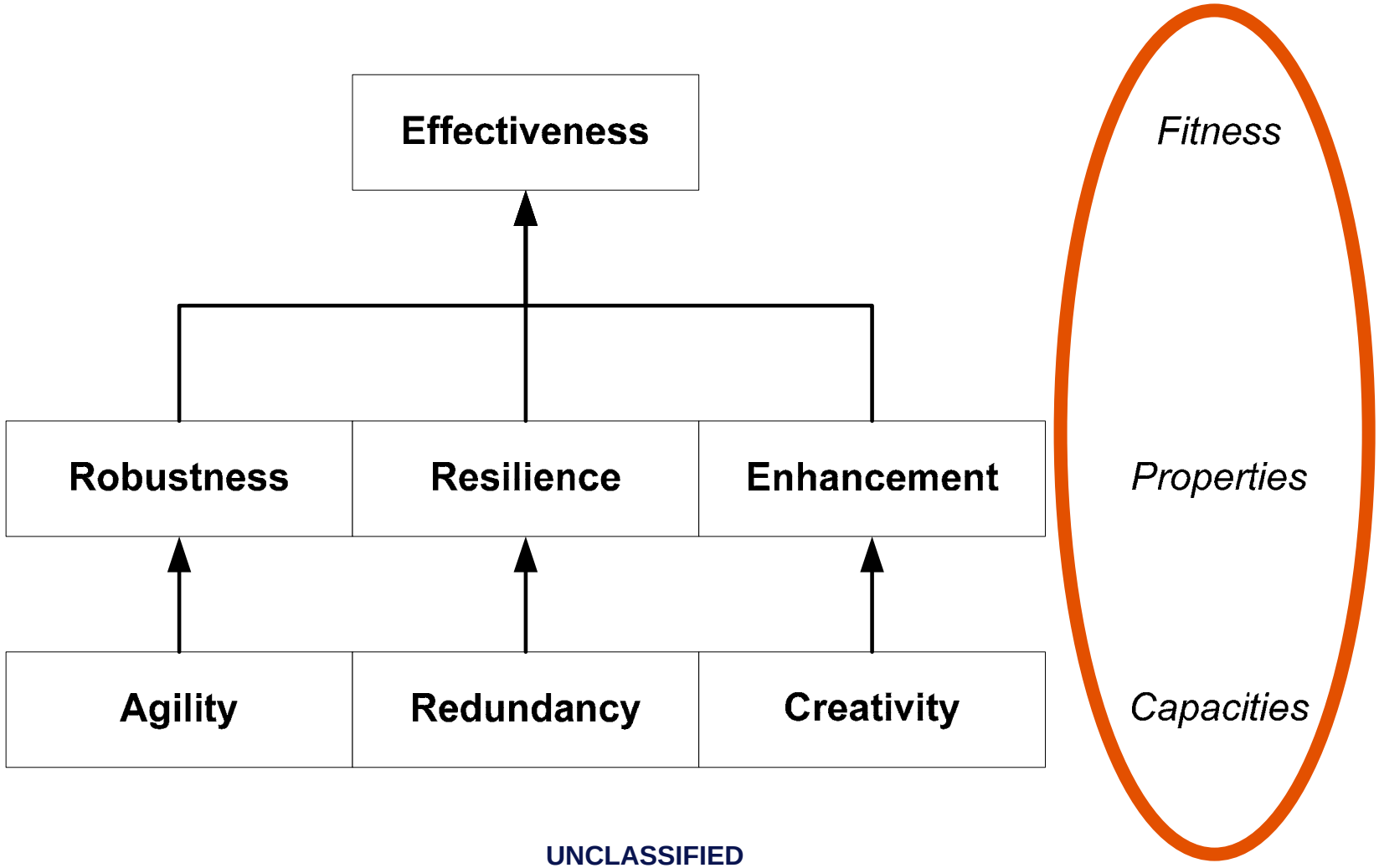
The Metacapability Conceptual Framework: The External View

Australian Government
Department of Defence
Defence Science and Technology Organisation



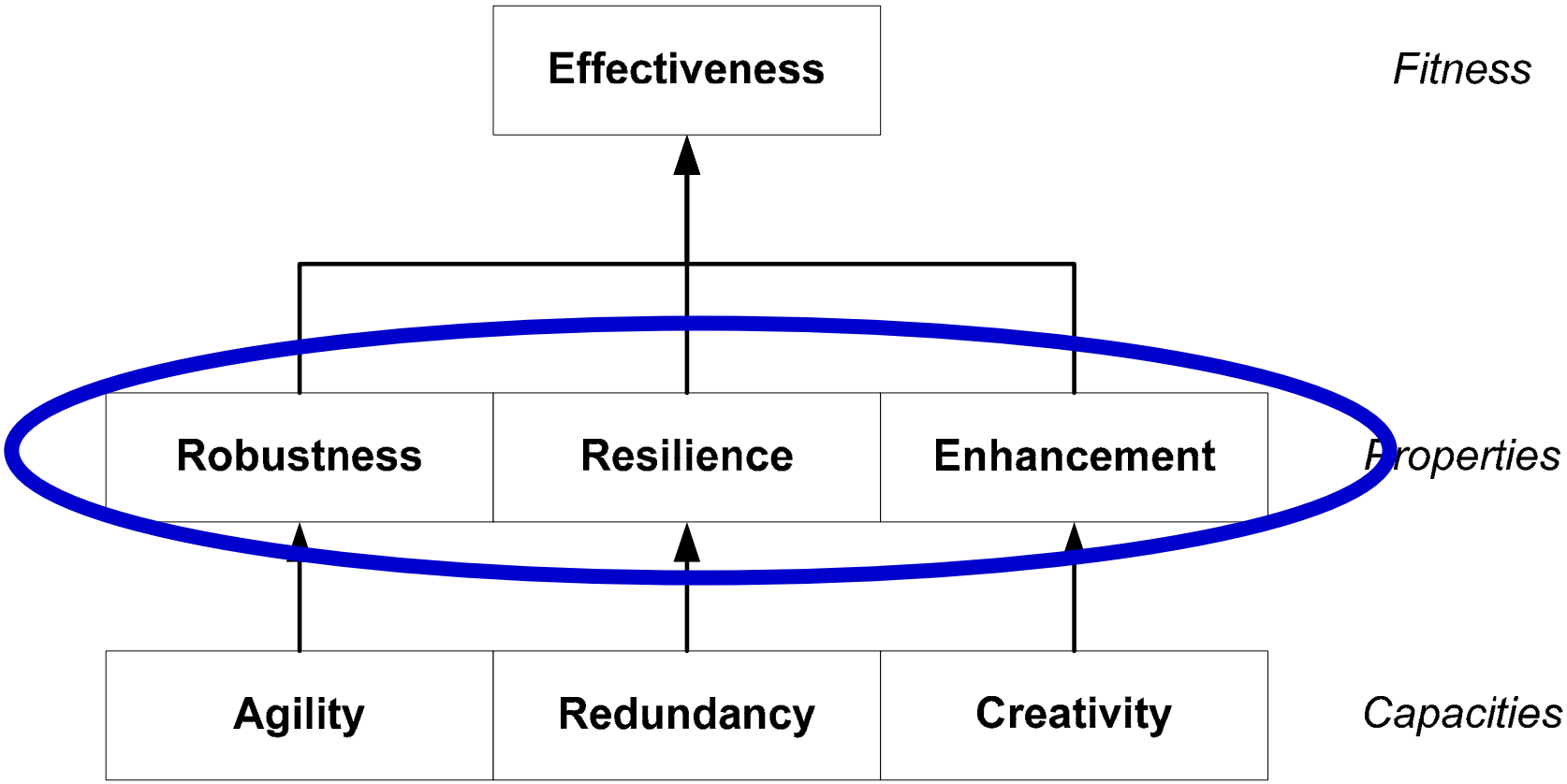
The Metacapability Conceptual Framework: The External View

Australian Government
Department of Defence
Defence Science and Technology Organisation



The Metacapability Conceptual Framework: The External View

Australian Government
Department of Defence
Defence Science and Technology Organisation



Linking the Two Layers

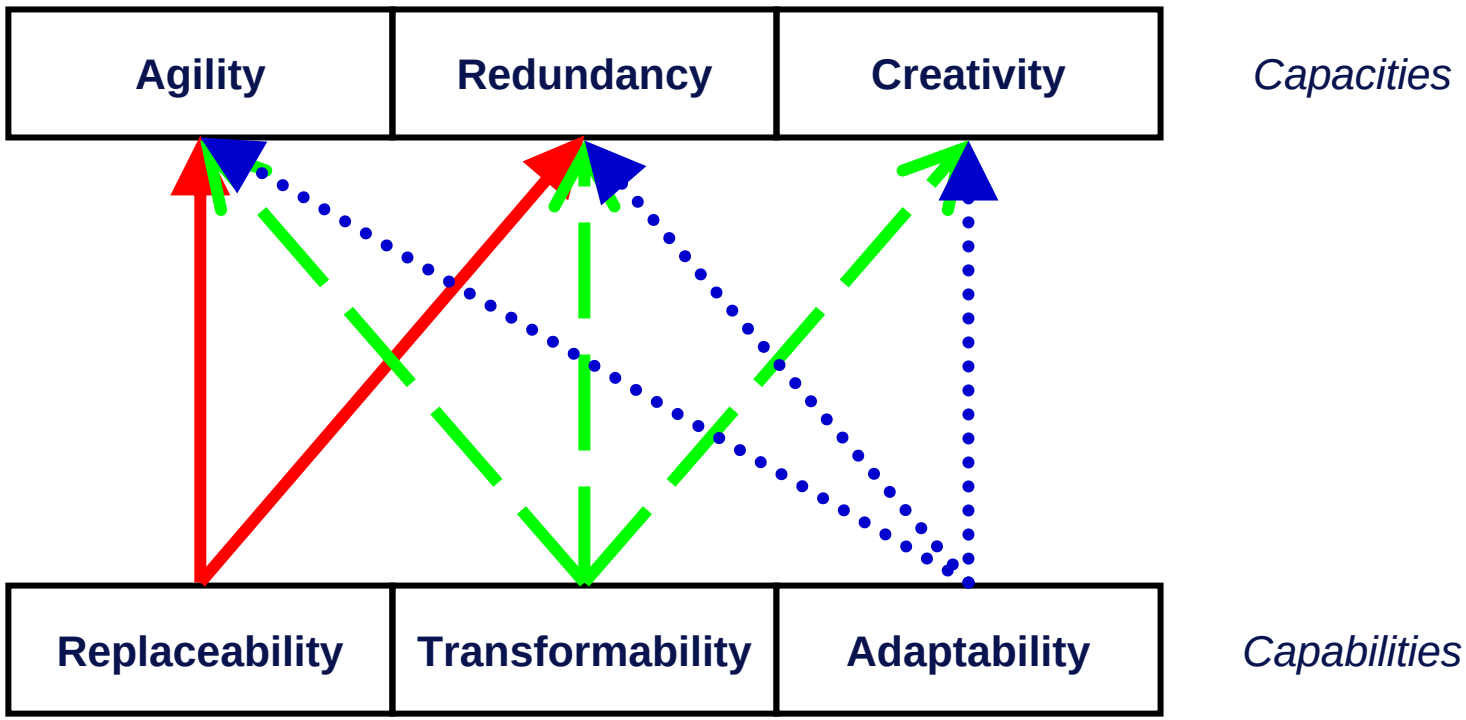
Australian Government
Department of Defence
Defence Science and Technology Organisation

Agility	**Redundancy**	**Creativity**	*Capacities*

Replaceability	**Transformability**	**Adaptability**	*Capabilities*

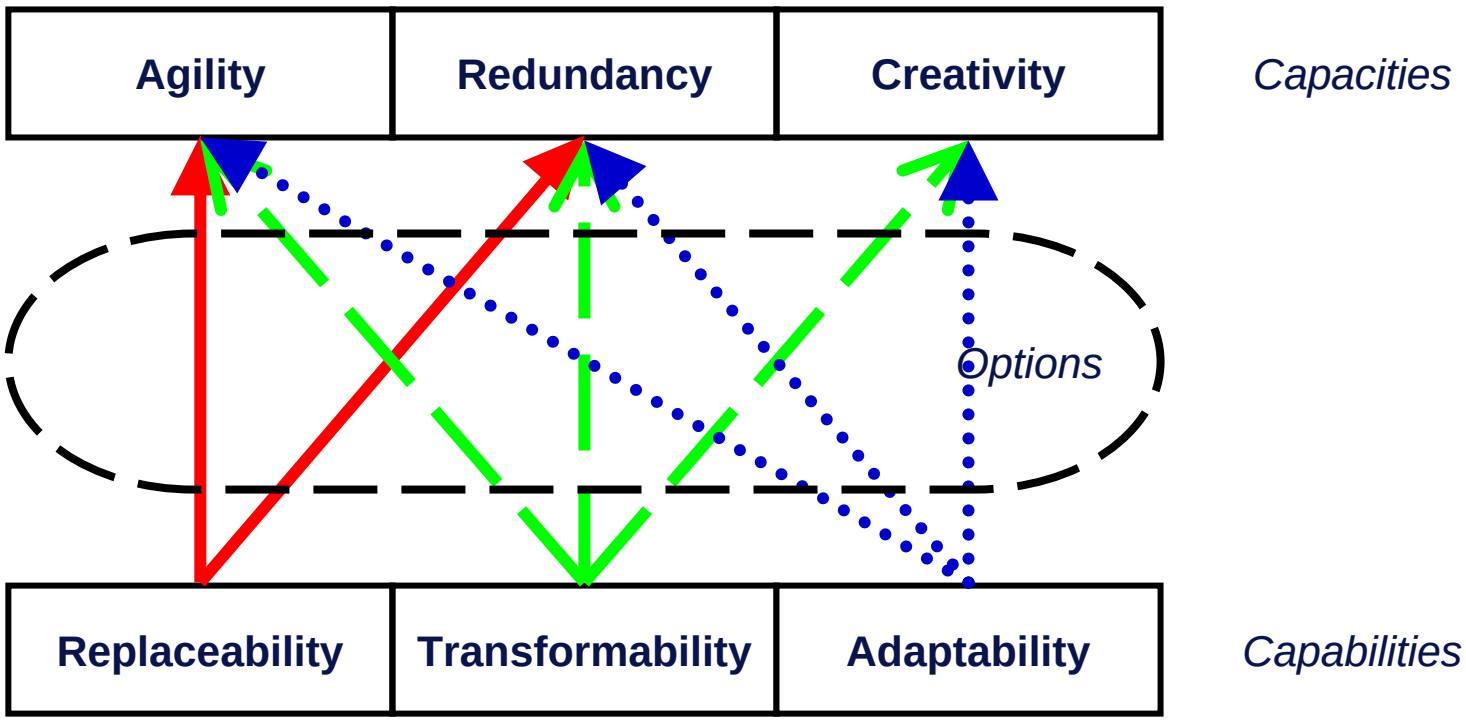
Linking the Two Layers

Australian Government
Department of Defence
Defence Science and
Technology Organisation



Linking the Two Layers

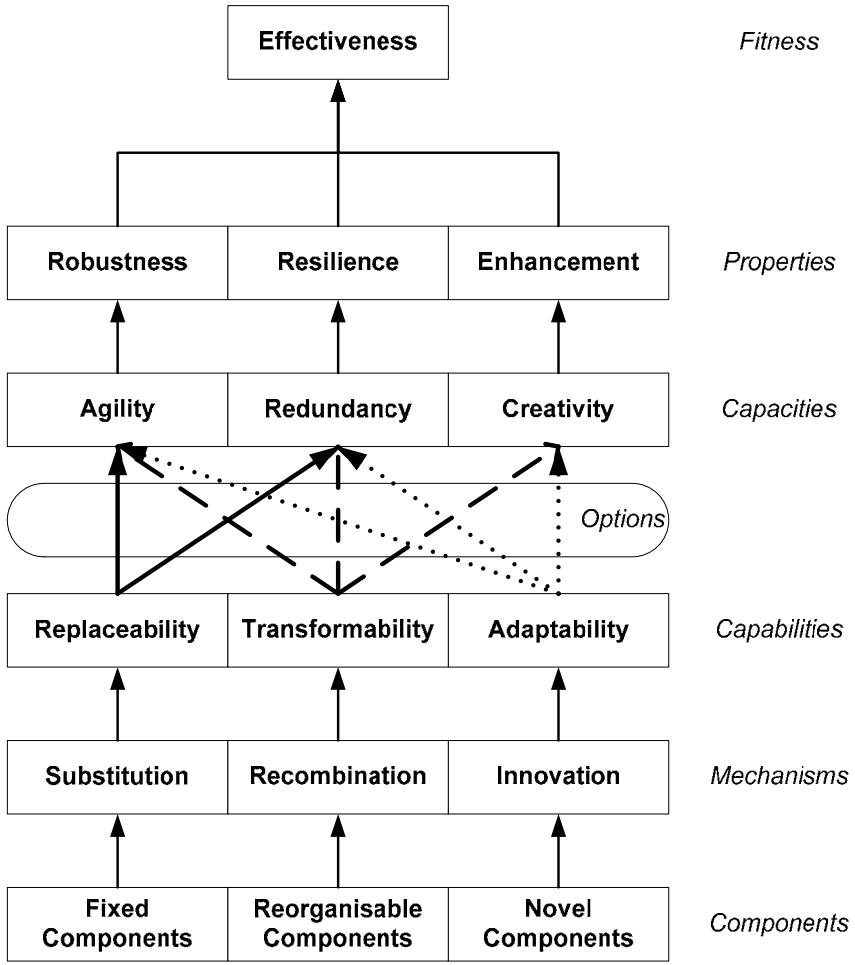
Australian Government
Department of Defence
Defence Science and
Technology Organisation



The Metacapability Conceptual Framework

Australian Government
Department of Defence
Defence Science and Technology Organisation

- The framework deliberately attempts to **simplify the design problem** by distinguishing between the internal and external views
- The framework relies on a strict set of definitions and a **formal ontology to support greater analytical rigour**.
- The **richness** of the "Agility space" identified by other authors is **reproduced here in a systematic way** through the many-to-many linkages between the internal and external views



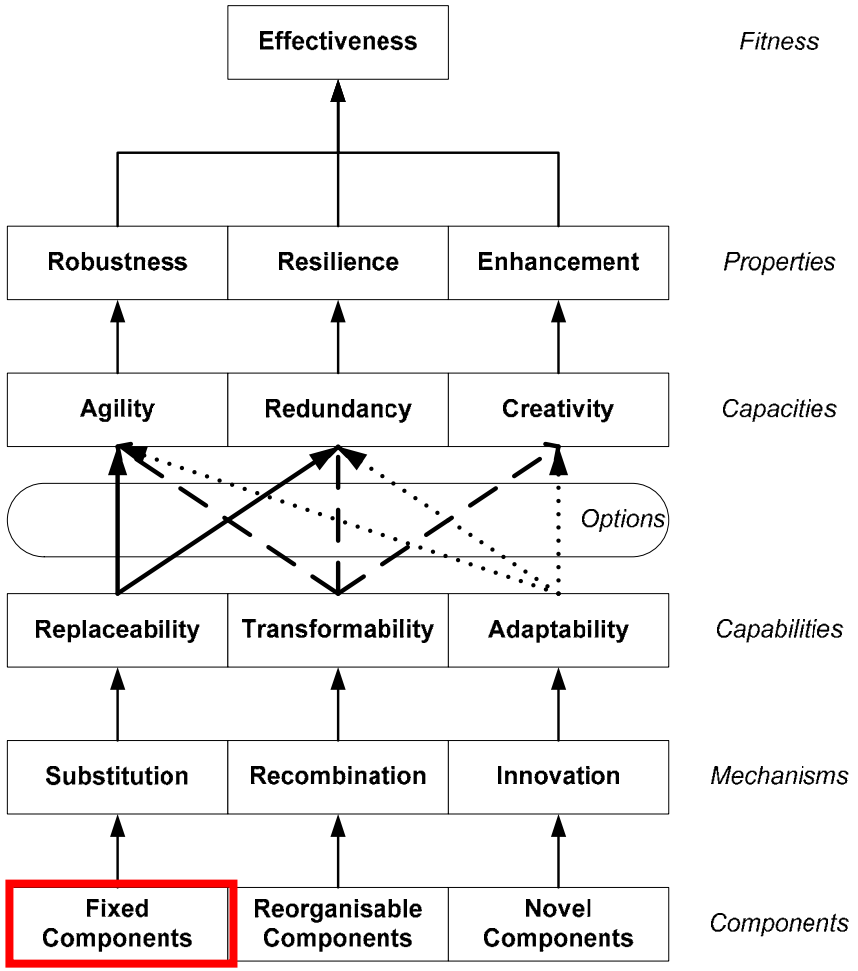
Case Studies

Australian Government
Department of Defence
Defence Science and
Technology Organisation

- Adoption of 6-pounder Gun (France, 1802-1805)
- The Grand Battery (France, 1807)
- Course of Action Development (contemporary)
- Failure to Execute Combined Arms (Kfar Darom, 1948)

Case Study 1:
Adoption of 6-pounder Gun (France, 1802-1805)

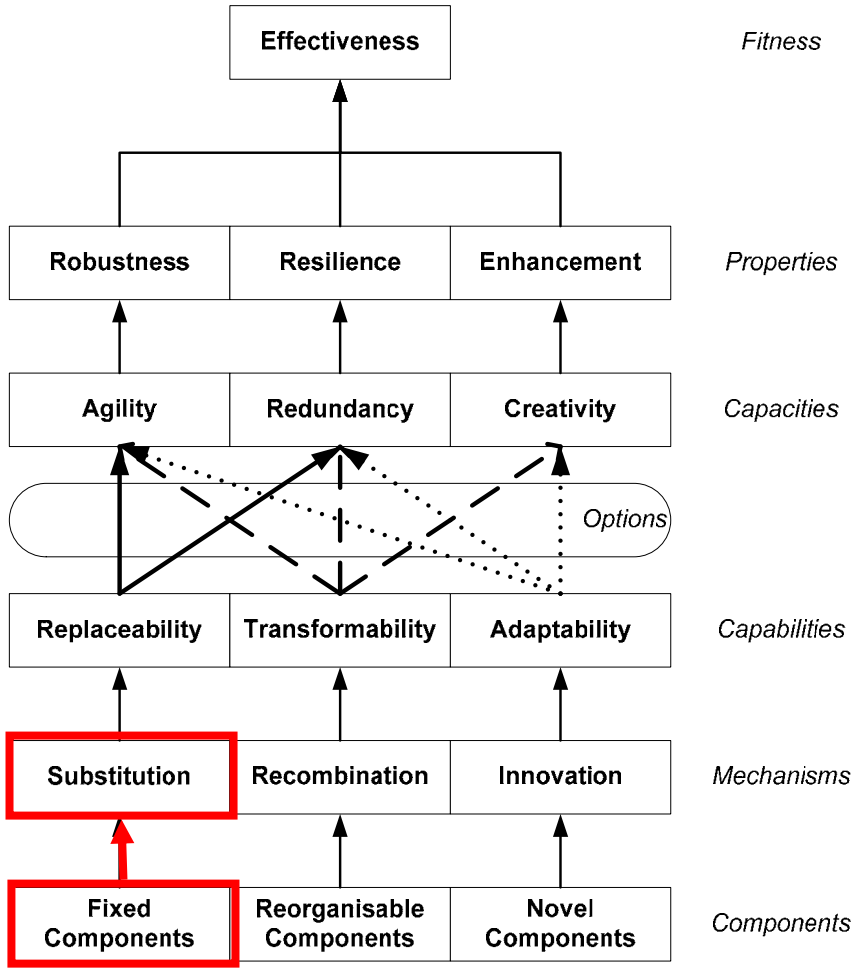
This example talks about the adoption of a standardized 6 pounder gun and how it improved the resilience of the Napoleonic Army.



Adoption of standardized 6 pounder

Case Study 1:
Adoption of 6-pounder Gun (France, 1802-1805)

Australian Government
Department of Defence
Defence Science and
Technology Organisation



Guns and parts of guns (even captured ordnance) were interchangeable

Adoption of standardized 6 pounder

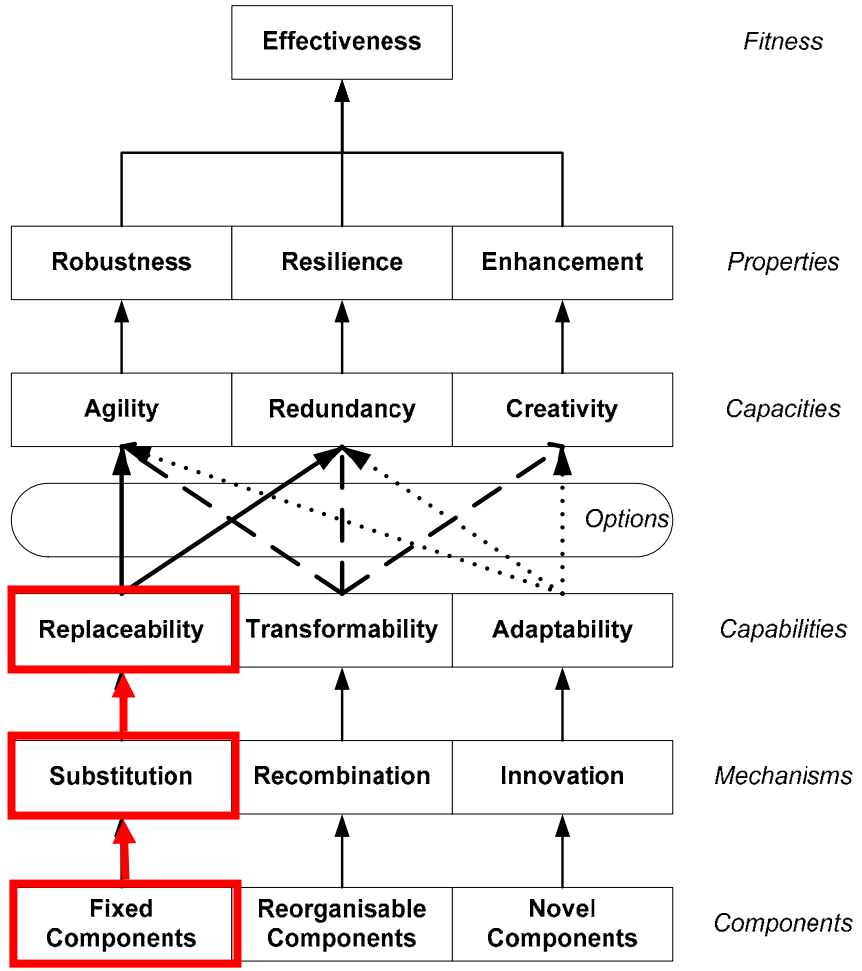
Case Study 1:
Adoption of 6-pounder Gun (France, 1802-1805)

Australian Government
Department of Defence
Defence Science and Technology Organisation

Units were therefore replaceable

Guns and parts of guns (even captured ordnance) were interchangeable

Adoption of standardized 6 pounder



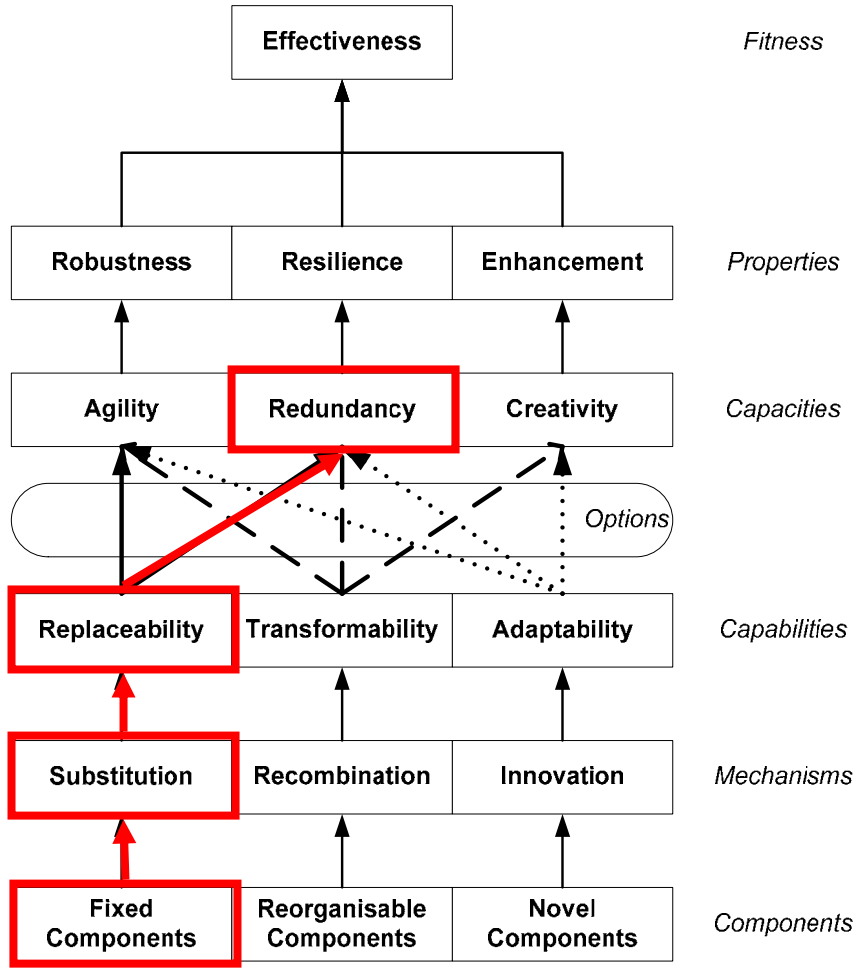
Case Study 1:
Adoption of 6-pounder Gun (France, 1802-1805)

From an observer's point of view, losses in or of artillery batteries were more easily coped with because a lost or damaged element could be replaced.

Units were therefore replaceable

Guns and parts of guns (even captured ordnance) were interchangeable

Adoption of standardized 6 pounder



Case Study 1:
Adoption of 6-pounder Gun (France, 1802-1805)

Australian Government
Department of Defence
Defence Science and Technology Organisation

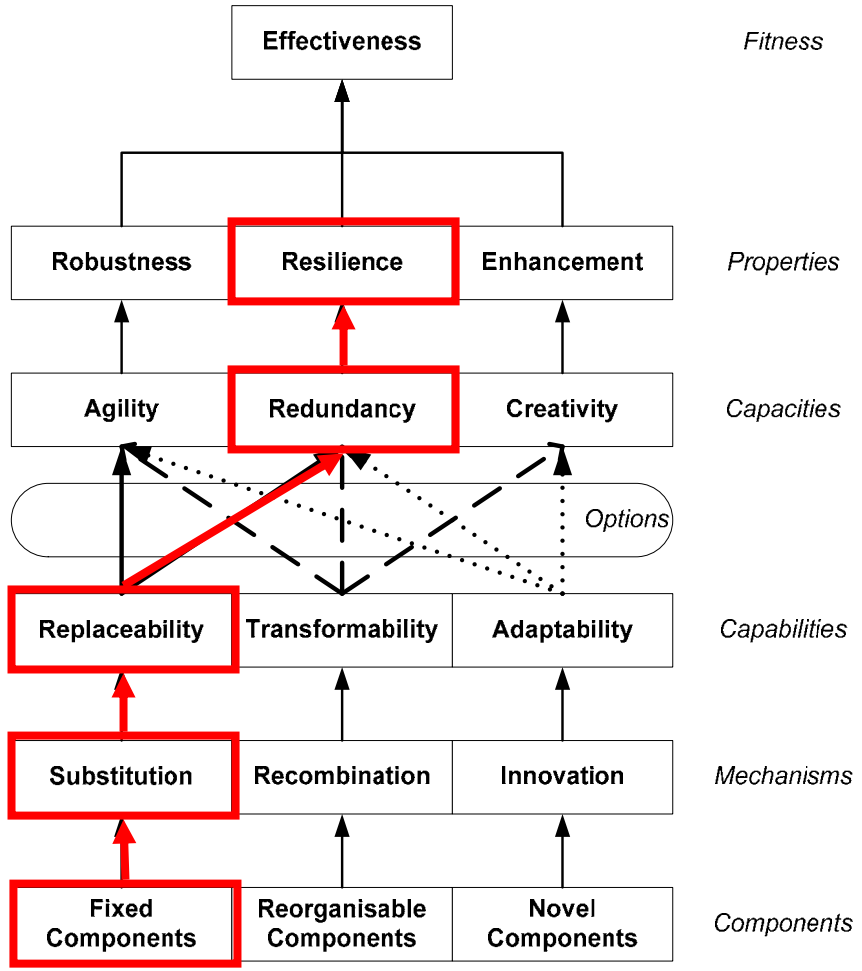
The army was able to cope with losses and maintain effectiveness

From an observer's point of view, losses in or of artillery batteries were more easily coped with because a lost or damaged element could be replaced.

Units were therefore replaceable

Guns and parts of guns (even captured ordnance) were interchangeable

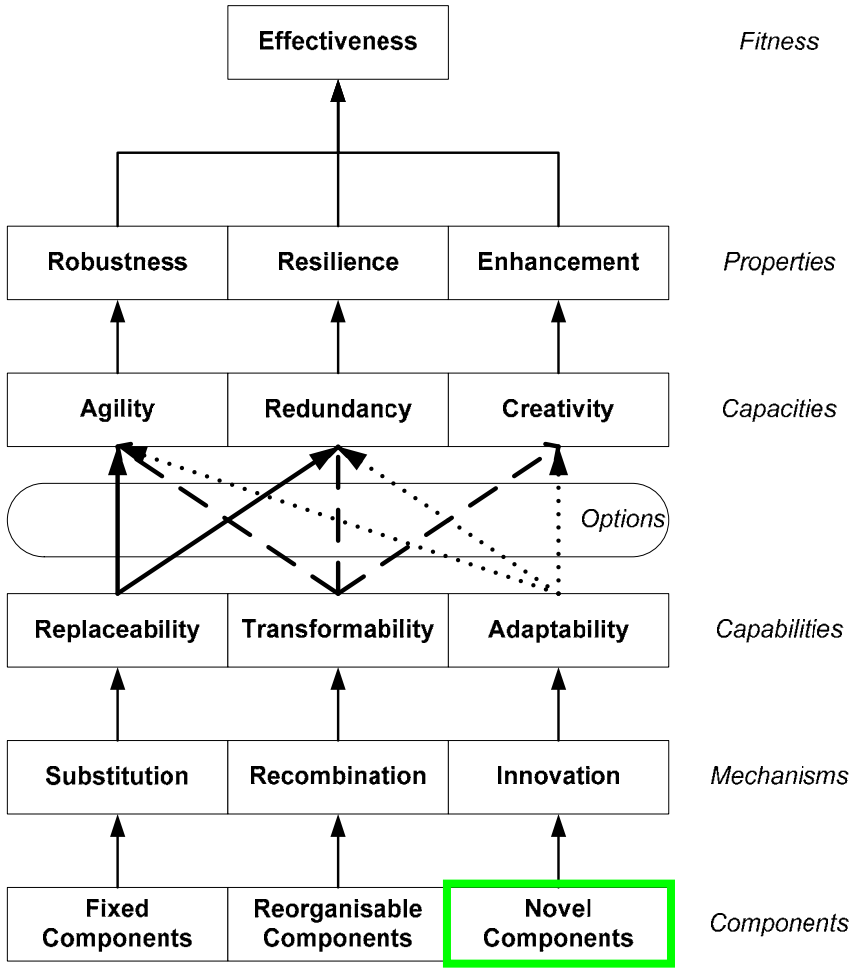
Adoption of standardized 6 pounder



Case Study 2:
The Grand Battery (France, 1807)

Australian Government
Department of Defence
Defence Science and
Technology Organisation

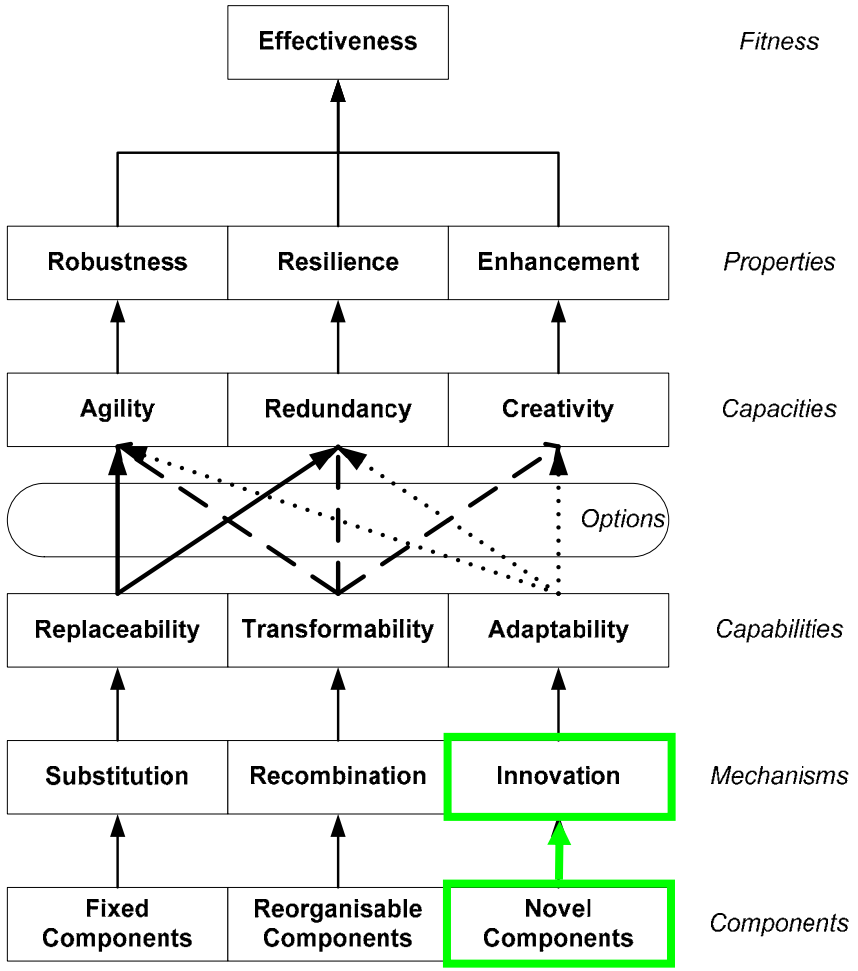
This example talks about the enhanced capability of the Napoleonic Army arising from the introduction of the Grand Battery as a driver for the development of a new doctrine.



Grand Battery as a novel component.

Case Study 2:
The Grand Battery (France, 1807)

Australian Government
Department of Defence
Defence Science and Technology Organisation



Grand Battery is a conceptual innovation

Grand Battery as a novel component

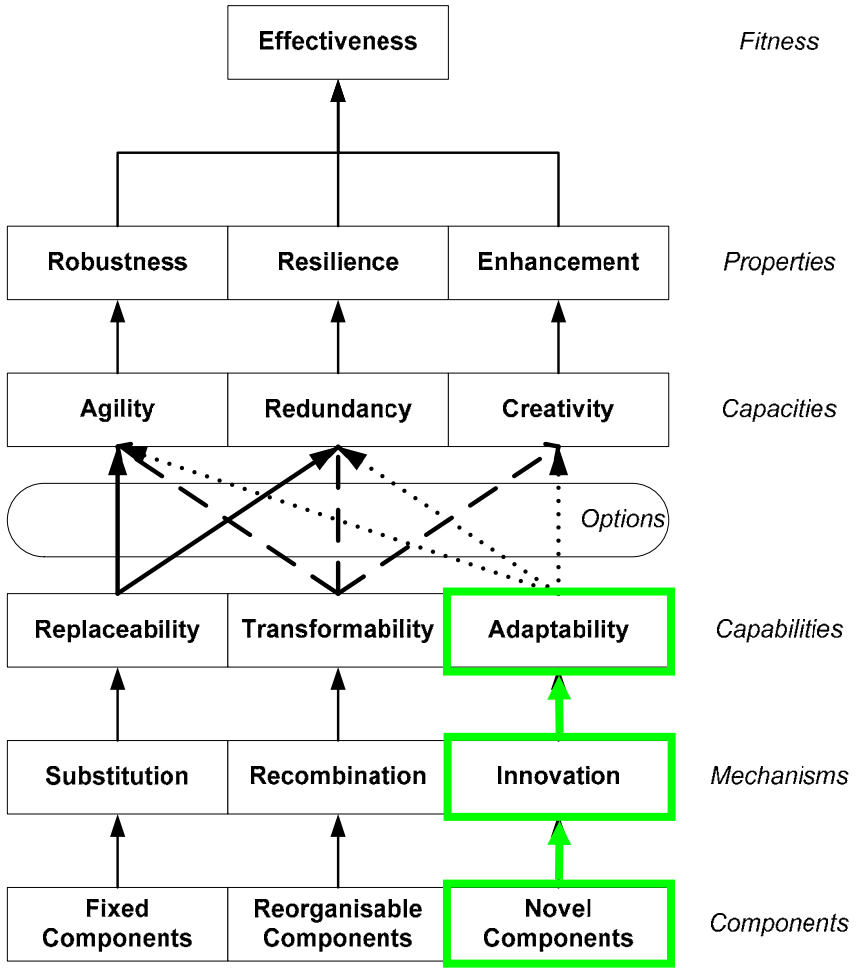
Case Study 2:
The Grand Battery (France, 1807)

Australian Government
Department of Defence
Defence Science and Technology Organisation

The doctrinal use of the Grand Battery differs from that of normal Horse Artillery

Grand Battery is a conceptual innovation

Grand Battery as a novel component



Case Study 2:
The Grand Battery (France, 1807)

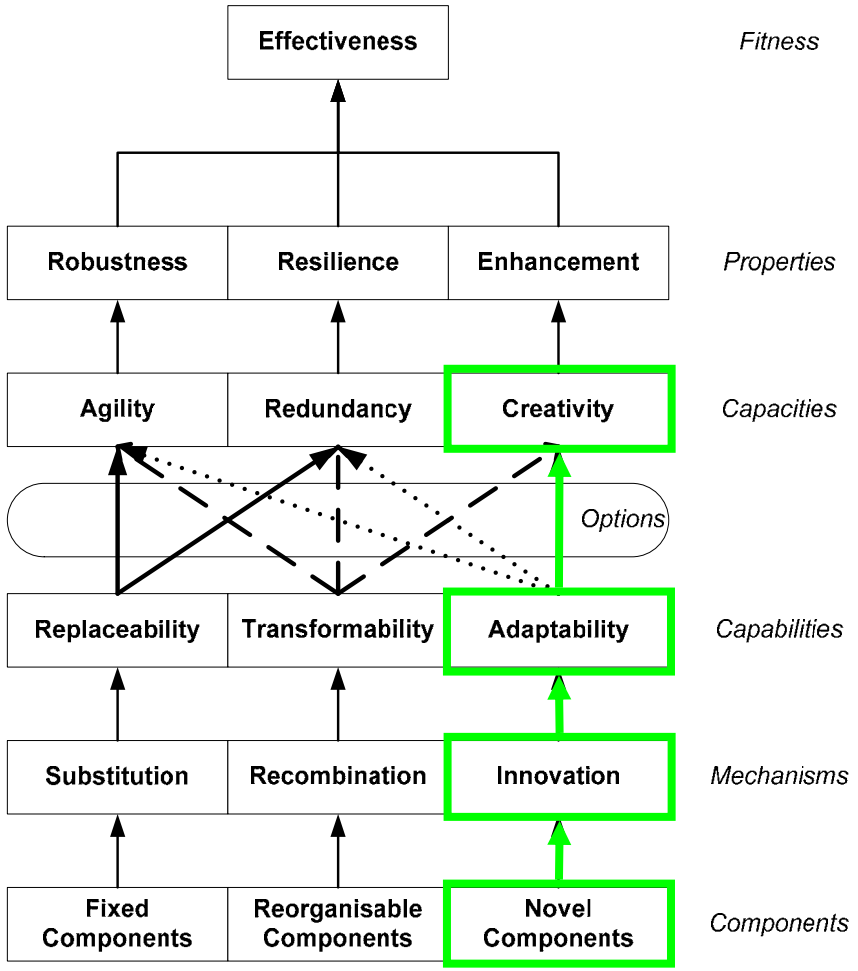
Australian Government
Department of Defence
Defence Science and Technology Organisation

Napoleon is seen to use the artillery in the form of the Grand Battery as a 'spearhead': a creative development in doctrine

The doctrinal use of the Grand Battery differs from that of normal Horse Artillery

Grand Battery is a conceptual innovation

Grand Battery as novel component



Case Study 2:
The Grand Battery (France, 1807)

Australian Government
Department of Defence
Defence Science and
Technology Organisation

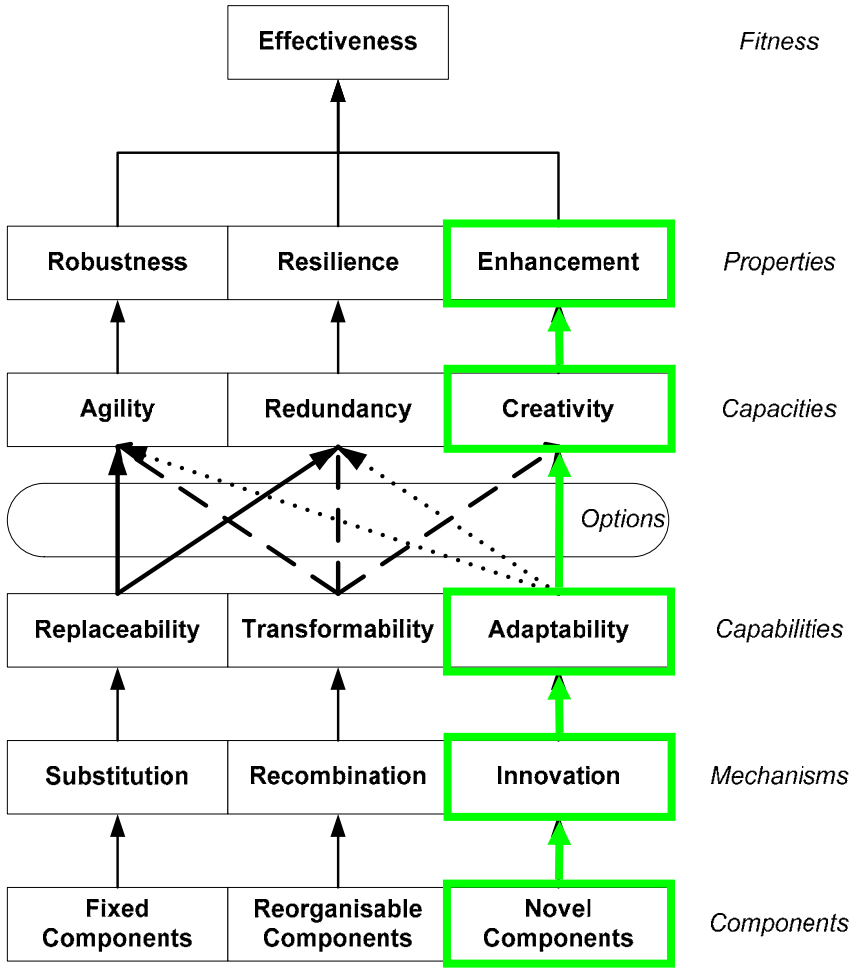
Army is able to create breakthrough with artillery and then exploit with horse/foot

Napoleon is seen to use the artillery in the form of the Grand Battery as a 'spearhead': a creative development in doctrine

The doctrinal use of the Grand Battery differs from that of normal Horse Artillery

Grand Battery is a conceptual innovation

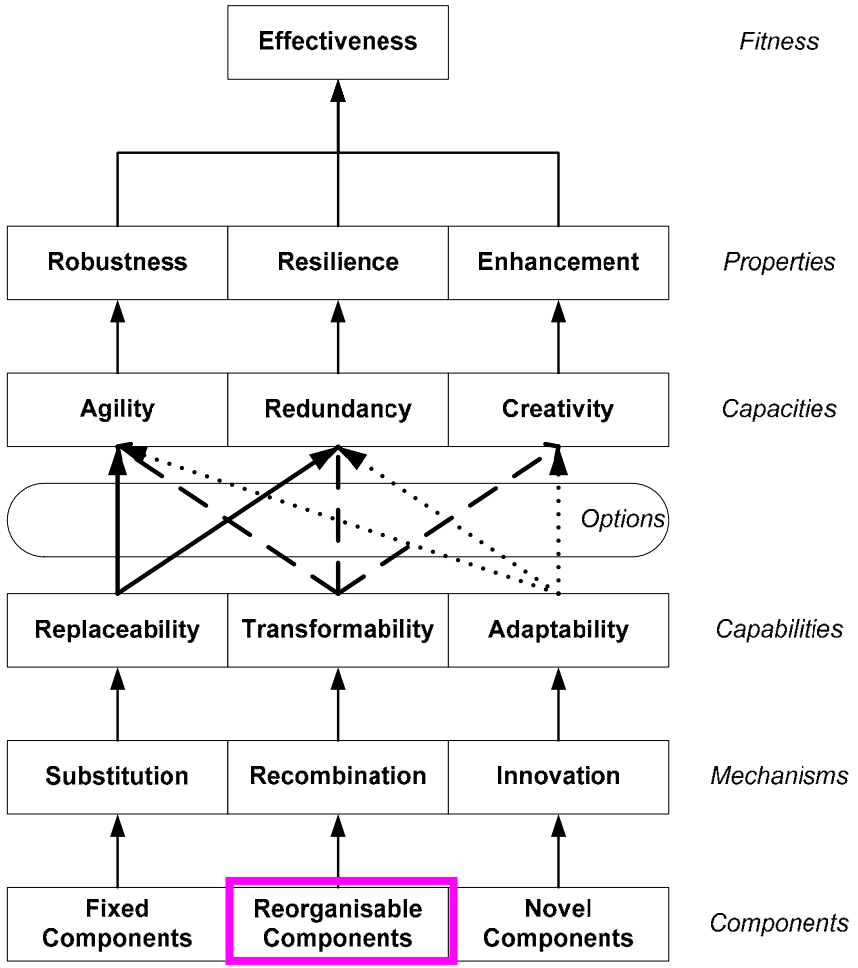
Grand Battery as novel component



Case Study 3:
"Course of Action Development Example"

Australian Government
Department of Defence
Defence Science and Technology Organisation

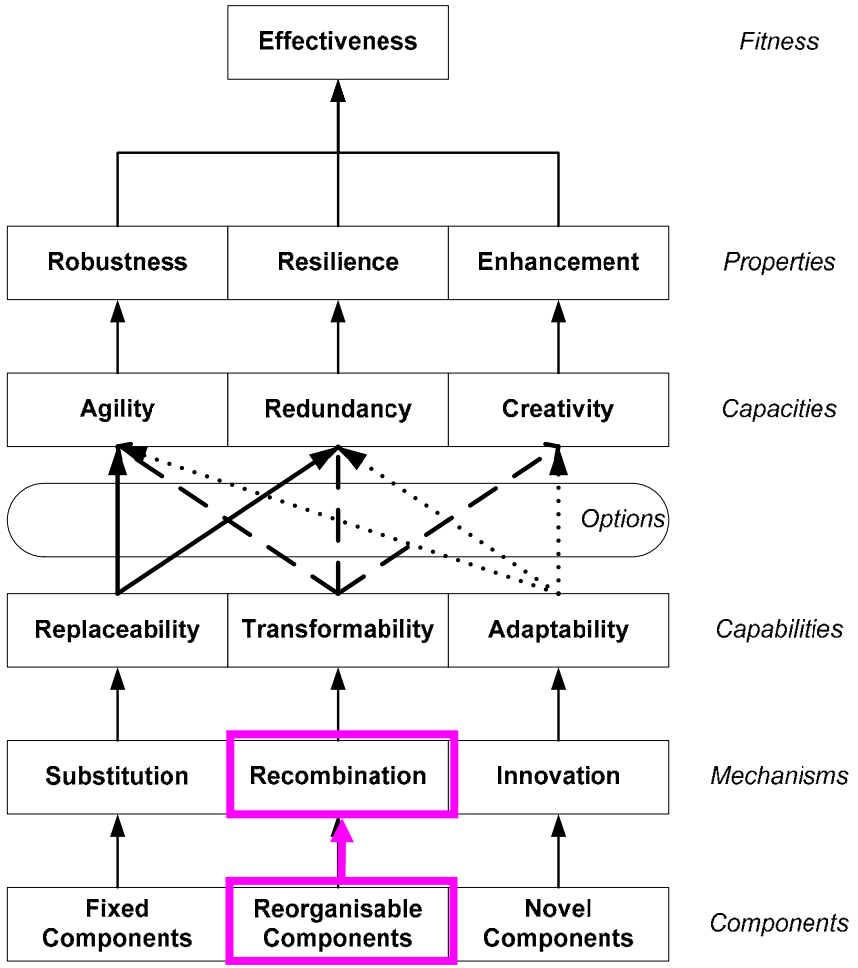
This example shows how Defence organisations generate new CoAs by integrating extant CoAs and how this can improve both force resilience and robustness.



Several independent courses of action (CoAs) are developed within a doctrinal process.

Case Study 3:
"Course of Action Development Example"

Australian Government
Department of Defence
Defence Science and Technology Organisation



Framed within a consistent doctrinal approach, they can contribute to a final CoA that is an integration of ideas from each.

Several independent courses of action (CoAs) are developed within a doctrinal process.

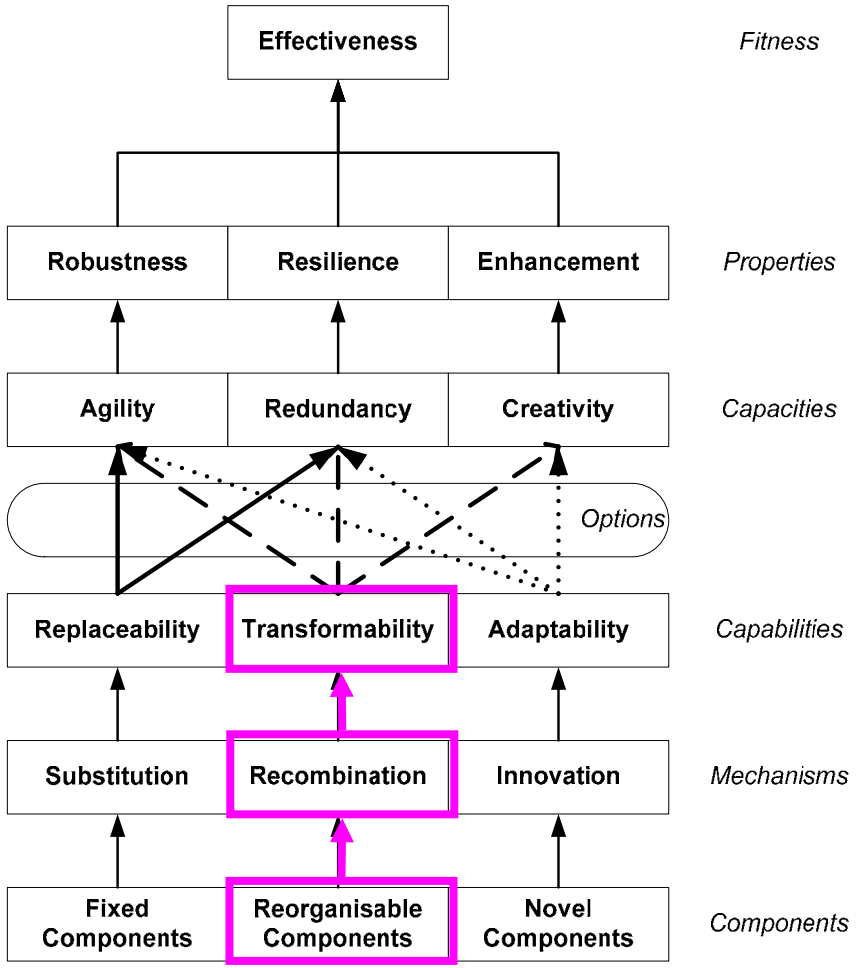
Case Study 3:
"Course of Action Development Example"

Australian Government
Department of Defence
Defence Science and Technology Organisation

If a capability within the force is lost, the force can quickly establish an alternative CoA by integrating established ideas.

Framed within a consistent doctrinal approach, they can contribute to a final CoA that is an integration of ideas from each.

Several independent courses of action (CoAs) are developed within a doctrinal process.



Case Study 3:
"Course of Action Development Example"

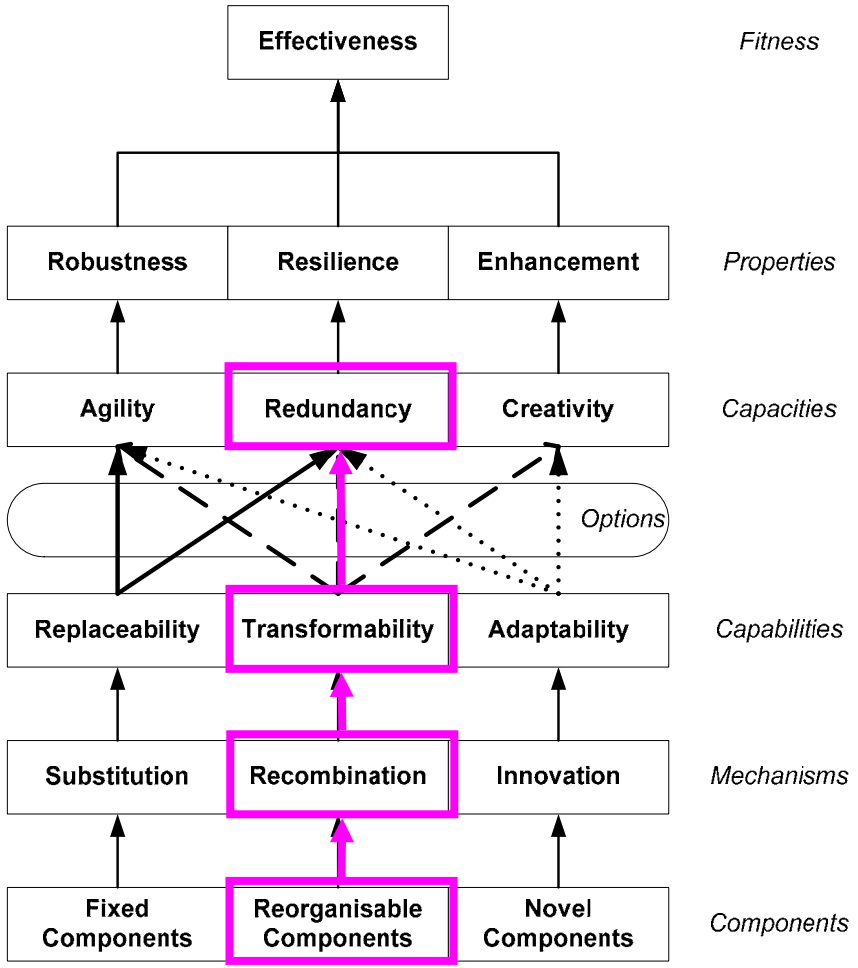
Australian Government
Department of Defence
Defence Science and Technology Organisation

From an observer's point of view, alternative plans are available when the original plan can't be executed due to internal losses.

If a capability within the force is lost, the force can quickly establish an alternative CoA by integrating established ideas.

Framed within a consistent doctrinal approach, they can contribute to a final CoA that is an integration of ideas from each.

Several independent courses of action (CoAs) are developed within a doctrinal process.



Case Study 3:
"Course of Action Development Example"

Australian Government
Department of Defence
Defence Science and Technology Organisation

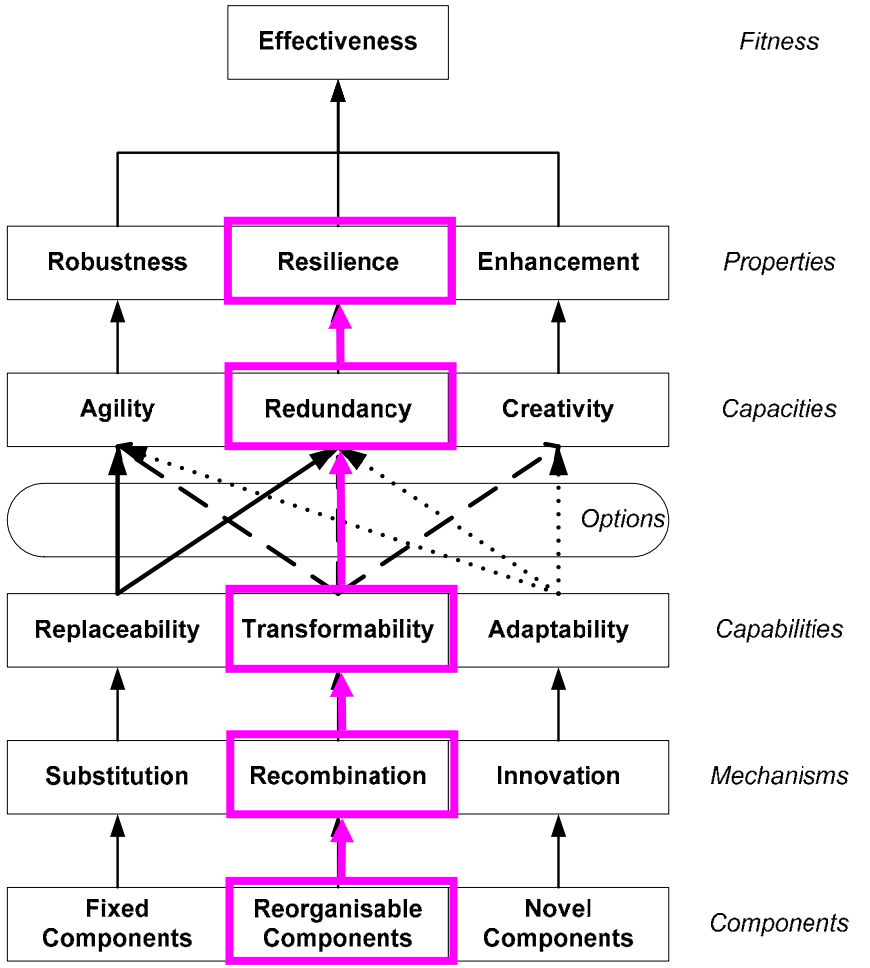
The force is seen to maintain its effectiveness despite losses or damage.

From an observer's point of view, alternative plans are available when the original plan can't be executed due to internal losses.

If a capability within the force is lost, the force can quickly establish an alternative CoA by integrating established ideas.

Framed within a consistent doctrinal approach, they can contribute to a final CoA that is an integration of ideas from each.

Several independent courses of action (CoAs) are developed within a doctrinal process.



Case Study 3:
"Course of Action Development Example"

Australian Government
Department of Defence
Defence Science and Technology Organisation

The force can maintain its effectiveness despite changes in the external environment.

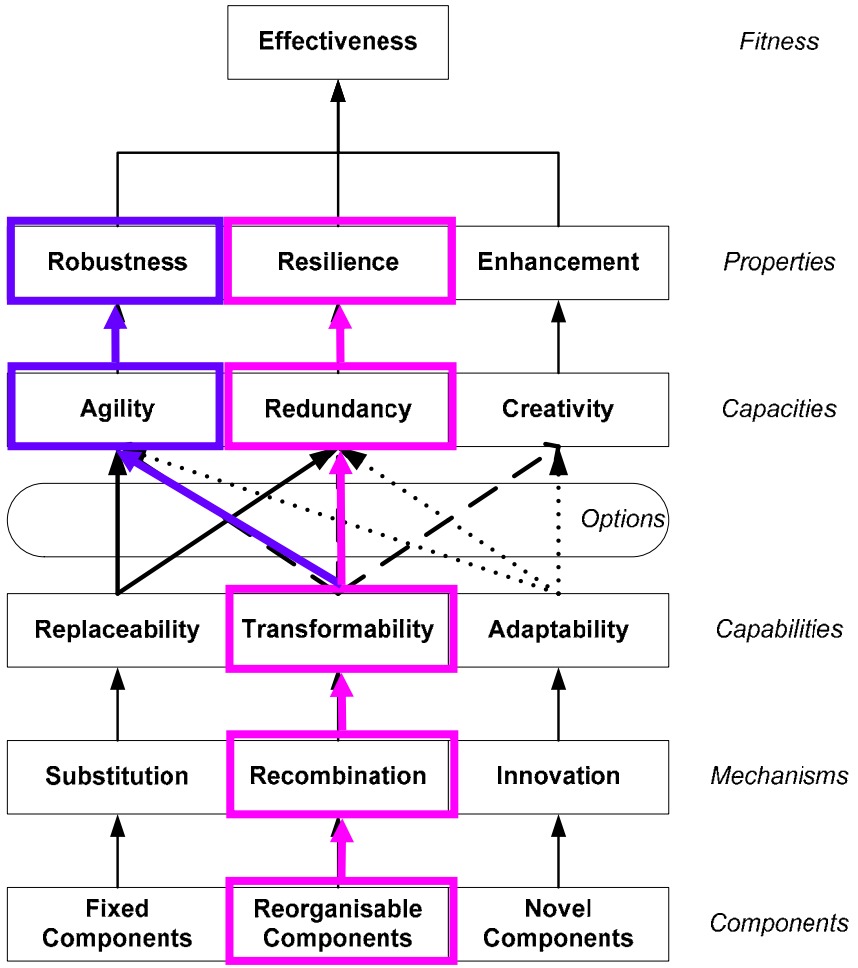
losses or damage.

From an observer's point of view, the ability to generate alternative CoA provides the force with capacity to cope with changes in external circumstances.

If a capability within the force is lost, the force can quickly establish an alternative CoA by integrating established ideas.

Framed within a consistent doctrinal approach, they can contribute to a final CoA that is an integration of ideas from each.

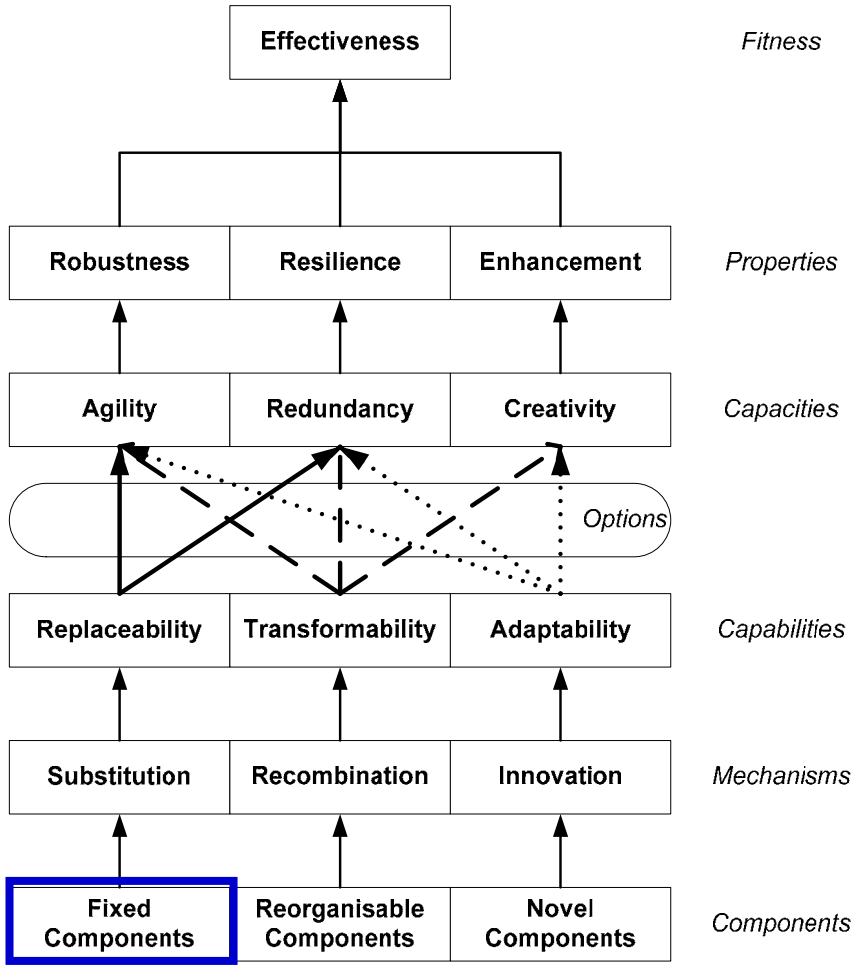
Several independent courses of action (CoAs) are developed in a consistent way.



Case Study 4:
Failure to Execute Combined Arms (Kfar Darom, 1948)

Australian Government
Department of Defence
Defence Science and Technology Organisation

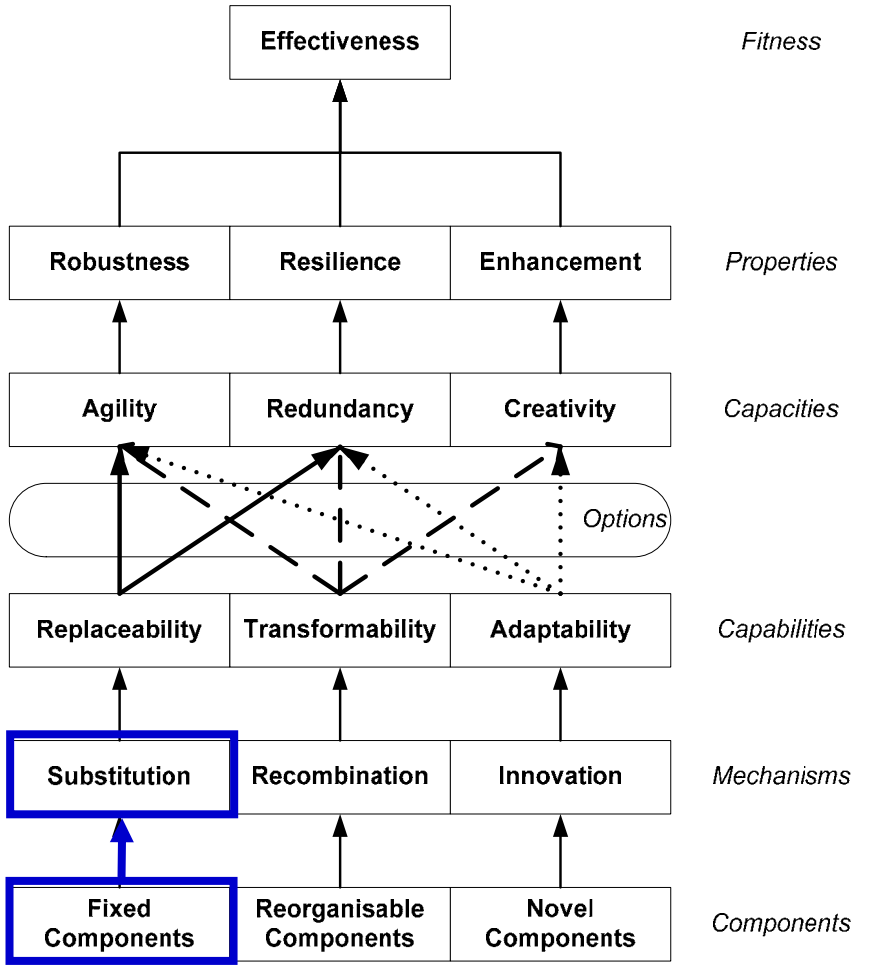
This negative example illustrates a failure to apply combined arms principles, and the impact this has on a force's ability to cope with changes in the external environment.



Egyption combined arms team assaults Kfar Darom.

Case Study 4:
Failure to Execute Combined Arms (Kfar Darom, 1948)

Australian Government
Department of Defence
Defence Science and
Technology Organisation



Infantry fall behind as armour enters the kibbutz. The infantry—ideally suited to controlling and securing complex terrain—is unavailable.

Egyption combined arms team assaults Kfar Darom.

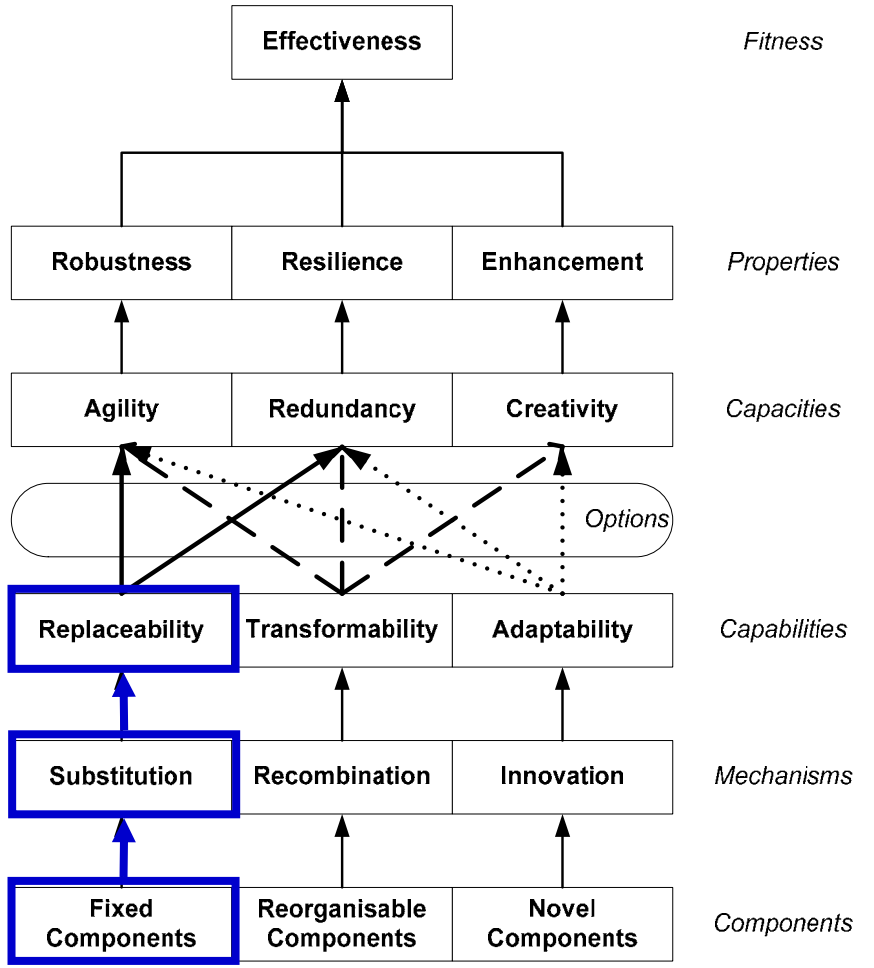
Case Study 4:
Failure to Execute Combined Arms (Kfar Darom, 1948)

Australian Government
Department of Defence
Defence Science and
Technology Organisation

Armour must fulfill the function normally fulfilled by infantry, but with little success.

Infantry fall behind as armour enters the kibbutz. The infantry—ideally suited to controlling and securing complex terrain—is unavailable.

Egyption combined arms team assaults Kfar Darom.



Case Study 4:
Failure to Execute Combined Arms (Kfar Darom, 1948)

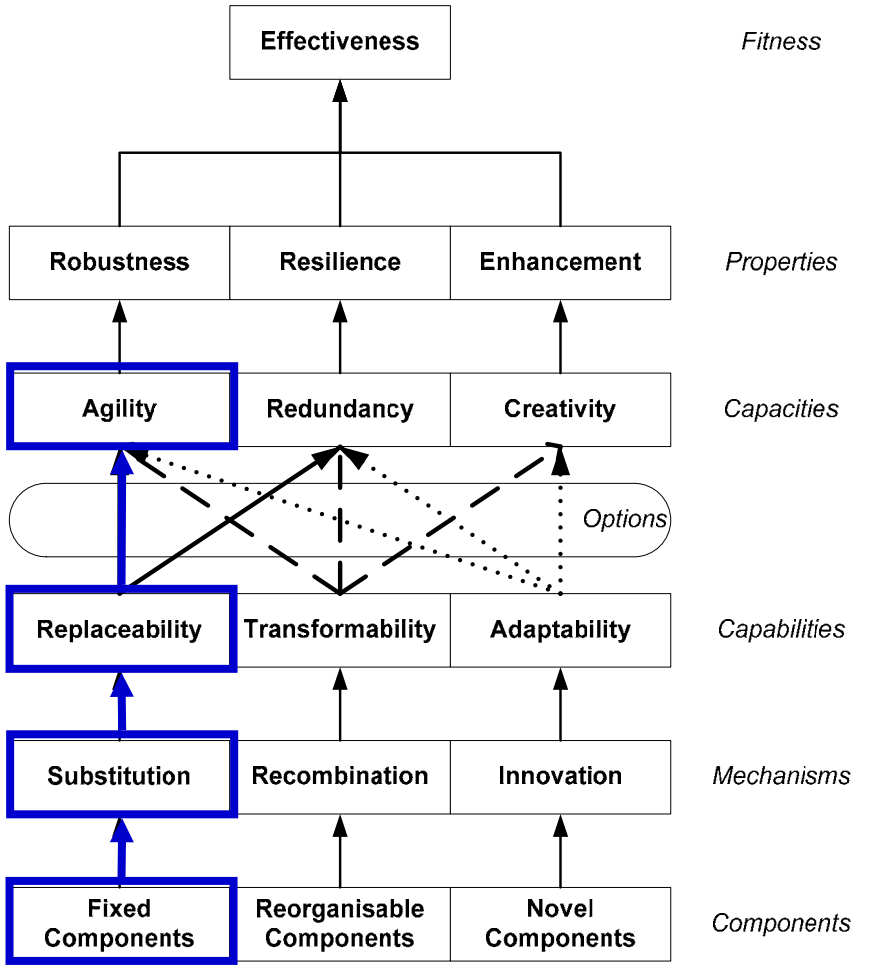
Australian Government
Department of Defence
Defence Science and
Technology Organisation

From an external point of view, the Egyption force, no longer a combined arms team, is unable to adjust to the complex terrain.

Armour must fulfill the function normally fulfilled by infantry, but with little success.

Infantry fall behind as armour enters the kibbutz. The infantry—ideally suited to controlling and securing complex terrain—is unavailable.

Egyption combined arms team assaults Kfar Darom.



Case Study 4:
Failure to Execute Combined Arms (Kfar Darom, 1948)

Australian Government
Department of Defence
Defence Science and
Technology Organisation

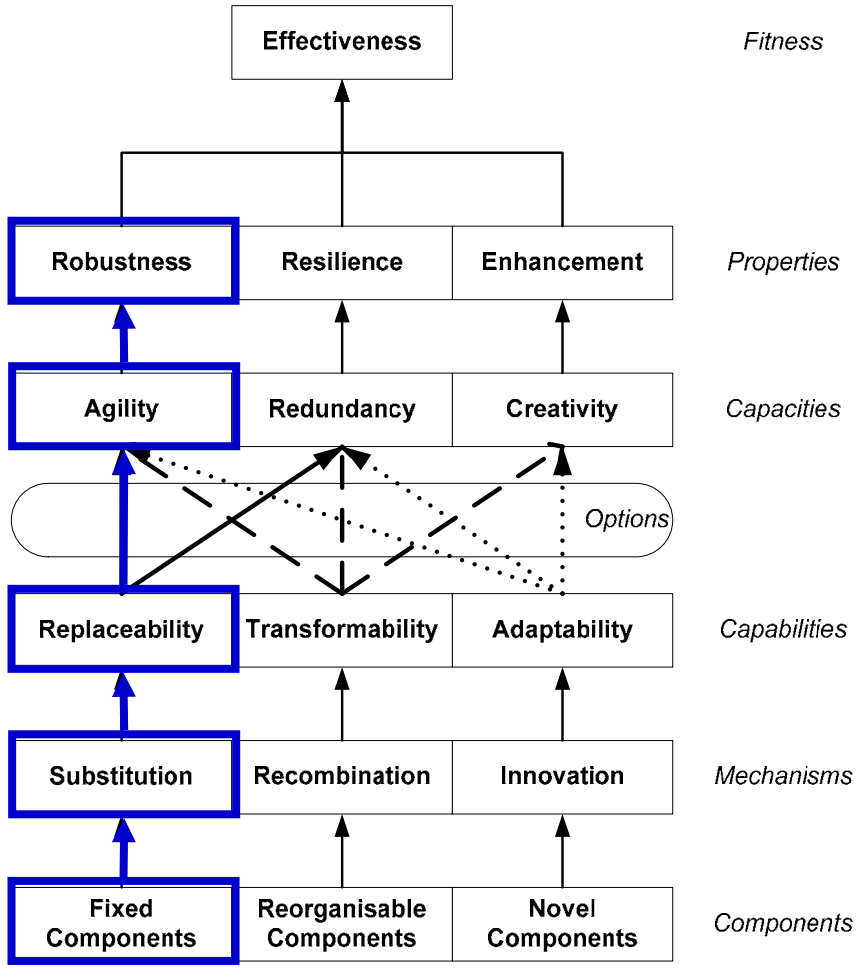
The force is repulsed from Kfar Darom because of the marked decrease in effectiveness in complex terrain.

From an external point of view, the Egyption force, no longer a combined arms team, is unsuited to the complex terrain.

Armour must fulfill the function normally fulfilled by infantry, but with little success.

Infantry fall behind as armour enters the kibbutz. The infantry—ideally suited to controlling and securing complex terrain—is unavailable.

Egyption combined arms team assaults Kfar Darom.



Examples of the strategies already in use that this framework elucidates

- Combined arms teams
- Multi-role aircraft
- Multiple ‘Tactics, Techniques and Procedures’ (TTPs)
- Reserve forces
- Multiple Course of Action Development
- GPS Constellation redundancies
- Topology and protocols of the Internet

Summary

- We have proposed a framework founded on the concepts of Agility established by Alberts and Hayes and other authors. It describes these concepts and the relationships between them in a systematic manner.
- The Metacapability Conceptual Framework differentiates between the internal design elements of a system (components, mechanisms and capabilities) and the external observable qualities of the system (capacities, properties, fitness).
- It defines the linkages between these two views, which is where simple design decisions can generate rich system level properties.
- Historical case studies have been used to illustrate and explicate the framework.

Future Work / Issues to resolve

- Further evaluation of the framework using military and C2 case studies. Currently we are examining the potential to derive value propositions from the framework and test these against real case studies using subject matter experts.

- The potential applications to:
  - non-traditional problems such as counter IED.
  - the analysis of adversary military capabilities.

- Development of concepts beyond the current framework such as “Shaping” (where a system influences its environment).

Further Information

Australian Government
Department of Defence
Defence Science and Technology Organisation

- Donald Lowe
  donald.lowe@defence.gov.au
  DSTO
  Russell Offices
  Canberra ACT 2600
  +61-2-62651182

- Simon Ng
  simon.ng@dsto.defence.gov.au
  DSTO
  Fishermans Bend VIC 3207
  +61-3-96267944