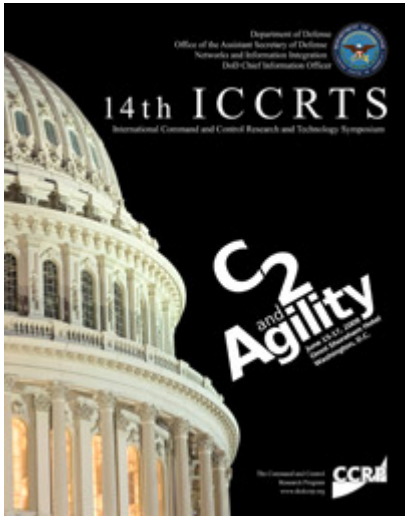
Evidence-Based C2 Metrics: A Survey



Anthony Dekker

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Australian Government
Department of Defence
Defence Science and Technology Organisation

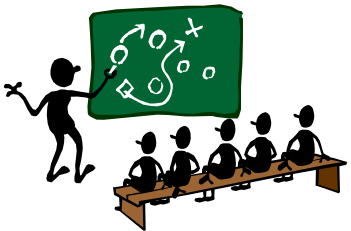
Overview of this talk

Goals and Philosophy

Document Metrics

Process Metrics

Cognitive Metrics



Discussion

Goals

- **Use C2 metrics to assess headquarters performance**

  … to enable organisational learning.

- **Survey literature to find "best of breed" metrics**

  … as a basis for further development.

Philosophy

- Want published evidence of **feasibility**

  … can we collect numbers without too much effort?

  … and without disrupting the headquarters?

- Want published evidence of **validity**

  … do the numbers mean anything?

  … metrics nudge organisations towards getting high scores

  … invalid metrics can be harmful, not just useless.

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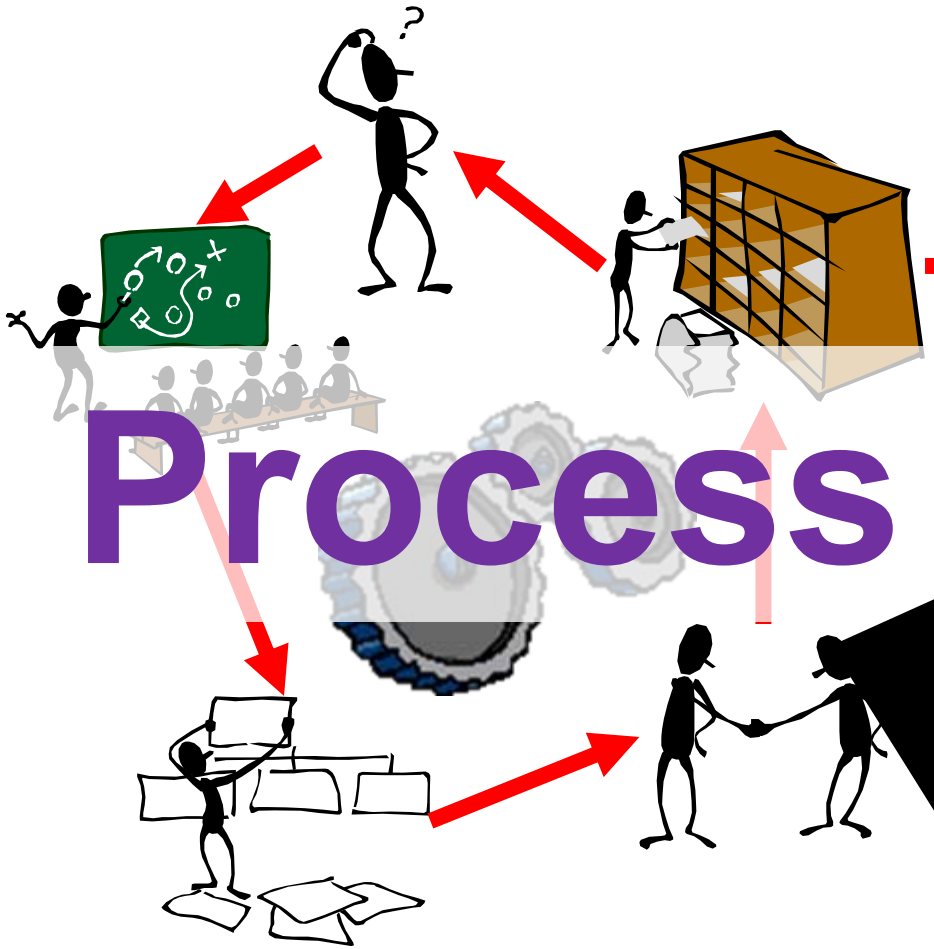
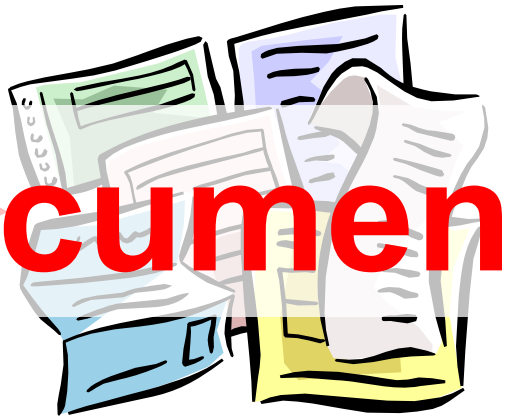
3 Types of Metrics



Process

Document



Cognitive

Document (Product) Metrics

Measuring the outputs of the process

Documents include plans, orders, etc.

Historical example: Guderian, 1940

Headquarters, XIX Army Corps
Operations Department

Corps H.Q., Soize
16.5.40

Corps Order No. 7 for May 17th, 1940

Unit SITREPs

1. The enemy opposing 1st and 2nd Panzer Divisions has once again been decisively defeated and is withdrawing westward along the whole front.
   XIX Army Corps has reached the area west of Montcornet with the mass of its forces. Advance units are moving towards the Oise between Origny and Hamégicourt.
   XIV Army Corps, following behind and to the left of XIX Army Corps, is covering the left flank along the Aisne.

XIV Corps SITREP

2. XIX Army Corps will continue to advance in a north-westerly direction on May 17th, by-passing St. Quentin and Péronne. Move off 09.00 hrs.
3. The advance will be as follows (for march routes see Annex 1):
   (a) *Right*: 2nd Panzer Division across the line Origny-Ribémont along march routes 1 and 2.
   (b) *Left*: 1st Panzer Division across the line Mézières sur Oise- Hamégicourt along march routes 3 and 4.
4. *10th Panzer Division* is once again under command. It will follow behind the left wing along the march routes previously numbered (on 16th May) 2 and 3, as far as Noircourt. Then it will send its *left wing column* through Dizy-le-Gros, Clermont Pierrepont, Hamégicourt. Then march route 4 in accordance with Annex 1.
   A road will be freed for the right wing column.

Higher HQ

5. *The 2nd (Motorised) Infantry Division* is placed under command of XIV Army Corps.
6. *Reconnaissance*: see Annex 2.

ISR

7. *Corps Headquarters*: originally Soize (3 miles east of Montcornet), then moving along march routes 2 and 3.

Signed: Guderian

Data Sources (from earlier same day)

Doc: ***Understandability (Restatement)***

Question: Are plans, orders, etc. **understandable**?

Metrics: Ask readers to summarise key points in their own words, and compare against list of key points from author(s).

Evidence: Successfully used by Singapore (Cheah and Fong 2006).

Problems: Workload on author(s) and analysts. Subjectivity.

Doc: ***Understandability (T/F Questions)***

Question: Are plans, orders, etc. **understandable**?

Metrics: Ask readers to answer a list of T/F questions

e.g. "Sharing information with NGOs is in line with the Commander's intent to avoid civilian casualties [T/F]"

Evidence: Successfully used in US/Singapore CTF exercise (Thomas, Pierce, Dixon & Fong 2007).

Problems: Workload on author(s) and analysts.

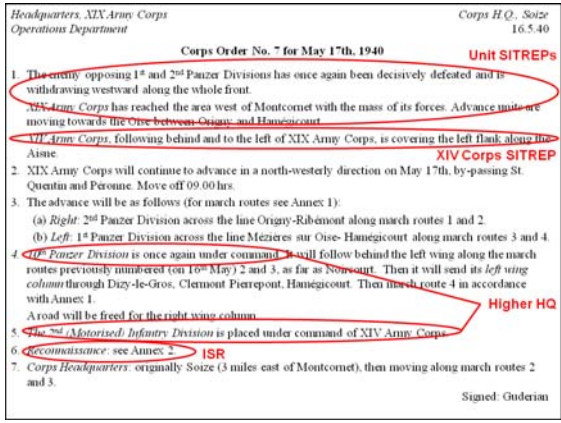
Doc: ***Data Sources***

Question: Is the document based on timely data sources?

Metrics: Number of data sources
Recency of data sources

Evidence: Use of these metrics in academia

Problems: Data sources may be implicit, so counting them may be difficult.



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Operations Department — 16.5.40

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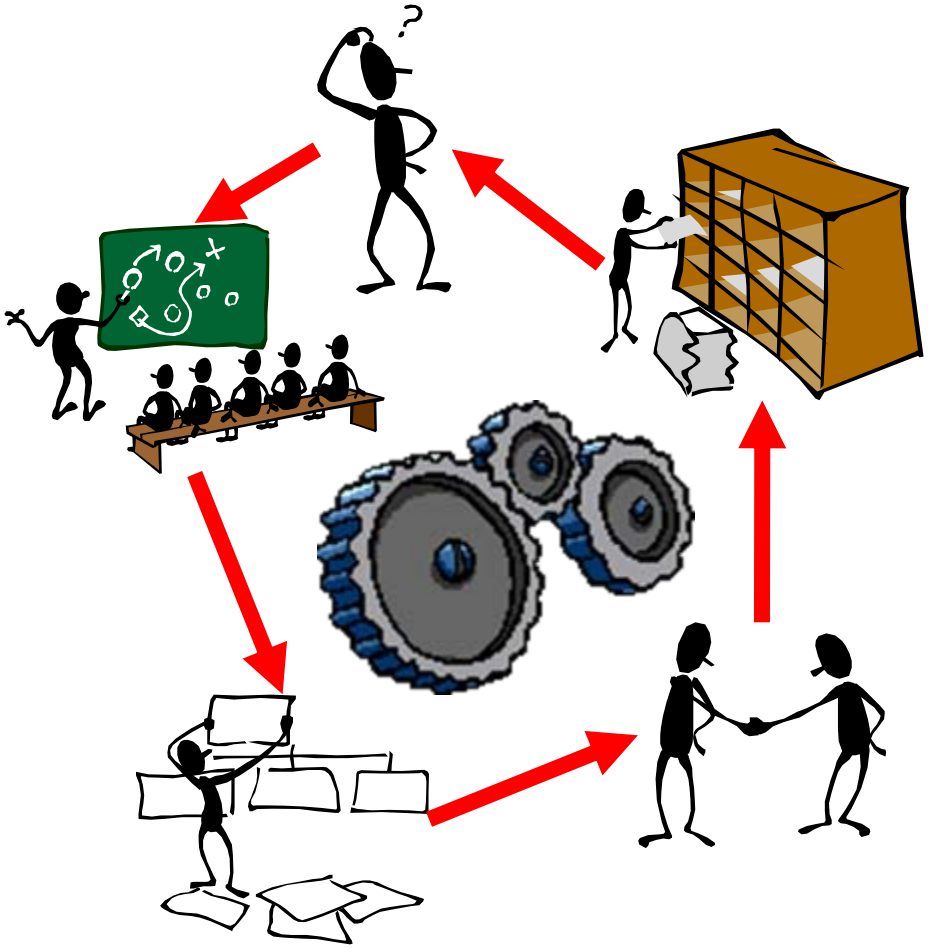
Process Metrics

Measuring the process itself



Process: ***Timing***

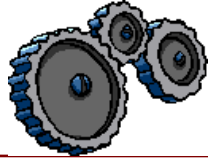
Question: How **fast** is the process?

Metrics: Time taken to react to events
Time to perform tasks
Throughput of tasks
– *all fairly easy to measure*

Evidence: Seems obvious that faster is better.

Problems: Must combine timing metrics with quality metrics to avoid encouraging “fast and sloppy” work.

Process: ***Breadth***



Question: Does the process consider enough options?

Metric: Number of COAs (Courses of Action) considered

Evidence: Recommended in US *Joint C2 Functional Concept*

Problems: "Considered" is a vague term
– danger of token COAs

Process: ***Workload***

Question: Are staff overworked?

Metrics: NASA Task Load Index and similar metrics

Evidence: Widely used, e.g. Cheah and Fong (2006).

Problems: Lack of evidence on relationship with HQ performance – when does overwork become dangerous?

Process: ***Teamwork***

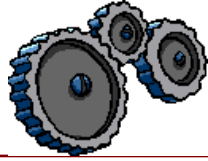
Question: How well are staff working in a team?

Metrics: Various
e.g. NATO Command Team Effectiveness Model (Essens *et al*. 2005)
– but no clear winners

Evidence: Considerable evidence that teamwork is important

Problems: Limited evidence for specific metrics.
No clear consensus on measuring teamwork.

Process: ***Interoperability***



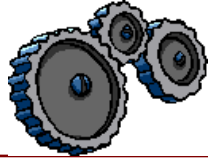
Question: How well does the agency interoperate with others?

Metrics: Various, e.g. OIM: Organisational Interoperability Maturity model (Clark and Moon 2001)

Evidence: Seems obvious that interoperability is good. OIM is frequently cited.

Problems: OIM is a fairly crude measure (only 5 levels).

Process: ***Aggregated Measures***



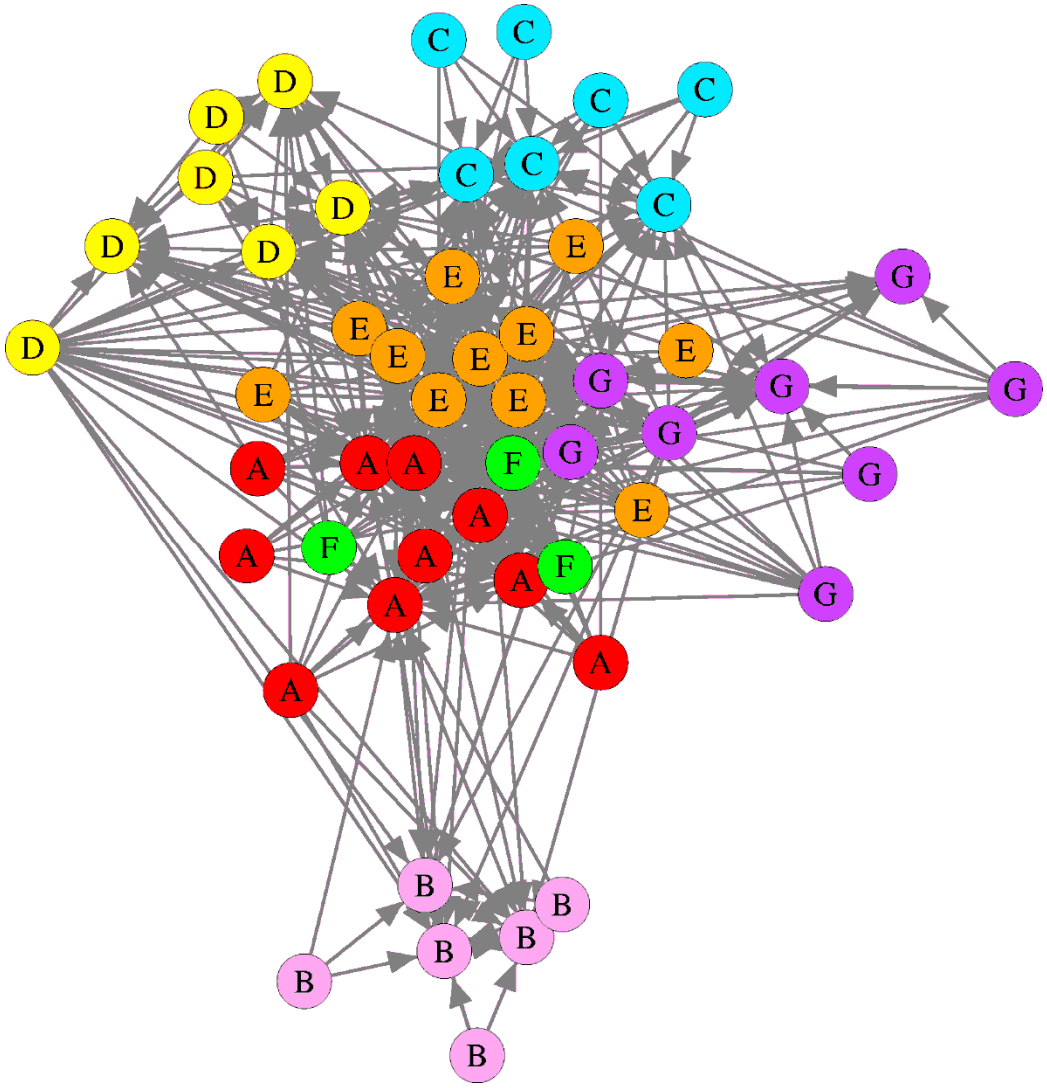
Question: Overall, is the process "good"?

Metrics: Aggregated measures such as Headquarters Effectiveness Assessment System (HEAT) and Army C2 Evaluation System (ACCES)

Evidence: Limited.

Problems: Not clear what the final score really means. NATO *Code of Best Practice for C2 Assessment* says these measures "have limitations."

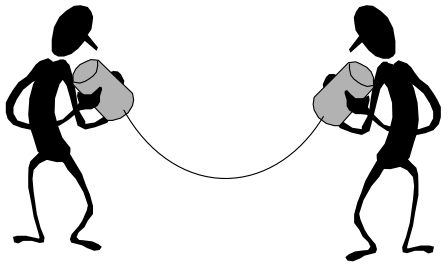
Process: ***Network Measures***



Organisational Network Analysis sheds light on operation of an organisation

Network produced by analysing **communication** (email, phone logs, etc.) e.g. Jarvis (2005)

Process: ***Network Measures***



Question: Is communication effective?

Metrics: Average network **degree**
Average network **distance**
and several other measures

Evidence: Considerable evidence for average distance.
Average degree is less useful.

Problems: Data collection may be difficult, especially for face-to-face communication.

Cognitive Metrics

Measuring inside people's heads

Situational Awareness (SA) metrics

SA: ***SAGAT***

Question: Do staff have good Situational Awareness?

Metrics: SA Global Assessment Technique (SAGAT)

Evidence: Very widely used.

Problems: Needs situation-specific questionnaire.
Needs “freezes” in operation.
Better suited to tactical level.

SA: *T/F Questions*

Question: Do staff have good Situational Awareness?

Metrics: Ask a list of T/F questions (as per doc metrics)

Evidence: As per doc metrics.

Problems: Analyst workload.

SA: ***Team SA***

Question: Does the **team** have good SA?

Metrics: Perhaps T/F questions & take worst of team

Evidence: Analogy to team shared agreement work.

Problems: Nobody seems to know how to do this.

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Metrics Overview

Understandability: **Restatement**

★ Understandability: **T/F Questions**

Doc: **Data Sources**

SA: **SAGAT**

★ SA: **T/F Questions**

SA: **Team SA**

Any Questions?

★ Process: **Timing**

Process: **Breadth**

★ Process: **Workload**

Process: **Teamwork**

Process: **Interoperability**

Process: **Aggregated Measures**

★ Process: **Network Measures**

- **Further work needed, especially on Team SA & Coordination**
- **Need better models of C2 → what needs to be measured**