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Process versus Battle-Rhythm: Modelling Operational Command and Control

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Abstract: Command and Control (C2) organisations often integrate the functions of (a) planning and (b) monitoring and control of operations. Planning for any large scale operation is usually conducted according to a business process. On the other hand, monitoring and control are performed according to cycles across multiple time scales. In military organisations the dominant cycle is called the battle-rhythm. Whereas the initiation of planning is often triggered by external random events, monitoring and control activities are largely triggered by the battle-rhythm and become part of the ongoing management routine of the organisation. We exploit this property in a novel approach to modelling and simulation to analyse the *balance of personnel resources* in integrated C2 organisations. We demonstrate this concept by considering a hypothetical organisation whose personnel variously must maintain the organisational battle-rhythm but, when external events demand, are required to suspend their routine work to plan appropriate responses. By quantifying the backlogs in routine work of organisational units, we are able to detect imbalances of workload as the tempo of operations increases.

Keywords: *Command and Control (C2), planning, monitoring, business processes, routine.*

1. INTRODUCTION: BATTLE-RHYTHM IN COMMAND AND CONTROL

Military Headquarters are organisations staffed to support the Commander of a military force in planning of operations and execution of those operations by the force. The nature of such organisations as bridges between the strategic commander and the tactical force – at the *operational* level of command – means that headquarters personnel must maintain a regular routine of information flow while being able to respond to unforeseen events in the dynamical external environment. We describe an innovative and practical method of providing modelling and simulation support to such organisations, taking this mixture of temporal regularity and unpredictability of staff work as a defining feature.

Our aim is to develop a practical framework for providing modelling and simulation input into decisions on the appropriateness of staffing numbers and structures for operational headquarters organisations. We have recently used this methodology to inform the establishment of Australia's new Headquarters Joint Operations Command (HQJOC) at Bungendore. The concern for *practicality* is borne out of this application. There are many sophisticated and rich modelling approaches to organisational work ranging from Business Process Modelling through to Agent-Based Distillations. Such frameworks undoubtedly include the dynamics upon which we focus here. However, the richer these models are the more data demanding they become. In the military environment with Australia's presently high operational tempo, as in many business organisations, the ability of analysts to access data to populate such rich models is constrained. Therefore an approach that captures the dominant modes by which headquarters staff is allocated to tasks at an appropriate level of aggregation is highly desirable. Our approach satisfies such practical requirements.

We call the core of our approach the Competing Cycles Concept, which posits that stress points in the distribution of staff to tasks is dominated by *interference between multiple temporal cycles,* namely nested daily, weekly and monthly regular cycles, together with irregularly triggered processes. The Concept originates for us in the observation that much (though not all) of the staff effort in the control of execution of operations exercised by a military headquarters is *not* usefully described by *parallel lines of ordered sequences of tasks* performed at different levels of the organisation; rather, such control is splintered across meetings and briefings at many levels that are fundamentally regulated by the so-called battle-rhythm of a military headquarters. There are many definitions possible of battle-rhythm but its key effect is the *synchronisation* of processes and activity across multiple levels of an organisation. MAJGEN Molan (2008: p135) gives a vivid account of headquarters battle-rhythm from his time as Deputy Chief of Staff for Strategic Operations in Iraq in 2004:

> As I settled in, I found the routine of the headquarters unrelenting. Briefing followed briefing followed meeting followed meeting. To fit everything into one day, we worked out what we called the "battle-rhythm" of the headquarters. The battle-rhythm started with the commanding general, George Casey. His staff would identify the major meetings for him to attend each day. … Once the battle-rhythm was worked out for the commander, it flowed down. Everything would be worked out around the rhythm of the next level up. Although we hated having so many meetings, they were the only way to coordinate this extraordinarily complex activity.

The concern of battle-rhythm is ultimately the human needs of headquarters staff as can be readily appreciated to the extent that in headquarters with tactical interfaces the rhythm includes also the activity of sleep (Kamena, 1999). The battle-rhythm, as a means of regulating activity, is in one sense a manifestation of "Control" within the theoretical understanding of "Command and Control" by Pigeau and McCann (2000, 2002): *Command* is the creative expression of human will necessary to accomplish the mission; *Control* is those structures and processes devised by command to enable it and to manage risk; and *Command and Control* is the establishment of common intent to achieve coordinated action.

Battle-rhythm control is not exercised via a feedback loop within an engineering "process" but *control exercised over multiple processes* and activities. Traditional Business Process Modelling – as described, for example, by Aguilar-Savén (2004) – focuses on ordered sequences of activities for the development of a product. Simulation of multiple business processes competing for resources such as staff is one means of testing the compatibility of such processes with staff structures and numbers. Battle-rhythm *deconflicts* these processes and activities from outside any single process flow and thus manifests *Command*: the exercise of human will and creativity resulting in *changes* to processes and structures. We have argued elsewhere (Kalloniatis *et al.*, 2009) that such human activity does not readily admit to process decomposition.

Nevertheless, a headquarters also works, or strives to work, through well-defined processes. In Molan's case one of these was the Time-Sensitive Targeting (TST) Process (Molan, 2008: p187). The triggering of this process was disruptive of activities regulated by the battle-rhythm (Molan, 2008: p 142). Thus, formal processes coexist and indeed *compete* with the maintenance of the battle-rhythm in headquarters

organisations in their control of operational execution. In models of such organisations, Business Processes are appropriate for the former (for example, for such studies of TST in Air Operations, see Lo and Au (2007)) but are impractical for the latter.

The Competing Cycles Concept can be understood also from a more theoretical view of organisations. This arises from research into organisational "routines" going back to March and Simon (1958). Pentland and Rueter (1994) summarise the literature here and describe the conflict between routines as "automatic" and yet also "effortful". Our aim is to give some flavour of this literature and relate it to our approach. Routines are "repetitive patterns of action that are functionally similar"; in other words they are "re-useable" and therefore serve "automation". But routines are also "regular … encounters, in time as well as in space" representing "institutionalized features of social systems" which therefore need to be "worked at". Our perspective is that processes and the intentions of battle-rhythm are different manifestations of "routine". Business Processes are routinised work flow with formalised sequences of tasks *ordered with respect to each other*, while battle-rhythm is routinised activity *ordered with respect to "clock-time"*. The drivers of such routinisation of work in organisations nevertheless are fundamentally the same but not within the scope of this paper.

The modelling approach we adopt here is more generally applicable to non-military organisations, for example to entities that fit into the mould of so-called Maintenance Organisations (Mobley, 2004). These engage in scheduled "preventive" (or proactive) and unscheduled "remedial" (or reactive) maintenance of manufacturing systems. The latter unanticipated "failures" can be minor or catastrophic. Mobley proposes that manpower utilisation for reactive work in healthy proactive maintenance organisations should be below 10%. A similar figure applies for the amount of overtime work. There are implications in this area for military headquarters organisations that we will explore in a subsequent paper.

The paper is set out as follows. In the next section we discuss the field of application of this modelling work, namely, the modern nature of military headquarters and their organisational structures and functions. We then discuss the model of a hypothetical headquarters in detail, including hypothetical numerical inputs with emphasis on the modelling approach rather than the validity of specific data. In the fourth section we discuss simulations of this model and how insight into organisational "stress" points can thereby be gained. We conclude with a summary of our results.

2. OPERATIONAL MILITARY HEADQUARTERS AND OPERATIONS

Modern military headquarters are all direct heirs of the organisational revolutions that took place under Napoleon. The General Staff in the Napoleonic Imperial Headquarters, headed by General Louis Alexandre Berthier, performed functions ranging from information management between the emperor and his army, the elaboration of Napoleon's orders and plans and performance of general administration in every aspect of the *Grande Armee* (see van Creveld, 1985). This structure has evolved into the Continental Staff System (CSS), which is used in NATO and many other militaries. In the environment of Joint operations, involving all three military services, this is referred to as the Common Joint Staff System (CJSS) or J-staff structure. This is indicated, in one form, in Figure 1. Each J-unit has a particular specialisation and is typically headed, depending on its size, by a Colonel or Brigadier level officer. The time frame of perspective in the work of different units in this structure can vary. For example, the J5 is responsible for supporting the Commander in taking the long term view of the activities of tactical forces: strategy and longer term planning. *Monitoring and Control*, the day-to-day management of military operations and shorter term rapid planning, is primarily the responsibility of the J3. This is our focus then, with the J3 and supporting J1, J2, J4, J6 and J8 as the units whose work we model. Monitoring and Control implies the following core activities:

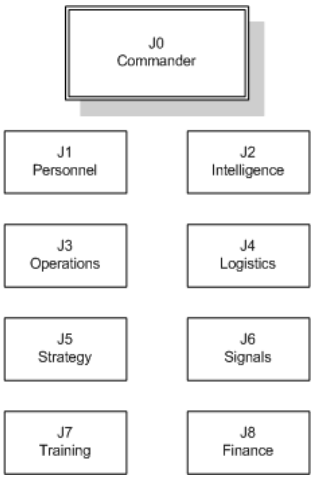

Figure 1 Common Joint Staff System

- battle-rhythm maintenance: this concerns the feeding of information into and out of a daily briefing cycle that keeps every echelon of command abreast of the events of the immediate past and future;
- information management for longer term cycles, namely meetings held on a weekly, monthly or quarterly basis, which typically involve higher strategic concerns and higher ranked military officers (but the longer term cycles may fall to the J5 staff to manage);

- incident response: this concerns the management of information and responses to relatively minor unforeseen events that cannot be achieved within the 24-hour routine cycle of activities; and
- crisis response: this is similar to incidents, except that the scale and significance of unforeseen events is more severe, assumes highest priority and may involve more formal, if compressed, planning *processes*.

Staff in J3 are directly responsible for these activities but depend on individuals or teams within the other J-units (who have their own processes and activities) for their work. Therefore, the battle-rhythm and the initiation of crisis/incident response processes will cascade through elements of these other units. In the spirit of our quotations from Molan, these activities compete for the attention of staff officers. In particular, Crisis Response requires the formation of response teams that may be required to work continuously for up to 48 hours (McKearney, 2000). A recovery period is then necessary, after which staff officers return to a backlog of routine work that they must clear to return into the battle-rhythm. Our observation is that, stressful as crises are, these may be rare events and that it is the management of work backlogs – due to interruptions of their battle-rhythm – that is the greatest source of *risk* to staff officers: risk of *systematically* extended hours, that quality of outputs may be reduced, that mistakes are made in the haste to clear backlogs or that tasks are passed to individuals lacking complete Situational Awareness (SA).

3. MODEL DETAILS

3.1. Modelling Tool

We used WebSphere Business Modeler Advanced (Version 6.0.2) ("the Modeler") to construct executable models and to conduct simulation experiments (Version 6.2 is the most recent). The strengths of this tool are its simple graphical interface for model construction and its ability to show animation of control flow and task activity while simulations are executing. The latter helps to verify correct operation and to diagnose any observed flaws. Processes are naturally modelled in this tool while battle-rhythm activities are also easily represented as tasks initiated from "calendars". The tool has an inbuilt capability to conduct some statistical analysis and to export data to Excel for further analysis, tabulation and graphing.

3.2. The Headquarters

We base our analysis on a hypothetical headquarters structure that has many of the generic features seen in such organisations around the world. We do not specify the rank structure apart from identifying three grades of military officers: the Commander, senior staff officers and subordinate staff officers. The headquarters has a tactical interface via a watch centre staffed by some shift system to operate 24/7. The key J-unit here is the J3 with two "teams", J3x and J3y, with different operational foci, for example, different geographical responsibility or regular versus special operations. Around these are the remaining J-units. The numbers of senior and subordinate staff officers in these units are given in Table 1. The numbers of senior staff officers in these units is intended to reflect only those available to support monitoring and control; there may be others with their subordinates engaged in planning, exercises and other non-operational activities. As the focus of such work is on the distribution of staff officers within the traditional framework of military headquarters, we do not represent here the detailed activities of the heads of the J-units and the Commander.

Commander (J0)						
J3x	**J3y**	**J1**	**J2**	**J4**	**J6**	**J8**
5	5	5	3	4	7	7
20	25	22	12	27	24	37

Table 1 A hypothetical headquarters establishment: the first row of numbers is the number of senior staff officers and the second is that of subordinates.

3.3. Routines and Processes

Daily Routine: This is the core of the model. It consists of two fundamental elements: the times of key meetings in an operations centre involving senior staff officers, potentially with the Commander, and what we term "background work". Times assumed in the model are given in Table 2. Briefings are represented as a "task" requiring a start time, duration and prescribed participants or their delegates. Background work is represented by three main blocks of activity during the work day: start-up, morning and afternoon work.

Daily Briefings		Background Work	
Night Watch Report	0730–0745	Start Work	0700–0730
Commander's Daily Update Brief	0745–0815	Morning Work	0815–1200
Day Watch Report	1615–1630	Afternoon Work	1230–1630

Table 2 A headquarters daily routine

Based on Parkinson's Principle (Parkinson, 1958) that "work expands to fill capacity" and our observation that in military headquarters work days are full even in the absence of a "gun fired in anger", these blocks of activity with the briefing times are structured to fill a regular "working day" of 0700–1630 with a thirty minute lunch break. *This does not imply that military staff officers work only nine hour days*. Rather, this is the base level of work on top of which is added work related to incidents and crises and servicing of backlogged routine tasks. These blocks are built from iterated loops of fifteen minute "chunks" of individual work whose content and products are not specified. In this specific model, these constituent tasks cannot either be shared or "shed", though most Business Process Modelling tools can model such features.

Weekly Routine: This involves attendance of specified staff at scheduled meetings with the duration specified as a single unbroken period. Preparation time for attendees of 30 minutes in two 15 minute chunks commencing at 1100 is included on the work day preceding each meeting. The Weekly Routine in the hypothetical headquarters consists of: a Strategic Meeting (Tuesday 0900), an Update Brief across Operations (Wednesday 1000) and a Heads of J-units meeting (Friday 0900), all attended by the Commander and intermediate level officers. The finer detail of these timings is less significant than their potential conflict with the unforeseeable requirement for briefings and provision of guidance for crises and incidents.

Crisis Response: This, after the Daily Routine, is the other major pillar of this model. It is the highest priority activity, so that other tasks must wait before allocation of resources. For the present purposes we take the worst case scenario that headquarters teams developing responses to a crisis must work continuously for the maximum 48 hours (McKearney, 2000). As mentioned earlier, often a compressed version of formal planning processes is applied in such cases. The most significant dimension of such work is the manifestation of creative human collaborative work in such intense activities. We have argued elsewhere (Kalloniatis *et al.*, 2009) that such activity cannot be decomposed into a process. The same position is argued across the spectrum of business environments by Mintzberg (1994). In this spirit, we represent this 48 hour period of activity in the model as a *single continuous task* to which representatives from the different J-units are allocated. The numbers of subordinates allocated in the hypothetical headquarters are given in Table 3. Again, these numbers are hypothetical. A single senior staff officer from each J-unit will lead this team within the particular specialisation. Higher level officers (heads of J-units up to the Commander) are allocated to short information transfer tasks during this 48 hour period on an intermittent basis with decreasing frequency the higher in the command chain.

J3x	J3y	J1	J2	J4	J6	J6
4	4	3	3	3	2	3

Table 3 Allocation of subordinate staff from different J-units to Crisis Response Teams.

Incident Response: A trigger for an incident is allocated to the relevant J3 unit depending on the nature of the incident, followed by transfer of information up the chain of command to the Commander and guidance returning down. These information transfer tasks are assigned ten minutes for each step in the command chain. Two out of the combined pool of senior and subordinate staff officers in each J-unit are then allocated for three hours to developing a response which undergoes approval back through the command chain.

3.4. Frequencies of Crises and Incidents

We investigate below the impact of increasing the number of crises within a six month period on the background of a set rate of incident triggering and the daily and weekly routines. However incidents and crises call upon different specialisations, and therefore J-staff, with different rates. Here we assume that the

J3x	J3y	J1	J2	J4	J6	J8
4/wk	7/wk	10/wk	5/wk	4/wk	4/wk	5/wk

Table 4 Weekly rates of occurrence of incidents for different J-units

focus of the two J3 units is such that, on average, more crises occur for J3x than for J3y while incidents are more frequent for J3y. A rationale for this may be that one organisation interfaces with large Joint Task Forces (JTFs) that have the capacity for dealing internally with crises while the other interfaces with more disparate smaller scale operations and must provide many of the services of a JTF from within its own resources. Correspondingly, more of the unforeseen events are of the scale of incidents while crises are typically fewer. We assume a simple 2/3-1/3 rule for crises: 67% of crises fall to J3x and 33% to J3y while all other specialisations are required. The rate of occurrence of incidents for other J-units is given in Table 4.

3.5. Interpreting Simulation Results

Simulations of this model focus on the development of *queues* in process and activity steps related to the routine and Incident Response as more high priority crises occur in a six month period. The queues need to be interpreted carefully, namely in terms of risk, as discussed above. The Australian/NZ Standard for Risk Management 4360 states: *Risk is the chance of something happening that will have an impact on objectives.* Risk is therefore intrinsically probabilistic. This means that the repeated generation of backlogs, not single instances, will lead to stress on, or errors by, individuals or reduced quality. In the analysis of simulations we therefore focus on the differences between the sizes of backlogs for the routine work of the various J-units and rank structures (senior, subordinate staff officers) within them. We interpret these as imbalances of risk within the headquarters and seek to mitigate these imbalances with reallocations of responsibilities or staff. Because the imbalance is the concern, Relative Risk is plotted with no absolute scale.

4. EXAMPLE SIMULATION RESULTS AND ANALYSIS

Here we report the result of varying the total number of crises occurring within a six month period of time from 6 up to 14 with a fixed background of incidents and routine activity. The events are triggered with a uniform distribution but such that they do not immediately overlap, though the backlog of one may overlap with the next crisis. Results are given for a single simulation run; error bars can straightforwardly be obtained by examining multiple runs. Reading the number of backlogged tasks as "relative risk" we plot this in Figure 2 without a scale as a function of total number of crises for the different J-units. We see that as the number of crises in the fixed period increases the degree of risk increases for all J-units. Being concerned about risk imbalance, we immediately observe that for one specific role there is a concern seen in the sharply rising red curve of Figure 2 after more than four crises in six months: the senior staff officers in J2. Looking back at the organisational structure we can appreciate the source of this behaviour: J2 has only three senior staff officers available to fulfil the role of Crisis Response Team lead for that specialisation combined with the time scale of impact of Crisis Response and the recovery day on lower priority tasks. Conclusions from smaller scale fluctuations should be commensurate with the validity of the input data.

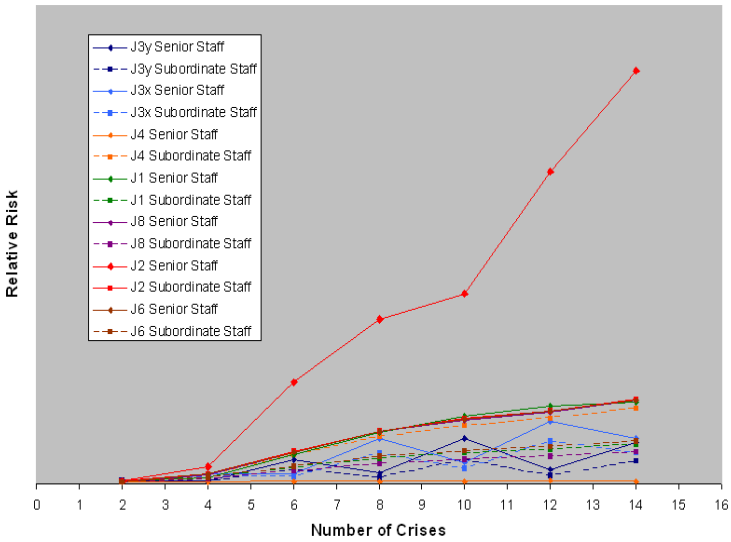

Figure 2 Relative Risk as a function of increasing numbers of Crisis events in a 6 month period for different organisational units and

Within the same model we can now explore means of mitigating this leading source of risk. We investigate two scenarios for risk mitigation: (a) delegation of the role of Crisis Response Team lead down to a subordinate staff member in the at-risk J-unit ("delegation") and (b) reduction by one of the number in, say, J8 and creating a fourth senior staff officer position in the J2 unit ("redistribution"). We compare these two scenarios to the original structure, the "baseline", in Figure 3. We observe here that the delegation scenario improves the situation for the J2 senior staff pool but not as much as creating an extra position. This is because delegation involves further burdening the subordinate staff pool in J2, as seen in the corresponding slight increase for this pool for the delegation scenario. At the same time there is barely any impact on the J8 staff pools: this function has spare capacity. On the basis of such a study, we would recommend a change of

establishment consistent with approach (b) if the frequency of crises is expected to be high. This would balance the risk across the organisation within small fluctuations and fixed manning.

5. DISCUSSION

Many other studies could be undertaken here: variations in the total number of incidents, stability analysis against variations in the input rates, variations in the number of crises requiring the different J-units and variations in the time required for Crisis Response Teams to be stood up within the 48 hour maximum. Similarly, such a modelling approach can be extended to include deliberate planning by the J5 unit. Within this approach further levels in the staff hierarchy and the impact of load-shedding can easily be modelled (the latter by using the "maximum resource wait time" task attribute available in many Business Process simulation tools). We emphasise the sparseness of data required: a timetable of meetings, a hierarchy of scales of time required to respond to unforeseen contingencies, approximate rates at which certain military specialisations are required to develop responses, and the organisational establishment. Such data can be gathered through subject matter experts with minimal impact on operations. The model can straightforwardly be built in any of the commercial Business Process Modelling tools that, with their graphical and analytic capabilities, are ideal for analyst-client interactions and do not require more than a standard server. The framework is based on sound organisational theory, resonates with the realities of military practice and can be enriched according to the available fidelity of data. We conclude that our Competing Cycles Concept leads to an appropriate modelling framework for organisations with a regular routine overlaid by unpredictable higher-priority tasks. As such, it should be applicable to a wide variety of military and business environments.

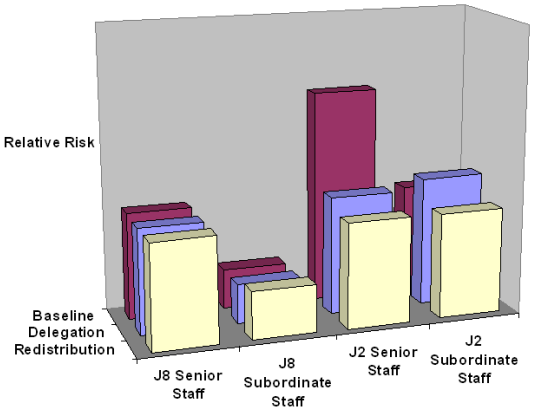

Figure 3 Relative Risk for different J-units and levels under different changes to establishment

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