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Fightn' N' Stuff

Wing Commander David J. Foster, RAF

I git thar fustest with the mostest men.[1]

—Lieutenant General Nathan Bedford Forrest

The means of victory is concentration . . . . There are only four key factors to think about if we seek success in concentration. Thinking about these factors is not a simple task. For although few in number, their impact, dynamics and interdependencies are hard to grasp.

To win in battle we must concentrate combat power in time and space. Strategy and tactics are concerned with the questions of what time and what place; these are the ends, not the means. The means of victory is concentration, and that process is our focus here. There are only four key factors to think about if we seek success in concentration. This is not a simple task. Although few in number, their impact, dynamics and interdependencies are hard to grasp. This is a problem as much of perspective as of substance. It concerns the way we think, as much as what we are looking at. The factors are not functions, objects or even processes. They are best regarded as conditions representing the nature of what we are dealing with in seeking concentration. They are:

Variability - Uncertainty - Synchronicity - Complexity

In this analysis we take a systems view of the world to look at basic concepts, to arrive at a way of looking at things, rather than to present a set of answers. The ideas are fuzzy, so we use simple words and pictures. Simple words like *stuff*. This means fuel and spares . . . bullets, bombs and missiles . . . tools, machines, power and water . . . food, maps and toilet paper . . . and anything else we need to keep us in the fight. The use of simple language is not a trivialisation; it forces us to focus on essentials. One of the problems we face is the way we think. Here we attempt to look at things from a new angle, to break out of the old frame of reference, to think out of the box, to reflect on the basics.

In the widest sense of the term, which is how we will use it, logistics is the crucial enabler for operations. However, logistics on its own is not worth talking about. It is not independent. It exists only as one-half of a partnership that governs the success or failure of concentration. Our aim here is to develop a simple, holistic description of the partnership of operations and logistics, to provide a perspective for effective thought and action.

First we explore the fundamental nature of the partnership. We start at the point where operations and logistics meet, then step down into the world of stuff to take a look at what happens there. Once we have a picture of the basic mechanics of logistics we move on to look at what links activity in the world of operations to work in the world of stuff. We then use our new perspective to examine how the particular nature of a military force governs the way things happen in practice. Here we look at the differences and similarities in the structure and dynamics of the partnership in the separate cases of land, maritime and airpower, to determine how the partnership works. In conclusion we offer a view of what really matters in managing the partnership to achieve our goal of effective concentration.

. . . logistics governs the tempo and power of operations. For us, and for our enemy. We have to think about the partnership of operations and logistics because it is a target. A target for us, and for our enemy.

Why is understanding this so important? Logistics governs the tempo and power of operations. For us, and for our enemy. We have to think about the partnership of operations and logistics because it is a target. A target for us, and for our enemy. Like any target, we need to fully understand its importance, vulnerabilities and critical elements to make sure we know what to defend and what to attack. All military commanders, at all levels of command, rely on the success of this partnership. How well they understand it will make a big difference concerning how well it works for them and how well they work for it.

> A real knowledge of supply and movement factors must be the basis of every leader's plan; only then can he know how and when to take risks with those factors, and battles are won only by taking risks.
>
> —Field Marshall A. C. P. Wavell

Real knowledge in this context is deep knowledge, not simply how long it takes a force to move from A to B, or the numbers of weapons needed to take on a particular enemy strength; but an understanding of the likely behaviour and response of the logistics system, in the face of the real demands, of real operations, as they develop and as they are executed. So this is a tale of two systems and how they work together as one: operations and logistics—*fightin' n'stuff.*

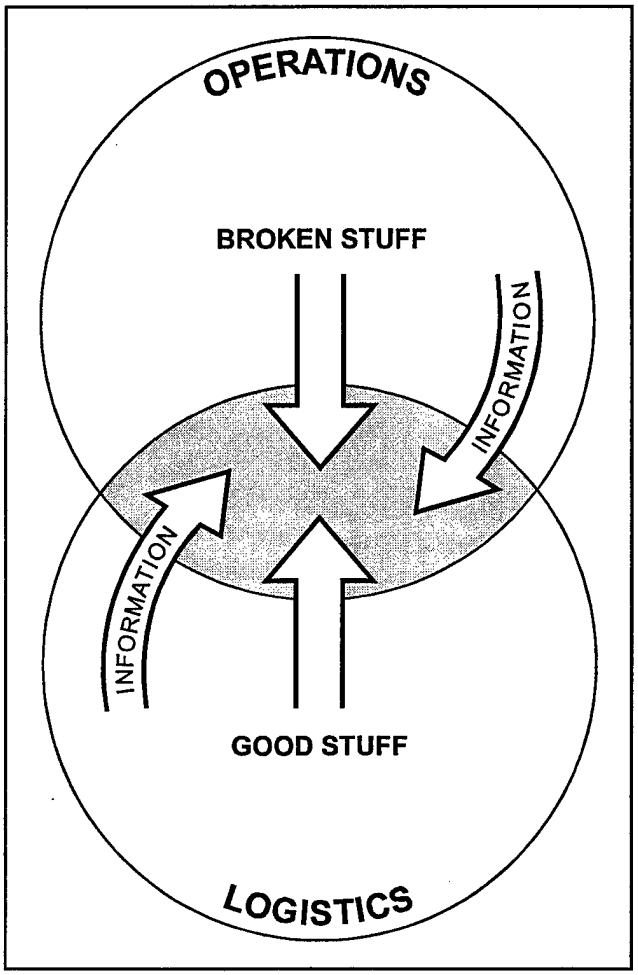

Figure 1. Operations and Logistics

Part One—The Nature of Fightin' n' Stuff

Operations and logistics sit alongside each other; they overlap (Figure 1). Imagine the overlap as the area where fighting machines are loaded before launch and recovered after an engagement. Between the two systems there is an interface where information and objects are exchanged, in both directions. This *communication* takes time and energy. Logistics gives operations the stuff needed to bring a weapon to readiness. Stuff includes fuel and things that go bang, but also serviceable parts for the weapon and personal kits for its operators. Lack of stuff usually gets the most attention; it is what makes the most noise, where the pain seems to come from, where failure first becomes apparent. But often it is not where we find the real cause of failure; lack of stuff is the symptom, not the disease.

Logistics gives operations information. We sometimes overlook the importance of getting this right, and then we fail. To be effective, operational planning must have a good indication of how the logistics system is likely to perform under load. But operators are not mind readers, they have to be told what can and cannot be done.

Even less well understood is how much our success depends on operations getting stuff and information back to logistics. Firstly, a lot of stuff is scarce and critical. Broken stuff of this kind is a potential resource. The quicker we mend it and get it back into circulation the higher our readiness states will be. Consider the priority given to operational turnarounds to get an aircraft fuelled and armed and back online for the next mission. The same urgency is needed in regenerating critical aircraft components, for exactly the same reasons. Secondly, logistics needs information. Some of our stuff runs out of life and some we break. Some stuff we consume, like fuel. Timely and accurate information on actual and potential usage, in terms of breakage, failure and consumption, is important. Without this feedback on changing circumstances the logistics system cannot respond and adapt and support performance will deteriorate.

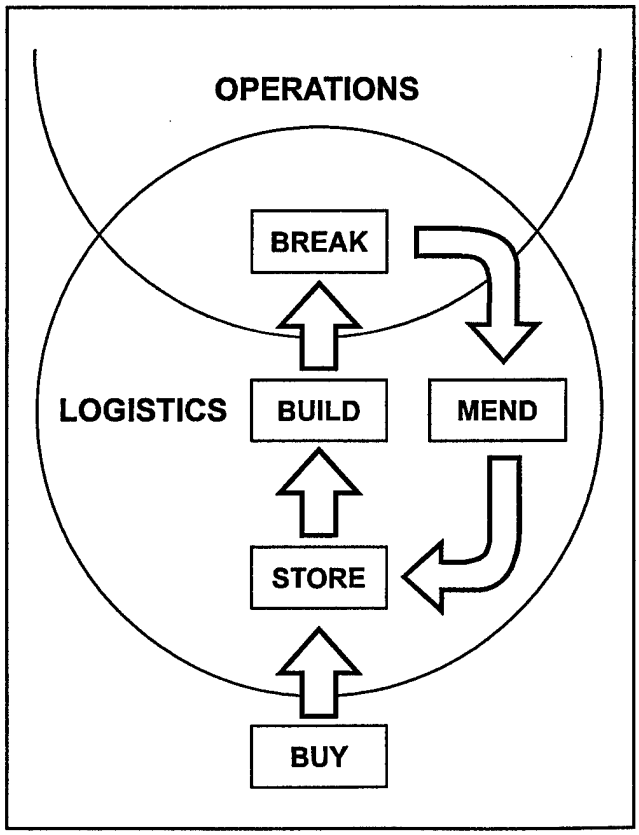

Figure 2. Processes

Now we have a simple view of the key *transactions* between operations and logistics. But what happens inside the two systems? What drives the transactions? Our next step is to take a close look at the world of stuff.

To get answers we need to look at logistics as a complete system, and we need to stand well back to get the whole picture. We need to think about: what the system is for, what it includes, what it produces, what happens inside it and what is needed to

feed it, how it is put together, what it handles and how it works. The fundamental purpose of logistics in our context is to enable the focusing of combat power, in time and space. That is what it is for, but what is it? This analysis proposes that we can see it as just a few very simple processes (Figure 2).[2]

Clearly, before we can do anything we have to bring new stuff into the system from outside: we BUY. This is a fundamental process, but we are concerned in this discussion with the problems of fighting with the stuff we have already got our hands on. We will not consider here the planning, budgeting and programming issues, the *shopping* problems, important though they are.

What do we do with stuff once we have it? We MOVE it around the system. When it is not moving we STORE it. This all takes people, facilities, transport, management and time. We MEND stuff we have broken and stuff that fails. This takes skills, tools, spare parts and time. And for complex stuff each different piece usually needs its own very specific skills, tools and test equipment. We put stuff together to BUILD more complicated stuff. Again this takes skills, tools and equipment that are specific to the task and more time. Each process is very simple. It is true that within the MEND box we find very skilled and intricate engineering activity, but in essence all that clever work does is generate more demands for more stuff. It is tempting to identify a separate process showing us REPLACING stuff we have consumed, but this is merely a special case of the general cycle. When we consume stuff, the flow is only one way. There is one caveat. Figure 2 shows operations as the only source of broken stuff. This is just a schematic simplification. Stuff also breaks and is consumed in the logistics system.

These are simple processes. What makes logistics such a puzzle is that we put hundreds of these simple processes into a complex network of relationships and then populate the network with thousands of families of components, subsystems and parts all moving around the network from one simple process to another, sharing pathways, hitting bottlenecks and waiting. Waiting for parts to arrive to complete a set and fill the last hole in a component. Waiting for repair facilities to be free.

Consider what this means, at each stage. First we have to find all the parts we need and get them together in one place. Then we have to put them together as a set. This takes time, tools and skill.

Only when the last part arrives and is fitted, when the last hole is filled, can we move on to the next stage. And we do not know what will arrive last and how long it will take. Building creates delays, and they add up. For an individual part, no journey through the network will be like any other. This fact is simply a result of the complexity and interdependence of the network itself. Delay in the time taken by one process will add to the delays in processes further down stream. The resulting variability[3] in how long things take to do is a fundamental condition of any logistics system. Once we start dealing with the assembly of complex mechanical and electronic stuff, and the test and repair of components, we enter a world of probability distributions and queuing. It is like going for a haircut, having a car serviced or buying a stamp in the post office. We cannot rely on a precise schedule. How long it takes all depends on who else wants to do the same thing at the same time.

The crucial question is: how can we organise a logistic system to meet these demands effectively, when we know that the time taken to do things in any logistic system will always be variable?

This is important and bears emphasis. Logistics is made up of very simple processes, but these are arranged in a network of interdependencies that, when acting on the many different units of stuff that are needed to support each weapon, create a complex, busy, dynamic system full of *variability* (the first of our four key factors). To be successful, this system must respond to the demands caused by activity in the operations system; not just what is wanted now, but what may be wanted later; not just what is wanted by operations, but what is wanted by parts of the logistic system to complete work needed to continue productive throughput. This leads us to the second key factor.

How and when demands will emerge is a source of *uncertainty* for the logistics system. We do not know what will fail next, nor exactly when. This is the core problem for the partnership. We want continuous forward motion; to get this we seek certainty and speed, however, because of the very nature of logistics, we face uncertainty and delay. The crucial question is: how can we organise a logistic system to meet these demands effectively, when we know that the time taken to do things in any logistic system will always be variable?

(Continued on next page)

Most Significant Article Award

The Editorial Advisory Board selected "The Political Economy of Privatization for the American Military," written by Colonel R. Philip Deavel, USAF, as the most significant article in the Volume XXII, Number 2 issue of the *Air Force Journal of Logistics*.

Fightin' N' Stuff continued from previous page)

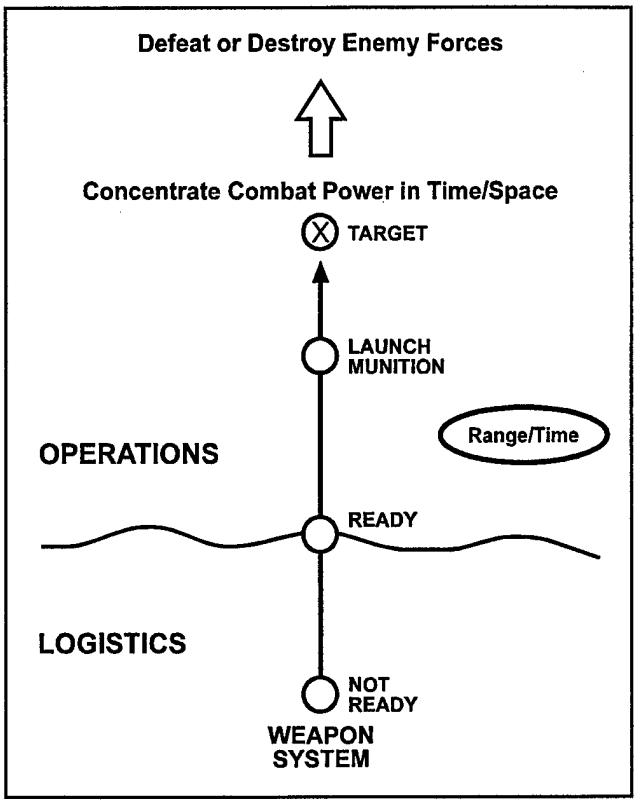

Figure 3. Mission

A good way to understand a process is to start with the end product and work backwards; in this context we need to stand at the front line of the world of operations and look to the rear (Figure 3). In simple terms, the final output from operations is an engagement, where a target is hit. To do this we have to concentrate combat power in time and space and this requires weapon systems loaded and fit to fight. This point of readiness is where operations and logistics touch. Notice that, in the world of operations, we are first concerned with range between the loaded weapon system and the target. This range translates into seconds, minutes or hours, depending on the weapon system. Whatever measure is used, the cycle of action—ready, aim, fire—is relatively quick. But an even more important factor is opportunity. The target is often moving and only visible or vulnerable for short periods of time. The cycle of action is not only quick; the opportunity to act is often fleeting. So readiness is crucial.

The activities that happen after—ready, aim, fire—we call recovery and regeneration. The weapon system is offline while we check serviceability, remove and replace failed parts and reload with fuel and munitions. Time taken for recovery and regeneration is influenced by the complexity of the tasks and the availability of good stuff to replace the bad (or to fill holes in weapon racks) and skilled people and the necessary tools and equipment to do the job. There are three types of output from this process. Firstly, a loaded weapon system: this goes back into the operations world. Secondly, information: this will include failure rates, time taken to replace components and perhaps new ways of doing work faster. We will also get information on how fast we are using our stocks, how many holes need to be filled. The third output is bad stuff that has been removed and replaced; this bad stuff will be input to the logistics system. The detail of what happens to the good stuff when it returns to the world of operations is outside the scope of this article. For our purposes of understanding what influences the task of concentration, we now need to follow the bad stuff back into the logistics black hole.

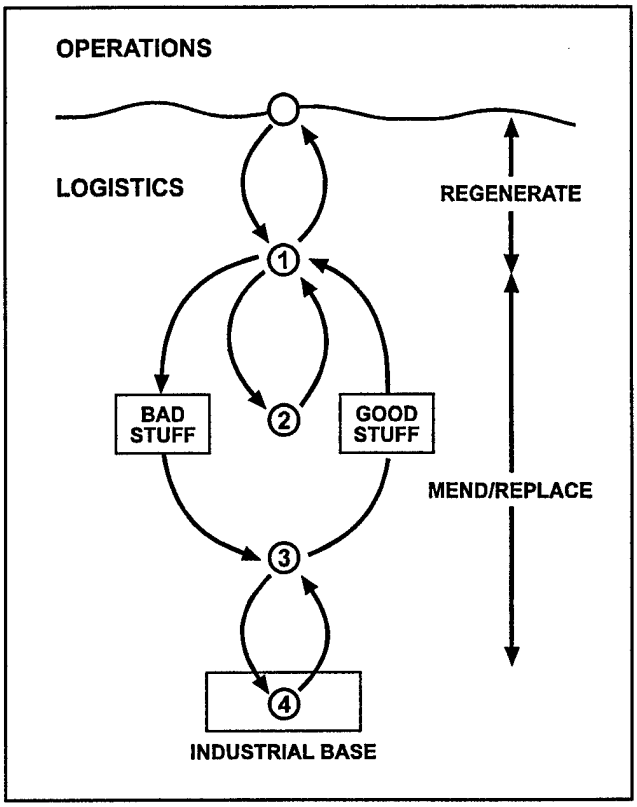

Figure 4. Interface and Echelons

In the logistics world we talk about echelons of support (Figure 4). As we move back from the interface with operations the complexity of work that can be done at an echelon increases. Typically, a first echelon task would be simply to remove and replace a black box in a system, or to rearm. At second echelon we might test functions and replace modules that can be simply plugged in or pulled out of the system. To address more complex maintenance and repair tasks, for example to do internal work on an aircraft power plant, we would expect to go back to a third echelon, where we have concentrated the skills, spares, tools and test facilities to gain economies of scale and a focus of expertise. Finally, for work such as complete rebuilds, or for small populations of very complex equipment, or processes involving exotic materials, we may move back to a fourth echelon, often to the commercial manufacturer. Where we put our echelons, and what capabilities we give them, largely determines the shortest possible time it could take to mend or replace things. How long work really takes is determined by the way we operate within this structure; in short, how effective we are as a team.

Earlier we saw that in operations we focus on opportunity and range, and we think in seconds, minutes or hours. In logistics

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we are first concerned with the time it takes to *mend* something, which will be at least hours and sometimes days. But, more crucially, when we think about moving stuff, we step into a world of distance and much slower speeds. Our units of time quickly move from hours to days to weeks as we move back through echelons one to four. We stop looking at the clock and start reading the calendar. Remember, it is not just the physical transportation that takes time; it is the preparation for movement, shipping delays and simple queuing for resources and facilities that really bite. And we are not moving just one package through the system; we are moving thousands, all competing for space and attention at every stage. To understand the nature of this movement, we need to take a look at pipelines and how they interact with the stuff that moves through them.

What do we mean by a pipeline? Often the first image that comes to mind is of very long tubes of metal crossing the tundra. Pipelines getting fuel from A to B. But any means of transporting stuff can be understood as a pipeline. We can think of a convoy of trucks on a road, men on bicycles struggling along jungle tracks in Vietnam, or a production line in a factory. Whatever their shape, size and components, when we describe them in systems terms all pipelines have three basic characteristics: capacity, length and flow rate. This means: how big and how heavy can each lump of stuff be? How many lumps of stuff can we have in the pipe at any one time? How far apart are the ends of the pipe? How fast can we push the lumps of stuff down the pipe? And most important of all, how long does it take between putting a specific lump of stuff in the pipe and getting it out at the other end? Also, for many pipelines, more capability often means less flexibility. Setting up a pipeline, or changing where we put the ends, are the classic problems of the fireman. The faster the flow of water and the wider the bore of the fire-hose, the more effort it takes to move. It takes more manpower, and it takes more time. And Heaven help the fireman if he has put the fire truck in the wrong street. He cannot stretch the hose, and he will have to empty it and roll it up before he can move the truck to where it is really needed.

It gets harder; in logistics we have to deal with many pipelines, of different capabilities, in a complicated and busy network. The most obvious problem in a network is how to have some control over the many flows that merge and diverge. If we are not careful we can overload smaller pipes by putting them downstream of bigger pipes. To keep the flow going we may have to speed up flow in a smaller pipe, or restrict flow in a bigger pipe that happens to be upstream. It is like plumbing. Coupling copper and plastic pipes of different sizes is not easy. In the transportation world one of the biggest challenges is getting this transfer right.

There is a golden rule: "just in time, not just in case." He who breaks this rule loses his gold.

Because of the uncertainty of demand, and the variability of the many processes connected by the logistics system network, the natural tendency of even a well designed system is for backlogs to build up and for flows to interfere with each other. Forward motion slows down and sometimes stops. In extreme cases the system can be paralysed. How can we deal with this natural tendency? To some extent the solution lies in good plumbing. We anticipate surges in flow and droughts in supply and design our system to be flexible. The most important technique is to position spares and spare capacity, at well chosen points in the system so that when there is any interruption in supply we can use the local buffer to produce what we need to fill the hole and keep forward motion going. We may think of buffers as header tanks, or reservoirs, producing steady pressure and uninterrupted flow. The goal is always to maximise throughput of the whole system. Buffers are essential but they take up space and cost money. The aim is to keep them to a minimum. Too much stuff in buffers is just as bad as too little. There is a golden rule: "just in time, not just in case." He who breaks this rule loses his gold.

There is one more pipeline characteristic we need to consider: invisibility. Despite attempts to track progress, most pipelines are opaque. We know what went in, but we often cannot see exactly where things are now. If a package is late we will know, but not that it is going to be late. Or even how late it may be. We take a bad thing and make it worse. We hide things when we put them together on pallets in batches to get economies of scale. This is the result of an inevitable trade-off. The aggregation of stuff for transportation gives us a cost benefit and moves more stuff faster. But it also makes the task of finding, reprioritising and redirecting individual items much harder. It reduces flexibility.

As a result of our analysis we can now propose the fundamentals of any logistic system as:

Variability of Process

Uncertainty of Demand

Capacity and Flexibility of the Network

Design and Management of Buffers

The first two are conditions, two of our four key factors that relate to the general nature of the partnership we are examining. The second two are the basic characteristics of any particular logistic system we may construct. As we step up out of the world of stuff and cross the interface with the world of operations we

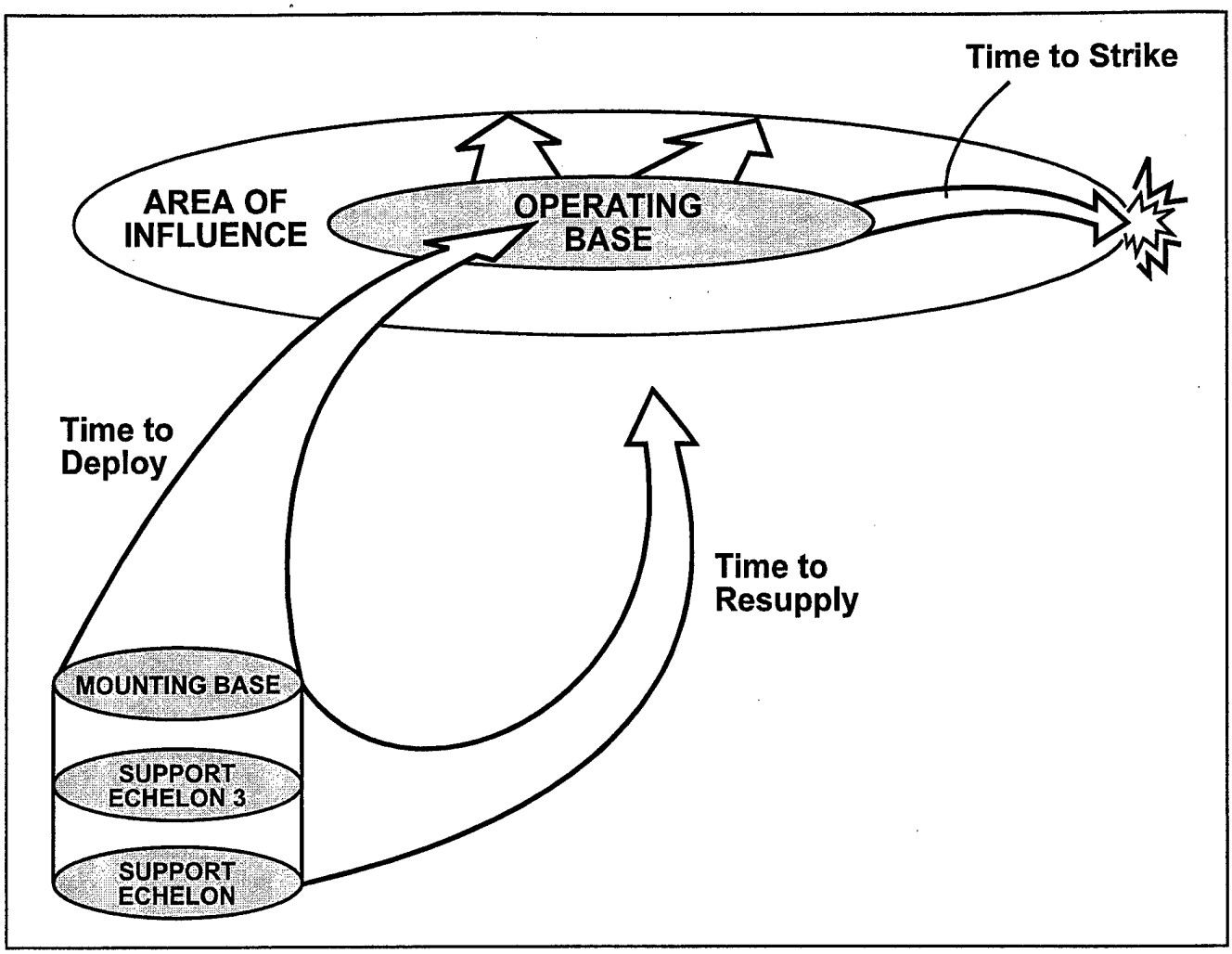

Figure 5. Power Projection

meet the third of our key factors. It is not a condition of either world. It is the fundamental quality of the partnership between operations and logistics—*synchronicity*. What does this strange term mean?

The goal of the operations system is to concentrate combat power in time and space. To make that possible, the logistics system has to concentrate stuff in time and space, and it has to be useful stuff. What is useful is defined directly by the needs of operations. Because they share the same stuff and feed each other with stuff and information, the processes in both systems need to be synchronised. But this is not easy to do; for two main reasons. Firstly, people working in operations and in logistics will tend to have very different time horizons. Operations is focused on range and fleeting opportunity; logistics is seeking continuous flows, often over long distances. This leads to different mind sets, a different sense of how fast things need to get done and how reactive to be. Secondly, each world has a different view of what constitutes a unit of work. The focus on stuff is different. This creates another tension between the systems that makes keeping in step hard. What is this different focus?

Logistics processes tend to batch repair work and to palletise stuff into shipments to get production and transportation economies, but this inevitably holds some things up. On the other hand, processes in direct support of operations focus on holes to be filled and therefore on the individual things that are needed to fill those holes. The urgency in the operations world to bring unserviceable weapon systems back online creates an imperative to get everything done immediately; from this point of view any delay is bad.

Our problem is to get and maintain synchronicity between two systems: each with a natural tendency to look at the world differently and march to different drummers. The solution lies in good system design and good planning processes and people who are comfortable with ambiguity and constant change. We have to remember the environment will always be unsteady. To succeed we need to be flexible enough to accommodate uncertainty of demand and variability of process. The truth is that logistic systems will never be easy to deal with: they are simply too complex, too dynamic and too big. We cannot ever fully control them; we can only prepare them and sustain them. Additionally, the partnership with operations is itself complex, dynamic and dependent on many actors. The resulting condition of *complexity* is the last of our four key factors. It is clear that, whatever else we do, to deal with the challenge of complexity we will always have to do a lot of thinking and organising before the shooting starts, if we are to hope to win.

Our problem is to get and maintain synchronicity between two systems: each with a natural tendency to look at the world differently and march to different drummers.

Part Two—The Dynamics of Fightin' n' Stuff

We have looked at the fundamental nature of the partnership. Now we need to examine how it works in practice by looking at the similarities and differences in the application of land, maritime and airpower. In the case of airpower we will look a little deeper. But first, we need to think about power projection in general terms (Figure 5).

From an operations point of view, the crucial determinants of effective power are the time to strike and the rate of striking. From a logistics point of view, the crucial determinants of effective support are: time to deploy, but in terms of useful packages of capability; and time to resupply, but in terms of useful amounts of useful stuff. Getting the bombers quickly into theatre is of little value if you have not got anything there for them to drop. So how does the nature of military power determine how operations and logistics work together?

For land forces, most of the support capability is relatively close to the operating base, and everyone is close to the battlefield. The echelon structure, with stocks, is massive, slow to deploy and relatively slow to move. We can imagine a force tethered by a large, unwieldy pipeline. It is true that in manoeuvre warfare forces may detach from the pipeline, but not far and not for long. In the Gulf we saw an operation lasting less than 100 hours resulting in an advance of perhaps 300 km. But this was at full stretch, after massive preparations and with no enemy strikes against our own logistics. The army structure moves as one; it flows in waves across the ground. Movement is punctuated by pauses to resupply and regenerate. When the forces are engaged, rate of consumption can be much faster than rate of resupply. Launch of the next offensive operation can be whenever the commander judges that enough forces are reloaded and in position to meet opportunity. Risk assessment is all. Opportunity may most often be due to enemy weakness and may be unpredictable in time and weight of effort needed. Small forces can have big effects if used suddenly, in the right place. Surprise and shock action pays off. This possibility puts a premium on mobility of logistics on the battlefield.

For naval forces, the operating base can always be moving. Because of this it has to be at the end of a long and flexible pipeline, that will of necessity be narrow and will be broken from time to time. Pipeline capacity is low and flow can be interrupted. For this reason a naval force needs more stocks and more *mending* capability on board the operating base. Like land forces, a navy has to take its buffers into the fight. Because of this, it is more critical to get things right before deployment; catching up is hard. Maximum power is fixed at the start of the operation when the fleet leaves its home port and diminishes rapidly once engagements occur.

What does the partnership look like in the case of airpower? The list of characteristics is well known, but what do the words mean? We can propose the following interpretation. Airpower measures by the clock rather than the calendar. Airpower can go anywhere, can attack scattered targets, attack deep targets and attack simultaneously over a wide area. Airpower can be very precise; and can be responsive: in the range of capabilities, in deployment and in the tempo of operations. But we must stress the conditional nature of all these capabilities, because to do all these things we have to get our bases in place, our capability to regenerate stuff online and our rounds, men and equipment in place to reload at the rate we need. And then keep it going. This, of course, is logistics.

So, for land-based air, there are similar challenges as in the cases of land and maritime forces, but also some unique opportunities to get sustained, flexible, combat power by carefully synchronising operations and logistics. The operating base is static, once deployed. But new bases can be activated relatively quickly and the forces can be redeployed between bases quickly and over long distances. As a result, air forces can build up power at the base to a schedule and adjust the schedule while build-up is in progress. More power can be brought to bear faster and in different places, far apart—what we may call *switchability*.

The capacity and flow-speed of supply pipelines can be increased given time and use of an air bridge which can redirect the flow of force multiplier stuff very quickly, stuff like the critical spare parts that keep weapons online. With an air bridge direct to the operating base the pipeline can be brought right up to the weapon systems. This capability is crucial for airpower because it relies completely on technically very complex and somewhat fragile systems operating far from support echelons. Despite steady improvement in reliability and maintainability of aircraft systems, the foreseeable future operations will continue to generate significant failure rates, resulting in a great deal of difficult test and repair work. With fast, reliable pipelines vulnerable regeneration capability can be kept further back from the threat. This means the number of support forces near the battle can be reduced, and this, in turn, reduces the requirement for force protection. If fewer personnel and less equipment are sent it does not take as long to deploy a force and it does not cost as much to keep them in place. We talk about reducing the mobility footprint. Fast reliable pipelines mean the flow around the repair loop can be speeded up and buffers of spares can be smaller. This reduces cost and releases funds for other purposes. For complex aircraft spares, moving them faster is usually much cheaper than buying more.

The reach of airpower means that commanders can often choose to put an operating base near or on a good transportation hub, readily maximising flow and so maximising combat power. Air forces are not constrained to line up with the enemy forces on a shared patch of ground and make the best of the infrastructure that happens to be there. Deployed air forces *en masse* are not limited by a finite magazine of weapons and the need to disengage and return to port for rearming. A word of caution: an important element of airpower flexibility comes from having a choice of weapons, but this choice can generate more uncertainty. For example, it introduces the question of what

weapons to ship out, in what order, before the shooting starts. Here coordination between operations and logistics planning is critical. In general, air transport cannot move large quantities of heavy stuff, so we must to look far enough ahead to have time to send the bulk of weapons by sea. Nevertheless, well planned and adaptive resupply can match the consumption of stuff by air forces even under conditions of a sustained tempo of operations generated by a fast sortie cycle. If resupply is effective, air forces can reload and retask quickly and continuously. To achieve, this there must be good information and effective, integrated movement and repair processes.

We have seen that differences in the nature of the forces and their application naturally leads to differences in approach for the fundamental logistic processes of stocking, sustainment and regeneration. These differences in process determine how forces set up their structure, how they distribute stuff around the structure and in what quantities and the rules that must be followed to best manage their activities, to achieve success. So now we understand the nature and dynamics of the partnership: what is critical to success, what really matters most in doing fightin' n'stuff.

The goal for the partnership is to achieve concentration. To get the right stuff to the right place at the right time and to keep on doing it. This has to be achieved in the context of four conditions: variability, uncertainty, synchronicity and complexity.

Conclusions

The goal for the partnership is to achieve concentration. To get the right stuff to the right place at the right time and to keep on doing it. This has to be achieved in the context of four conditions: *variability*, *uncertainty*, *synchronicity* and *complexity*. To deal with these key factors we have to have two things, the right attitude and the right fitness: doctrine and capability. The right attitude helps us identify what must be done; fitness provides the energy and flexibility to do it. The right attitude is to think first and most about just five things.

1. The operations/logistics partnership is a target for our enemy—protect it.

We must try always to think of an enemy looking for the decisive points in the partnership. What we want to make strong, they will try to weaken. Where we want agility, they will want to paralyse us. What we can do to our enemy, we can do to ourselves by lack of attention. So all concerned with operations and logistics must protect and care for the partnership and the things it needs for success. This includes stuff and information and people. Also, we must not forget, the corollary is just as important: the operations/logistics partnership of the enemy is a target for us, we must attack it.

> The layman tends to associate air superiority with destruction of enemy aircraft . . . it is not the only approach. A potentially vulnerable sequence of events (the aircraft chain) must take place before an aircraft fires a missile or drops a bomb . . . it is possible to eliminate an air force by successful attacks on any point in this chain.[4]
>
> —Colonel John Warden III, USAF

2. Think about the physics.

Stuff is heavy and it fills space. Anything we want to do needs to take account of the weight that will have to be moved, over what distance, with what effort. Usually this all comes down to time, a delay between the idea and the act. If we think about the physics we can know the earliest time we can finish any task and we can separate the possible from the impossible. It is crucial to determine the scope of the physical logistics task early in any planning process. Planners must know how long things take and why they take that long.

3. Think about what needs to be done when—and tell everybody.

Once we have given instructions and the stuff is in the pipeline it will fill that space until it emerges at the other end. The goal is to make sure that the stuff coming out of the pipe is exactly what is needed at that point in the operation. If it is not then we have lost an opportunity—useless stuff is doubly useless. Useless in itself and wasting space and effort and time. Moving useless stuff delays operations. Even in a shooting war extra missiles are a luxury if there are already enough for the next three days, but aircraft are grounded for lack of engines. In setting priorities it is important to think about what might have to be done, even if it is not part of the current plan. It might be tempting to insist on maximum numbers of all alternative weapons choices being shipped to a base, but if there is no thought given to the sequence of arrival of the right mix, the enthusiastic but undisciplined outloading of weapons might put back the earliest time action can be taken. For example, changes to rules of engagement or other operational factors, such as prevailing weather conditions, may introduce limits on which weapons we can use legally or effectively. Also, priority of order of arrival will change with conditions and with the nature of the force deploying. For example, the political need to show a presence quickly may lead a commander to take the risk of using the first air transport sorties to get aircraft turn-round crews and weapons into theatre before deploying all the force protection elements.

4. Think about defining useful packages of stuff.

Stuff is only useful when all the pieces to complete the jigsaw are assembled. Until the last piece arrives there is nothing but something complicated with a hole in it. It is vital to know exactly what is needed to make a useful contribution to the operational goals and to manage effort to complete unfinished jigsaws, not simply to start more. Useful stuff often has a *sell-by* date. If it arrives too late it has no value and the effort expended has been wasted. The sell-by date must be clear to everyone who is helping

build the jigsaw. And it is important to work on the right jigsaw first. In any operation there is a need to relate stuff in the pipelines to joint operational goals, not to single service or single unit priorities. It is no good having all the tanks serviceable if the force cannot get enough aircraft armed and ready to provide air cover; or ensuring that the bomber wing gets priority at the expense of its supporting aircraft.

5. Think about what has already been started.

The length of a pipeline is measured in time not distance. There will always be a lag in the system and it is important to remember what has already been set up to happen later. Constantly changing instructions can waste a lot of energy just moving stuff around to no real purpose. Poorly conceived interventions driven by narrow understanding of local and transitory pain can generate instability and failure in the system.

So, there are five things to think about. But thinking is not enough. We have got to be smart and fit to win. It is important to conclude with some thoughts on the fitness we must seek to guarantee a robust partnership of operations and logistics.

We must not become so focused on what we have planned for that we fail to recognise and respond to what is really happening.

We need systems that can cope with damage, disruption and confusion. Remember, we expect variability in performance, just by the nature of the logistic processes. We need simple rules, simple procedures and a clear view of the mission. People must be in no doubt of what they should be trying to achieve. This might be compared with the notion of *mission command*. We must not build systems that are rigid and too dependent on fixed infrastructure; this mistake is usually the result of seeking local efficiencies without considering the impact on overall system effectiveness. The partnership has to be resilient. We need systems that can respond quickly and effectively to change. Remember, we expect uncertainty in demand just by the nature of the activity we are supporting. We need to be ready and able to redirect and accelerate, and we must be open to learning as we go and to exploiting new knowledge immediately. We must not become so focused on what we have planned for that we fail to recognise and respond to what is really happening. Both partner systems have to be adaptive.

We need a partnership that concentrates effort on meeting operational objectives so every action adds the maximum value to combat power. As much as we can, we must link what we do in the logistics system directly to the contribution in combat readiness. We must not work to measures of output at intermediate sections of the pipeline; we must measure all performance in terms of the outcome at the business end of the pipe. Logistics has to be focused on operational outcomes.

What we always face are trade-offs, in time, investment and operational opportunity. One of the purposes of deliberate

Knowing what the critical success measures are comes from good analysis and design—from asking the right questions, from thinking clearly about the system we work.

planning, and the exercising of systems for real, is to highlight these trade-offs, to understand their interdependencies and to learn how to get the best result even when we do not have all the facts. A robust partnership will beat a tidy plan, every time. The focus of trade-offs at the operational level is the commander. His planning and execution must be centred all the time on the need to synchronise operations and logistics. Making trade-offs is unavoidable; variability and uncertainty see to that. But making better trade-offs, faster than the enemy, is how we win. Knowing what we are doing helps. And doing as few stupid things as possible and as many clever things as we can is important. We need knowledge on what is happening, why and how it will change things. Information on the performance of critical success measures in the process is crucial to gaining these insights. Knowing what the critical success measures are comes from good analysis and design—from asking the right questions, from thinking clearly about the system we work.

Experience teaches that most often things go wrong because of poor understanding and poorer communication, because of lack of clear focus on essentials, on what really matters. Too often we work at doing things right, not on doing the right things. We measure efficiency rather than effectiveness. Thinking about the nature of things is hard. But it is what we must do if we are to truly understand and be effective.[5]

> Gentlemen, the officer who doesn't know his communications and supply, as well as his tactics, is totally useless.
>
> —Lieutenant General George S. Patton, USA

Notes

1. Widely used misquote of: "I always make it a rule to get there first with the most men."
2. Foster, D. J., "A New Look at Wholesale Logistics," *Air Force Journal of Logistics*, Volume 19, No. 4, Fall 1995.
3. Womack, J. P., Jones, D. T., and D. Roos, *The Machine that Changed the World*, New York: 1990. Goldratt, E. M., *Theory of Constraints*, New York: 1990.
4. Warden, John A., III, Colonel, USAF, *The Air Campaign: Planning for Combat*, Washington, DC: Brassey's, 1989.
5. Handy, C., *Understanding Organisations*, Oxford: 1993.

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