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Survivability Design in Hostile Environments: Lessons from Squids, Ships, Startups, and Supply Chains

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ABSTRACT

This paper introduces a novel ERP model of survivability design using natural analogies. Management theories frequently emerge from biological metaphors. Every entity seeks to continue existence, to survive. Firms, governments, and individuals balance survivability factors of efficiency, resilience, and prominence (ERP) to stay alive. The researchers employ a comparative analysis methodology between squids, military ships, startup firms in the defense industry, and strategic supply chains using these analogies and a novel ERP model as an analytical framework. Comparing the cases yields general principles of strategic design that potentially extend to other entities that function in hostile environments. These principles primarily relate to the relative significance of threats, the importance of ERP factors, the nature of interrelationships among the ERP factors, and the tradeoffs involved while taking actions to improve survivability. The paper offers insights into the use of ERP analogical case analysis as a means for interdependent entities to co-create strategies to plan for and overcome dilemmas in hostile environments.

Keywords: Survivability Design, Hostile Environments, Bioinspired Design, Nature-Inspired Strategies.

INTRODUCTION

The COVID-19 pandemic has highlighted the importance of designing systems that are able to survive and flourish in a world where many unknowns exist. This type of system design, which can thrive in an uncertain hostile environment, is commonly known as "survivability design". Historically, survivability design has been a key consideration in the design of military crafts like aircraft and navy vessels (Ball and Atkinson 1995; Ball and Calvano 1994). Today, businesses and organizations have a heightened awareness of the importance of incorporating survivability design into their operations. This includes using techniques like contingency planning to anticipate and prepare for unforeseen circumstances. These plans are typically developed to address challenges that may arise in hostile environments (Handfield et al. 2021).

The design field recognizes the importance of robust frameworks in the area of strategic design to aid research and decision-making in organizations (de Moura et al. 2011; Meroni 2008; Noble 2011). Analogical reasoning has been a valuable tool in design theory and practice (Dorst and Lamber 2006; Goel 1997), with nature and biology providing a wealth of analogies for designers (Mak and Shu 2004). This paper aims to build on existing literature by

presenting a strategic model of survivability design. Our proposal is based on an analogical comparison with living organisms that thrive in hostile environments with high levels of uncertainty.

1. NATURE OF HOSTILE ENVIRONMENTS

Numerous independent decision-making entities operate in environments that can be designated as hostile – where the very survival of the focal entity is threatened. By entity, we mean any independent thing of existence. A business firm operating in an uncertain macroeconomic environment or a critical infrastructure system struggling to cope in the face of a disruptive pandemic comes to mind. However, these are not the only examples. There are analogous specimens in nature, such as marine animals in harsh underwater environments, or examples in kinetic operations such as a military vehicle in enemy territory. The study of such entities can help us better understand how to design survivable systems in a generic environment that is hostile.

Three distinct threat elements characterize hostile environments: (1) limited resources, (2) uncertainty environmental forces, and (3) the presence and attention of antagonistic objects. The dynamic response of the entity to the three elements – limited resources, uncertain forces, and rival attention, determines its survivability. We can track the "health" of a focal entity by observing three macro survivability factors associated with an entity of interest: efficiency, resilience, and prominence. Each of these factors contributes to survivability directly and through its influence on the other two factors (Figure 1).

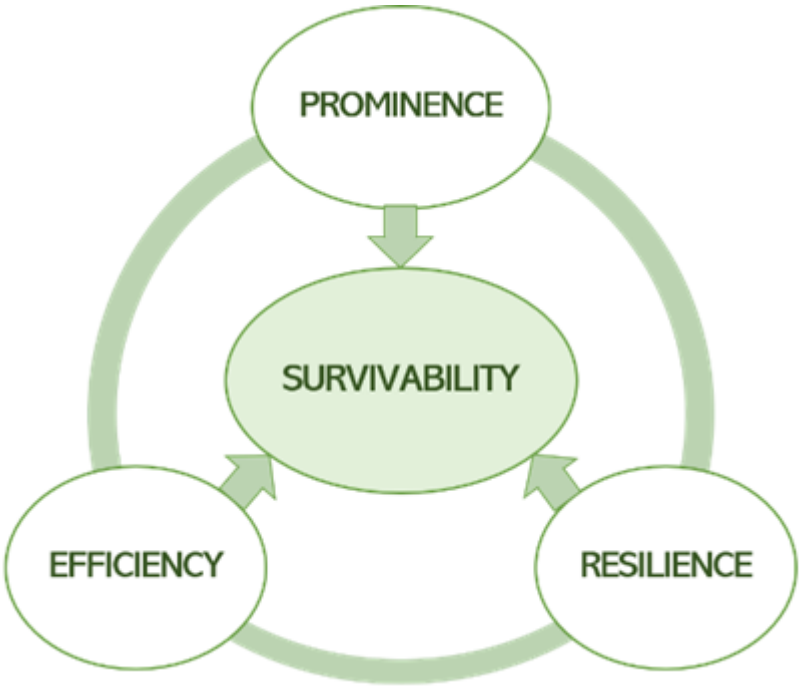

Figure 1. Survivability Factors: Efficiency, Resilience, and Prominence

Efficiency is the degree to which the entity can best use its resources with the least waste. Resilience is the degree to which it can withstand, avoid, or recover from impacts from uncertain environmental forces. Prominence, in hostile environments, reflects the degree of attention a focal entity receives from other unfriendly decision-making entities such as rivals and predators, while maintaining or controlling the relative attention of decision-making entities they wish to attract such as mates or their own prey. We refer to the trifecta as the

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ERP factors, where each of the factors can be viewed as a generic response function to one of the threat elements as linked in Table 1.

Table 1: Threats and Survivability Health Factors Linkage

Threat Element	Survivability Factor
Limited Resources	Efficiency
Uncertain Environmental Forces	Resilience
Attention from Antagonistic Entities	Prominence

When the threat consists of limited resources, the entity can improve its survival by improving its efficiency and eliminating different waste forms. Two of the most critical resources are energy and time, and these are considered exchangeable; if you run faster, you burn fuel quicker. Resilience represents the ability to withstand environmental forces and avoid damage. The higher the force the entity can withstand, the greater the resilience. Palm trees that bend in the wind versus snap under the influence of a given force, the lower the damage, the greater the resilience. An entity may be resilient to one type of force and non-resilient to another. For example, a mine-resistant vehicle can withstand improvised explosive devices but is too bulky to keep from rolling over under uneven terrain. Commonly, we observe a tradeoff between efficiency and resilience. The underlying reason for this tradeoff is that an entity requires extra resources to be deployed to manage uncertain environmental forces. These extra resources comprise redundancies, reinforcements, or repair systems, enabling an entity to overcome extreme conditions. Thus, a higher level of resilience leads to higher resource demands and consequently lower levels of efficiency. Moreover, high efficiency requires fine-tuning to a specific environmental condition, preventing an entity from developing resilience.

In the presence of antagonistic entities such as predators and rivals, a focal entity can improve its survivability by modifying its prominence. The relationship between the health factor and survivability is monotonic when it comes to efficiency and resilience. Everything else equal, the greater the efficiency or resilience, the better the survivability. In the case of prominence, the relationship with survivability is more nuanced. Both low and high-prominence strategies may be applied to avoid or scare a predator. In nature, we see low prominence strategies employed in biological organisms such as camouflage, hiding, and refuging being used and high prominence methods such as deimatic behavior (startle displays) and conspicuous coloration against predators. The use of prominence strategies is occasionally complicated by friendly entities in the environment towards which the focal entity might desire to use a different form of prominence strategy. For instance, an animal may desire to attract a mate while it is trying to avoid a predator. A business firm may attempt to hide its actions from competitors while garnering the attention of customers or investors.

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Moreover, an entity might utilize multiple prominence strategies against an antagonistic entity if one fails or as a means to reinforce the effects. Thus, an entity is well served if it has access to multiple prominence strategies and the ability to switch between such strategies. Forces that pull at the tension between resilience and efficiency can be avoided or mitigated with the effective use of prominence strategies. In such cases, what would be a need for higher resilience can instead focus more on energy efficiency using effective prominence reduction to unwanted attention from hostile forces (i.e., predators, competitors, regulators, and adversaries).

2. STATIC AND DYNAMIC SURVIVABILITY DESIGN IN NATURE AND BUSINESS ENVIRONMENTS

To overcome threats, entities in a hostile environment commonly utilize adaptations that modify ERP factors to improve survivability. These adaptations may be static-long-term or dynamic-short-term adaptations that modify one or more of the entity's attributes, such as size, form, color, or function. Thus, an entity might benefit from static adaptations, such as being larger (or small) in size relative to other animals in its environment. An animal might also benefit from dynamic adaptations, such as changing its size quickly, such as observed with the porcupinefish, which can nearly double in size, extending spikes along its body when threatened.

Such adaptation often has a natural bearing on one or more of the three ERP factors. Take the case of static and dynamic adaptations of size in nature. Generally, larger animals are more prominent than smaller ones. Such a difference in prominence can be advantageous or detrimental to the animal's survivability. Additionally, relative size differences play a role in prominence. An entity that appears much smaller or much larger relative to its reference group can attract increased attention from a predator. In some instances, unusual attributes relative to peers can help animals avoid predation, a phenomenon referred to as apostatic selection. Likewise, quick changes in attributes such as size can exaggerate its prominence and frighten away potential predators. Analogically, a business might benefit from its absolute and relative size, as well as its ability to embellish its size or success, in the eyes of a potential competitor eyeing its market. Sometimes these embellishments can go so far that they build momentum around an essentially non-existent value proposition. This level of size embellishment can take it too far, as we have seen with regard to the Silicon Valley lab, Theranos, or legal challenges around the majority sale of Twitter.

Static adaptations such as large or small size can also influence the efficiency and resilience of the animal. For example, the phenomenon of deep-sea gigantism is associated with high efficiency and large size (i.e., the giant squid). Depending on the environmental force in question, size may be helpful or detrimental to an animal's resilience. Larger animals may be more resilient to extreme winds, whereas smaller animals may be in general more resilient to extreme temperatures. Dynamic changes in size can also impact the efficiency and resilience of an animal, such as by changing its surface area, which can affect energy dissipation and resilience against environmental forces such as ocean currents. Correspondingly, in business operations, a firm may establish robust and trusted sources of supply through strong supplier development, relationship management, and colocation (i.e., the Honda model) that are resilient to uncertainties arising from competition. Others may choose to establish multiple sources of supply that are vetted but easily interchanged in cases of environmental uncertainty. The tradeoff for multiple sources is that one risks losing in-process efficiencies gained from institutional learning, co-creation, and trust. The same geopolitical actors can use varied dynamic sizing for similar ends. For example, in early 2014, clandestine Russian troops invaded and seized Crimea from Ukraine. Russia employed low prominence and high efficiency to strategically overtake the capital and the peninsula without triggering a timely counteroffensive from Ukraine and its allies. As of December 2021, Russia was employing a completely different strategy with the remaining parts of Ukraine. They amassed large numbers of troops on the Russia-Ukrainian border under the guise of seasonal exercises. This activity is a high-prominence strategy with low resilience. Though the number of operational troops was high, there was no significant build-up in logistic channels and material necessary

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to sustain an actual invasion. Many believed this action is simply posturing to get the US and NATO allies to the negotiating table to discuss Russia's concerns over Ukraine joining NATO. What this strategy lacked in resilience by limiting available logistics, it gained in efficiency by forcing a recently announced conference between the US, NATO, and Russia without having to employ large amounts of resources for sustained resistance necessary for a full-scale invasion. The risk they ran, as we now know, is that they were ill-prepared to maintain an invasion without significant losses.

In each context, we observe all ERP factor trades at play. Furthermore, all must be considered in these dynamic trade spaces with rich scenario analysis to prevent naïve and myopic decisions that can lead to catastrophic failure in hostile environments. Squids want to avoid being eaten, firms hate losing market share or failing, and countries do not want to be invaded or go to war unless necessary. Managers who operate in hostile environments can learn from studying analogical examples of strategic ERP decisions by all types of entities.

3. COMPARATIVE ANALYSIS OF ENTITIES IN HOSTILE ENVIRONMENTS

Hostile environments are often fluid, with the nature of threats changing quickly. Thus, dynamic adaptations are necessary beyond just static adaptations. An entity benefits from possessing an ability to (1) sense changes and (2) take decisions/actions that maintain or improve its ERP health factors. This ability entails developing sensory capabilities and dynamic agility to respond quickly to perceived and realized threats. Sometimes, in the presence of a threat, an entity finds itself having to modify one of the ERP factors to improve survivability unilaterally. However, such modifications can undesirably impact the other two factors. Our goal is to study the interrelationships between the ERP factors, primarily to guide decision-making in organizations situated in hostile conditions.

We examine four cases: squids, ships, startups, and supply chains, focal entities operating in seemingly different environments, yet with similar generalizable themes, to compare the generality of the inter-relationships between the ERP factors. The first case (squid) is of an individual decision-making marine animal. The other three entities are complex systems, where the decisions/actions are taken by coordinated individuals distributed across the system. We can arrange the four cases based on the degree of coordination required for decision-making: squid < ship < startups < supply chains. Squids simply make individual decisions, while supply chains require vast amounts of interconnected networks to make informed decisions. Consequently, our cases should help us identify a wide range of situations relating to different types of threats and their varied responses in hostile environments.

Our primary goal is to identify general principles that may apply to any organization operating in hostile environments. For this purpose, we engage in a comparative case analysis of the four entities to uncover similarities, differences, and unique features. For each of the cases, we examine the following themes:

- What is the specific nature of threats and their distribution in the hostile environment?
- What are the essential resources that impact survival? How can efficiency improve survivability? What are some of the steps the entity takes to improve efficiency?

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- What are the environmental forces that threaten the existence of the entity? How can the entity develop resilience against these forces?
- What are the antagonistic objects encountered by the focal entity? Are there prominence adaptations used to counter rivals and predators? What is the role of high vs. low prominence in survival?
- What is the relative importance of each type of threat? What is the relative importance of the ERP factors?
- What is the nature of the inter-relationship between the three ERP factors?
- What are some of the distinctive features of the entity or its environments that impact its survivability?

3.1. Case: Squids

Squids are a diverse species belonging to the family of cephalopods which also include cuttlefish, octopus, and nautilus. The specific nature of the threat depends on the environment the individual species resides in. While squids can sometimes be threatened by limited food availability and environmental forces such as strong currents, predators are the most significant common threat. Different species of squids make up an important food source for birds, fish, and sharks. Some squids feed on other squids. Several species have developed numerous prominence-related adaptations as a response to predation-related threats. The number of prominence adaptation mechanisms in cephalopods is dependent on the complexity of the environment (Hanlon and Messenger 2019). Certain squid species possess a wealth of prominence adaptations that they can choose to deploy in the presence of predators and rivals (DiMarco and Hanlon 1997). These strategies can be used to attract, avoid, hypnotize, sneak up on, threaten, or alert other entities. Some of these strategies have a social role. Sentinel squids often alert other squids about the approach of a predator. The extensive array of prominence adaptations allows for flexible strategies based on situational factors. The choice of prominence mechanism may hinge on the predator's size. For a larger predator like a shark, the squid might choose a strategy such as hiding or ink discharge for distraction. For smaller predators, the squid might resort to startle behavior. Squids are required to balance their use of prominence mechanism between antagonistic and friendly organisms. Certain squid species use unilateral prominence displays to communicate different messages to different entities (rivals vs. mates) at the same time—the size of the squid species influences both its prominence and efficiency. For example, the giant squid is an exemplar of deep-sea gigantism. These creatures inhabit deep waters to decrease prominence and improve efficiency. Such an action helps to conserve energy as well as avoid attention. In all cases, the relative hostility of the environment and the originating foci of that hostility dictate the natural ERP trades taken.

3.2. Case: Military Ships

The type of threat ships face depends on their operational goals and operating environment. Most types of ships face resource limitations in the form of energy and time. Such a threat is generally minor for most watercraft. A rare example of a vessel that ran out of energy resources is the submarine USS R-14 (SS-91) which ran out of fuel while searching for a tugboat and had to rely on a makeshift sail made from hammocks and blankets. More

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significantly, large vessels also face threats from environmental forces such as extreme weather, increasing their instability and placing them at risk of flooding. Military ships must be attuned to antagonistic attention from enemy crafts and airborne threats. In order to navigate the above threats, military ships are required to make tradeoffs involving all three ERP factors. Higher efficiency translates to higher speeds (time) and lowers ships' fuel consumption (energy). The consequence of higher efficiency can include both higher and lower levels of prominence. More efficient ships may be faster, making them more challenging to detect, target, or intercept enemy crafts. However, fast-moving crafts may be more conspicuous relative to their background, risking detection in some situations. Higher efficiency can often result in lower resilience. Faster ships must sacrifice hull strength in favor of speed to build and deploy, as in the Littoral combat ship (LCS; O'Rourke 2011), a class of small combat ships designed for the US Navy, first commissioned in 2008. A similar tradeoff is observed in the choice of aluminum alloys over steel as the material of choice for naval structures. Aluminum alloy ships are generally less expensive, lighter, and faster. However, vessels made of aluminum alloys may be more vulnerable to extreme loads such as underwater explosions and high-velocity impacts from torpedoes (Galanis and Papazoglou 2007). Efforts to improve resilience by reducing vulnerability, such as introducing component redundancy and shielding, can be detrimental to the ship's efficiency (Ball and Calvano 1994).

Maintaining low prominence plays a crucial role in the survivability of military crafts, including naval ships, when faced with the risk of being targeted by enemy observers. Low prominence helps avoid detection and avoiding enemy attention. Naval ships in World War II extensively used prominence strategies observed in nature, such as camouflage, mimicry, and masquerades (Forbes 2011). Other prominence-reduction strategies used in military crafts include decoys and signature reduction to reduce susceptibility (Ball and Calvano 1994). However, low-prominence strategies pose a risk in the presence of friendly fire. The German passenger ship *MV Spreewald* was sunk in 1942 by U-333 because it could not be identified, due to disguise, by the German submarine. Thus, military ships benefit from developing differential prominence, where they can increase attention from friendly entities and avoid detection from antagonistic crafts.

3.3. Case: Defense Startups

Startups encounter threats on all three fronts – resources, forces, and rivals. Resource threats manifest in the non-availability of capital and the absence of qualified personnel. Thus, efficiency is often paramount to the survival of startups. Ventures that "burn cash" too quickly often die a quick death. For years the Department of Defense has wrestled with the so-called "valley of death" for these startups in defense R&D investments. These firms get initial support and capital to explore their new ideas but very little available funding to scale and commoditize their inventions. For human-resource-related efficiency improvements, startups often turn to multifunctionality, where departments perform multiple roles, and the employees resort to wearing "multiple hats." Hostile environmental forces are related to public policy, and difficulty navigating government markets also impacts their survival ability (Josephson et al., 2019). External threats include larger competitors that may seek to steal intellectual property or engage in predatory behavior. There are benefits and risks of stealth for a startup. Stealth can keep a company away from prying eyes. The downside of stealth is that it can reduce the likelihood of being noticed by friendly entities such as potential investors and customers. It presents the "prominence dilemma" for startup firms, which is especially

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pronounced in defense markets. Firms need to adopt a 'superb bird-of-paradise' approach to dealing with this dilemma. They need to be invisible to competition yet overly attractive to potential mates. The superb bird-of-paradise (greater lophorina) is a species in New Guinea that appears as an ordinary-looking bird until it is time to attract a mate. At that time, it extends a bright electric blue feather band under its neck to create a fantastic display.

To contend with the prominence dilemma for nontraditional defense startups, the US Air Force has created a similar strategy by bolstering efforts to decrease IP risks for startups working on government contracts in the past five years. Using a novel approach to Small Business Innovation Research and Small Business Technical Transfer (SBIR/STTR) funding, the Air Force has started to increase the amount of money spent on contracts that do not require overly burdensome cost accounting regulation or forfeiture of IP rights with dual-use technology startups. The Air Force uses an open-topic strategy in this program to increase dual-use technology small businesses to government customer matching (increasing prominence) without forcing these firms to respond to full and open solicitations that either reduce their prominence with the government or increase their prominence with competitors. In a full and open solicitation, the government dictates a specific requirement, and firms that do not align well with the requirement may not be evaluated or may be selected out of competition. In the past, even having developed an idea under SBIR/STTR may have resulted in the production contracts being solicited full and open to competitors. With the open-topic model, firms can find grassroots users of their solutions and vie for direct federal funding to conduct customer discovery across the department and potentially earn additional dollars to scale their concepts into full-rate production. New organizations such as AFWERX and its AFVentures arm increase these startups' prominence amongst venture capitalists and exponentially increase the private dollars invested in bringing the technology to market faster. This strategy has increased startup prominence with (friendly) customers and investors while decreasing it with (hostile) competitors. Essentially the Air Force has allowed these nontraditional defense firms to overcome the prominence dilemma by becoming 'superb birds-of-paradise' in government markets.

3.4. Case: Strategic Supply Chains

The role of prominence depends on internal and external threats and the need to attract attention in the case of a defect or failure. An inherent tradeoff between efficiency and resilience becomes apparent during disruptions (Ivanov et al. 2014). The supply-chain challenges that merged post the COVID-19 pandemic have demonstrated how designing supply chains for high efficiency and low waste can result in poor resilience in turbulent times. Prior to the COVID-19 pandemic, there were mixed approaches to supply chain resiliency. Some entities built up large amounts of buffer stock while others developed lean manufacturing processes that enabled just-in-time inventory management. The lesson learned from the post-COVID supply chain experiences shows that one cannot simply stock up for uncertainty, nor can an organization put cost ahead of the ability to operate during a mass disruption. Firms had taken an approach to "lean" and "just-in-time" inventory that was more about lowering carrying costs than it was about having transparent and frictionless access to materials and components necessary for operations and production. Just-in-time only works if it is 'available-just-in-time' not 'ordered-just-in-time.' They are drastically different concepts, as evidenced by various levels of firm COVID response performance in the years following the pandemic's start.

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In contrast to just-in-time, government agencies such as the Strategic National Stockpile (SNS) had built up stocks of items that were obsolete and expired and had no near-term source to replenish them (Handfield et al. 2020). This approach to resilience came at a cost to efficiency and effectiveness. Further, for touted security reasons, the location of the SNS stockpiles had been kept secret. This action would seem to be a reasonable prominence strategy given that the SNS was built initially to counter chemical, biological, or nuclear attacks. However, during a mass pandemic, the process to access its stock also became opaque to the states that required them during COVID-19, demonstrating an ineffective trade of higher resilience and distribution efficiency for lower levels of public prominence in the name of national security. The sad irony is that more lives were at risk due to a lack of clear SNS access versus any risk ever imposed by an enemy actor. This incident demonstrates the risk of not understanding the ERP trades when designing optimal survivability approaches in hostile environments. Higher supply chain prominence has been seen as a threat to national security if bad actors trace and act upon the networks.

However, it is also a threat to national security if the government or firm cannot trace the network of suppliers and components. This outcome leaves unprotected cyber vulnerabilities, opportunities for counterfeiting by profiteers, and access to tampering by saboteurs. It also creates an inability to execute the agile, adaptive, and aligned distribution of shared resources efficiently and equitably during mass contingencies (Finkenstadt and Handfield 2021). Firms do not always want customers or the government to see deep into their supply chains. Such visibility may uncover unwanted attention to things such as cost data that impacts negotiated margins, supplies that derive from human exploitation, and the firm's inability to manage a transparent and traceable network of suppliers responsibly. Such instances are rife across global markets and are coming to light daily due to COVID-19 disruptions. Finally, a real-time case-in-point, what looked like a Russian strategy of low logistics prominence is shaping up to be a major lesson in a poor E-R-P strategy of the highest order.

4. COMPARISON OF CASES

We find that the importance of different forms of threats may be different across the four cases. This relative difference also highlights the differences in significance between the three ERP factors (Table 2).

Table 2: Comparison of Cases

Threats/Case	Squids	Ships	Startups	Supply Chains
Significance of limited resources as a threat to survival	Low	Low to Moderate	High	High
Significance of uncertain environmental forces as a threat to survival	Low to Moderate	Moderate to High	High	High
Significance of antagonistic entities as a threat to survival	High	High	High	Low to Moderate
Estimated importance of ERP factors	P>R>E	P>R>E	E~R~P	E~R>P

Comparing the cases yields general principles that potentially extend to other entities that function in hostile environments. These principles primarily relate to the relative significance of threats, the importance of ERP factors, the nature of interrelationships among the ERP factors, and the tradeoffs involved while taking actions to improve survivability. We also observe that what may seem like a higher threat condition for uncertain forces (ships) is less

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uncertain than others (startups and supply chains) based on ERP strategies from others in their network. We can measure threats and risks on two axes, consequence and probability of occurrence. For instance, a naval ship may be more likely to enter a hostile environment where human lives are on the line. That may lead most observers to rate its threat level as higher. However, we are speaking about the relative threat to the entity's survivability. A naval ship may carry high consequences of hostile actions from environmental forces and antagonistic parties, but it also has means of increasing certainty of occurrence (the other axis of risk) and building resilient systems. Startups exist, by design, in areas of high uncertainty and maximum consequence. They are trying to establish themselves as new entrants to a market, or more often of late, first entrants to emerging markets. Supply chains suffer from a consistent lack of transparency and flexibility by suppliers, manufacturers, and customers both up and downstream. They can be attacked by antagonistic entities such as the 2020 and 2021 REvil ransomware attacks. Supply chains are also often impacted by the uncertainty of environmental forces such as global pandemics or weather-related events.

We notice that the significance of the survivability factor is related to the distribution of the threat. An important implication is that organizations that seek to improve their survivability should carefully examine the relative significance of the three forms of threats. If the relative significance varies over time, organizations should be able to modify their priorities regarding the importance of ERP factors. It is incumbent on business entities operating in hostile situations to carefully weigh their actions and consider their implications on all three ERP factors. Businesses should be conscious of the indirect effects of their actions if they attempt to modify one of the three ERP factors unilaterally. Firms profit from the capability to switch between high efficiency and high resilience modes, mainly if situated in environments where resources are limited and uncertainty is high. Businesses benefit from developing multiple prominence strategies based on environmental, and situational factors. However, there are tradeoffs involving different prominence strategies at the entity's disposal. Interdependent entities can co-create strategies to overcome dilemmas in ERP factors by observing analogical cases, enabling concerted use of the ERP model by managers, policy-makers, activists, and academics in analyzing and planning for hostile environments.

5. IMPLICATION FOR STRATEGIC DESIGN THEORY & PRACTICE

The ERP framework of survivability design can contribute to strategic design theory and practice in the following ways:

- The proposed ERP framework of survivability design can facilitate the comparison of systems that operate in vastly different, hostile environments that threaten their survival.
- It provides a shared vocabulary for comparing challenges, priorities, and strategies across diverse contexts.
- It can assist organizations in evaluating strategic design decisions in a more holistic manner. Decisions & and actions will be evaluated not merely on their impact on one of the ERP factors, but all three factors.

Moreover, the framework's common language can potentially aid in identifying design heuristics (Yilmaz and Seifert 2011) and support the use of strategic design tools like scenario planning (Hindrichson and Cattani 2022). It can also provide novel contexts for developing

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prompt engineering methods for strategic design using AI in a rapidly emerging and changing strategic landscape.

ENDNOTES

The statements and positions of this paper are those of the authors and do not represent the official position of the Department of Defense, Navy, or United States Air Force.

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