Understanding How National Culture Influences Productivity through the Cognitive and Social Behaviours of Production Workers

by

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Declaration

This thesis is the personal work of Altricia Nyoka Dawson. The thesis titled “Understanding how national culture influences productivity through the cognitive and social behaviours of production workers” is submitted in partial fulfilment of the degree of PhD at the University of Warwick. The thesis has not been submitted for a degree at any other university.

The interpretations that this thesis contain are based on the researcher's reading and understanding of the original texts and they are not published anywhere in the form of books or articles. The books, articles and websites, used to produce this thesis are acknowledged at the respective place in the text and in the bibliography.

Abstract

The globalisation of manufacturing has occurred rapidly over the past half-century. It was facilitated by the lowering of trade barriers and the technological transformation of the factory, which has made managing multinational operations easier. As part of the globalisation of manufacturing, multinational corporations established operating facilities in countries with lower production costs and in countries where indigenous production was required. This required production systems developed in one context to be transferred and deployed in another, and the management of production workers from culturally diverse backgrounds.

The main objective of this research is to understand how national culture influences the behaviour of production workers and moderates the relationship between worker behaviour and manufacturing performance. To investigate these behavioural influences an experimental design of the paper airplane manufacturing simulation was used to measure worker behaviour and manufacturing performance in tasks configured for the mass, lean and craft production systems. Two types of worker behaviour are investigated, cognitive behaviours and social behaviours. Cognitive behaviour is explored as the systematic differences in how workers from different national cultures perceive manufacturing tasks through event segmentation. Event segmentation is a strand of the wider theories on chunking which measures how people parse events for memory and recall. In the case of manufacturing, this theory is used to measure how workers identify boundaries or breakpoints in assembly. In so doing, an objective measure of perception was obtained. Social behaviour in the form of direct feedback and social support from co-workers is measured using workers' responses on work design questionnaire scales. The impact of these behaviours on manufacturing performance is analysed for a British and Chinese sample using multilevel linear modelling (MLM).

The results show that national culture affects both cognitive and social behaviours. Chinese workers perceive fewer event segments in the manufacturing task than British workers. Also, Chinese workers are more incline to receive feedback and social support from co-workers. Often, production workers are visible to each other to enable greater utilisation of space and the increased facilitation of interdependence. This

study demonstrates that indirect feedback from being able to see co-workers' performance was positively related to productivity. National culture moderates the effect of cognitive behaviour on productivity. This moderated relationship was such that event segmentation only significantly relates to the performance of Chinese workers in the most flexible task configuration. National culture did not moderate the effect of social behaviour on productivity.

These findings demonstrate that the influence of task configurations on manufacturing performance may not be universal, as the impact of worker behaviour on productivity was different between specialised and flexible configurations. Moreover, these findings contribute to understanding the behaviours of production workers and how these behaviours are influenced by national culture. There are also practical implications for reducing testing and ramp-up costs in configuring manufacturing tasks and production systems as operations expand globally.

Chapter 1 Introduction

1.1 Expanding Operations Globally

As production experiences its fourth revolution (Schwab, 2016, p. 13), the barriers to global expansion wane. Growing access to international markets through globalisation was the impetus of the second industrial revolution (i.e. mass production and assemblies). The cultural integration facilitated by the homogenisation of economies and politics increased opportunities to exchange resources across cultural borders on a large scale. As trade barriers continued to be dismantled and computer technology ushered in the third industrial revolution, it became easier to synchronise globally dispersed operations. The improvements in trade and manufacturing technology, coupled with the general improvements in communication and transportation, made it more cost-effective for operations to expand globally (Prasad et al., 2001).

The fourth industrial revolution is expected to transform the use of production technology with smart systems (i.e. machine and data learning) and autonomy. The possibility of remote operation facilitates the management of plants and the channels among plants in multinational production. Therefore, research on how national culture affects workers in internationally dispersed plants is vital.

Many operations have pursued cost reduction as a source of competitive advantage by locating to new international markets to be closer to consumers and to access cheaper labour (Ferdows, 2018). Although the home for many multinational operations remains in developed countries, several companies have taken advantage of lower labour costs and the steady labour supply required to sustain factories by expanding to developing countries (Schmenner, 1997). Ferdows (1997) is quick to debunk arguments that production is shifting to developing countries, given the steady inflow of foreign investment to developed countries. Undoubtedly, the mature business conditions in developed countries still make them attractive locations for production. However, production is expanding globally to developing countries, which are often not the sample for academic research. This process of offshoring has become the norm,

not the exception. Therefore, the reference to operations management in many studies, more than likely, signals multinational operations management.

The internationalisation of operations can be demonstrated with the influential case of Toyota Motors. Toyota had one manufacturing plant in Japan in 1948. Today, Toyota has over 50 manufacturing plants outside of Japan in 28 countries, including Australia, China, Asia, Africa, Europe, Latin America and North America (Toyota, 2019). Figure 1.1 demonstrates the global production trend for Toyota between 1935 and 2011.

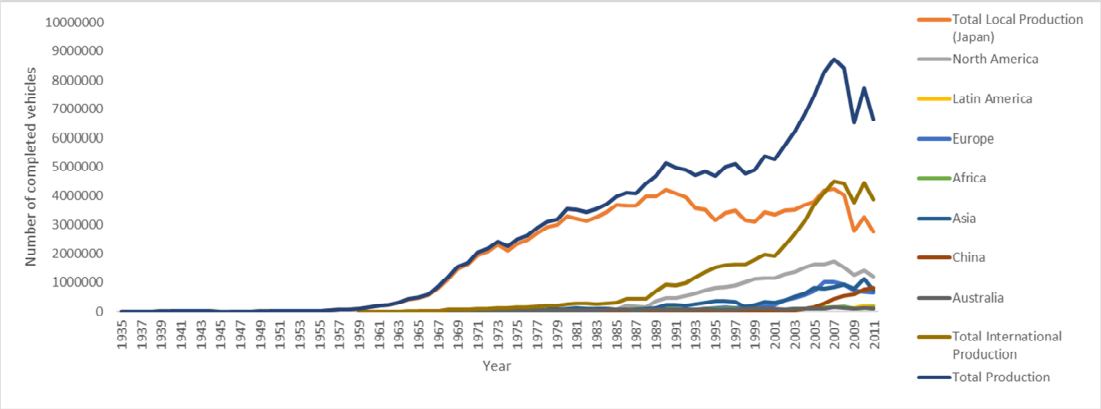


Figure 1.1 Toyota Vehicle Production (1935-2011). Data taken from Toyota (2019)

From Figure 1.1, it can be determined that up until the late 1950s, Toyota's production was confined to Japan, with a small number of exports internationally. As national borders opened and economic conditions improved, local production was complemented by the development of Toyota plants in other countries. Despite the continued rise in domestic production, there was a steady increase in international production at the outset of the 1990s, with international production ultimately surpassing local production. This expansion, which was aimed at bringing production closer to new markets, has not been a distribution of isolated plants internationally. Instead, this expansion has created a network of Toyota plants that not only sell completed products to consumers but also trade parts among each other.

The Toyota example is only one of many. The world entered "an age of transnational manufacturing, where things made in one country are shipped across national borders for further work, packaging, assembly, storage, or sales, and products sold in a country

are often shipped across national borders for repair, reuse, remanufacture, recycle, or disposal" (Ferdows, 1997, p. 102).

Corporations that engage in multinational production can be considered as having a home base and foreign affiliates or hosts acquired through foreign investment, mergers or acquisition. The output of these host countries can be used as a measure of internationalisation and offshoring. In 1990, production from hosts accounted for US$8 billion (including sales and value-added at current prices). In 2018, production in host countries reached US$35 billion (UNCTAD, 2019). The growth in employment also signals the global expansion of operations. Employment in foreign affiliates increased by almost 300% between 1990 and 2018. Therefore, researchers have accepted that if operations are to remain relevant and sustain competitive advantage as they expand, greater contextual information is required in predicting performance (Chakravarty et al., 1997; Zhao et al., 2006).

1.2 The Role of National Culture in Operations Management

Inherently, globalisation means that firms operate in countries that have different national cultures. Therefore, operations managers and operations management scholars need to understand the influences of this global context on supply chain accessibility, performance objectives and production systems. For example, the Toyota production system (lean) was the necessary adaptation of the Ford automotive system (mass) from the United States to the Japanese cultural context (Ohno, 1988).

Charles Sorensen, instrumental in the establishment of production at the Ford Highland Park plant, embraced mass production and saw the automobile as an assembly of parts (Sorensen & Williamson, 2006). To simplify production and materials handling, each employee specialised in one task, and each of their specialised task assignments contributed to creating the final product. "It was the complete and consistent interchangeability of parts and the simplicity of attaching them to each other" that was important for mass production (Womack et al., 1990, p. 27). While effective in the United States, this system was not suited for Japan (Ohno, 1988).

Taiichi Ohno, an engineer and later vice president of Toyota, interpreted the impact of the financial crisis in the 1930s and later the oil crisis of the 1970s as a need for cost reduction and waste management. However, for the Japanese, it was also important to find meaning in their work, a way of understanding their contribution to the collective, which is also a value for other Asian societies (Nisbett et al., 2001). “In the Japanese system, operators acquire a broad spectrum of production skills that I call manufacturing skills and participate in building up a total system in the production plant. In this way, the individual can find value in working” (Ohno, 1988, p. 14). According to Taiichi Ohno, this adaptation of the mass production system to Japanese workers was a way of improving productivity without increasing waste. A similar need for adaptation was demonstrated when American firms wanted to implement Toyota’s lean system.

Holweg (2007) argues that there were many misconceptions about the failure of lean transplants, one of which is the idea that the lean system was tied to the Japanese culture. Rather, Holweg (2007) maintains that it is the management practices of the Japanese that were superior, and once this notion was understood, plants such as NUMMI (New United Motor Manufacturing Incorporated) were able to flourish using the lean system. The challenge of transferring the lean system to the United States was due mainly to the superior manufacturing performance of the Japanese (Holweg, 2007), which resulted from the “painstaking strategic management of people, materials and equipment” (Abernathy et al., 1981, p. 74). However, this superior management style, inclusive of the production system design, was guided by the cultural tenets of the Japanese. As a result, American workers were not just learning different management and working styles at NUMMI. They were, in part, learning the Japanese way of doing things. NUMMI exemplifies how culturally influenced behaviour can be curtailed by training and redesigning production systems. However, there are key concerns about the long-term effect of these design changes on the worker. Womack et al. (1990) warned that the lean production system might change how people work but not how they think.

While researchers must be careful not to associate every social phenomenon with culture, one cannot underestimate the magnitude and pervasive influence of this phenomenon. National culture is critical to managerial practices or organisational

adaptation (Metters et al., 2010). Culture provides a pattern of basic assumptions or rules that its members learnt while adapting to external challenges and finding ways to maintain the collective (Shein, 1992; Hofstede, 2001). As the mass production system was derived from the American perspective of Charles Sorensen, the lean system was derived from the Japanese perspective of the production designer Ohno and his team. It is important to note that what was coined as the best production system by two leading manufacturers was notably different. Therefore, ultimately, the production system reflects the "individuality of the person in charge" which includes their national culture (Ohno, 1988, p. 95). Ohno (1988) notes that:

> In the American [production] system, a lathe operator is always a lathe operator and a welder is always a welder to the end. In the Japanese system, an operator has a broad spectrum of skills. He can operate a lathe, handle a drilling machine, and also run a milling machine. He can even perform welding. Who is to say which system is better? Since many of the differences come from the history and culture of the two countries, we should look for the merits in both. (p. 14)

This distinction between the production systems transcends the management practices of these two organisations, as the production systems mimic culturally distinct behaviours highlighted by Hofstede (1980) and Trompenaars and Hampden-Turner (1997). Westerners are often seen as adapting individualistic behaviour which narrows the scope of perception to specific parts and objectives (Nisbett et al., 2001). In contrast, Asians are seen as being more collective, seeing relationships where the westerners see parts. As such, it is quite logical that greater fulfilment would come from being able to complete the product from beginning to end rather than attaching isolated parts.

Changes to the lean system in the American context may result in undesired behaviours stemming from greater responsibility, reduction in the management hierarchy and increased teamwork. Although the design of the lean production system improves productivity, it may also cause stress as workers have more responsibility for quality (Womack et al., 1990). Also, Westerners are inclined to view success as moving up the management hierarchy. This ties in with cultural goals of personal agency and individual achievement. Consequently, the creation of a flatter

organisation using lean principles may conflict with established measures of achievement and professionalism. Whereas the lean system calls for synchronisation through teamwork, the mass system calls for individual task execution. The concern is that we can assimilate the best practices of a particular culture, without reconciling the underlying behavioural differences. This situation presents an opportunity for behavioural research that examines the impact of national culture on the behaviour of production workers and how the configuration of the tasks within different production systems interact with these cultural differences to affect performance. In brief, the impetus for this research is the desire to investigate the behavioural differences between workers from diverse cultures and how these cultural differences affect performance.

1.3 Production Systems in Multinational Operations

The operations are a layer of systems and processes that are often referred to interchangeably. For this thesis, a taxonomy of operations is described to link the worker to the production system. This taxonomy contains three levels: the production system, the transformation process and the task configuration. The outcome of this hierarchy is a production task which is executed by the worker as the value-added point of contact between the worker and the production system (see Figure 1.2). It is necessary to explain these concepts as they constitute the core conceptualisation of operations within this thesis. At the crux of the production system is the goal of transforming material input and labour resources into finished goods and services. However, the notion that this plant-level production is designed to reflect the globalised operating context is less apparent in the literature. Compared to other topics in operations management, research on the configuration of the production system and the tasks comprised is limited because the intricacies of the operations process are usually hidden (Hayes et al., 2005). Furthermore, multidisciplinary knowledge is often required to solve production problems, bordering on areas such as engineering and technology. Hence, researchers of operations management must not be tempted to overlook the effect that different operating contexts have on the relationship between the worker and their production task.

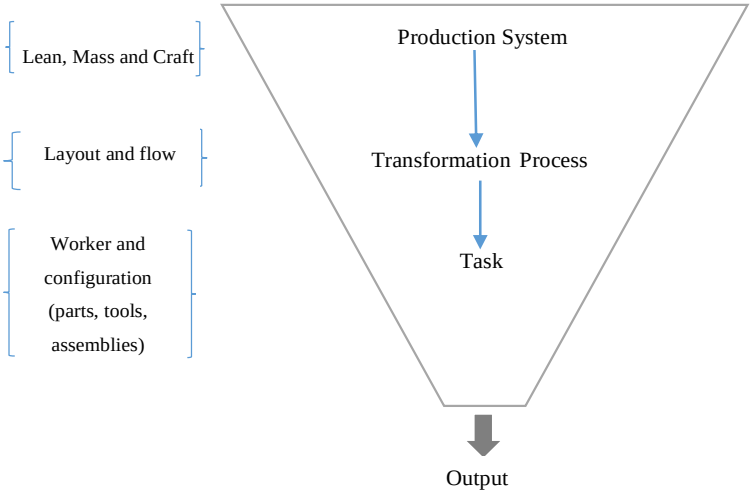


Figure 1.2 A Taxonomy of Operations

The production system is aimed at pulling together all the elements required to sustain production within the plant. The production system encompasses all processes of the organisation dedicated to the creation of goods and services as well as the necessary distribution and servicing (Jacobsen & Rudolph, 1997; Jacobsen et al., 2001). The design of the production system reflects the constraints of production, including how the system fits into the supply chain. Also, there is a need to understand the technological, environmental, ethical and market constraints that will shape the scope of the system (Jacobsen et al., 2001).

One important element of the production system is its philosophy, as it determines many of the design features of the transformation process. For instance, the guiding philosophy of mass production is scientific management, often referred to as Taylorism. Scientific management sets out the principles of the division of labour or specialisation as a way of reducing movement between tasks and the time needed to learn tasks (Taylor, 1911). Since this system aims to keep production simple and thus manageable, downtime represents the loss of production hours. Similarly, lean production is based on the philosophy of waste reduction, whereas the craft system is focused on giving the highest level of value to the consumer (Womack et al., 1990). Although these production systems will be addressed further in the literature review, the transformation process within these systems is explored to connect the worker to the production task.

Akin to the idea of the production system is the operations or transformation process shown in Figure 1.3. There are many variants of this representation. However, this thesis draws on the inferences of Slack et al. (2016) and Holweg et al. (2018).

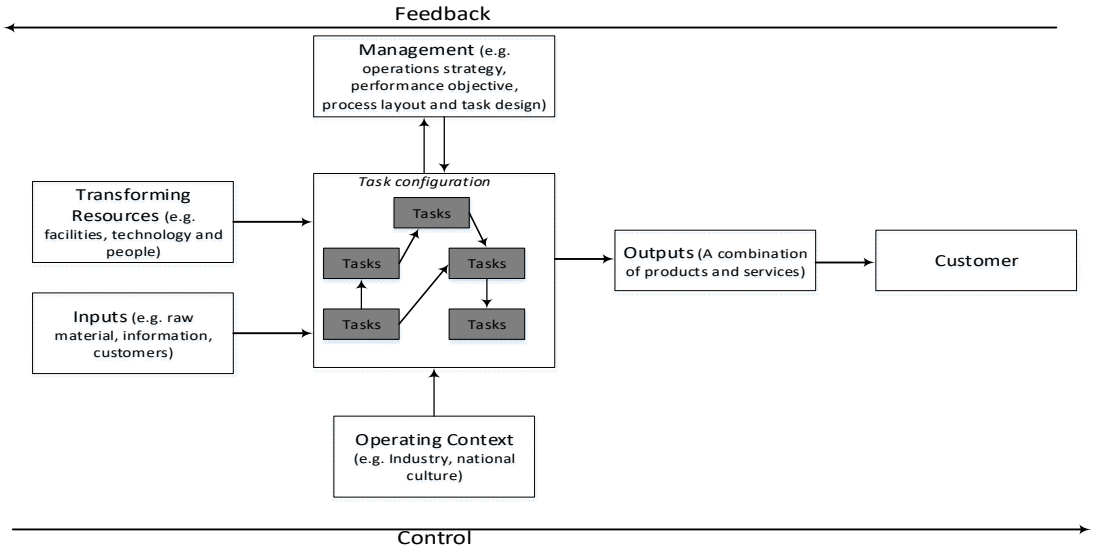


Figure 1.3 The Operations Process

To understand the hierarchy, one should conceptualise the terms ‘system’ and ‘process’. A system is a collection of elements brought together to achieve an objective (Blanchard, 1991). Thus, it seems reasonable to assume that elements of the production system can transcend the conversion process (i.e. tacit elements such as management philosophies). On the contrary, however, the operations as a process can be confined to the input-conversion-output idea (Holweg et al., 2018). A process represents “a sequence of activities that turns inputs (or resources) into outputs (products or services)” (Holweg et al., 2018, p. 31). This sequence of events is contained in the operations that use time, space, information and other resources to produce the output of the process. Another purpose of the process is to produce a desired level and variety of output. This purpose not only ties into the production system that is used but dictates how the process is designed (i.e. layout and flow). Moreover, processes are hierarchically neutral. There can be processes within processes at different levels of the organisation (supply chain, operations, and task). Although a process can define any activity with a sequence, for clarity in this thesis, the process is associated with transformation.

Operations are influenced by the operating context, which guides the interpretation of the operations strategy. The operating context influences all the elements of the operations. For example, culture affects what the customer demands, which influences the inputs required for production. Likewise, contextual variables such as culture affect the people in the transformation process, including shop floor workers, service providers and decision-makers. How an employee interprets her task may be related to beliefs engendered by their culture. Similar considerations are also valid for other contextual variables such as the industry within which operations are associated. Therefore, the transformation process needs to adjust to the changes in the operating environment.

The transformation process is configured to optimise the flow of resources through the process. Furthermore, this process is often classified by the trade-off between volume and variety (Hayes et al., 2005), although other objectives can be considered. Designing the production process requires answers to key questions such as how much control should be included, whether employees should work in groups, and whether they should produce part or all of the product. Also, how much job enlargement or creativity is included in the job is all guided by the tenets of the production system. There are four flows that can be considered: material, energy, information (knowledge and control) and financial (Jacobsen et al., 2001). The flow that is most often noted is the flow of materials because of their association with the finished product.

In deciding the flow of resources through the operations and how to lay them out, there is an attendant decision involved: how to convert the process into manufacturing actions or tasks. Consequently, the output of the production process is a task that requires action by a worker. The worker engages with the production system through the completion of this assigned task or set of tasks. This task output of production resources includes information (i.e. standard operating procedures or SOPs, tools, and parts) and design considerations (i.e. layout type, process flow) that require the worker's discretion in merging these resources to create output. Therefore, the production process contains a collection of elements that must be bundled and organised into tasks to achieve the desired output (Jacobsen et al., 2001). All levels of the production taxonomy articulated in Figure 1.2 influence the task configuration,

thus making the task the outcome of numerous strategic decisions at different levels of the operations.

Task configuration includes issues such as how many assemblies to include in a task, what tools the worker needs to complete the task and the level of interdependence between tasks. Another necessary consideration is the arrangement or pattern of materials, parts and tools associated with the completion of a task. The task configuration specifies boundaries between tasks and is accompanied by instructions on how to complete the tasks.

An efficient process manages the cost and time of production (Yeung, 2008). Hence, a major task consideration is how to improve efficiency by making the merging of resources intuitive or quicker for the worker. A table can be used to illustrate this concept. The speed of assembly is increased by making parts multifunctional, with all sides of the table consisting of the same size material and making the tabletop easier to identify with denser material or rounded edges. Another example is achieving mass production by limiting the task variety. The resulting performance effect is a reduction in the need for learning and movement while increasing speed and quality in the process. Therefore, task configuration has the potential to limit ambiguity and the time needed to decide on the action to take by making it "obvious" to the worker how each part should be assembled and how they fit in the workflow. This strategy elevates task features in the operations process to cues for the worker to perform.

1.4 Linking the Production System to Behavioural Operations

Operations performance is only achieved if the worker can execute the tasks within the process. Therefore, process design features provide "levers for managers to manipulate the dynamics of any system, subject to intermediate contextual outcomes…However, most critically, the appropriate use of these levers cannot be determined without an appreciation of the role of human behaviour" (Eckerd & Bendoly, 2015, p. 7). Although considerations of the worker are integral in manufacturing, the primary focus has been on concerns of ergonomics, relinquishing the behavioural impact of the task configuration to other fields such as organisational sciences and psychology.

The behavioural impact of task configuration or design was popularised by the monotonous effect that mass production systems had on worker motivation and satisfaction (Morgeson & Humphrey, 2008). While the division of labour within the mass production system was yielding efficiency and productivity results, workers were becoming less satisfied with their jobs, which led to increased absenteeism and turnover rates (Hackman & Lawler, 1971). However, despite the recognition by key proponents of Taylorism such as Gilbreth and Gilbreth (1916) that their focus on specialisation came with behavioural consequences, efforts to address these concerns were promulgated in the organisational behaviour (OB) literature.

Morgeson and Humphrey (2008) note that the declining interest in studying the behavioural implication of tasks and the environment of the worker, particularly in industrial fields such as operations management, may be attributable to the success and saturation of investigations in the organisational behaviour field. However, as displayed by the taxonomy, there are many layers to the operations process that are often not referenced, or even considered, in the OB literature. This is a major oversight for the operations literature, as the design of production tasks is not the central focus of these psychological studies (see Morgeson & Humphrey, 2008). Organisational behaviour theorists tend to take the task characteristics of the operations management context as given (Eckerd & Bendoly, 2015) and restrict production performance to efficiency. For example, specialisation and simplicity are the main operations task characteristics researched in the OB literature (Campion, 1988; J. R. Edwards et al., 2000; Morgeson & Campion, 2002) and these investigations are few (Humphrey et al., 2007). Further, these characteristics are presented as generic production features but are rarely associated with production systems other than mass production. The increased popularity of behavioural operations may provide an opportunity to rectify this lost perspective.

One major behavioural consequence for the multinational operation is that workers in different countries may interpret similar task features differently. Where culture differs for the manager and worker or between workers of culturally distinct plants, performance can be affected. First, culture can cause the manager to prefer a particular task configuration (Hofstede, 1993). This preference is manifested in the combination of strategy and artefacts, which in turn affects the worker’s perception. Masuda and

Nisbett (2001) found that cultural differences in the environment can elicit culturally specific perception by focusing attention on particular elements of the environment. Workers from different cultural backgrounds can perceive the same task differently (Masuda & Nisbett, 2001; Kitayama et al., 2003; Nisbett & Miyamoto, 2005). Therefore, the behavioural impact of environmental factors such as culture on the operations, should not be overlooked. Hence, the tenets of behavioural operations are explored in the context of multinational production.

1.5 Worker Behaviours in Operations Management

> "Behavioral operations management explores the interaction of human behavior and operational systems and processes. Specifically, the study of behavioral operations management has the goal of identifying ways in which human psychology and sociological phenomena impact operational performance, as well as identifying the ways in which operations policies impact such behavior." (Bendoly et al., 2015, p. ix)

Behavioural operations (BeOps) draws from other principal disciplines such as cognitive psychology and social psychology which is influenced by sociology. Therefore "Behavioral Operations Management is a multi-disciplinary branch of OM that explicitly considers the effects of human behavior in process performance, influenced by cognitive biases, social preferences, and cultural norms" (Loch & Wu, 2005, p. 13). Cognitive psychology allows us to conceptualise the environment as an interplay between an actor and a stimulus that elicits a response from the actor. The focus is on moderating the relationship between the stimulus and the actor's response to achieve the desired performance or action. Extending this view to the operations, the worker responds to the features of the operations, including the layout of the production system and the configuration of the tasks contained (Eckerd & Bendoly, 2015). Organisational behaviour is an applied branch of psychology which focuses on behaviour in the organisation—behaviour such as satisfaction and motivation (Eckerd & Bendoly, 2015). Psychological models of behaviour delineate the link between the observed behaviour and the unobserved cognitive processes. Social psychology broadens the scope of the behavioural analysis to a group of people, how they relate

to others, and what social process is responsible for this relationship (Loch & Wu, 2005). Thus, sociological theories underpin this area of psychology.

By addressing some core behavioural concepts, this section will explore cognitive and social theories that affect worker behaviour in the operations. Given the focus of this thesis on the multinational nature of the operations, national culture is addressed as a behavioural variable. Specifically, this study addresses how national culture affects the cognitive process of perception, and the social support and feedback workers give to each other.

There are some building blocks to BeOps that help explain the actor-stimulus-response relationship. They include mental models, biases and heuristics. The glut of information in the social environment compels the human brain to select ways of capturing small chunks of this stimuli as a representation of the whole. These chunks or snippets of information are referred to as mental models in cognitive psychology (Zacks & Swallow, 2007) and are related to schemata in sociology (DiMaggio, 1997). In addition, these mental models are representations of knowledge and information-processing mechanisms formed by past experiences with objects or events (DiMaggio, 1997, p. 269) and are used during perception to organise memory (Zacks, Tversky, et al., 2001). How the brain selects these units of memory has consequences for how we perceive the environment.

Often the criteria for selecting the information that forms the mental model arises from the worker's experience of the immediate task environment or social encounters over a lifetime. Consequently, perception is shaped by the information contained in mental models and forms expectations of what things should look like and how future information is organised and recalled (Mandler, 1979; G. Cohen et al., 1993). Thus, human biases can result from the idiosyncrasies of mental models, where these biases are created through the outcome of mental models or through the processes that update the mental model. Finally, a bias is a systematic deviation from an expected outcome (Baron, 2008). A detailed examination of the interplay between perception and behaviour will be presented in the literature review.

Behavioural operations examines observed behaviours in the worker's performance and relates them to cognitive and social processes. An example, the tendency of

managers to present optimistic project performance due to an overconfidence bias (Gino & Pisano, 2008). Another example is the tendency for Americans to be less trusting than their Chinese counterparts after a contract breach by a supply chain partner (Eckerd et al., 2016). Although these behaviours can be measured in the form of output, it can also be measured as actions taken in decision making or in the process of creating the output. For example, behaviours can be measured as simply differences in targeted output versus actual output. The behavioural literature speaks to systematic errors which are deviations from expected operational performance (Bendoly et al., 2006). Other behaviours can be significant differences between the performance of workers, which results from having different mental models of the same operational situation. These differences are easier to identify when behavioural differences are between groups of workers, as in the case of Eckerd et al. (2016).

Given these differences, it should be emphasised that mental models can be shared (Bendoly et al., 2015). If individuals are exposed to the same experiences, they could develop similar mental models which may result in group biases in perception. One such shared experience is culture. Therefore, the concern of the BeOps scholar in such a situation would be how shared mental models associated with cultural information might shape the worker's perception of their tasks and how this process creates human biases in work-related action or output. Since this thesis explores the behavioural influences of culture, the subsequent section will explain further how culture can affect behaviour.

1.6 Defining National Culture

Culture is a difficult term to define. However, there are definitions throughout the literature that effectively demonstrate the scope and multi-layered nature of the concept. An anthropological view of culture is "as information – skills, attitudes, beliefs, values – capable of affecting individuals' behaviour, which they acquire from others by teaching, imitation, and other forms of social learning" (Boyd & Richerson, 2005, p. 105). Hofstede's (1980, p. 260) sociological perspective is that culture represents the "collective programming of the mind that distinguishes one group or category of people from another." Culture is a latent construct that often manifests

itself through other constructs, such as customs, attitudes, status, psychology or management principles (Hofstede, 1993; Metters et al., 2010). Loch and Wu (2005, p. 206) warn that research in behavioural operations is incomplete without understanding the influence of culture, as "culture surrounds us in ways that we are not even aware of (we 'swim in it' like fish in water), and fundamentally influence what we do."

The behavioural effect of culture has largely been explored as output or performance differences. In such cases, culture is an explanatory variable, often representing the country or region within which a plant is located. For example, Pagell et al. (2005) tested whether there was a cross-cultural difference in supply chain buyer behaviour by categorising suppliers as North American, Asian and European. In some instances, the aim is to validate existing theories or instruments in a new country or to compare the output of multinational operations. Studies such as these are informative in revealing significant differences in output between operations in different countries, with the underlying assumption that performance resulted from differences in culture. While this assumption is not incorrect, national and cultural differences cannot be conflated, as differences between countries can result from other social phenomena, including politics and legislation (Lee Park & Paiva, 2018). While these other social phenomena are certainly influenced by culture, cultural assumptions may be invalid if these variables are important and omitted from the analysis. Thus, these studies must be complemented by research that seeks to understand the social and psychological processes through which culture enters and affects operating performance.

One method of validating culture, which has been used in the literature, is to investigate measurable dimensions of the construct to assess the impact of specific cultural traits on performance. For instance, Hofstede's notion of cultural dimensions was used to explore the impact of national culture on investments in manufacturing practices and performance (Wiengarten et al., 2011). Lee Park and Paiva (2018) assess how the operations strategy and manufacturing process in a multinational context were affected by Hofstede's cultural dimensions. According to the researchers' findings, manufacturing processes and strategies differed significantly based on national culture, as measured by the cultural dimensions, and indicate the need for culture to be integrated into global business strategy.

The use of cultural dimensions to analyse the cultural impact of the operations is a significant step in incorporating its complexity. However, further work can still be done to investigate the cognitive and social behaviours that transmit these cultural traits to the shop floor. By understanding how culture moderates these behaviours, decision-makers can design production tasks and stimulate or dampen unwanted behavioural effects. This study investigates two types of behaviour that can be affected by national culture, cognitive behaviour and social behaviour. The relationship between national culture and cognitive behaviour is explored by using schemata theory to understand how culture affects the cognitive process of perception. The more extrinsic social behaviour is assessed by how culture affects feedback and social support between workers.

1.7 The Influence of National Culture on Cognitive Behaviour

Schemata theory is used to posit how culture affects perception in line with explorations of culture and cognition by (DiMaggio, 1997). To be specific, mental models are working memory representation (short-term memory) of the environment, whereas schema theory is presented in the literature as a long-term representation of the environment with more abstract details than mental models (DiMaggio, 1997). Given that culture is a long-term social phenomenon, we start at the level of schemata and demonstrate the relationship with mental models and reconcile this relationship further in the literature review.

According to schema theory, knowledge is packaged into units called schemata. This knowledge includes representations of objects and events, including the relationships between these representations and how they should be used or interpreted (Rumelhart, 1977). As such, the cultural beliefs, norms and linguistic idiosyncrasies are all captured in these schemata (e.g. Goffman, 1974; DiMaggio, 1997). As people interact with members of the same culture repetitively in particular situations, these schemata become more defined and reinforced (Nishida et al., 1998). Over time, these cultural schemata form unconscious expectations of what things should look like and how they should be organised as a way of making perception more efficient. These abstract expectations form part of the information stored by mental models of the work

environment. As a result, workers turn up for work with predetermined meanings of objects in the operations process based on the degree of similarity with their cultural schemata and may perceive the operations through a cultural lens.

Arguably, schemata can be influenced by other processes, including organisational culture, biology and education. Following the previous arguments, schemata could also be influenced by organisational culture if the worker is exposed to it over a long period. Therefore, the discussion as to how organisational culture can foster desirable worker behaviour and mitigate the impact of external social influences is an important consideration. Likewise, schemata can be influenced by biological impairments (Baron, 2008), such as vision and hearing issues.

Lessons concerning the structure of space and time learned in school are generalised to the workplace (Willis, 1977). Therefore, workers exposed to the same educational system may share similar mental models of the temporal sequence and position of organising and executing work. Baggett and Ehrenfeucht (1988) found that prior knowledge or experience had an impact on how workers decomposed products into subassemblies, including the number, content and names of assemblies. This research focuses on national culture as a source of schemata because of its encompassing scope to the extent that it influences other sources of schemata (Pagell et al., 2005).

Many perceptual processes could be studied in manufacturing, including the worker's perception of interpersonal relationships. For this study, the focus is on the worker’s visual reception of the operating task for memory encoding and recall for performance. Thus, what is needed is a measure of perception that allows for the assessment of a person's perceived sequence of events. We, therefore, turn to event segmentation theory as a means of measuring the workers’ perceptual organisation of a manufacturing task.

Segmentation deals with how people separate a sequence of events into chunks of smaller events or information. The cues for creating chunks and where and how well people identify the boundaries of these chunks are the concerns of segmentation. Research on segmentation has taken place using behavioural experiments with visual tasks such as pictures (Newtson, 1973), videotape (Zacks et al., 2001) and text (Wang, 2009) as stimuli. In these investigations, perception is measured as the number of

chunks that a person creates by tapping a key or inserting a symbol while viewing the sequence of events.

Given that segmentation aids memory and recall, how well a person nests smaller (i.e. fine-grained) chunks within larger (i.e. coarse-grained) chunks of events has also been measured as the hierarchical structure of events (Zacks & Tversky, 2001). In perceiving events, observers can create coarse-grained chunks which correspond to more abstract segments of information, separated by more considerable changes in stimuli and observer goals. Within these coarse chunks are fine-grained chunks which refer to related actions that are differentiated by smaller changes in stimuli than coarse-grained chunks and allow richer interpretation of information (Hard et al., 2006). Improving the hierarchical structure of segmentation has been shown to improve learning accuracy in task performance (Hard, 2006) and impact memory impairment caused by Alzheimer's and age on perception (see Zacks & Swallow, 2007; Kurby & Zacks, 2011).

Using visual stimuli accompanied by unitisation tasks have proven reliable in identifying the length (Newtson, 1976) and location of chunk boundaries (Speer et al., 2003). However, evidence that people segment their experience as it is perceived has come from neurophysiological research. Functional magnetic resonance imaging (fMRI), and variations of this neuroimaging technology, has shown that specific regions in the brain (i.e. lateral posterior cortex, medial posterior cortex and lateral frontal cortex) experienced increased activity at points in natural perception which participants later identified as event boundaries with key pressing (Zacks & Tversky, 2001; Speer et al., 2003; Zacks et al., 2007). Applications to manufacturing can be seen in the design of specific software using segmentation techniques to design manufacturing instructions (Mura et al., 2013).

Event segmentation is compatible with how tasks are configured in production. In addition, the cultural differences in event segmentation identified by the literature allow us to trace the impact of culture from the multinational operations environment through the process of perception. Finally, this provides an opportunity to trace the impact of these culturally determined differences in perception to manufacturing performance.

1.8 The Influence of National Culture on Social Behaviour

Dramatic changes in work have occurred over the past few decades (Parker et al., 2001; Rousseau & Fried, 2001; Holman et al., 2002; Johns, 2006). Researchers have tried to account for these contextual changes by investigating new characteristics such as the social aspects of jobs and explore more environmental variables as moderators of the effect of job characteristics on performance (Grant et al., 2011). Early work design research recognised the importance of the social characteristics of work Trist & Bamforth, 1951; Turner & Lawrence, 1965). Job design pioneers such as Oldham and Hackman have noted that the omission of social characteristics from the literature, even by them, was a grave error (Oldham & Hackman, 2010).

The Work Design Questionnaire (WDQ) (Morgeson & Humphrey, 2006), has been cited by Oldham and Hackman (2010) as a measure of social characteristics. The WDQ was validated with 540 incumbents holding 243 distinct jobs and demonstrated excellent reliability and convergent and discriminant validity. The WDQ contains four measures of social characteristics – social support, interdependence, feedback from others and interaction outside the operation – which reflect the fact that work is performed within a broader social environment.

Many of the characteristics in the work/job design literature do not apply to this study because of the controlled nature of an experiment. However, in recreating the task interdependence of shop-floor workers, some level of social interaction may have been facilitated. First, highly interdependent jobs provide increased contact and more opportunities for communication between workers (Salas et al., 1999). Also, social behaviour may be a response to group expectations (Seers et al., 1983). That is, social interaction helps bound individual roles (Alderfer & Smith, 1982) by clarifying the roles that each individual fills (Tuckman, 1965). Further, high levels of social interaction can allow workers to benefit from co-worker advice (Morgeson & Humphrey, 2008) or helping behaviour (Perlow & Weeks, 2002).

The social element of working in groups is often not reflected in manufacturing research. However, the effect of social interaction can be explicitly tested. Therefore, the impact of social support and feedback on performance are explored as these social

behaviours were most relevant to the experimental design. Social support reflects the degree to which a job provides opportunities for advice and assistance from others (Morgeson & Humphrey, 2006). Feedback from others reflects the degree to which others in the organisation provide information about performance. Early theorising suggested that feedback could also come from co-workers (Hackman & Lawler, 1971).

Researchers have noted that social behaviours are essential components of work and are likely to impact a variety of work outcomes (Parker et al., 2001). For example, researchers have pointed out that relationships between workers are among the most important determinants of well-being (Myers, 1999) and perceptions of meaningful work (Gersick et al., 2000; Wrzesniewski et al., 2003). Social characteristics are expected to reduce the stress of jobs by buffering workers against adverse work conditions (Karasek, 1979; Karasek et al., 1982). They may also increase work motivation and satisfaction (Adler & Kwon, 2002; Humphrey et al., 2007) and promote resilience, security, and positive moods on the job (Ryan & Deci, 2001). However, the relevance of research in social behaviour has seen growth due to the increased use of teams in organisations (Ilgen, 1999; Arthur, 2005). Further, research has shown that these social characteristics can be moderated by macroscopic factors such as national culture.

Although the majority of job design models have focused on individual motivation and satisfaction, researchers have also suggested that job designs are embedded in national cultures, institutions, technologies and organisational structures (Brass, 1981; Roberts & Glick, 1981; Dean & Snell, 1991; Spreitzer, 1995; Robert et al., 2000; Parker et al., 2001). For example, Robert et al. (2000) reported a negative relationship between empowerment and job satisfaction in India, which was credited to the high levels of power distance in the Indian culture. Likewise, job design may have a stronger effect on workers in cultures characterised by high power distance, where workers are more likely to conform to supervisors' expectations (Leung, 2001).

As with the influence of national culture on cognitive behaviour, the cultural dimension of individualism vs collectivism has been most researched. Several job design studies have assessed how the effect of job characteristics may differ due to

this cultural dimension. For example, there was a weaker relationship between autonomy and the critical psychological states of the Job Characteristic Model in Bulgaria and Hungary than in the Netherlands which is more individualistic in culture (Roe et al., 2000). Furthermore, in a sample of more than 100,000 employees from 49 countries, Huang and Van De Vliert (2003) found that enriched job characteristics are related more strongly to job satisfaction in countries with high individualism, strong governmental social welfare programs, and low power distance. Also, co-workers are most likely to assist others if they are from more collectivistic cultures as this support or feedback is seen as part of the job (Perlow & Weeks, 2002). Therefore, we can expect collectivistic cultures to influence more social interaction in the form of support and feedback. Assessing the impact of national culture on social behaviours in production improves the management of operations in different cultural contexts. In sum, a theoretical contribution can be made by identifying and addressing some of the shortfalls in the operations literature concerning the influence of national culture on worker behaviour.

1.9 Shortfalls in the Operations Management Literature

As operations assimilate to new international contexts, the need for production systems and tasks to reflect the international scope of production must not be forgotten. Moreover, the rise of the era of mass customisation has changed how we configure operations tasks within the production system. Efficiency is being forced to exist alongside increased levels of operational flexibility. This more complex operations environment suggests that research on task configuration is needed in behavioural operations, as operations tasks have moved far beyond the generic mass production envisioned by Taylorism. The behavioural concerns of operations tasks are more than simply monotony, as manufacturing features such as the buffer sizes (Schultz et al., 1999) and the impact of configuration on task learning (Bailey, 1989) are some of the areas for further research. However, these behaviours must be interpreted not just from a Western perspective, but from a multinational perspective to achieve comparable international productivity.

There have been numerous investigations into how worker behaviour affects efficiency in the long-run when design features such as specialisation create fatigue and a lack of satisfaction and motivation (see Grant et al., 2011). These investigations supported the rise of research on task configuration in the organisational behaviour literature. However, the nuances of the operations environment have dissipated from the literature. Furthermore, researchers in operations management seem to have left the research of task configuration to other fields, citing these behavioural discussions as human resource issues. Thus, the paucity of research in the area of operations task configuration is not surprising (e.g. Dabhilkar & Ahlstrom, 2013).

Understanding differences in performance also requires an understanding of how workers interface with the operations through their tasks. Numerous behavioural studies have disproved the implicit assumption that managerial decisions are effectively communicated or instantaneously learned through training (see Bendoly et al., 2006). Therefore, the cognitive processes that affect instantaneous learning in the operations environment, such as perception, must be explored. Likewise, the behaviour of workers can be affected by the work environment, including their co-workers. Therefore, examining the cognitive and social influences on worker behaviour will allow the operations practitioner to reduce or adjust expectations for the testing period required for a new production system and decrease costs related to poor performance prediction.

A cultural perspective on the operations is relevant (Kortmann et al., 2014), as the literature does not yet contain full explorations of the mechanisms that inhibit the transferability of manufacturing processes to different cultural contexts. Hence, an opportunity exists for cultural research in operations management that improves understanding of the mechanisms through which culture affects the operations. There is a shortfall in the operations literature when it comes to a theoretical study on how national culture moderates worker behaviour and the impact that worker behaviour has on manufacturing performance in different task configurations. Gaining insight into worker behaviour in operations management can have a profound effect on performance as small changes in behaviour can add up to many productive hours over time (Eckerd & Bendoly, 2015).

1.10 Purpose of the Study

Greater access to international markets, resources and production has made the inclusion of national culture in operations research relevant. This thesis sheds light on the influence of national culture on the behaviour of the operations worker and their performance. Although most of the points raised can influence discussions on the global expansion of services, the empirical base of the thesis is a manufacturing setting, as the tangibility of the manufacturing process facilitated the observation of behaviour. As a result, this study is a benchmark for research in less tangible areas. This thesis is an interdisciplinary study that merges literature from psychology, organisational behaviour, sociology and anthropology with that of operations management to solve an operations problem.

The main objectives of this research are to understand whether national culture influences worker behaviour and whether national culture moderates the impact of worker behaviour on manufacturing performance in different task configurations. There are systematic differences in how workers from different cultures perceive their manufacturing tasks and relate socially within their groups. The process of perceiving the operations is often taken for granted. However, perception is a complex process. It involves seeing a stimulus (i.e. product part) and assigning a description to this stimulus based on memory (Zacks & Sargent, 2010). If the worker's perception of the artefacts in the task environment differs from that of the task designer, performance becomes less predictable. Moreover, since perception is governed by a person's experiences, the continued exposure to one's culture is likely to influence how workers ascribe meaning to objects and relationships. Thus, culture can affect how employees perceive the operations environment (Ronen & Shenkar, 1985; Nisbett & Miyamoto, 2005). Achieving efficiency is dependent on configuring the task environment to optimise the flow of resources. Therefore, many operations use a production layout where co-workers and their output are visible to all workers. Therefore, direct or indirect social behaviours can be engendered during production, which may affect the latter.

These relationships are studied through controlled experiments which allow for the assessment of culture and performance at the individual level, removing confounding

macro factors. It is acknowledged that investigating cultural differences in worker behaviour at the level of the shop floor worker is problematic and costly, because any interference may result in the loss of productive time. The solution was to design a lab experiment involving the paper airplane manufacturing simulation to replicate the nuances of the operations process. The paper airplane simulation has formed the cornerstone for manufacturing pedagogy in operations management for some time. Consequently, the use of this simulation is not to replicate the complexity of the manufacturing environment but to effectively replicate and measure the task attributes and workflow of the operations.

Perception is framed using a type of chunking theory known as event segmentation. Chunking is a collective term denoting theory that explains how people perceive ongoing events. Chunking is a cross-disciplinary theory which is sometimes viewed as a quasi-ontology because of its widely accepted explanation of how parts relate to the whole. This theory is fitting for manufacturing as the production process is often segmented into assemblies based on numerous strategic decisions pertaining to part size, process layout and workflow policy. Likewise, social behaviour can be measured using the job/work design literature, which posits a number of social characteristics which may affect the behaviour of workers as they execute their tasks. With the significant resources committed to making the 'assembly decision', it is equally important to understand how these segments are perceived by the workers and how social interaction between workers may affect performance. Similarly, whether these assembly decisions are universally perceived should be a concern for operations as they expand globally. Explicit hypotheses are developed in Chapter 3 in the review of the literature. A summary of the methodology used to assess these hypotheses follows in the next section.

1.11 Methodological Summary

This study contains a pilot study and two experiments. The pilot study was used to test the measurement of event segment and the use of the manufacturing simulation as an experiment. In the main analysis, for Experiment 1 participants were given an instructional video of the paper airplane manufacturing simulation to identify event

segments. In Experiment 2, participants were asked to perform a task requiring the assembly of the paper airplane in the instructional video. The use of this simulation is not to replicate the complexity of the manufacturing environment but to effectively replicate and measure the task attributes of manufacturing tasks. This paper airplane factory simulated three task configurations associated with the mass, lean and craft production systems.

A total of two hundred and forty-six participants were recruited for this study. Participants were incentivised using a payment scheme that paid an experiment turn-up fee and a variable fee for each good product made. A British and Chinese sample were used for cultural comparison, representing the Western and East Asian cultures, respectively.

Multilevel linear modelling (MLM) was used to assess the impact of national culture on worker behaviour and productivity within different task configurations. MLM allowed us to capture the repeated measurement of the three task configurations within each worker.

1.12 Theoretical Contribution

This thesis makes a theoretical contribution to behavioural operations with a specific contribution to understanding the relationship between culturally moderated worker behaviours, manufacturing task configuration and performance. Worker behaviour is explored at the cognitive and social level. Cognitive behaviour is explored through the lens of chunking theory which explains the relationship between perception and performance in operations management. Chunking theories have been applied to disciplines such as linguistics (Gobet, 2016; Gobet et al., 2016), music (Godøy, 2008) and psychology (Miller, 1956; Song & Cohen, 2014) to understand of how a continuous flow of information or event is understood in parts. However, the absence of chunking theory from the operations literature is puzzling given its ingrained synergy with core tenets of operations management such as specialisation, process/part design, assembly layout, and so on. By using a widely accepted way of explaining assemblies and sub-processes in mainstream operation literature, this thesis contributes to broadening the theoretical scope of the operations management.

Social behaviours are explored through the lens of job/work design theory. The job design literature was inspired by research on manufacturing, such as the Hawthorne studies, on the impact of fatigue on worker motivation due to the repetitive nature of mass assembly tasks (Roethlisberger & Dickson, 1939). Job design theorists suggest that job characteristics such as social and task characteristics produce critical psychological states in the job holder, which influence some outcome (Hackman & Oldham, 1975, 1976, 1980; Morgeson & Humphrey, 2006). These theories extend to work design when non-compensatory activities are included. Ultimately, these states lead to a set of positive work outcomes.

Insights from the job design literature have been used in OM research. Applications to the production context of include examining job design as a success factor during the lean adoption process (Martínez-Jurado et al., 2013) and incorporating both the technical and social dimensions of the operations to improve the success of mass customisation (Liu et al., 2006). However, the success of the job design approach, partially due to the saturation of the literature, created a shift from the context of the operation. Consequently, the nexus of job design and production within the discipline of OM has been left under-explored. Although organisational studies may use operations as a context for job design research, the care required to exploit the specific characteristics of the operations and further relate findings to the OM literature has not been forthcoming (Eckerd & Bendoly, 2015).

The production task is the point at which the worker adds value to the operations. Hence, operations tasks are designed to aid workers to perform. As workers perform these tasks, there are cognitive and social processes that influence their performance, and this influence may differ according to the national culture of the worker. While these cultural differences in cognitive and social behaviours are explored in other areas of the operations such as at the level of the supply chain (Eckerd et al., 2016; Lee et al., 2018), little attention has been paid to production tasks. Nonetheless, behavioural considerations can improve the prediction of performance and the configuration production tasks (e.g. Doerr et al., 2002; Doerr et al., 2004). Consequently, this thesis contributes to the literature by exploring how national culture influences the cognitive and social behaviours of workers and how these behaviours affect manufacturing performance in different task configurations.

1.13 The Structure of the Thesis

This thesis consists of eight chapters, including the introduction. The structure of the remainder of this thesis is discussed in this section.

Chapter 2 presents a review of the behavioural operations literature. This chapter is aimed at understanding the scope of behavioural operations and understanding worker behaviours beyond traditional heuristics and biases.

Chapter 3 reviews the influence of national culture on worker behaviour. After establishing the definition for national culture, this chapter explores the cognitive and social behaviours of interest and develops the hypotheses that guide their investigation.

Chapter 4 contains the methodology used to test the hypotheses developed. Included is a look at the sample selection criteria, the flow of workers through the experiment and the disclosure of how variables were measured. This section is followed by a discussion of the multilevel model developed for this study.

Chapter 5 showcases the results of the pilot study and Experiment 1. The purpose and preliminary findings of the pilot study are described, followed by findings on the cultural differences in cognitive behaviour.

Chapter 6 presents the findings from Experiment 2. The national differences in social behaviours are assessed first by measuring responses from a debriefing survey. This analysis is followed by an examination of manufacturing performance from the paper airplane simulation. Findings on how national culture moderates the impact of cognitive and social behaviours on performance in the simulation, is also presented.

The discussion of the findings is presented in **Chapter 7**. Salient points include the following: (i) the cultural differences in assembly breakpoint recognition; (ii) the cultural differences in the social characteristics of the manufacturing environment; (iii) the use of task configuration to mitigate the effects of worker behaviour; and (iv) the influence of indirect worker feedback through co-worker performance on productivity.

Finally, **Chapter 8,** summaries the thesis and highlights the theoretical contributions to behavioural operations, with a specific contribution to understanding the relationship between culturally moderated worker behaviours, manufacturing task configuration and performance. This chapter also details the contribution made by examining worker behaviour as it relates to completing production tasks and the implications for practitioners managing global operations. Since a thesis is a body of work requiring intensive reflection, the limitations of this study are also presented along with suggestions for future research.

Chapter 2 Literature Review: Worker Behaviours in Operations Management

The purpose of the literature review is to outline the theories that form the foundation of this investigation and develop the hypotheses and the conceptual framework being examined by this study. The study is framed using theories of behavioural operations (BeOps), job design, national culture and cognitive perception. These theories are used to understand how cognitive and social behaviours affect worker performance in multinational operations. The review of the literature is presented in two chapters, Chapter 2 and Chapter 3 (see Figure 2.1). The literature is presented in two chapters to adequately establish the scope of behavioural operations (Chapter 2) and present the theory directly related to the development of the hypotheses (Chapter 3).

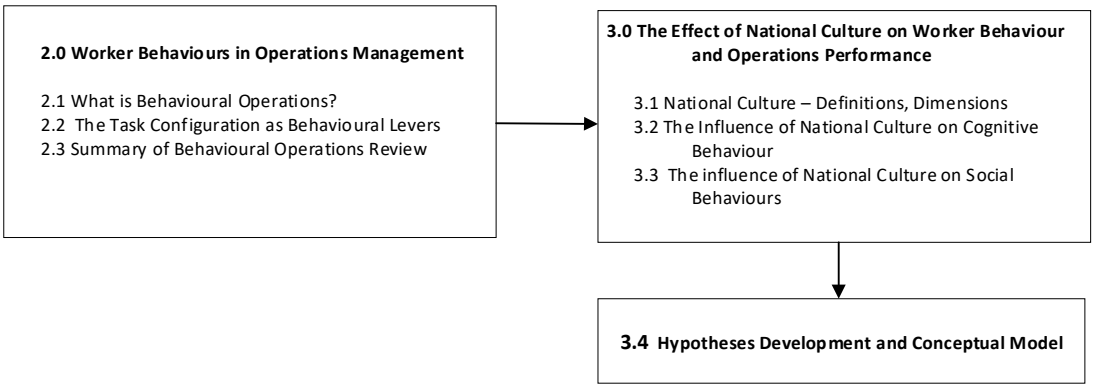


Figure 2.1. Interdisciplinary Literature Guide

Chapter 2 is a review of the behavioural operations literature to establish the scope of research in this area. This is important for behavioural operations, given the focus on cognitive biases and heuristics, which may overshadow other behavioural influences such as national culture (Loch & Wu, 2005). As such, a suitable definition for behavioural operations, that expands its scope beyond biases, is identified (§2.1). This thesis focuses on how national culture affects the behaviour of shop floor workers in manufacturing operations. Therefore, the relationship between BeOps and multinational manufacturing is established followed by an examination of the

production task as the bridge between worker behaviour and operations performance (§2.2).

The second aim of this review is to look at the specific relationships being hypothesised by establishing how national culture affects behaviour through the cognitive process of perception and the social characteristics of work. As highlighted in Chapter 1 (Introduction), assessing the impact of these behaviours is an exploratory analysis to understand how national culture affects operating performance through workers. These relationships are discussed in Chapter 3.

The research agenda for operations management (OM) has undergone significant changes since its acceptance into the social sciences. The industrial revolution of the 18th and 19th centuries brought with it a heightened need to study the management of operating processes. The division of labour and the steam engine, which were pioneered by Adam Smith and James Watt respectively, created the foundation for mass production. These inventions gave rise to the need to study the management of the 'factory'. Additionally, a need emerged to explore the functional aspects of the production of goods and services. The 20th century also brought with it increased sensitivity to globalisation and free trade. Operations were called upon to be leaner and more automated as managers realised that competitiveness depended on the effective management of production systems (Voss, 1984; Pil & MacDuffie, 1999).

However, modern operations are shifting from mass production to mass customisation to facilitate frequent changes in customer demand (Brolin et al., 2017). Many manufacturing operations are still reliant on manual assemblies to achieve flexibility at acceptable levels of efficiency. As such, workers need to be considered in the development of production systems (Brolin et al., 2017). Numerous researchers argue that 'perfectly' designed processes do not yield optimal performance because little has been done to understand the people who use and create these systems (see Loch & Wu, 2005; Bendoly, 2006; Gino & Pisano, 2008). Croson et al. (2013, p. 1) posit that "all contexts studied within operations management contain people… managers making decisions, employees working in and improving processes and customers buying products". The importance of the human element is further underscored by Hayes et al. (1988, p. 242), who assert that "superior performance [and]...the

capabilities that create a competitive advantage come from people – their skill, discipline, motivation, ability to solve problems, and their capacity for learning."

People design and manage the operations process (Boudreau et al., 2003) and are responsible for executing the production tasks within. For ease of analysis, most OM models simply assume that participants interfacing with the operations process are rational thinkers or can be induced to act rationally through monetary incentives (Gino & Pisano, 2008). Powell and Johnson (1980) emphasise the need to incorporate behavioural factors into models of operating performance. "Understanding a manufacturing plant does not just require a theory of human motivation and a theory of material flow: it also requires a means for describing interaction between the two" (Hopp, 2004, p. 5). Bendoly et al. (2006) further highlight the importance of the human element by positing that "When it comes to implementation, the success of operations management tools and techniques, and the accuracy of its theories, relies heavily on our understanding of human behavior" (p. 737). These studies heralded the importance of behavioural operations management, which considers the effects of human behaviour in process performance (Loch & Yaozhong, 2005).

2.1 What is Behavioural Operations Management?

When employees behave differently from normative models of behaviour in a predictable way, they cause systematic errors (Thaler, 1980) which may affect performance. Understanding and controlling these unanticipated behaviours is the purpose of behavioural operations (BeOps) management. Many normative models assume that employees are predictable in their actions, independent of others, not part of the product, emotionless, and observable (Boudreau et al., 2003). However, other parts of the literature contradict the accuracy of these models as their application to the operating processes has resulted in some operating anomalies. As such, some of the sources of these behavioural anomalies in the operations are discussed.

The literature from the recent popularisation of behavioural operations has largely explored how biases and heuristics affect worker behaviour. Reviews by Bendoly et al. (2006) and (Gino & Pisano, 2008) demonstrate this focus on decision biases and heuristics. However, efforts by Bendoly et al. (2015) and Loch and Wu (2005) to

highlight other behavioural investigations in OM, have led to definitions of BeOps that explicitly include a reference to the wider field of psychology – not just biases – and the sociological influences on behaviour:

> Behavioral operations management explores the interaction of human behaviors and operational systems and processes. Specifically, the study of behavioural operations management has the goal of identifying ways in which human psychology and sociological phenomena impact operational performance, as well as identifying the ways in which operations policies impact such behavior. (Bendoly et al., 2015, p. ix)

> Behavioral Operations Management is a multi-disciplinary branch of OM that explicitly considers the effects of human behavior in process performance, influenced by cognitive biases, social preferences, and cultural norms. (Loch & Wu, 2005, p. 13)

Therefore the purpose of this review is to, first, facilitate an understanding of cognitive biases and heuristics as major themes in BeOps. Then to expand the understanding of operating behaviours by looking at social and cultural influences of behaviour that go beyond the cognitive limitation of biases.

Cognitive biases and heuristics

A bias is a systematic deviation from a normative outcome, while a heuristic is an approach that people use to make decisions, often involving situations of incomplete information and aimed at reducing decision-making time and cost (Baron, 2008; Bendoly et al., 2015). Both can affect behaviour negatively or positively (see Katsikopoulos & Gigerenzer, 2013). What is apparent, however, is that being unaware of biases or heuristics can influence the accuracy of predicted performance. The following section provides more credence to these two terms, which comprise the cornerstone of investigations into systematic behaviours in operations.

To understand how biases and heuristics are created, it is helpful to investigate the basic cognitive action of thinking, followed by a demonstration of how thinking can generate a predictive or systematic way of behaving, predominantly according to the

arguments of Baron (2008). Thinking is a method of finding and selecting among potential possibilities when there is doubt about how to act, believe or achieve personal goals. Thus, decisions are made to accomplish goals that are based on beliefs about what actions will achieve these goals. Since a good decision is one leading us to desired goals or actions, it can be seen as a desirable trait; much of the research on thinking and decision making in the social sciences is concerned with comparing the decisions people make to what would have been a 'good' decision. As an illustration, why do supply chain personnel consistently inflate demand from source to supplier when they know the detriments of overstocking? The ideal decision here would be to convey the correct demand, which includes the prescribed buffers from statistical models.

This ideal or good decision is customarily expressed as a normative model—in other words, a standard that defines the best thinking to attain a goal. For inventory problems, such as the bullwhip effect, the theory of inventory management (demand control or theory of swift even flow) is helpful. Use of this theory could prove that inflating the demand will lead to overstocking, which results in the tying up of capital in inventory. However, using normative models of thinking can be cumbersome at times—for example, when having to evaluate the entire theory of inventory management for each purchase order. Rather, we could use the anecdote that inflating demand leads to inflated holding costs/excess stock. Regarding the previous example, if employees consider the rule of thumb that overstocking leads to increased inventory costs, then the overall goal of inventory management could be satisfied. These rules of thumb are known as heuristics and are regarded as provisional reasoning that employs shortcuts in information processing to reduce cognitive effort in decision making (Kahneman et al., 1982; Goldstein & Gigerenzer, 2002).

Heuristics are standards that are often relied on to simplify the selection and processing of information, in situations of risk and uncertainty (Tversky & Kahneman, 1974). Gino and Pisano (2008) define heuristics as the convenient 'rules of thumb' that individuals use to solve complex problems. However, heuristic principles are not necessarily bad (Gigerenzer, 1991; Katsikopoulos & Gigerenzer, 2013). Thus, using the heuristic that overstocking leads to higher inventory costs will only be poor decision making if we fail to update this heuristic to account for information that

improves the accuracy. For instance, overstocking during a natural disaster may be necessary to fulfil demand in the short-term. In a revenue management problem, Bearden et al. (2008) found that decision makers who used sophisticated policies did no better than those who used simple heuristics to make policy decisions.

Biases are the prejudices or imbalances in a person's mental inclination (Tversky & Kahneman, 1974). A bias is usually defined by a scenario in which, when individuals are given evidence of the type A, they will constantly make decision B rather than decision C, which is expected based on some normative model. Since one's biases are very consistent, rules that describe such biases have large predictive power (Baron, 2008). One obvious source of biases is biological limitations associated with a physiological impairment or the brain's inadequacy to process all information. The mind's information processing capacity is biologically limited. In other words, we possess neither infinite nor photographic memory. The result is 'bounded rationality' (Simon, 1955; 1956). Hilbert (2012), also demonstrated that noisy information processes could generate several biases. This distortion arises from the mind's imperfection. Since it can neither absorb nor compute all information, a certain degree of distortion may take place (Hilbert, 2012). Some examples of biases and heuristics are presented in Table 2.1.

Table 2.1 Operating Errors caused by Systematic Worker Behaviour

Biases/ Heuristics	**Description**	**Systematic Errors in OM**
Information Avoidance	The tendency to avoid information that may cause mental discomfort or dissonance.	Refusal to change failing suppliers because the company has worked with them for years.
		Using well known IT tools, even when better options exist.
Confirmation Bias	The tendency to seek information that is consistent with their own views or hypothesis	Managers might forecast excessive sales based on market information that is consistent with their own perspectives.
		Management may judge the quality of their service based only on the feedback received from satisfied customers.
Salient Information	The tendency to weigh more vivid information (based on prior experience/incidents) than abstract information like statistical base rates.	The positive or negative experience of a product manager may weight more heavily in developing a new product than the success statistics for that product category.
Anchoring or Adjustment Heuristics	The tendency to rely heavily or "anchor" on one trait or piece of information when making decisions.	Anchoring might cause managers to rely heavily on last year's sales in forecasting rather than adjusting based on all available information.
Sunk Cost Fallacy	The tendency to pay attention to costs already incurred and cannot be recovered when making current decisions.	Companies may keep outsourcing even when the desired results are not being met because of past transaction costs.
		Managers may keep investing in a product even though they are failing because of initial capital outlays.
Planning Fallacy	The tendency to underestimate task-completion times	Managers tend to focus on the project and underestimate the time for meetings and other tasks. Thus, all areas of Operation are affected by optimistic completion times.
Conservativism	The failure to update their opinions or beliefs when they receive new information.	This may result in inaccurate forecasts and products to be developed that are no longer required by the market.
Overconfidence	The tendency to be more confident in one's own behaviours, opinions, attributes, and physical characteristics than they ought to be.	Overconfidence may result in the project manager engaging the company's resources in too many projects simultaneously.
Illusion of Control	The tendency to believe that one can control or influence outcomes that are external to their authority.	Managers may believe that they have control over a supplier's decision or other parties in the supply chain.
Hindsight bias	The tendency to think of events that happened in the past as more predictable than they, in fact, were before they took place.	Managers may not reflect on the real cause of certain outcomes that are seen in retrospect as not surprising and completely predictable. In product development, managers may overlook the reason for failures and repeat the same errors.

Note: This is an adaption of Gino and Pisano (2008, p. 683) Table 1 "Impact of Heuristics and Biases on Operating Systems and Processes."

Biases and heuristics have been responsible for systematic errors in all areas of the operations, including the supply chain, inventory management, projects and revenue management (Gino & Pisano, 2008). For example, project managers are susceptible to the anchoring and adjustment heuristic and related costs. The anchoring and adjustment heuristic is the tendency to rely on one aspect of the information presented to make a decision. It has been found that project managers tend to depend heavily on

past experiences rather than analysing all available information in developing projects and products (Aranda & Easterbrook, 2005). The consideration of sunk costs is also demonstrated in the linear relationship between the allocation of additional resources for failing projects and the proportion of the budget already used. Although excessive sums have been spent, managers continue to invest in the hope of better results rather than ceasing investments to save funds (Garland, 1990; Whyte, 1991).

The complexity of the operations environment means that oftentimes multiple biases and heuristics may be responsible for a systematic error, such as the case of the newsvendor and bullwhip effects. The newsvendor experiment was first explored by Schweitzer and Cachon (2000) and represents the biased inventory orders of a newsvendor facing random demand. Copies of the newspaper that are unsold are worth nothing but ordering insufficient inventory results in a loss for the newsvendor. Researchers are preoccupied with the resulting pull-to-centre effect observed when the model is used (Castañeda & Gonçalves, 2015). For example, when an item has low profit margins and should be ordered in small quantities, people tend to order more than the optimum quantity, whereas when an item should be ordered in large quantities due to large profit margins from low cost, people tend to order less than the optimum quantity. As a consequence, workers demonstrate an ordering bias where they order a suboptimal quantity between the normative solution and average demand (Bostian et al., 2008).

The newsvendor problem has been explained in different ways. This includes overconfidence in the worker (Ren et al., 2017), random error (Su, 2008) and the effort to reduce inventory errors (Schweitzer & Cachon, 2000). Although there has been no consensus on the cause of the problem, numerous replications of the results and the financial impact of the bias have led to some successful efforts of debiasing. These debiasing efforts include changing the experience and feedback of the workers, so they have more information to make decisions (Bolton & Katok, 2008); there have also been reports of no improvements in behaviour using these debiasing measures (Bolton et al., 2012).

Another popular behaviour that affects operating performance is the ‘bullwhip effect’ in supply chains. This refers to the tendency for demand to be overestimated as the

information moves upstream from the customer to the supplier. The bullwhip effect is often studied in an experimental setting using the Beer Distribution Game which models different stakeholders in the supply chain. According to the research, the bullwhip effect emerges from flawed mental models with incomplete information (Sterman, 1989). Like the newsvendor model, improving feedback to workers has been used to correct this bias (Croson & Donohue, 2006).

The newsvendor problem and the bullwhip effect are referenced frequently in the behavioural operations literature because of the complexity of the observed behaviour. The operations environment is a combination of actions that often need to be explained by different simultaneously occurring cognitive processes. These observed biases in behaviour are sometimes a combination of other biases (Eckerd & Bendoly, 2015). Therefore, researchers try to untangle the phenomena by exploring alternate explanations.

It can be argued that confining discussions to the exhaustive list of biases and heuristics by Baron (2008) or Gino and Pisano (2008) can limit explorations of other psychological processes that may influence systematic behaviour in the operations. This intrinsic view of biases as individual prejudices caused by cognitive limitations should not be seen as the only cause of systematic behaviours in the operations. These behaviours can also be created by interpersonal influences such as social preferences (Loch & Wu, 2005), moral motivations (Loewenstein et al., 2001; Pfister & Bhöm, 2008) and national culture (Loch & Wu, 2005; Eckerd et al., 2016). The following section focuses on these contextual influences on behaviour.

National Culture and social preferences

People develop some social utility from interacting with others (Loch & Wu, 2005). Social preferences have a structure that help people to navigate the complexity of social interaction based on emotional cues. Through social interaction, people value status, fairness, respect, relationships and identify with a group. An emotional response to these concepts demonstrates an individual's social preferences. Emotions are "complicated collections of chemical and neural responses" (Damasio, 2000, p. 51) that form patterns of behaviour that create advantageous circumstances to the

organism. Nesse and Berridge (1997, p. 64) add that “Emotions are coordinated states, shaped by natural selection, that adjust physiological and behavioural responses to take advantage of opportunities and to cope with threats that have recurred over the course of evolution.”

Social preferences resulting from emotions can impact motivation and performance without financial incentives (Loch & Wu, 2005). For example, offering status without financial compensation can motivate workers. Therefore, the interpersonal validation of status can improve productivity when criteria are linked to motivating behaviour (Frank, 1984). Further, a plant manager who knows workers by name and treats them with respect can be rewarded with loyalty. Experiments in a supply chain show that where relationships are formed player behaviour is less aggressive in dyadic relationships and players are willing to forgo profits for status. Social preferences can, therefore, influence rational behaviour (Loch & Wu, 2008).

Another source of worker behaviour is national culture. “Bringing people issues into OM requires including not just human psychology, but also human culture” (Loch & Wu, 2005, p. 11). Culture can create collective behaviours in the population that are carried with the worker into the operations. Therefore, culture is represented as information that is embedded in the minds and words of workers, and the artefacts of their environment, which is translated into behaviours through biology and psychology processes. The impact of culture on worker behaviour is discussed in more depth in section 2 of this review as it is the source of interest for this study.

Having identified three sources of behaviour, it is important to highlight that they are not mutually exclusive. For example, culture can affect social preferences. Ways of dealing with group relationships, status and fairness may resemble similar cultural values (Fiske et al., 1982). Culture may also cause cognitive limitations, for instances, by making certain information more salient (Loch & Wu, 2005). An attempt to understand the interplay of external and internal behavioural sources was undertaken by Eckerd and Bendoly (2011) by detailing some of the psychological building blocks of (i.e. perception and mental models) which guide behaviour. These concepts, which were discussed in the introductory chapter, constitute the starting point of the

behavioural investigation of this thesis. Importantly, an understanding of behaviour allows us to uncover other systematic behaviours in the operations literature.

Eckerd and Bendoly (2015)'s interest in moving beyond the 'popular' behavioural operations literature comes partially from Eckerd's experience in investigating perception and culture. Her research delves into psychological breaches of social contracts between buyers and suppliers in the supply chain and demonstrates how these breaches negatively affect task behaviours (Hill et al., 2009; Eckerd & Bendoly, 2011; Eckerd & Hill, 2012; Eckerd et al., 2013; Eckerd et al., 2016; Lee et al., 2018). By extension, given the international nature of supply chains, these studies have pointed to the behavioural differences between workers from different cultural groups.

An evident shortfall in the review of systematic behaviours the operations management is the lack of research on production. The early review work of Gino and Pisano (2008) was extensive. While the impact of worker behaviour on production management and workflows were assessed in Bendoly et al. (2006), the sparsity of research in this area was highlighted. Furthermore, the role of employees has expanded simultaneously with an increased push for efficiency and consistent customer experience (Parker et al., 1997; Parker et al., 2001). As a result, it has become even more critical to operations to determine how tasks are configured. Therefore, the next section reviews the design of production systems with the aim of linking behaviour to the configuration of tasks. This is important as the task configuration acts as the stimuli for production behaviour.

2.2 The Task Configuration as Behavioural Levers

A task is a "set of prescribed activities a person normally performs during a typical work period" (Griffin, 1987, p. 22), and its configuration is simply the organisation of the task content, including scope, material tools and workstation. How production tasks are configured can influence performance outcomes, such as productivity, motivation, satisfaction or turnover (see Hackman & Oldham, 1976; Parker et al., 2001; Torraco, 2005; Morgeson & Humphrey, 2006; Humphrey et al., 2007; Grant et al., 2011) because they are easier to influence and control than other contextual variables such as culture, relationships and worker behaviour in general (Hackman &

Oldham, 1980). As such, tasks can be levers for behavioural change within an operation (Griffin, 1987; Cappelli, 2000). Effective configurations of tasks as a part of the wider transformation process can provide a competitive advantage (Pfeffer, 1994; Pisano & Wheelwright, 1995; Teece et al., 1997; Hayes et al., 2005; Kolus et al., 2018) by improving time to market (Pawar et al., 1994; Wheelwright, 1994; Burchill & Fine, 1997), production costs, yields, throughput time and reduced work in progress (Susman, 1992; Terwiesch & Bohn, 2001; Lager, 2002). It can also lead to smoother production ramp-up (Terwiesch & Bohn, 2001).

Operations studies have shown the impact of task changes on worker behaviour including personality (Juran & Schruben, 2004), stress (Aiello & Kolb, 1995), and bias (Bansal & Moritz, 2015). Task changes include the level of task interdependence, goal-setting and feedback (Bendoly, 2006). Buffer build-up can motivate workers to improve performance by signalling goals or feedback (Hirst, 1988; Linderman et al., 2003; Bendoly & Hur, 2007). Buffer visibility can also reduce social loafing and improve productivity by acting as performance feedback in interdependent teams (Schultz et al., 2003). Later work by Schultz et al. (2010) demonstrated that worker performance could be influenced by the speed of co-workers. Longer task completion times increased the probability of task non-completion and also resulted in increased errors (Lin et al., 2001), whereas improvements in considering the needs of the workers in the operations process improved workers ability to produce products conforming to specified requirements (Edwards & Lees, 1971). Approximately 50% of quality problems in manufacturing can be solved through process design (Turner, 1993).

Studies comparing worker behaviour across different production task configurations have also emerged. Worker heterogeneity and within worker variability was not constant across configurations (Doerr et al., 2004), and satisfaction was highest when goal type and production systems matched (Doerr et al., 1996). A similar task comparison by Bailey (1989) showed that workers were more likely to forget procedural tasks akin to highly specialised processes rather than flexible assembly tasks. Since design decisions relating to worker behaviour do affect production outcomes (Neumann et al., 2006), the inclusion of worker behaviour in process design

can improve operations performance. In this regard, human workers are invaluable, as they must interpret the design and execute it.

The influence of performance objectives on task configuration

How tasks are configured are guided by the performance objective of the individual production systems and the production system philosophies being employed; both effects also have implications for each other. We will look at each in turn. Performance objectives contextualise what value the operation wants to give the customer. Two major objectives made apparent by global competition and the power of demand are boosting efficiency and increasing flexibility throughout the production process. Operational efficiency is associated with cost and time reductions as a ratio of the operational inputs (Yeung, 2008). An appropriate measure of improvements in efficiency in relations to manual assemblies is labour productivity (Mukherjee et al., 2000). Labour productivity measures the efficiency with which members of a production line execute their tasks and is often measured as units produced per direct labour time utilised (Mukherjee et al., 2000).

However, satisfying the expectations of the consumer in a competitive and global operations environment requires both measures of efficiency and flexibility to cope with uncertainties (Germain et al., 2001). Flexibility allows the operations to meet the uncertainty in customer demand (Kathuria & Partovi, 1999; Koste & Malhotra, 1999; D'souza & Williams, 2000). Different types of flexibility can be grouped based on the section of the operations process being referenced, such as resource flexibility (i.e. machine and labour), process flexibility (i.e. material flow and routing) and output flexibility (i.e. volume and mix). Flexibility in operations resources and processes can be classified as internal competencies that facilitate the capabilities of output flexibility (Slack, 1983, 1987; Teece et al., 1997; Kathuria & Partovi, 1999; D'souza & Williams, 2000; Zhang et al., 2003; Kortmann et al., 2014). Striking the right balance of flexibility and productivity is vital to sustaining competitive advantage (Zhang et al., 2003). At the same time, achieving flexibility is often linked with relinquishing some of the restrictive mechanisms used to increase productivity.

How much flexibility in labour contributes to mix and volume flexibility is determined by the task configuration. For instance, a task configuration with less specialisation and interdependence can achieve mix flexibility by creating slack in the production system, allowing workers to make choices between routes and material. This added discretion enables workers to produce different combinations of products (see Slack, 1983, 1987; Ramasesh & Jayakumar, 1991; Upton, 1994; Koste & Malhotra, 1999). Nevertheless, there is still a need for efficiency mechanisms, such as specialisation in manual assemblies, to control unwanted behavioural effects (Powell & Johnson, 1980). Hence, understanding the cognitive limitations to human performance (see Bendoly et al., 2006; Croson et al., 2013; Lee Park & Paiva, 2018; Li et al., 2018) and how these limitations may be mitigated by task configuration is an important contribution to operations strategy.

A by-product of specialisation is interdependence. The extent to which employees rely on team members to complete a task is referred to as task interdependence (Van der Vegt & Janssen, 2003). In a specialised manual assembly where work flows between workers, upstream workers may depend on downstream workers to supply work in progress (see Doerr et al., 2004). Improving the productivity of workers by adjusting the degree of worker interdependence without increasing specialisation has been achieved by using lean tools in mass production, one of which is the Kanban system. Since this lean tool paces the production process, it gives workers time to supervise the quality of their tasks while reducing unnecessary repetition in creating excessive buffer inventory. Another consideration in designing tasks is the actual characteristics of the production system or their ‘philosophies’.

The impact of production system transitions on task configuration

The growth in consumer demand fuelled by the increasing wealth and accessibility to new markets has forced production systems to evolve and become leaner and more responsive. Prior to the second industrial revolution, craft production was prevalent using highly skilled workers who were flexible to satisfy the specifications of the customer. The broad skill set of the craft workers enabled them to manufacture complete products (Womack et al., 1990), which made cell manufacturing possible. The flow of materials through the operations processes was at the discretion of the

worker, with tools being very simple and multipurpose, which facilitated high levels of customisation in production. Craft production was too costly as markets and competition expanded. Hence, mass production was introduced in the early nineteenth century.

The mass production system is often associated with the idea of large-scale demand, standardisation of processes and products, and interchangeable parts. The premise behind this theory was that employees would develop efficient techniques for completing tasks, while time wasted switching between tasks would be decreased (Morgeson & Campion, 2003). The tasks within this system reflected these characteristics by allowing for tight supervision, controlled communication to avoid confusion and maintain chain of command, specialised equipment to avoid downtime, the use of inventory to buffer the flow of production between stages—and strict task sequence. These tasks are often accompanied by detailed instructions as to how workers must complete the task (Womack et al., 1990). The popular line layout favours volume over variety and is associated with achieving higher levels of productivity. One of the problems with short and repetitive task content is that it commonly ends up being tedious, which leads to fatigue (Vinchur & Koppes, 2011). Consequently, researchers became concerned that attempts to achieve productivity were being pursued at the expense of employee wellbeing, satisfaction and motivation (e.g. Walker & Guest, 1952; Herzberg et al., 1959; Hackman & Oldham, 1976).

Lean production combines the advantages of Craft and Mass: avoiding waste while maintaining some degree of flexibility. The aim of this production system was to use less to achieve more (Womack et al., 1990). The Japanese version of this system, promulgated by Toyota under the guise of the Toyota Production System (TPS), is a mass production system that focuses on reliability, flexibility and speed, rather than low cost and volume (Hayes et al., 2005). Although there is division of labour, workers are more broadly trained, and equipment has a more general purpose to facilitate flexibility. Furthermore, there is more interdependence among workers to add some synchronicity, suggesting an increased dependence on team members (Ohno, 1988; Slack et al., 2016). Key characteristics of Lean include the pull control system, where production is triggered by demand (Shah & Ward, 2007). Not only does this system utilise teams, but it also benefits from team synchronisation by balancing the speed

within the system, which is facilitated by elements such as a Kanban system (Ohno, 1988). The central features of Lean have also sparked numerous debates as to whether these features can be transferred to a non-Japanese context (Holweg, 2007).

The early research on Lean attempted to reconcile the early delays that the United States had with transferring this production system. Early explanations of the success of Lean in Japan included lower wages, government incentives for automobile makers and the onset of robotics in the factory. There was truth in these speculations by the West (Womack et al., 1990). However, an important story is how the Japanese had to adapt their production system to the economic and social context that they faced in their operations (Ohno, 1988). Likewise, feeling that one had made a difference, no matter how small, was important to society. Albeit somewhat confusing to Western culture, the average Japanese workers shared a common cultural value of self-sacrifice for the wellbeing of the community (Liker et al., 1999). As such, the Lean production system needed to give more responsibility to workers to facilitate task ownership (Ohno, 1988). Moreover, satisfaction was derived from seeing the production processes from beginning to end, making multitasking important. Given the cohesive nature of Asian societies (Nisbett et al., 2001), working as part of a team, which is encouraged by Lean, was merely a transferral of an established societal norm.

These elements of Lean, which were accepted as successful management practices (Holweg, 2007), were the outcome of the Japanese operating context. This context included the cultural norms and values already inherent in individuals who had been raised in Japan. Culture diffuses into practices of work organisation, making it more difficult to reconcile systems of work across cultures than within (Kogut, 1991; Pil & MacDuffie, 1999). This relationship between culture and the operation can lead to operations in some countries performing better than operations in other countries because sub-optimal management practices have been locked into the culture and the resulting management practices (Pil & MacDuffie, 1999). Therefore, transferring operations across borders has been successful with an assessment of how the production system matches the new operating context. This recontextualization of the production system starts with understanding how the technology, organisational practices and work practices being transferred fit the local environment and requires a transformation of the meanings within the production system to suit the cultural

environment of the transplant (Brannen et al., 1999). For example, although transferring lean style systems from Japan to the United States achieved success, these transplants may have been less successful than their Japanese counterpart (see Brannen et al., 1999), because of the cultural alignment to individual goal setting in Western countries.

Recontextualization has been facilitated by joint ventures between home and host transplant countries, which were meant to understand the management practices of both cultures. This was the case of the automotive plant transfer from Japan to the US, NUMMI (New United Motor Manufacturing Inc.), which was a joint venture agreement between Toyota and GM (Holweg, 2007). Likewise, Brannen et al. (1999) used the case of the bearing manufacturing company NSK Ltd. to detail a successful case of recontextualization. In this instance, recontextualization reconciled the differences in operations context caused by internationalisation. This suggests that "Every cultural environment is embedded with its own system of organizational signification involving distinct work-related assumptions, behaviours, and practices. Given this reality, misalignment easily occurs between what is sent from abroad and how it is perceived locally" (Brannen et al., 1999, p. 118). As in the case of Lean, differences in cooperating language, process design and task configuration, including the level of team interdependence, form part of the planning for international expansion. Thus, research involving the cost and time of contextualisation can have a valuable impact on the transfer of production systems across cultural borders.

This idea of cultural misalignment and the need for a transition period for production systems is not only confined to Lean production systems. For example, similar concerns arose when the US automobile industry transferred its mass production system to the predominantly craft-based auto manufacturing system in Europe (Womack et al., 1990). This reconciliation of the impact of national culture on production systems and shop floor workers falls within the purview of behavioural operations.

2.3 Summary

The operations literature has yet to investigate the relationship between task configuration and behaviour in the productivity/flexibility debate. Although a few studies have examined the impact of task configuration on worker behaviour (Morgeson & Campion, 2002), there has been a paucity of comparative research on tasks designed to promote productivity and those designed to promote flexibility. This is partially because most systems are designed with an element of both flexibility and efficiency. Consequently, performance metrics tend to reflect efficiency measures given a particular level of flexibility.

One could argue further that in the case of manual production, the capacity for labour flexibility increases the susceptibility of the operations to the cognitive side effects of the worker. While labour flexibility can help to smooth process failure and demand, task configurations that overlook the behavioural effects of workers may overvalue the benefits of flexibility (Schultz et al., 2003). This behavioural effect may be intensified with increases in worker autonomy, as more process and output flexibility are required. If workers have even "one iota of discretion", then impactful research models must include worker behaviours and behavioural antecedents (Powell & Johnson, 1980, p. 48). Therefore, discussing the impact of the relationship between task configuration and worker behaviour on operations performance is important. Further, the former relationship is accessed between national cultures to further inform the global expansion of operations. The performance objectives and production systems must be translated into tasks that are actionable by the available workers (Jacobsen et al., 2001; Morgeson & Campion, 2002). Therefore as culture affects worker performance (Pagell et al., 2005), then tasks must be culturally relevant to accommodate the foreign labour force. The analysis of production systems “critically benefits from a systematic understanding of how people in those settings think about the work context in which they operate” (Eckerd and Bendoly, 2015, p. 7). Therefore, national culture is assessed in the subsequent section with the intent of identifying how culture affects the operations through the worker.

Chapter 3 Literature Review: The Effect of National Culture on Worker Behaviour and Operations Performance

An American operations manager visits a Malaysian factory. During production, over 100 workers begin yelling and banging on their machines, resulting in the loss of 8,000 hours of production time. The reason: There is a common belief among Malaysians that spirits inhabit factories (and the world). This is an account that spans multiple factories in Malaysia, but to an American, it may seem absurd (Ong, 1987). Other failures highlighted by a JOM special issue on the impact of culture on the operations, include failures to expand manufacturing networks into India by Delta Air Lines and Home Depot. The different experiences of travel and home improvement between cultures resulted in operations failures (Metters et al., 2010). These scenarios evidence the potential impact that national culture has on operations performance. The purpose of this chapter is to establish how national culture affects cognitive and social behaviours of workers. Following this discussion, the hypotheses and conceptual framework that guide this investigation are developed.

As depicted in Figure 2.1, a definition of national culture is established (§3.1). This is followed by an examination of the relationship between the cognitive process of perception and national culture and the effect of perception on performance (§3.2). National culture does not just affect cognitive behaviour but also guides social preferences or interactions between co-workers. Therefore, how national culture affects the social characteristics of work is examined, followed by a discussion on how social characteristics can affect worker performance (§3.3). Finally, this chapter ends with the presentation of the conceptual framework for this research and the development of the hypotheses (§3.4).

3.1 National Culture – Definitions, Dimensions

An anthropological view of culture is “as information – skills, attitudes, beliefs, values – capable of affecting individuals’ behaviour, which they acquire from others by teaching, imitation, and other forms of social learning” (Boyd & Richerson, 2005, p.

105). This view of culture explicitly highlights the link between cultural information and behaviour. However, this view does not contradict sociological views such as Shein (1992) and Hofstede (2001). This information is transmitted by a “set of stories, frames, categories, rituals, and practices that actors draw upon to make meaning or take action” (Giorgi et al., 2015, p. 6). A cognitive perception of culture has also emerged, emanating from cognitive anthropology (Goodenough, 1971; Smircich, 1983). Culture from this perspective is interpreted as a system of shared beliefs and knowledge (Rossi & O'Higgins, 1980) that creates a “unique system for perceiving and organizing material phenomena, things, events, behaviour and emotions” (Goodenbough, quoted in Rossi & O'Higgins, 1980, p. 63). However, these definitions are not mutually exclusive and skewed, depending on the objective of the research (Giorgi et al., 2015). For example, a cognitive investigation of culture by Lee et al. (2018) used the cultural justifications of Hofstede as its basis for cultural distinction. Therefore, culture affects all aspects of human life, cognitive and social.

While much of the cultural research in operations maintain a comparative view from studies such as Hofstede (1980) and GLOBE (House et al., 2004), efforts have been made to move beyond comparing output differences to understanding the cultural dimensions and known behaviours of workers from different countries. Studies such as (Hofstede, 1980, 1983) are important because they provided a way for researchers to identify culture in employees and provided measures of culture.

The most popular dimension found in both studies on culture is the individualism versus collectivism dimension. This dimension speaks to the affinity of some cultures to exhibit personal agency while others adhere to collective agency or duty to society rather than to oneself (Stedham & Yamamura, 2004). Western cultures, such as the UK tend to have greater levels of individualism and reward self-reliance and individual merit. Countries with high levels of collectivism – Eastern countries such as China –reward more cooperative relationships focused on achieving group goals. Cultural differences in individualism have influenced a range of organisational behaviours, such as the propensity to cooperate (Parks & Vu, 1994), engage in organisational citizenship behaviours (Moorman & Blakely, 1995) and the establishment of trust between organisational stakeholders (Lee et al., 2018).

There is still relevance for cultural investigation in operations management. As operations expand globally, there continues to be an investigation of national culture in OM. Much of this research has examined differences between countries and regions in the area of product development (M. Song & Parry, 1997), planning and control (Sheu & Wacker, 2001) and quality performance (Ettlie, 1997; Vecchi & Brennan, 2011). Additionally, many studies have assessed cultural differences in supply chain performance (Pagell & Chwen, 2001; Dyer & Chu, 2011; Eckerd et al., 2016; Lee et al., 2018) and manufacturing performance (Wiengarten et al., 2011).

Although culture has been given research priority when operations are being located to non-traditional western countries (e.g. Asia), culture has not been given the same attention as economic and environmental factors when establishing new operations (Metters et al., 2010). “With globalisation, the impact of cultural adaptation will need to be central to our study of operational topic[s]” (McLaughlin & Fitzsimmons, 1996, p. 56). This dearth of research stemmed from the complexity involved in measuring social issues and linking these factors to cost minimisation strategies. Consequently, a need grew for further studies on social factors to complement the literature (Schmenner, 1979; L. Chen, Olhager, et al., 2014). Szakonyi (1998) warns that manufacturing is often so overwhelmed with keeping operations going that it tends to sacrifice long-term performance. As such, understanding contextual issues may be sacrificed for more obvious financial gains.

Studies of culture in operations using experiments have emerged as a way of increasing control and understanding the cognitive processes through which culture enters the operations (Eckerd et al., 2013; Eckerd et al., 2016; Lee et al., 2018). Realising the processes through which culture affects the operation has been achieved in part by using experiments to control for extraneous factors that may be hidden by macro studies (Eckerd et al., 2016). This understanding leads us to a cognitive view of culture.

3.2 The Influence of National Culture on Cognitive Behaviour

Given the encompassing nature of culture, it is an intrinsic part of all employees and serves to define how employees interact with the artefacts of the operations. Early views of culture as a consistent and unitary construct acquired during socialisation made it difficult to measure and use the construct in the management literature (Giorgi et al., 2015). The aim of this study is not to examine the lived culture of the operating agent. Instead, what people do with culture is of immediate concern. Thus, we turn to the concept of cultural schemata and examine the work of researchers who try and reconcile culture with cognition.

Culture is experienced in bits of information or as schemata that organise that information (DiMaggio, 1997). Thus, since DiMaggio suggests that culture should be viewed as small bits of information or schemata of culture, the concern becomes what information, situations or artefacts may 'cue' a culturally related behaviour. Therefore, D'Andrade (1995) notes that when cognition is implicit, rapid and automatic, there is a heavy dependency on culturally available schemata: knowledge structures that represent objects or events related to a particular culture and provide default assumptions about their characteristics, relationships, and consequences under conditions of incomplete information. These schemata may facilitate efficiency at the expense of accuracy (Kahneman et al., 1982). Looking specifically at the link between 'cultural schemata' and cognition, one can find various implications.

Workers are alerted to the use of cultural schemata by how the social situation is framed (Goffman, 1974). Apart from guiding an employee's perception, cultural schemata have two main implications. First, employees from different cultures internalise different schemata. As a result, they may differ widely in their reactions to similar objects or events (Masuda & Nisbett, 2001; Kitayama et al., 2003; Nisbett & Miyamoto, 2005). Second, in situations where the task engineer and worker do not share the same culture, anticipated perception and actual perception may differ. Mental representations are created and reinforced with constant exposure to culture in the form of language and beliefs (Meshkati, 1991).

We can begin to see the implications of schemata theory on the operations. The manufacturing process can be viewed as a stream of information dedicated to achieving a operations goal. Often the number of parts contained in a subassembly and the order in which they are assembled are predetermined for the worker. However, how workers perceive the relationship between subassemblies or processes may not match the cultural information contained in workers' schemata, because of intricate differences in schemata between the designer and the worker. To illustrate, a worker might falsely recall having input a part in an assembly because she repeated this task thousands of times. Importantly, workers may have different schemata for an identical task because their underlying knowledge differs (see Chi et al., 1981). For these reasons, improving the performance of workers requires the consideration of the social forces that create and reinforce schemata. Schemata is important to perception and action because it qualifies present working context. Therefore we focus on perception as it "shapes the individuals' evolving contextual understanding and leads to biases and heuristics…" (Eckerd & Bendoly, 2015, p. 8), by linking other elements in Zacks and Sargent (2010) perceptual model to cultural schemata.

Perceiving a manufacturing task using event segmentation theory

Figure 3.1 is the conceptual model that guides this discussion. This model uses inferences from Eckerd and Bendoly (2015) schematic framework of behavioural operations and Zacks and Sargent (2010) event segmentation model on perception. The framework by Eckerd and Bendoly (2015) demonstrates that operational design features are the levers for managers to manipulate operating systems. However, these levers are only effective if managers understand their behavioural side-effects. The model emphasises that workers' perception of the task content and the biases and heuristics that they trigger is the determinants for action and performance. The model of perception by Zacks and Sargent (2010) complements the prior operations framework by presenting a detailed conceptualisation of perception, which links behaviour to long-term memory schemata such as national culture. Therefore, this section commences with a definition of culture and linking culture long-term memory. This argument is further developed to show how culture affects performance by influencing perception.

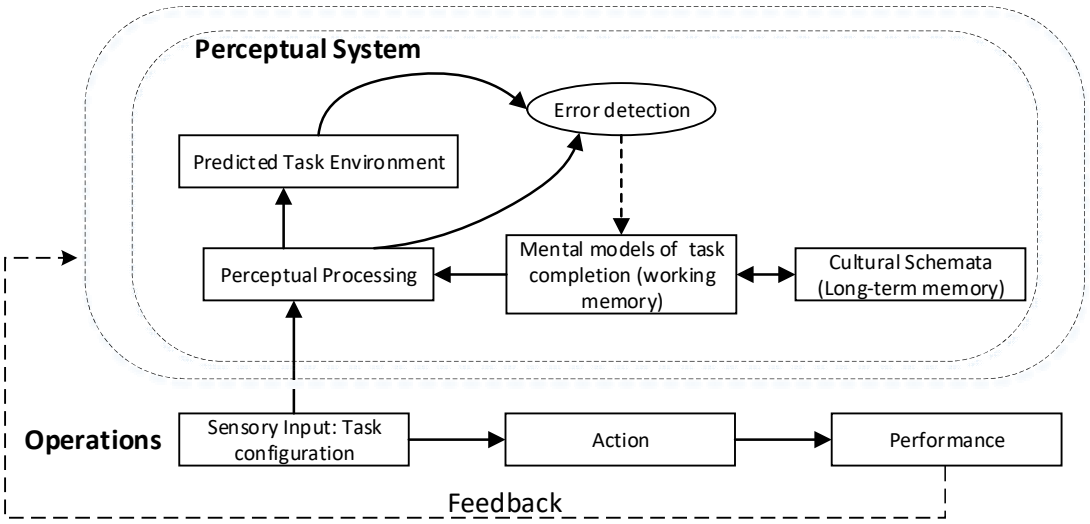


Figure 3.1 Cultural Perception of the Manufacturing Task Environment

Perception is the process of humans receiving information through their sensory organs. From Figure 3.1, the information being received for the workers is the task configuration (Eckerd & Bendoly, 2015). However, this process of perception is not passive (Heider, 1958). As people repeatedly experienced stimuli through sense receptors, they begin to adapt. For instance, after standing in a room with a foul odour for an extended period, the smell may seem more tolerable. Hence, as information passes through the receptors, it is interpreted and organised based on past experiences. This processes of perception is explained using the quasi-ontology of chunking, which is a widely accepted explanation of how parts relate to the whole – elements or objects with stronger interrelationships concatenate into chunks, and elements with fewer relationships are segmented into different chunks (Gobet et al., 2001; Godøy, 2008; S. Song & Cohen, 2014; Fonollosa et al., 2015; Gilchrist, 2015; Gobet, 2016; Gobet et al., 2016; McGatlin Kristen et al., 2018). Specifically, event segmentation theory, which is a cognitive interpretation of how people 'chunk' visual events for memory and recall, is applied (see Heider, 1958; Newtson, 1973, 1976; Zacks, Braver, et al., 2001; Zacks, Tversky, et al., 2001; Speer et al., 2003; Zacks et al., 2006; Zacks et al., 2007; Zacks & Swallow, 2007; C. A. Kurby & Zacks, 2008; Zacks et al., 2009; C. Kurby & Zacks, 2011; Mura et al., 2013; Sargent et al., 2013; Gold et al., 2016; Richmond et al., 2017).

This theory was chosen for application to the perception of manufacturing task because of clarity in linking the task to schemata and empirical finding from the application to operations theory (Hard, 2006; Mura et al., 2013; Kolbeinsson et al., 2017) and the finding on segmentation differences between national cultures (Chua et al., 2005; Nisbett & Miyamoto, 2005; Miyamoto et al., 2006; Wang, 2009).

An event is “a segment of time at a given location that is conceived by an observer to have a beginning and an end” (Zacks & Tversky, 2001, p. 17). In perceiving an event, individuals tend to parse this information into smaller chunks or segments as a way of facilitating memory and learning (Zacks & Sargent, 2010). In recalling yesterday’s activities, one might organise them into separate chunks, such as entering a classroom, removing your laptop, placed a question on the board and asked students to start a group activity (see Heider, 1958). Smaller activities are nested within these larger chunks of the day’s activities and are grouped by distinct themes or goals for ease of recall. If these steps were not identified as being related to the lecture, then the day’s activities may be remembered poorly (Richmond et al., 2017).

Therefore, the theoretical premise of event segmentation is that the brain parses a continuous stream of information into discrete chunks as it passes through the sense receptors (Zacks & Sargent, 2010). Most of the studies on event segmentation concentrate on sight as the primary perceptual sense. However, hearing and other senses are highlighted as supporting senses that can affect perception by directing attention to major changes in stimuli—loud sounds, for example. The strength of event segmentation theory lies in its neurocognitive approach, which shows specific responses in the brain when chunks are formed (Zacks et al., 2007; Zacks & Sargent, 2010). The primary argument of event segmentation is that prediction makes the perception of a world filled with stimuli more efficient (Enns & Lleras, 2008). For instance, when a table is viewed, although the light waves from the surface of a table may distort its colour or position, one's perception of the table, including its shape, size and colour, does not change (Heider, 1958). This finding reinforces the notion that perceptual processing facilitates the prediction of the environment when there is incomplete information. Moreover, predicting the sequence of an event reduces the cognitive load of the individual, allowing for the planning of action and attention.

To make accurate predictions, one must be able to adequately characterise the present context or surrounding environment. For example, when individuals move from home to a factory, the shift in situation guides their perception and underlying prediction of the flow of events relevant to the specific context. Their representation of what is currently happening is facilitated by event models (Zacks & Sargent, 2010). Event models are working memory representations of a situation that are consistent with the event. These event models allow us to ignore the haphazard elements of the situation, as in the case of the table previously discussed and are another term which refers to the generic mental models as posited by Eckerd and Bendoly (2015). Also, new workers on a production line may not be able to anticipate the pace of the line, but as the work progresses, their expectation of the arrival of each product on the line will improve. Finally, the workers will position their bodies correctly in anticipation of the object.

Event models do not just aid perception using the task environment but are also guided by long-term memory in the form of schemata (Zacks et al., 2007). Building on the previous discussion of schemata, event-related schemata are memory representations that capture shared features of previously encountered events and store more general information about the sequence of actions, and the movement between objects and people. These schemata also contain information about the probability of a future pattern of events and the actor's goals. These more abstract representations are guided by factors that influence goals and perception, such as beliefs and norms associated with national culture. Thus, culture helps workers frame uncertain task features and events and emphasises what the culturally acceptable beliefs and norms are, as well as the permissible forms of action given the context of the operation. Furthermore, culture directs attention by making certain features of the task more salient.

The outcome of perception is a corresponding action that satisfies the perceived task. However, expected performance can be affected by undesired behaviours which result from the effect of task configuration on the structure of perceptual chunks. Chunks are demarcated by breakpoints. The information contained between breakpoints can be referred to as intervals and contain information that is associated with some relational characteristic determined by the goals of the observer (Newtson & Engquist, 1976). If breakpoints are the points at which chunks are formed, then breakpoints should be

more susceptible to changes in stimuli that interrupt the relational bond between elements in the interval.

Distinctions have also been made between breakpoints caused by the change in major goals and thus stimuli (coarse breakpoints), and the breakpoints that are less disruptive (fine breakpoints) that represent smaller sub-goals or segments within the coarse breakpoint (see Zacks, Tversky, et al., 2001). Thus, breakpoints are points in perception that observers may be most cognitively aware, enabling them to process additional or notably different stimuli. This heightened cognitive processing allows stimuli at breakpoints to receive more attention (Hard et al., 2006). In addition, coarse breakpoints constitute the greatest change in stimuli and could be more disruptive to perception than fine breakpoints (Kolbeinsson et al., 2017). Therefore, assembly breakpoints between the end of symmetric assemblies and the beginning of an asymmetric assembly are coarser breakpoints, than breakpoints between two symmetric assemblies. Breakpoints between two symmetric assemblies can be considered fine breakpoints because the symmetry reduces the drastic change in stimuli. Behavioural responses to this increased cognitive process at breakpoints may cause observers to stop movement and, reorient themselves—or action can become amplified at this point (Barker & Wright, 1955; Newtson et al., 1977; Hard et al., 2006).

The relationship between chunk boundaries and movement can be linked to changes in a person’s goal, which may result in changes in assembly artefacts (Hard, 2006). When individuals complete one goal and begin to pursue another, they pause or reorient their bodies in preparation for the next goal—for example, repositioning one's body after completing a subassembly to start a new subassembly. This can include small actions, such as releasing or grasping an object, refocusing eyes or body towards the objects related to the next goal, or walking towards the new goal-related object (Baldwin & Baird, 1999). These movements or pauses are not independent of the environment or the object, as changes in the object can stimulate changes in perception. In a manufacturing setting, the change in the product may stimulate breakpoints that signal when subassemblies are complete. Furthermore, the worker may need to alter position or tools in starting the next goal or subassembly. Therefore, changing the task configuration or workflow of the operations (i.e. changing the

breakpoints in assembly flow) could change the worker's perception and performance. Using event segmentation theory, researchers demonstrated that the best time to deliver task notifications in manufacturing was at breakpoints within a task sequence as frustration and task times are reduced (Bailey & Konstan, 2006). Likewise, transmitting messages at a coarse breakpoint in the task configuration is most effective because this is when the worker is most cognitively aware (Iqbal & Bailey, 2008; Kolbeinsson et al., 2017).

Event models do not only rely on immediate contextual information but also information learned outside the operation over a lifetime, namely through culture (e.g. Wang, 2009). Thus, culture can help the worker frame uncertain task features and events (DiMaggio, 1997). It underlines what the culturally acceptable beliefs and norms are, as well as the permissible forms of action given the context of the operation. Additionally, culture directs attention by making certain features of the task more salient (Loch & Wu, 2005). Research in various other social science fields has highlighted cultural distinctions in perception (Nisbett et al., 2001; Kitayama et al., 2003; Nisbett & Miyamoto, 2005) and subsequent related differences in assembly performance (Hard, 2006; Wang, 2009). Nonetheless, these studies have yet to consider the nuances of the operations management context. Specific cultural traits, individualism and collectivism, have been proven to affect perception creating holistic of analytic ways of perceiving events (Masuda & Nisbett, 2001; Nisbett et al., 2001; Wang, 2009; Kitayama & Murata, 2013). These cultural influences on perception are explored.

Evidence of individualism and collectivism in event segmentation

The cultural trait that has found the most consensus across cultural models and has been heavily researched is individualism (i.e. vs collectivism). Work by Venaik and Brewer (2008) emphasises this dimension as the most congruent between the Hofstede and Hofstede (2005) and the GLOBE studies (House et al., 2004), suggesting the strength of this dimension, especially as it relates to Asian and Western cultures. The individualistic nature of the Western societies and the collective nature of East Asian societies find their roots in the ancient Greek and Chinese civilisations, respectively (Nisbett et al., 2001). Nisbett et al. (2001) offer an in-depth overview of the impact of

these ancient civilisations on modern cognition and behaviours and follow up with empirical work to test their assumptions (see Nisbett & Miyamoto, 2005). Hence, this study builds on these assumptions to develop hypotheses.

Differences in social structure and epistemological preferences in ancient Greek and Chinese societies created the norms and values that are apparent in modern Chinese and Western societies. The ancient Greeks' view of the social world was guided by the encouragement of personal agency power residing in the individual (Nisbett et al., 2001). The society of ancient China was more complex. The Chinese stressed social agency rather than personal agency. Individuals were meant to feel as though they belonged to a larger social group, and the expectations of the group guided the behaviour of the individual (Masuda & Nisbett, 2001; Nisbett et al., 2001). This collective view transcended to the material world, where the Chinese viewed the world as a collection of integrated matter, where elements or objects existed within a more extensive system (Hansen, 1983). The Chinese were more focused on continuity and the context within which the object is situated rather than on discreteness and isolated objects. This individualism transferred to the organisation of the Greeks' physical environment into discrete objects which could be categorised or explained by rules and models. This focus on personal agency and the object reduces the importance of viewing the relationship between discrete events and the relationship between events and their context.

These distinctions are broad categories in describing how people perceive events. Research on the impact of culture on perception indicates that Asians often perceive relationships and similarities among objects and events, whereas Westerners tend to focus on salient features of individual objects and events (Nisbett & Miyamoto, 2005; Norenzayan et al., 2007). When compared to Westerners, Asians tend to be better at detecting relationships between events (Ji et al., 2000), experience greater difficulty in separating objects from their surroundings (Kitayama et al., 2003), and pay more attention to relationships in the field (Masuda & Nisbett, 2001). These cultural differences have been validated by looking at differences in attention between these cultural groups using eye-tracking (Chua et al., 2005; Rayner et al., 2007).

Summary

The model for this analysis shown in Figure 3.1, brings together the previous discussion on culture and perception and links it to task performance. The configuration of the task acts as the sensory input for the perceptual process (Eckerd & Bendoly, 2015) and reaction to these sensory inputs create a pattern of perception. These perceptual patterns are consistently different between cultures. Asians tend to perceive fewer breakpoints in a task, as they view more relationships between assemblies and focus on the context of the product as a whole, rather than the individual breaks in assembly. In essence, Asians may segment their manufacturing task into larger chunks. In contrast, the analytical perceptual tendencies of Westerners may make it more likely to attend to salient properties of tasks, especially breaks in assembly. This may lead to the perception of a greater number of breakpoints in a manufacturing task. Therefore, the concern is whether differences in task perception affect the relationship between task configuration and performance and whether the former relationship is similar across cultures.

3.3 The Influence of National Culture on Social Behaviours

An understanding of how social preferences affect behaviour and how these preferences can be defined by national culture was established in Chapter 2. For example, people may behave in particular ways based on their perception of fairness and trust, which may be rooted in national culture (Eckerd et al., 2016). The concept of social preferences, which forms part of the behavioural operations literature (see Section 2.1.2), is akin to the social characteristics of the job design literature. However, social characteristics focus on the relational behaviours facilitated by the work environment, whereas social preferences relate to intrinsic or individual differences between workers.

This study focuses on the social behaviours of work because of the employee and output visibility in production layout and the interdependence in assembly tasks (Grant, 2007; Grant et al., 2011). It is anticipated that social behaviours arising from these characteristics are more easily reconciled with national culture than cognitive behaviour. Therefore, the analysis of the impact of national culture on worker

behaviour is discussed in this section to understand how the social characteristics of the production environment may affect worker performance.

The job design literature was inspired by research in manufacturing, such as the Hawthorne studies, on the impact of fatigue on worker motivation due to the repetitive nature of mass assembly tasks (Roethlisberger & Dickson, 1939). As production systems increased in complexity, reductionist approaches which assumed normative worker behaviour became obsolete, and there was a need to include social and psychological variables of the task environment in the prediction of performance (see Walker et al., 2010; Dekker, 2011). Many models and theories of job design have been proposed and documented in numerous reviews (Parker et al., 2001; Morgeson & Campion, 2003; Grant et al., 2011). Job design theories such as Job Characteristics Theory (Hackman & Oldham, 1975, 1976, 1980), suggests that job characteristics such as skill variety, task identity, task significance, autonomy and feedback—produce critical psychological states in the job holder, which influence an outcome (see Figure 3.2). These theories extend to work design when non-compensatory activities are included. Ultimately, these states lead to a set of positive work outcomes.

Insights from the job design literature have been used previously in OM research. Applications to the context of the operation include examining job design as a success factor during the lean adoption process (Martínez-Jurado et al., 2013). De Treville and Antonakis (2006) suggest that a configuration of lean production practices is more important for worker motivation by extending the job characteristic model to the lean production context. Also worth noting is a study by Liu, Shah and Schroeder (2006) that demonstrates that job design practices that incorporate both the technical and social dimensions have a significant impact on improving the success of mass customisation. However, the success of the job design approach, partially due to the saturation of the literature, created a shift from the context of the operation. As a consequence, the nexus of job design and production within the discipline of OM has been left under-explored. Although organisational studies may use operations as a context for job design research, the care required to exploit the specific characteristics of the operations and further relate findings to the OM literature has not been forthcoming (Eckerd & Bendoly, 2015).

More general limitations of the job design exist. Reference to the job or work characteristics, is very broad, with less explicit reference to task structures themselves. This has created some challenges for researchers using this theoretical approach, as it is difficult to separate the characteristics of work, which are external to the worker, and the individual characteristics of the employee, which might be affecting their perception of the work environment (Roberts & Glick, 1981). In addition, some aspects of the model have failed to accumulate research support, especially the relationship between job characteristics and behavioural outcomes (Loher et al., 1985; Fried & Ferris, 1987).

Researchers have sought to address some of the limitations of earlier job design theories by investigating more job characteristics, outcomes, mediators, moderators, and antecedents within job design (Parker et al., 2001; Morgeson & Humphrey, 2006). Figure 3.2 shows an adaptation of the Grant et al. (2011) integrative job design model which collates some of the prominent variables and relationships that have been researched in the job design literature. This is included to show the breadth of job design research and to aid in the specification of the conceptual model for this study.

The review of the literature presented in reflects the dramatic changes in work that have occurred over the past few decades (e.g., Johns, 2006; Holman, Clegg, & Waterson, 2002; Parker et al., 2001; Rousseau & Fried, 2001). Researchers have tried to account for these contextual changes by investigating new characteristics such as the social aspects of jobs and explore more macro-environmental variables as moderators of the effect of job characteristics on performance.

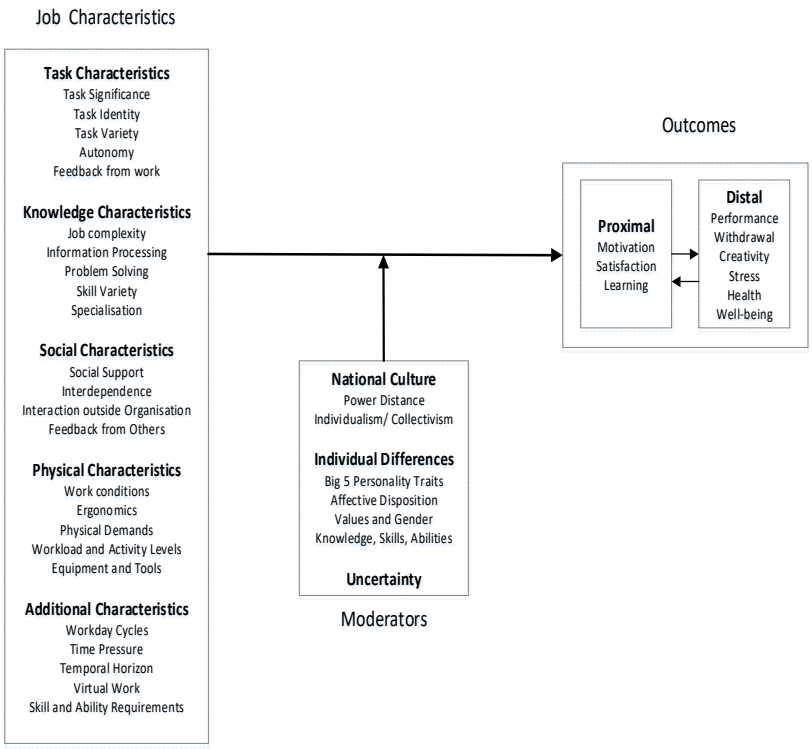


Figure 3.2 Selected Relationships Explored in the Job Design Literature. Adapted from Grant et al. (2011)

Early work design research recognized the importance of the social aspects of work (Trist & Bamforth, 1951; Turner & Lawrence, 1965). Two social characteristics (dealing with others and friendship opportunities) were identified and examined by Hackman & Lawler (1971). These social characteristics were shown to be related to satisfaction, but there were relationships with behavioural outcomes or motivation. This tempered investigations in social characteristics and received less attention in the work design literature (Morgeson & Campion, 2003). Job design pioneers such as Oldham and Hackman have noted that the omission of social characteristics from the literature, even by them, was a grave error (Oldham & Hackman, 2010).

Many of the characteristics in the work/job design literature do not apply to this study, such as task interdependence which was a condition of the experimental design. The controlled nature of the experiment led to participants experiencing the same conditions. However, in recreating the experience of the shop floor worker, this task interdependence, may have indirectly facilitated the social interaction of workers. First, highly interdependent jobs provide increased contact and more opportunities to communicate what each worker requires (Salas et al., 1999), what is expected in return

(Seers et al., 1995), and what each worker is doing (Humphrey et al., 2007). That is, this contact helps bound individual roles (Alderfer & Smith, 1982) by clarifying the roles that each individual fill (Tuckman, 1965). Further, high levels of social interaction can allow workers to benefit from co-worker advice and assistance from others (Morgeson & Humphrey, 2008).

The social element of teamwork is often not reflected in manufacturing research. Also, social interaction can be limited by controlled systems such as mass production. However, the effect of social interaction can only be known through explicit testing. Therefore, the impact of social support and feedback from co-workers on performance is explored, as these were most relevant to the experimental design. These two social characteristics form the cornerstone of this investigation into social behaviours.

Social support reflects the degree to which a job provides opportunities for advice and assistance from others (Morgeson & Humphrey, 2006). Research outside of the job design literature suggests that social support is critical for well-being (Ryan & Deci, 2001; Wrzesniewski et al., 2003), particularly for jobs that are stressful or lack many motivational work characteristics. Feedback from others reflects the degree to which others in the organization provide information about performance. Early theorising suggested that feedback could also come from co-workers (Hackman & Lawler, 1971). Hackman and Oldham (1975) focused on feedback from the job itself, which forms part of the task characteristics and not the social characteristics of work. For example, feedback from co-workers through social interaction should not be confused with feedback from co-workers which is gained indirectly by observing co-worker performance.

Researchers have noted that social characteristics are essential components of work and are likely to impact a variety of work outcomes (Parker & Wall, 2001). For example, researchers have pointed out that relationships between workers are among the most important determinants of well-being (Myers, 1999; Watson, 2000; and Cohen & Wills, 1985) and perceptions of meaningful work (Gersick et al., 2000; Wrzesniewski et al., 2003). Social characteristics are expected to reduce the stress of jobs by buffering workers against adverse job occurrences (Karasek, 1979; Karasek et al., 1982). They may also increase work motivation and satisfaction (Adler & Kwon,

2002; Humphrey et al., 2007) and promote resilience, security, and positive moods on the job (Ryan & Deci, 2001). However, the relevance of research in social characteristics has seen growth due to the increased use of teams in organizations (Ilgen, 1999), with several researchers conducting team task analyses (e.g., Arthur et al., in press; 2005).

Finally, it can be expected that social characteristics will positively affect manufacturing performance, such as productivity and conformance. Social characteristics provide a chance for job incumbents to learn from others and perform their job more effectively through the transfer of implicit and explicit knowledge (Berman et al., 2002). In addition, it is expected that social characteristics would reduce performance inhibitors, such as stress and work overload (Steers & Mowday, 1981). However, research has shown that these social characteristics can be moderated by macroscopic factors such as national culture. Therefore, the subsequent section reviews these social differences in social characteristics.

Evidence of individualism and collectivism in social behaviour

Considerable changes in the workforce have taken place as more women, culturally diverse and educated workers are joining the workforce (Fried et al., 2008). These changes have partly been brought on by the growth in demand facilitated by globalisation and economic growth. These contextual changes give rise to new questions about the design of work and the experience of workers. Although the majority of job design models have focused on individual motivation, satisfaction, and performance, researchers have also suggested that job designs are embedded in national cultures, institutions, technologies and organisational structures (e.g., Brass, 1981; Dean & Snell, 1991; Oldham & Hackman, 1981; Parker et al., 2001; Robert et al., 2000; Spreitzer, 1996). For example, Robert et al. (2000) reported a negative relationship between empowerment and job satisfaction in India, which was credited to the high levels of power distance in the Indian culture. Likewise, researchers have proposed that job design may have stronger effects in cultures characterised by high power distance, where employees are more likely to conform to supervisors' expectations (Leung, 2001).

As mentioned in Section 3.2.2, the cultural dimension that has been most researched due to its consensus across cultural models is individualism/collectivism (Venaik & Brewer, 2008). Similarly, several job design studies have assessed how the effect of job characteristics may differ due to this cultural dimension. There was a weaker relationship between autonomy and the critical psychological states of the Job Characteristic Model in Bulgaria and Hungary than in the Netherlands which is more individualistic in culture (Roe, Zinovieva, Dienes, and Ten Horn, 2000). Furthermore, in a sample of more than 100,000 employees from 49 countries, Huang and Van De Vliert (2003) found that enriched job characteristics are related more strongly to job satisfaction in countries with high individualism, strong governmental social welfare programs, and low power distance.

Regarding social behaviours, co-workers are most likely to assist others if they are from more collectivistic cultures as this support or feedback is seen as part of the job (Perlow & Weeks, 2002). Therefore, it is expected that collectivistic cultures encourage more social interaction in the form of support and feedback.

"Although the findings on job characteristics in the context of culture are promising, we need more theoretical development and systematic research on the effect of particular job characteristics on specific outcome variables in different cultures" (Grant et al., 2011, p. 438). The experimental design of this study is expected to curtail the impact of social characteristics on production. However, the use of two cultural samples provides an opportunity to investigate changes in social behaviour between cultures which enhances the literature.

3.4 Hypotheses Development

Having assessed how national culture affects both cognitive and social behaviours, the literature is summarised by developing the hypotheses which guide the investigation of this paper in the following section. This development is complemented by a conceptual model which outlines the relationships for analysis in Figure 3.3.

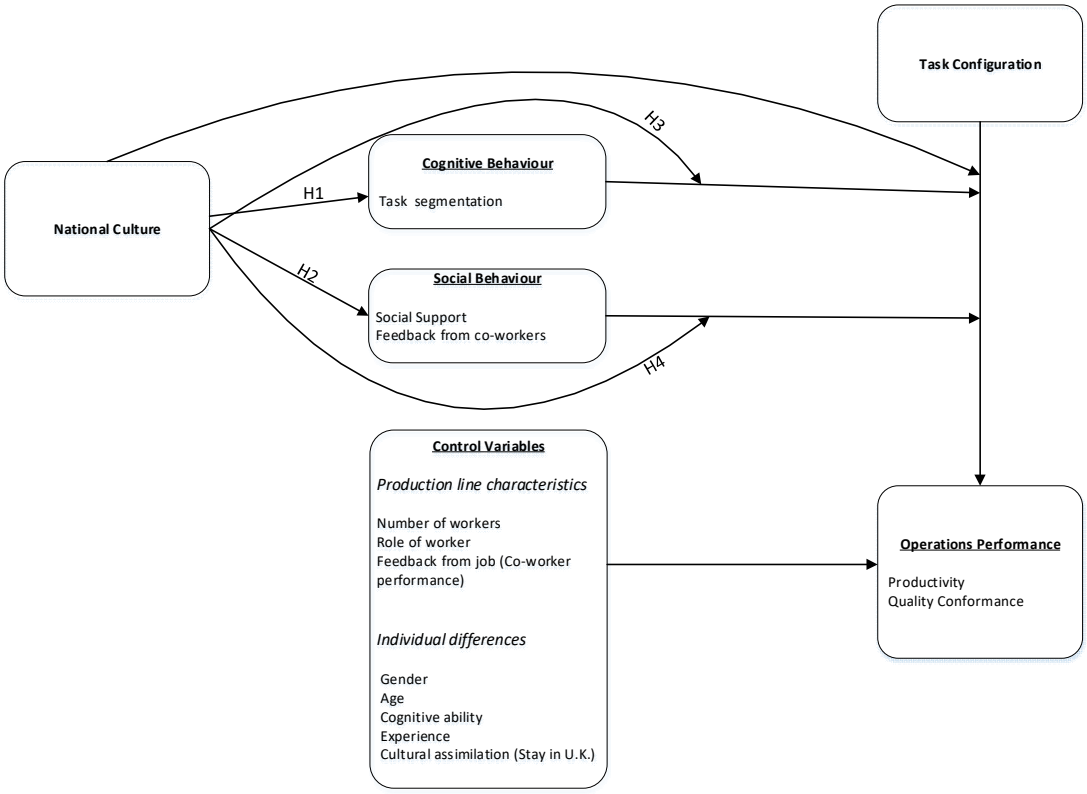


Figure 3.3 Conceptual Model

National culture affects operating performance in areas such as supply chains and manufacturing (§3.1). Quantitative methods have been used to investigate cultural differences in operating performance, with these measures summarised in (§1.3). However, there has been no rigorous empirical analysis of how culture affects worker behaviour, with behavioural studies incorporating culture mostly analysed in the area of supply chain management. Since managers must contend with configuring tasks for multinational employees, given the importance of offshoring to fulfil demand and resources (§1.1), the behavioural effects of national culture on performance are also a concern.

Investigations into worker behaviours can occur at the cognitive level (Eckerd & Bendoly, 2015), but also the social and cultural level (Loch & Wu, 2005). These behavioural categories are also not mutually exclusive. Arguably, incorporating discussions on the impact of culture on worker behaviour includes looking at how culture affects social interaction (§3.3) and the mental models which guide cognitive

processes such as perception (§2.2). However, these concerns are complex, and the measurement and the measurement may be less compelling than other renowned behaviours (Eckerd & Bendoly, 2015; Ferdows, 2018). Nevertheless, this study aims to confirm whether workers from different national cultures have different cognitive and social behaviours and whether these behaviours affect operations performance.

Differences in behaviours resulting from national culture have been observed in the cognitive perception of ongoing events through event segmentation (§3.2). Earlier studies demonstrated that the collectivistic cultural trait of East Asians influences them to perceive a greater relationship between objects in daily routines, which causes them to see fewer event boundaries or breakpoints in segmentation (§3.2). This study aims to confirm these cognitive differences in operations tasks. Therefore, the following hypothesis is presented:

> *H1. Workers from the more collectivistic East Asian culture will perceive fewer event segments than workers from the more individualistic Western culture.*

Work in the operations environment is often completed by teams or within an open plan setting where co-workers are visible to each other. As a result, social behaviours that are facilitated by interpersonal relationships between co-workers can manifest within the operation (§3.3). The job design literature purports that behaviours resulting from national culture have also been identified in the social characteristics of workers as it relates to the level of social support and feedback between co-workers (§3.3). For example, co-workers are most likely to assist others if they are from more collectivistic cultures as this support or feedback is seen as part of the job (Perlow & Weeks, 2002). Therefore, it is expected that collectivistic cultures will facilitate more social interaction in the form of support and feedback. These studies demonstrated that cultures with a greater level of collectivism tended to engage in higher levels of social behaviour than workers from individualistic cultures (§3.3). Therefore, the following is hypothesis is presented:

> *H2. Workers from the more collectivistic East Asian culture will give more social support and feedback than workers from the more individualistic Western culture.*

Empirical validation of H1 and H2 is necessary to establish the relationship between national culture and cognitive and social behaviours within the context of operations management. H1 will be tested by measuring the number of breakpoints in the assembly task that are perceived by workers, while H2 will be tested using scales from the Work Design Questionnaire (Morgeson & Humphrey, 2006). Having understood the cultural differences in worker behaviour, an attempt should be made to ascertain whether accounting for these cognitive and social behaviours improves the prediction of operations performance for workers from different cultures.

Assessing the relationship between cognitive behaviours and manufacturing performance is complex and still exploratory. Therefore, the study aims to confirm whether these cognitive differences were more prevalent within specific task configurations (i.e. whether there was an interaction between task configuration and event segmentation) and whether this relationship was similar or different between workers from different cultures (i.e. whether national culture moderated the relationship between event segmentation and the task configuration) in the prediction of performance. This will be tested by including the event segmentation scores as predictors of manufacturing performance. The operations literature suggests that more rigid task configurations are designed to control for worker behaviour as specialisation reduces discretion and unwanted movement (§2.2). Therefore, the following hypothesis is presented:

> *H3. National culture moderates the effect of cognitive behaviour on manufacturing performance, in such a way that this task segmentation only significantly relates to performance for East Asian workers in the most flexible task configuration.*

Cognitive behaviours like perception are internal to the worker and implicitly guide behaviours (§3.2). However, workers are also guided by the validation they receive from the social interaction at work (§3.3). While the social aspects of work seemed less important early in studies on job design, the importance of the social aspects of work were acknowledged later (Oldham & Hackman, 2010).

Social interaction has been shown to be important to distal performance, such as worker motivation. However, several questions still arise about the role of the social

aspects of work, one of which is understanding what variables moderate the relationship between social characteristics of jobs and performance (Grant et al., 2011). The experimental design minimised the opportunity for social interaction. However, the group-based nature of the experiment presents a chance to understand how social support from co-workers and feedback may impact performance, even in this setting. Therefore, including the measures of social characteristics from the survey in the prediction of manufacturing performance addresses the following hypothesis:

> *H4. National culture moderates the effect of social behaviour on manufacturing performance in such a way that feedback and social support only significantly relate to performance for East Asian workers in the most flexible task configuration.*

Investigating H3 and H4 will allow us to understand how national culture affects the cognitive and social behaviours of workers and more so how these behavioural variables affect performance. Therefore, learning more about culturally diverse operations contributes to the literature by enhancing knowledge on how to configure culturally relevant manufacturing processes. The following chapter presents the methodology used to assess these hypotheses.

Chapter 4 Methodology

This chapter addresses the choice of research methodology used in this study, including the experimental research design, sample specification and multilevel analysis of experimental data. The quantitative method was most appropriate to investigate the impact of national culture on workers' cognitive and social behaviours and to use these behaviours in the prediction of operations performance. Qualitative methodologies, such as observations and interviews, provide a rich understanding of a few cases of human behaviour (Ragin, 2014). These methodologies allow the researcher to confront participants repeatedly to understand the lived experiences of participants (Merriam, 2014). Conversely, quantitative methodologies use mathematical models to test behaviours observed in the real world (Gelman & Hill, 2007) to examine causal relationships between variables and predict outcomes or behaviour (Fallon, 2016). Therefore, only a quantitative methodology, such as experiments can be used to test hypotheses and predict human behaviour. Thus, given the interest of this study to predict manufacturing performance, a quantitative methodology is more suited.

There are three primary research designs for quantitative research dealing with primary data collection: laboratory experiments, field experiments and surveys (Fallon, 2016). These methodologies offer different degrees of control over the research context and how this research context reflects the human behaviours being studied within the more complex real-world scenario. A laboratory experiment was chosen as the main methodology for this study because it allows for the control of the numerous confounding production factors that are present in a full-scale production plant (Lonati et al., 2018).

An event segmentation task was administered in Experiment 1, which is a method of assessing perception as it relates to predicting action performance (Wang, 2009). Experiment 2 tested the performance of the workers in three assembly task configurations. The relationship between the cognitive and social behaviours and manufacturing performance was facilitated by including the results of Experiment 1 and questionnaire as predictors of the performance gathered in Experiment 2 (e.g. Bailey, 1998; Hard, 2006).

This chapter will further address the suitability of this methodology in the research design, followed by detailing the structure of the paper airplane simulation and the caveats and pedagogic contributions of transforming the simulation into an experiment. There is a discussion of the suitability of the sample and how the participants experienced the experiment. Finally, the method of analysing the experimental data, multilevel linear modelling, is discussed. This discussion includes the variables that are included in the analysis and the development and specification of the multilevel model used for analysis.

4.1 Research Design

Experiments are an established research methodology for studying human behaviour, not only in operations management but also in psychology, economics and other older disciplines (Katok, 2011). Experiments are also used in various management disciplines, such as accounting and marketing, to establish cause and effect, by manipulating controlled treatments (Wacker, 1998). Being able to control situational factors using experiments, especially in a complex environment such as manufacturing, allows the researcher to focus on specific relationships (Bendoly et al., 2006). Furthermore, this method links analytical models to operating problems (Katok, 2011).

A review of six notable OM journals between 1985 and 2005 found that scholars have used experiments across various OM sub-disciplines to investigate behavioural issues (Bendoly et al., 2006). Generally, experimental research has been used to investigate systematic errors that result from individual biases and heuristics, such as the newsvendor phenomenon (e.g. Schweitzer & Cachon, 2000; Bolton & Katok, 2008; Bostian et al., 2008; Ovchinnikov et al., 2015; Ren et al., 2017; Li et al., 2018). However, broader psychological and sociological perspectives have also been incorporated in the behavioural operations literature. These include psychological investigations into trust (Hill et al., 2009; Eckerd et al., 2016). Additionally, there have been cross-cultural experiments (Ribbink & Grimm, 2014; Eckerd et al., 2016; Lee et al., 2018).

Despite the use of the experimental methodology by OM scholars, there has been a paucity of experimental work focused specifically on task organisation in manufacturing. For example, production and workflow management accounted for 30% of the articles reviewed in Bendoly et al. (2006). However, most of the articles in this category pertain to interdependence, feedback and goals, often examining the decision-makers and not the shop floor worker (Bendoly et al., 2006). This focus on decision-makers as research participants can be attributed to the difficulty and cost related to the loss of production time when frontline workers are used (e.g. Ong, 1987). Thus, this research contributes a relevant strand to the extant body of knowledge by complementing what we know about decision-makers with the actual task performance by frontline workers.

Despite the credibility of this method in testing human behaviour, experiments are not magical solutions for establishing relationships in OM (Shadish et al., 2002). They must be designed rigorously to achieve the necessary validity for generalisation (Lonati et al., 2018). Important validity discussions revolve around the use of deception which may infringe on ethical responsibility to participants (Hertwig & Ortmann, 2001; Rungtusanatham et al., 2011), small sample sizes (Button et al., 2013), and endogeneity (Ketokivi & McIntosh, 2017; Lonati et al., 2018). The design of this study accounts for these limitations by including an appropriate sample size for validity (Cohen, 1992), choosing a simulation that has shown external validity in reproducing production tasks, and addressing endogeneity and other validity issues. It should also be acknowledged that there was no need for deception in this experiment. These and other methodological issues are discussed in this chapter and the findings.

4.2 The Paper Airplane Simulation

This paper plane simulation was conceptualised as an assembly task including seven folds and the placement of one stick-on “star” (see Figure 3.1). The paper airplane factory simulated three task configurations that align with the Craft, Mass and Lean production systems. Four production workers took part in the simulation, and there was team production in the Mass and Lean tasks. The first worker in the production line made one centrefold, the second worker created two folds on the wing of the plane, the third worker created two additional folds on the wing and placed the star sticker as

the insignia, and the fourth worker produces the final two folds on the wings. The difference in the Mass and Lean configurations is that the latter has a higher level of task interdependence. This difference will be discussed in more detail later in this section. In the Craft production, each worker made paper airplanes independently, completing all the assemblies in Figure 3.1. The assembly view of the paper plane is important because it allowed for the comparison of tasks that had different task content. For example, the Craft task had eight assemblies per worker (including the "star"), whereas the Lean and Mass tasks contained two assemblies per worker, except for the third production worker who had three assemblies to complete.

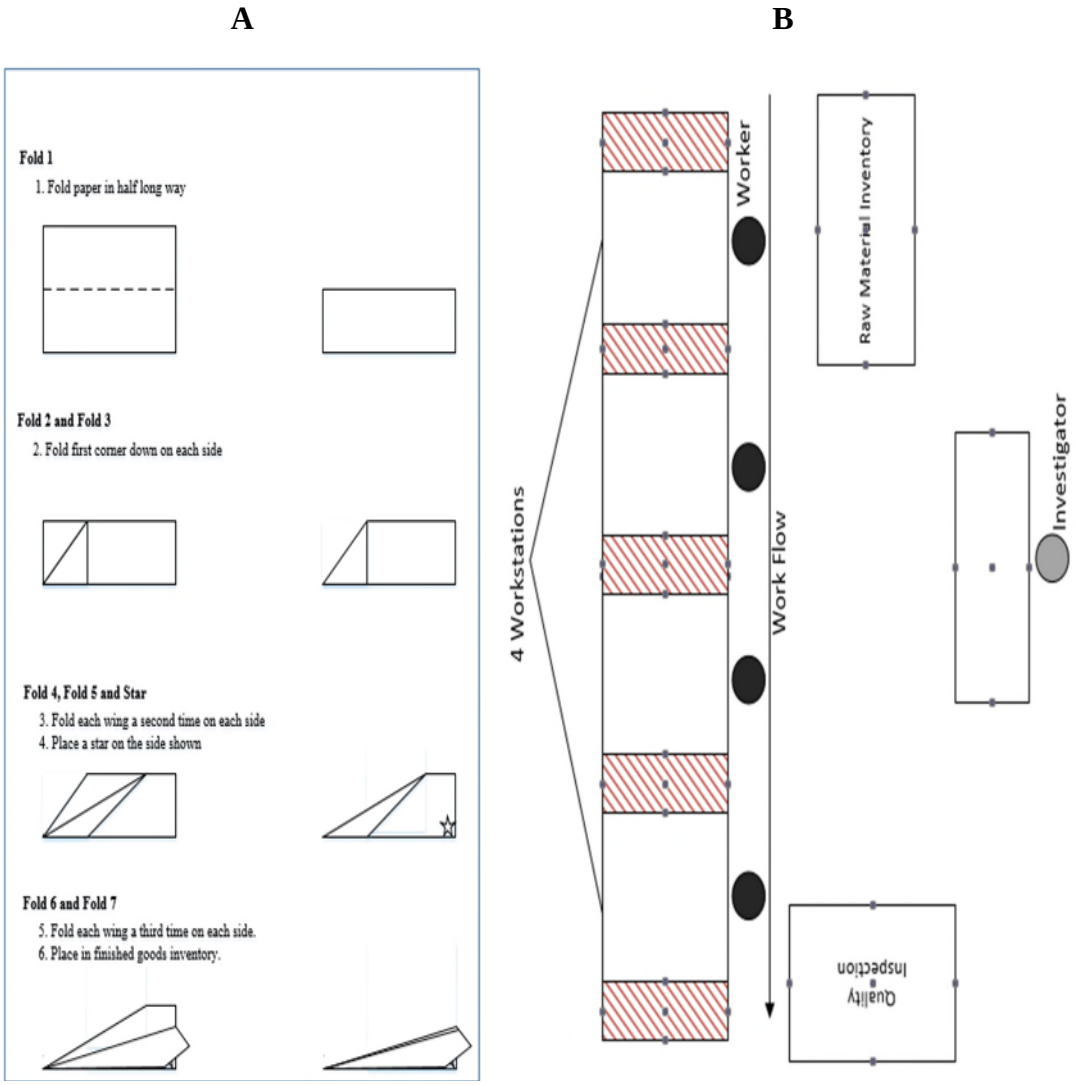


Figure 4.1 Instructions (A) and Paper Airplane Production Layout (B)

The paper airplane assembly can be further classified in terms of coarse and fine grain assemblies. Fold 1 and Fold 2 are different styles of folds (asymmetric), therefore moving between folds could create a coarse breakpoint in perception. A fine breakpoint would be at the end of Fold 2, which transitions into the beginning of Fold 3 because these folds are symmetric. Therefore, Fold 1, Fold 3, Fold 5, Star and Fold 7 are the assemblies associated with coarse breakpoints, while Fold 2, Fold 4 and Fold 6 are the symmetric assemblies associated with fine assembly breakpoints.

Under the Mass and Lean conditions, workers had shorter task content because they needed to complete only one of four steps in the creation of the product. For example, worker two only needed to complete Fold 2 and Fold 3. Each worker is assigned to a workstation, and work passes between adjacent stations into an area for the interstation buffer, as shown in Figure 4.1(B). These Mass and Lean task configurations were characterised by frequent breakpoints. These breakpoints signalled the need to pass work on to another worker or receive work-in-progress from another team member. In the Mass task configuration, participants were allowed to build up work-in-process or interstation buffer. The number of workstations and line positions is the same for the Lean and Mass tasks. However, in the Lean task configuration, a Kanban of one interstation buffer was used to reduce work-in-process and enhance synchronisation between workers.

Kanban is a material flow management system that forms part of the Lean manufacturing system and is one way of maximising efficiency and achieving just-in-time (JIT) manufacturing (Slack et al., 2016). This experiment used Kanban squares which marked spaces in the buffer station between workers, with an empty square used to trigger production. The demand rate was imposed to be a Kanban of the size of one (Lummus, 1995).

The three tasks in the simulation are classified in Table 4.1. All tasks have the potential for labour flexibility, given the use of manual labour. Likewise, there was no direct demand for mix or volume flexibility. Although the Craft task configuration allowed for increased process flexibility, there was no specialisation or task interdependence. The Mass task has some degree of task interdependence as the task was shared between workers. However, workers were free to work at their own pace;

specialisation was increased in this design, while process variability was constrained. The Lean task shared similar features with the Mass task, except for the higher level of task interdependence.

Table 4.1 Task Configuration Classification

Task Configuration	**Efficiency**		**Flexibility**	
Craft	Specialisation Task Interdependent	-/+ -/+	Labour Process	-/+ +
Mass	Specialisation Task Interdependent	+ +	Labour Process	-/+ -
Lean	Specialisation Task Interdependent	+ ++	Labour Process	-/+ -
Note: "-/+" represents design characteristics that are not being manipulated while the "- "and "+" represents the negative or positive direction of manipulation of the task characteristics.				

Simulation realism check

The use of a manufacturing simulation can raise questions as to whether the observed behaviour is measured accurately and matches authentic manufacturing behaviour. First, to strengthen internal validity, performance incentives were used to introduce consequential choices (Lonati et al., 2018). A realism check was also conducted to ensure that participants took their roles seriously and understood that the simulation was a plausible manufacturing context (Rungtusanatham et al., 2011). The realism check relied on Pilling et al.'s (1994) realism scales as used by Chen et al. (2014) and Eckerd et al. (2016). Using a seven-point Likert scale (1 – strongly disagree, 7 – strongly agree), subjects indicated whether they found the simulation realistic (μ = 5.42), took their role seriously (μ = 6.47), were aware of the issues discussed in the scenario (μ = 4.933), and whether they would make the same decision if they were faced with the same situation at their workplace (μ = 5.14). Also, participants were asked whether the simulation felt like a real production process (μ = 5.71) (Chen et

al., 2014) and whether they felt like they were working ($\mu = 5.64$). These results reveal the mean sentiments of participants regarding the realism of the simulation. Overall, participants found that the paper plane simulation was realistic and replicated key manufacturing characteristics. Awareness of the manufacturing issues ranked lowest but resulted from the use of a student sample, and prior knowledge was not necessary for this experiment. The confirmation of realism in the paper airplane simulation leads to a broader discussion on how to get more out of teaching simulations. For example, testing production behaviour by incorporating more contextual control akin to an experiment. The implication of these improvements are discussed in the following section.

Expanding the pedagogic scope of the paper airplane simulation

Teaching in Operations Management depends on the use of numerous simulations to make the real operating context more accessible for students and practitioners (Lewis & Maylor, 2007). An operational simulation is an abstraction of the operations that involve rules guiding how participants set goals, make decisions and take actions to achieve these goals. This long tradition of using simulations has seen over 113 simulations being used in the context of the operation (Riis & Mikkelsen, 1995). The 'Handbook of Behavioral Operations' also showcases several behavioural simulations that have been used to study behaviours in an OM context (Bendoly et al., 2015). The purpose of simulations is "to help to understand and solve complex real-life problems by constructing a small, simplified version of the problem, often called a 'model' " (Fripp, 1993, p. 8). Simulations should be able to elicit behaviour similar to what would be observed in a real task context (Sanderson & Grundgeiger, 2015).

Often, the competitive element added to OM simulations reduces the ability to measure behavioural effects related to cognition. Therefore, a significant consideration in transforming a simulation into a laboratory experiment is accounting for the impact of competition on performance (Lewis & Maylor, 2007). Competition in a classroom setting keeps participants engaged and can boost commitment to the task. However, there are some adverse effects of competition that might distort behaviour. For example, performing with such intense emotion can affect the capacity

to reflect and learn from feedback, especially where errors have been made (Lewis & Maylor, 2007). Likewise, competition may motivate the worker beyond normative performance levels in the short-term, which may not correspond with performance in a long-term work environment. To mitigate these possible effects, excessive competition was controlled for in this experiment by allowing only one production team per session.

Another consideration in the use of simulations is the level of fidelity. The fidelity of the simulation is the degree to which the simulation replicates reality (Alessi, 2000). However, what constitutes reality must be contextualised. The typology proposed by Rehmann et al. (1995) is adopted to explain the fidelity of the paper airplane factory as a simulation. Rehmann et al. (1995) argue that fidelity must be considered as equipment, environmental and psychological fidelity (see Figure 4.2).

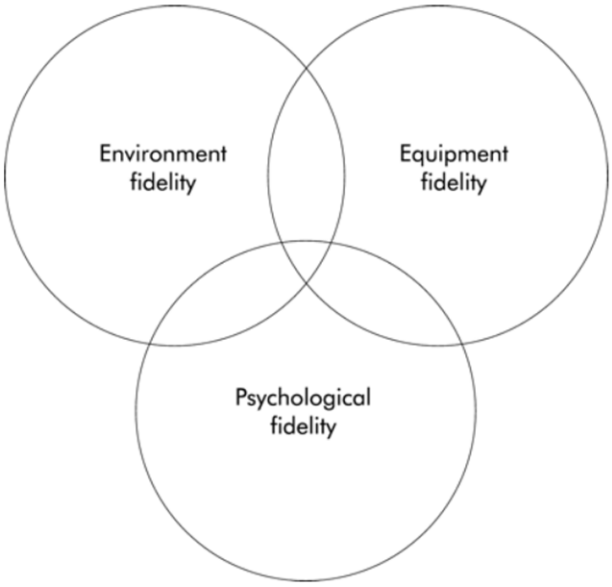


Figure 4.2 A Typology of Simulation Fidelity. Adapted from Rehmann et al. (1995)

The basic level of fidelity is equipment fidelity. Equipment fidelity refers to the degree to which the simulation duplicates the feel and the layout of the real production system. The physical layout of the paper airplane factory used workstations and interstation buffer spaces to capture the authenticity of the production line (see Figure 4.1). One drawback to achieving equipment fidelity in the paper airplane simulation is the use of paper for production material. While the material of a real task may have been

sacrificed in this simulation, paper does have some benefits. First, using real task equipment and material, while it adds credibility, may also reduce the generalisability of the task environment. Equipment fidelity is, therefore, the least important of the three forms of fidelity (Beaubien & Baker, 2004), as the environmental and psychological elements of the task may be constrained by the physical features of the task. Also, using paper facilitates the creation and storage of a high quantity of inventory. As noted earlier, over 200 participants took part in the experiments, using a task such as the assembly of a cart as in the case of Kolbeinsson et al. (2017) and Doerr et al. (2004).

Environmental fidelity is the extent to which the simulation captures the sensory information from the task environment, such as motion and visual cues. The success of the paper airplane simulation as a pedagogic aid has mostly been dependent on its environmental fidelity. The simulated motions of a production environment are quite prominent in the paper airplane simulation for the three basic production systems assessed. The simulation allows for an authentic representation of the real Mass task environment. This representation includes a re-creation of the motion cues of short task content and repetitive steps. It also includes inventory build-up and other visual cues. The use of the Kanban in the lean task to facilitate synchronisation in teamwork quite aptly represents the real task environment. Additionally, the flexible layout of the paper airplane factory facilitates individual task completion in a Craft production system, allowing each worker to produce his or her product.

Finally, the psychological fidelity of a simulation is the degree to which the participant believes that the simulation is a replica of a real-life task (Beaubien & Baker, 2004). Psychological fidelity is an essential aspect of transforming the simulation into a behavioural experiment because the importance of the experiment is to measure real behaviour. Hence, it is the behaviour elicited by the experiment, and not the task itself, that is generalisable to theory. Psychological fidelity was pursued by controlling the influence of competition on participant behaviour, as previously highlighted, and by ensuring that all participants complied with a strict procedure. This made behaviours comparable. Finally, the realism of the simulation was tested and reported on in the findings (Rungtusanatham et al., 2011). The following section explores the configuration for the three production tasks contained in the paper airplane simulation.

4.3 Participants

Sample size

Two hundred and forty-six participants were recruited for this study. Thirteen participants were removed from the study for missing data. One hundred and twenty-two participants were included in the main study and sixty-six in the pilot study. Forty-five participants were also recruited for a multinational control group for the comparison of event segmentation scores. participants were incentivised using a payment scheme that paid an experiment turn-up fee and a variable fee for each good product made. A British sample and a Chinese sample were used for cultural comparison in the pilot and main analysis. These samples represented the Western and East Asian cultures, respectively. Ninety-two (92) participants were British and ninety-six (96) Chinese. This sample size exceeded the recommended number of observations to achieve a medium effect at 0.05 level of significance (cf. Cohen, 1992). It is also worth noting that the use of repeated measurements in this study means the number of observations is more than the number of participants. Therefore, none of the main analyses used less than 240 observations.

Sample sizes for laboratory experiments using a physical task simulation are often less than 100 subjects because of the high level of control and fidelity required in these experimental designs. Furthermore, it is not feasible to facilitate large samples in such studies, as these simulations require significant resources, such as the extensive use of space and time (e.g. Doerr et al., 2002; 2004; Kolbeinsson et al., 2017). Participants were recruited using the University of Warwick's online recruitment system.

Selection criteria

To compare behaviours between cultures, East Asian and Western cultures were selected because of the established differences between the cultures, both from a sociological and operations perspective (Hofstede, 2001). Having two distinct cultures allows for the amplification of the behavioural effect (see Gelman & Hill, 2007). As previously noted, the sample of these cultures was taken from Britain and China, because of their historical connection in spreading Western and East Asian 'thought'

(Masuda & Nisbett, 2001; Nisbett et al., 2001). Discussions on individualistic and collectivistic cultures in the review of the literature partially reflect the widespread immigration and colonisation efforts by China and Britain. China remains the most populous Asian country. Hence, its noted cultural traits, such as collectivism, have a significant stake in what is known as the East Asian culture (Nisbett et al., 2001). The colonisation efforts of Britain have played a substantial role in what has been characterised as Western culture. Additionally, the pervasiveness of the English language has aided in diffusing British cultural values internationally (Crystal, 2012; Xue & Zuo, 2013). As such, both these groups are reliable representatives of the Asian and Western cultures.

There were strict criteria for inclusion in each cultural sample to ensure that participants were reasonably immersed in their respective cultures (Lee et al., 2018). It is important to assess the eligibility of participants for the cultural samples. Therefore, in line with research by Lee et al. (2018) and Eckerd et al. (2016), participants in these cultural groups needed to be born in China or Britain. In addition, participants had to have lived in their respective country of birth for no less than ten consecutive years as an extra precaution that they identified with the specific cultures. Another criterion for inclusion in the study was that the participants' parents have resided in either China or Britain for at least 20 consecutive years.

Student sample

The sample consisted of undergraduates (66%), postgraduates (30%) and professionals (4%). Using mainly students in cognitive studies is standard practice in behavioural operations (see Croson & Donohue, 2006; Huang et al., 2008; Eckerd et al., 2016). Although existing research casts doubt on whether using student subjects reduces external validity, several OM studies report no differences in student and practitioner samples (Machuca & Barajas, 2004; Croson & Donohue, 2006; Bolton et al., 2012). Student samples could be viewed as problematic if the behaviour being tested depended on the individual life experiences of the participants. However, even in such a scenario, it would still be difficult to apply findings to workers in a different company, industry, country or region (Bendoly et al., 2006).

Consequently, if student samples are used in experiments, the only concern is whether such samples are suitable for the theoretical scope and directional effects (see Stevens, 2011; Lonati et al., 2018). What is meant to be applied is not the specific experimental design itself but the general theories that it tests. “Well-designed experiments do not test how students, managers, and employees at a specific corporation act in certain contrived situations. They test whether representative humans react predictably to controlled stimuli” (Bendoly et al., 2006, p. 738). Our study has a universalistic scope where relationships are presumed to hold regardless of the population; basic norms and beliefs are not assumed to be different for students compared to the broader populations. In this case, using a student population is advantageous, as using workers from the shop-floor could result in effects from systems, such as an organisational culture biasing perception and performance. Besides, the task to be completed does not require expert knowledge. University students do not have an advantage or disadvantage over shop floor workers when it comes to making paper planes. Given the need for problem-solving in complex manufacturing environments and the advances in technology used on the shop floor, the educational gap between the factory worker and the student has diminished over the years.

4.4 Experimental Procedure

The flow of the experiment is summarised in Figure 4.3. This section of the methodology will, therefore, outline each stage of the experiment as experienced by the participants.

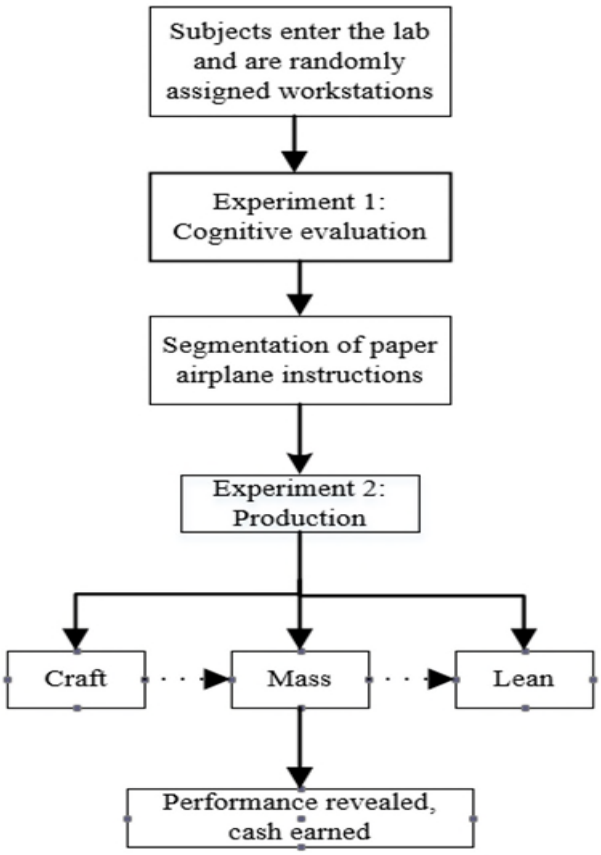


Figure 4.3 Flow of Experiment Activities

Upon entering the laboratory, participants were randomly assigned to a workstation. This randomisation ensures that internal validity is not compromised to ensure that the experimental conditions were not confounded by unobserved variables (Lonati et al., 2018). For example, preferences in seating or any other social preferences which may affect performance. They were then given the necessary consent forms to sign.

To transition into the experiment participants were given three questions which normally comprise the critical reasoning test (CRT). The result of this test was later used as a measure of worker aptitude or cognitive ability which may influence the learning of instructions. The CRT is a short psychological test of people's tendency to reflect on a question and also functions as a measure of cognitive ability and is often used as a test of intelligence quotient (IQ) (Frederick, 2005). The CRT will be discussed in the subsequent section on variables included in the analysis.

The event segmentation for each participant was then captured. Each participant was given a laptop that was preloaded with two videos with a timer synchronised to the media player.[1] One video was of someone assembling a pump (207 seconds) used by Mura et al. (2013), and the other showed the instructions for making the paper airplane (159 seconds). Stills from the videos are shown in Figure 4.4

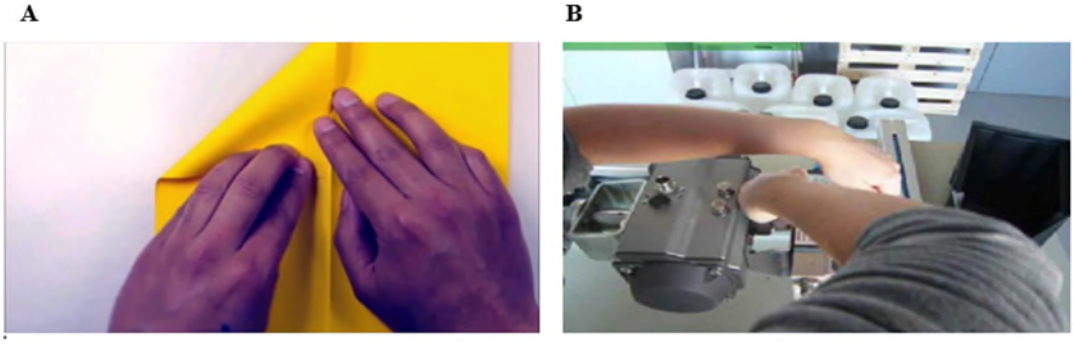


Figure 4.4 Screenshot of Video Instructions for Paper Airplane Manufacturing Simulation (A) and a Manual Pump Assembly Task (B)

While watching both videos, participants were asked to tap a key whenever they felt that a meaningful event had ended. This method of testing event segmentation is in line with previous psychological tests of event segmentation (Newtson & Engquist, 1976; Zacks & Sargent, 2010). Both videos are recorded as close view instructions, revealing only the assembler's hands with no audio. This view controls for any reactions to excessive movement and contextual biases such as language, gender, nationality. The IBES (instructions based on event segmentation), a tool developed by Mura et al. (2013) for measuring the segmentation in the manufacturing setting, was also used to segment the paper airplane instructional video (see Figure 4.4). Given that manufacturing tasks are usually accompanied by instructions and a period of learning, the IBES software allows employees to plan performance.

Once segmentation was complete, participants proceeded to the paper airplane production. The apparatus required for the paper airplane simulation included A4 paper and stick-on stars for the insignia. In a case where there were no-shows for the

[1] XNote Stopwatch was used to record segmentation http://www.xnotestopwatch.com/

experiment, the number of workers in the production line could be reduced to a minimum of three workers. In this situation, the task assignment for the first worker was completed before the start of production. Participants experienced each production condition randomly. Once the three production tasks were complete participants were debriefed on performance and compensated accordingly. Participants were also given an additional online debriefing questionnaire which captured demographic information and feedback on the realism of the task (Rungtusanatham et al., 2011). The overall procedure for this experiment is similar to that of Hard (2006), which also tested event segmentation followed by an assembly task.

4.5 Method of Data Analysis

Two experiments were undertaken for this study. The first is an assessment of participants' event segmentation. The second is an assessment of participants' performance in each production task configuration. The main method of analysis for these experiments was multilevel linear modelling (MLM). Multilevel linear modelling was used to assess the repeated measurements of segmentation scores and production in each task configuration. The justification for using MLM is presented in the subsequent discussion.

This model is a regression that accounts for the dependency in the data, including the use of repeated measurements. Repeated measures are used to describe the case when the same participant experiences all the conditions of the experiment — that is, all the task configurations or all trials of segmenting the instruction videos. However, a fundamental assumption of regression modelling is that the errors of the model or the residuals are independent of each other. Consequently, the assumption of independent errors is violated in a repeated measures experiment.

Another underlying assumption of regression is that the measurement of the dependent variable in each condition is independent. This means that observations should not be related. For instance, the same participants cannot be measured twice. However, multiple measurements of the same participant are desirable because each person is more like himself/herself than anyone else. Thus, errors related to individual

differences can be avoided by measuring the same person. At the same time, the use of repeated measures makes the regression test statistically inaccurate. Hence, using repeated measures requires another assumption: the presence of sphericity in the data. Sphericity means that the relationship between pairs of conditions in the experiment is equal (Field et al., 2012). Multilevel modelling overcomes the need to meet this assumption with the identification of grouping variables used at the higher levels of the hierarchy (see Field et al. (2012) for further discussion on sphericity and MLM). In short, multilevel models are well suited for repeated measurements in experiments (see Snijders & Bosker, 1999; Field et al., 2012; Finch et al., 2014). These and other assumptions of the MLM are discussed in a more structured manner after the presentation of the main model for analysis. This is to allow for familiarity with the variables and model being discussed.

A two-level model was used to evaluate the impact of the interplay between national culture and worker behaviour (level 2) on the relationship between task configuration and manufacturing performance (level 1). Therefore, the production outcome for each task configuration was measured at level 1 of the analysis as being nested within each participant at level 2. As previously highlighted, variables measured at the level of the participant are included at level 2 of the analysis and variables measured within each task are included at the first level of analysis. Figure 3.3 presented the conceptual framework that links the variables and hypotheses in the analysis, while Figure 4.5 shows a general layout of the multilevel data structure. A similar two-level model and data structure were used to assess the consistency of segmentation scores by evaluating the repeated trials of segmenting the instruction videos within each participant.

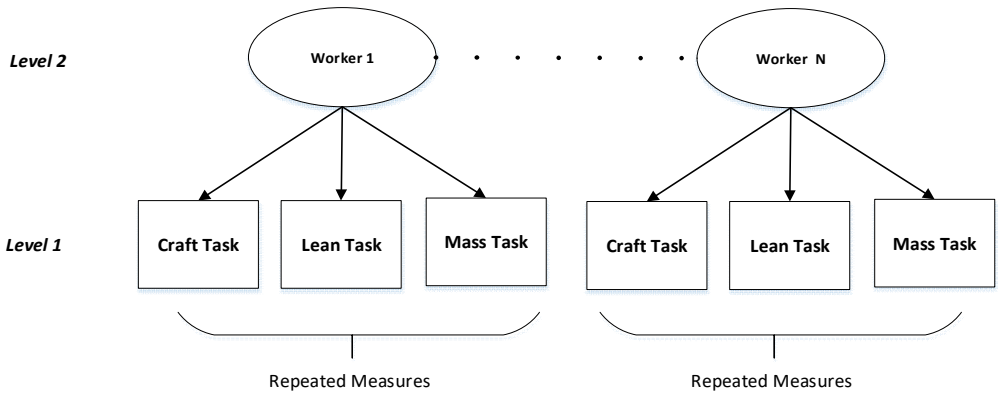


Figure 4.5 Layout of the Multilevel Data Structure

The modelling of worker behaviour in operations management often considers workers as independent of the system. There is statistical plausibility for this view, as regression modelling relies on the assumption of independence of observations (Jarque & Bera, 1980). However, this may not be true, especially in cases where workers are not working in solitude, and worker behaviour is being affected by working in multiple task configurations or experimental conditions (see Snijders & Bosker, 1999). As such, MLM is appropriate for studies in which worker performance across designs is being investigated, and observations may not be independent.

There are other benefits to MLM. For example, missing data and unbalanced conditions are not desirable, but this is a prevalent occurrence in data collection. In fact, MLM performs reliably with missing data points. Multilevel modelling also allows examination of within-level interactions and cross-level interactions. This is important in this analysis because the interaction between task configuration (level 1) and culture and perception (level 2) represents a cross-level interaction analysis. The testing of MLM also shows them as being more conservative, which results in more accurate significance testing when data have multiple levels (Goldstein, 2003).

Using MLM is almost always an improvement over classical regression modelling (Gelman, 2006). However, there are some limitations, especially when using cultural studies. In cases where the number of countries being assessed is few, there will not be enough higher-level units for estimation. This was a concern for this study, as participants were also clustered within cultural groups. Therefore, theoretically, culture could have been modelled as a third level of the analysis. However, this possibility was not feasible given the limited number of units at this level (only two cultures modelled) (Maas & Hox, 2004). The solution to this limitation is to introduce the higher-order variable as a ‘fixed effect’ which removes the variation between higher-level units. For that reason, the variable related to culture was treated as a fixed predictor at the second level of analysis (Tabachnick & Fidell, 2007).

The remainder of this chapter provides details on the variables used in the multilevel model, including the level at which the variables enter the analysis. This is followed by a mathematical representation of the multilevel model characteristics and the variables contained.

Variables for analysis

Dependent variables

The variables to be included in the multilevel model are discussed. An extract of the data for the main variables analysed is shown in Appendix III. The dependent variable for the event segmentation analysis was the resulting segmentation score. Thus, task perception was measured as the number of event boundaries identified by each participant as a ratio of the video length in seconds—i.e. the segmentation score. The video length represents the number of possible breakpoints (Newtson & Engquist, 1976). Consequently, the number of possible breakpoints in the pump video was 207, and for the paper airplane video, the number of possible breakpoints was 159. An initial comparison of segmentation scores over two trials was made to measure consistency. One hundred and twenty-two participants watched the two manufacturing instruction videos (British =60, Chinese = 62). A control sample of 45 participants from other nationalities was also included in this initial test. Participants segmented both the pump and the paper airplane manufacturing tasks twice, which can be referred to as two trials per task. Using a t-test, segmentation was not significantly different between trials in the pump task $t(166) = 0.949$, $\rho > 0.05$, $r = 0.073$. Also, segmentation was not significantly different between trials in the plane manufacturing scenario $t(166) = 0.717$, $\rho > 0.05$, $r = 0.056$. Therefore, segmentation scores are a reliable measure of event segmentation, as breakpoint consistency corroborated the findings from the literature (Newtson & Engquist, 1976).

The main dependent variable measured for the analysis of manufacturing performance was productivity. In the previous section on the ‘comparison of task configurations’, the paper airplane was broken down into eight assemblies to facilitate comparison. Therefore, the number of assemblies per production run, which was 8 minutes per task. Quality conformance was measured as a secondary outcome to assess the precision assembly. Conformance was measured as the weighted average of five quality criteria as a ratio of the number of planes produced by the worker. Specifically, quality conformance for each paper airplane was measured as one (1) minus the sum of the following errors: star placed on the incorrect side (0.20); no star placement (0.20); wings folded more than 1 cm from the apex of the paper airplane (symmetry, 0.20); any part of the star placed more than 4cm from the bottom and left edges of the plane

(precision, 0.20); and excessive crumpling or disfiguring of the paper airplane beyond reasonable recognition (material handling, 0.20).

Main Effects

The primary behavioural investigation of the study is the relationship between national culture and cognitive and social behaviour. Two distinct cultural groups, British and Chinese, were identified to assess the systematic perceptual differences between cultures. The distinctive preferences of these two social groups are firmly established in the literature (see Nisbett et al., 2001), thereby allowing for the amplification of this effect. Culture is added as the main predictor in the event segmentation analysis. Thus, in the study of production performance, national culture remains a major variable of interest. The segmentation scores from Experiment 1 are added as the main effect of cognitive behaviour in the models to predict manufacturing performance. Measures of social support and feedback are extracted from the 7-point questionnaire scales administered to participants at the end of the experiments. These scales were adapted from Morgeson and Humphrey (2006). Further treatment of these main effects will be shown in the section on the results.

Control Variables

The impact of possible confounding factors is accounted for by including relevant control variables. First, there are control variables for production characteristics which have formed the cornerstone for much of the research on production lines (Schultz et al., 2006). The more dependent workers are on other members in the group, then the more important it is to consider the workers' position in the production line. Therefore, the position that the worker occupied in the production line was added to the analysis, even though this consideration may be more important for the group production tasks. While most group production was carried out by four workers, the influence of no-shows resulted in the occasional use of three workers. Consequently, the line length is explicitly considered as the number of workstations used in production.

The individual differences are controlled for each worker, including age, gender, aptitude, and prior knowledge of the paper airplane simulation. Age and gender were included as basic control variables (cf. Zacks & Tversky, 2001; Kolus et al., 2018).

The results of the cognitive reflection test (*CRT*) are included as a measure of aptitude to control for the effect of academic ability on the worker's ability to follow the instructions. Since this simulation is regarded as low in complexity and represents an ideal baseline investigation, no prior skills were required. Nonetheless, the participants' previous knowledge of the paper airplane simulation was measured. This experience was measured on a two-point scale to determine whether or not workers had engaged in a variant of the paper airplane simulation previously. Since the Chinese workers were living in the UK, this influence is controlled by including the number of months that participants had lived in the UK in the analysis.

Studies on manufacturing have examined the characteristics of the production line that could have an impact on performance, including the length of the production line, process variability and buffer size. However, these characteristics may not be static and may influence worker performance beyond task configuration (Schultz et al., 2006). Hence, some worker behaviours besides nationality and perception were investigated. One behavioural concern, which is germane to production groups, is the effect that co-worker's performance may have on individual performance (Doerr et al., 1996; Schultz et al., 1998). Experimental research has found that the effort of the slower workers will increase, whereas that of the faster workers will decrease (Schultz et al., 2006). Therefore, this research includes a variable that measures the productivity of co-workers. Specifically, co-worker performance is calculated by taking the average productivity of all co-workers, excluding the worker of interest for each task. This independent variable estimates how workers react or are motivated by the difference in performance between themselves and co-workers.

Model development

The two-level MLM for the analysis of manufacturing performance can be expressed as:

Level 1(Task): $Y_{it} = \pi_{0i} + \pi_{1i}(T_{it}) + \pi_{2i}(X_{it}) + \varepsilon_{it}$ (1)

$$\pi_{0i} = \beta_{00} + \beta_{01}(Z_i) + r_{0i}$$

Level 2(Worker): $\pi_{1i} = \beta_{10} + r_{1i}$

$$\pi_{2i} = \beta_{20} + r_{2i}$$

Where Y_{it} is the outcome variable for worker *i* in task configuration *t*, π are the level 1 regression coefficients, β are the level 2 regression coefficients, ε_{it} is the level 1 error and the $r's$ are the level 2 random effects. T_{it} is a dedicated task configuration predictor variable and X_{it} is a task-varying predictor variable (co-worker performance). Z_i is a vector of worker characteristics that are time-invariant predictor variables (i.e. nationality, segmentation scores, social support, feedback, gender, age, aptitude, experience, length of stay).

If it is assumed that Z_1 represents segmentation scores, Z_2 identifies the worker's nationality, Z_3 represents a vector of the level 2 variables and $\bar{X}_i$ represents the mean X_{it} for each worker (included for robust-endogeneity measures and discussed in the section on validation), then the worker level parameters can be substituted in the task level equation:

$$Y_{it} = (\beta_{00} + \beta_{01}Z_{1i} + \beta_{02}Z_{2i} + \beta_{03}Z_{3i} + \beta_{04}\bar{X}_i + r_{0i}) + (\beta_{10} + r_{1i})T_{it} + (\beta_{20} + r_{2i})X_{it} + \varepsilon_{it} \quad (2)$$

Finally, the three-way interaction term investigated in hypothesis 3 can be expressed as:

$$Y_{it} = (\beta_{00} + \beta_{02}Z_{2i} + \beta_{03}Z_{3i} + \beta_{04}\bar{X}_i + \beta_{10}T_{it} + \beta_{20}X_{it} + \beta_{30}T_{it}Z_{2i}) + (\beta_{01} + \beta_{05}Z_{2i} + \beta_{11}T_{it} + \beta_{12}T_{it}Z_{2i})Z_{1i} + (r_{0i} + r_{1i}T_{it} + r_{2i}X_{it} + \varepsilon_{it}) \quad (3)$$

General notation and inferences are consistent with Raudenbush and Bryk (2002) and Finch et al. (2014). Similar manipulations can be used to expand the model for hypothesis 4.

The terms in parentheses in equation 3 are arranged to identify the simple intercept (ω_0) and simple slope (ω_1) presented by Aiken and West (1991). An effective

treatment of the simple slope analysis for multilevel purposes is discussed by Bauer and Curran (2005) and Preacher et al. (2006):

$$\omega_0 = (\beta_{00} + \beta_{02}Z_{2i} + \beta_{03}Z_{3i} + \beta_{04}\ \bar{X}_i + \beta_{10}\ T_{it} + \beta_{20}\ X_{it} + \beta_{30}\ T_{it}Z_{2i}) \quad (4)$$

$$\omega_1 = (\beta_{01} + \beta_{05}Z_{2i} + \beta_{11}\ T_{it} + \beta_{12}\ T_{it}Z_{2i}) \quad (5)$$

Multilevel model assumptions, effect sizes and fit

Like linear regression analysis, MLM has assumptions which validate the relationships estimated by this procedure (see Snijders & Bosker, 1999; Field et al., 2012). If these assumptions are not met, the parameter estimates may not be valid. The first assumption is that the residuals or errors in level 2 of the model are independent. The residuals are the difference between the predicted linear line and the observed data. In terms of this research, students are expected to be independent of the other. This assumption ensures that the random intercepts and/or slopes are independent across subjects. Level 2 residuals are also expected to be independent of level 1 residuals. Therefore, errors from the subject level estimates (level 2) are unrelated to errors at the individual level. This ensures that the interpretation of coefficients is accurate. Participants were randomly selected for this study. Therefore, there is no reason to assume any violation of independence.

Homoscedastic normality of residuals is also expected for in level 1 residuals (Snijders & Bosker, 1999). The level 1 residuals should be normally distributed and should have a constant variance. Homoscedasticity means that the variance in the output variable is constant across all values of the dependent variables. This is important as excessive differences in variance between observations suggest that observations may not be randomly dispersed around the predicted line of fit. This may bias the standard errors and create incorrect assumptions about significance. Likewise, the level 2 intercepts are expected to be normally distributed. First, it must be ensured that variables having random intercepts are properly specified. In this case, T_{it} which specifies the three task configurations is included. The random coefficients are assumed to be normally

distributed around the overall model. So, in a random intercept model such as this, the intercepts for each condition or task configuration is assumed to be normally distributed around the overall model.

Finally, there can be a high level of linear correlation between two independent variables in multilevel models, especially when there are cross-level interactions (Finch et al., 2014). This occurrence is known as multicollinearity. To counter this occurrence, variables in MLM are normally centred (Aiken & West, 1991; Finch et al., 2014). Centring is the process of transforming a variable into deviations around the mean. This implies that the mean for the sample of the centred variables is 0 and that each observation represents a deviation from the mean, rather than its raw value. If the raw scores for the independent variables are used to calculate the interaction and both the main effects and interaction terms are included in the subsequent analysis, it is very likely that collinearity will cause problems in the standard errors of the model parameters. For this analysis, the independent variables are mean centred in accordance with (Aiken & West, 1991).

In addition to the previous assumptions, there are some caveats to the multilevel model due to the structure of the data. MLMs are typically built in stages to demonstrate the effect that variables of interest have on the fit of the model. The fit of the multilevel model is tested using a chi-square likelihood ratio test (-2LL). This ratio uses the assumptions of the log-likelihood function (Field et al., 2012). The log-likelihood is an indicator of how much of the unexplained variance exists after the model has been fitted. Hence, the smaller the log-likelihood, the better the fit. It should be noted that -2LL (-2 x log-likelihood) is an adaptation of this log-likelihood, also referred to as the deviance statistic, and is the preferred measure of model fit because the chi-square distribution is a convenient way to calculate the level of significance. It also allows for the comparison of models by looking at the difference between the chi-square likelihood ratios. This difference is known as the likelihood ratio with a chi-square distribution and with degrees of freedom equal to the number of parameters "*k*" in the new model, minus the parameters in the old model (Finch et al., 2014). Parameters can be seen as predictors, where variables are continuous. When the variable is categorical, each of the levels or contrasts specified for the variable will be included as a parameter. Equation 6 presents the chi-square statistic for comparing the fit of multilevel models:

$$\chi^2(change) = \left(-2LL(old)\right) - \left(-2LL(new)\right) = 2LL(new) - 2LL(old)$$

$$df = k_{new} - k_{old} \qquad (6)$$

In addition to the fit of the model, assessing effect sizes in MLM is problematic. The traditional effect size in linear regression is calculated from the R^2 of the model, which represents the explained proportion of the variance in the outcome. However, when variables are being added at multiple levels, the variance parameters may increase as predictors are added to the model, which is counter-intuitive to what may happen in the ordinary regression analysis. Albeit challenging, adjustments can be made to the R^2 to create a pseudo R^2 for multilevel interpretation. This research uses the pseudo R^2 by Snijders and Bosker (1999), which reports the proportional reduction of error for predicting the individual outcome at level 1 of the model, because of its notable use in the literature (e.g. Glaser et al., 2016). The pseudo R^2 is calculated as the estimated sum of the residual variance at level 1 of the model $\hat{\sigma}^2$ and the residual variance at level two denoted $\hat{\tau}_0^2$. These parameters are calculated for the fitted model as a ratio of the baseline model and then subtracted from one ($1 - \frac{(\hat{\sigma}^2+\hat{\tau}_0^2)^{new}}{(\hat{\sigma}^2+\hat{\tau}_0^2)^{baseline}}$). Positive values of the pseudo R^2 show a reduction in error and a positive change between two pseudo R^2s shows an increase in prediction power resulting from the newer model reducing more proportional error than the older model.

The assumptions in this section will be used to validate the findings and will be presented in the subsequent section.

4.6 Summary

The central purpose of this study was to investigate whether task configuration moderates the effect of the interaction between culture and perception on manufacturing performance (H3). This hypothesis is supported by two other hypotheses that test the impact of task configuration on improving efficiency (H1) and

any cultural differences present in the perception of the manufacturing task environment (H2). To explore these hypotheses, this study employed a repeated-measures experimental design involving 122 participants identifying event boundaries in an event segmentation task followed by the completion of three production tasks in the paper airplane simulation. The cultural comparison was made between two samples: British and Chinese. Data on culture and task perception (segmentation scores) were supported by including other control variables related to worker behaviour, demographics and line characteristics. Multilevel modelling was used to assess the data. This model included a two-level analysis where the segmentation trials and production in the three task configurations were nested or repeated within each worker.

Chapter 5 Results – National Differences in Worker Behaviour

This results for this study are presented in Chapter 5 and Chapter 6. Three experiments were designed for this study, including a pilot experiment and two consecutively ran main experiments. The pilot was designed to assess the nuances of transforming the paper airplane simulation into an experiment and explore the behavioural differences between production workers from different nationalities. Following the pilot, the primary investigation is completed using two concurrently ran experiments referred to as Experiment 1 and Experiment 2.

Experiment 1 assessed the cognitive differences in workers' perception by testing the national differences in event segmentation scores. After completing the previous experiment, participants worked randomly in three task configurations of the paper airplane manufacturing simulation. The experimental transformation of this simulation is referred to as Experiment 2. The latter experiment is used to measure manufacturing performance, notably worker productivity and quality conformance. Also, a questionnaire was used to extract the workers' demographic and to measure the social behaviours of social support and feedback.

Chapter 4 will present the results of the pilot study and Experiment 1, which assesses the national differences in workers' cognitive behaviour (H1). Chapter 5 will present an assessment of the second experiment which includes results on the national differences in social behaviours (H2) and investigates the relationship between manufacturing performance and the cognitive and social behaviours expressed (H3 and H4). The following section details the aim and results of the pilot study and how this study assisted in developing the later experiments.

5.1 Pilot Study

Based on current theorising, culture influences operating performance (Kull et al., 2014; Lee Park & Paiva, 2018; Lee et al., 2018). Therefore, production workers from different nationalities, who are assumed to be submersed in their respective national cultures, exhibit different cognitive and social behaviours which may affect

performance. However, testing for behaviours within the operations environment is difficult, given the numerous factors being experienced concurrently. Thus, a pilot experiment was conducted to determine whether the paper airplane simulation could elicit manufacturing performance indicative to the literature and to do a pre-assessment of workers' cognitive behaviours.

Sixty-six participants (British = 37, Chinese = 29) took part in the pilot study. All criteria highlighted in the methodology for sample selection applied to the pilot study. Like the primary analysis, the cognitive differences in segmentation were assessed before participants engaged in the manufacturing simulation. This preliminary assessment utilised the text segmentation method used by Wang (2009). Appendix I shows an example of the text segmentation completed by participants from different samples. Text segmentation scores were measured as the number of breakpoints identified by the participant divided by the number of words in the text. The following results were extracted from the pilot study:

- *National differences in cognitive behaviour*- An independent sample t-test was conducted to compare the difference in segmentation scores between British (M = 0.0511, *SE* = 0.003) and Chinese (M= 0.0376, *SE* = 0.005) samples. The segmentation scores between both samples was significantly different t (49.788) = 2.195, $\rho < .05$, r = .3. Therefore, on average, Chinese participants were more likely to create fewer event segments. With these results achieving a medium effect size.
- *National differences in productivity* – A general linear mixed model (GLMM)[2] was conducted to assess the performance differences between both nationality groups. This analysis is comparable to a 2 (nationality) x 3 (task configuration) factorial analysis with repeated measurements. The findings of the pilot study are presented as learning summaries for further investigation. As such, more detailed applications of the analytical methodologies are presented for

[2] A general linear mixed model is used when assumptions of general linear models such as regressions, ANOVA and ANCOVA are not met. In this regard, workers experienced all task configurations which violates the requirement of independent observations, as discussed in the section on the Methodology. A multilevel linear model (MLM) is classified as a GLMM. However, in this preliminary analysis, there is no attempt to sequentially build a model, but merely to understand the differences in performance. Therefore, MLM is discussed in the main experiments.

Experiments 1 and 2. It is anticipated that the Mass and Lean configurations with increased specialisation will increase productivity. Productivity was higher in the specialised task configurations than the more flexible Craft configuration, $\beta = 0.084$, $t(128) = 5.23$, $\rho < .05$. Although Chinese workers were more productive than British workers, there was no significant productivity difference, $\beta = 0.164$, $t(64) = 1.93$, $\rho > .05$. There were also no other significant main effects or interactions.

It was observed from the pilot experiment that there were cognitive differences between nationalities and that the simulation captured the performance differences expected within the task configurations. However, the pilot also facilitated some qualitative observations:

- *Co-worker productivity as indirect feedback* – Productivity in the room seemed to be synchronised, even when there was no interdependence between workers. This led to an investigation into whether the productivity of co-workers influenced individual productivity by giving indirect feedback on performance. It is anticipated that in the Lean task, which is configured for work synchronisation, co-worker performance should be closely linked to individual performance. However, co-worker performance should rationally not be related to individual performance in the Mass and Craft tasks, unless the performance of co-workers is motivating individual productivity. A general linear mixed model (GLMM) was used to assess the impact of co-worker performance on productivity across task configurations and nationalities. The measurement of these variables is similar to what is posited in the methodology for the main analysis. The results show that co-worker productivity significantly boosted the productivity of individual workers, $\beta = 0.011$, $t(117) = 3.611$, $p < .05$. However, co-worker performance was not just influential in the Lean configuration, but the main effect observed was similar for all task configurations and cultural groups. Therefore, no other main effects or interactions were significant.
- *Social support and direct feedback* – The production environment was open-plan to facilitate the easy flow of resources, as in the case of most manufacturing plants. For example, this production layout facilitated the

motivating influence of co-worker productivity. However, this layout also allowed for the possibility of social support and direct feedback affecting productivity. Therefore, the behavioural variables of social support and feedback were adapted from Morgeson and Humphrey (2006) work design questionnaire for future analysis.

Learning from the pilot study facilitate the inclusion of three additional variables in the analysis: social support, feedback and co-worker productivity. The first of the two main experiments is subsequently discussed in this chapter.

5.2 Experiment 1: Assessing National Differences in Cognitive Behaviour (H1)

Segmentation of pump assembly visual instructions

One hundred and twenty-two participants watched the pump and the plane videos (Chinese = 62 and British = 60). The video instructions for two task contexts were evaluated. First participants were asked to create task segments for a pump assembly. The pump assembly task has a higher level of equipment fidelity than the paper airplane simulation. Therefore, this task was used to compare event segmentation with the plane simulation. Each participant completed two trials of creating segmentation scores for each task context. In the case of the paper plane simulation, a third trial was assessed using the IBES software. A higher segmentation score indicates that the participant created more breakpoints while viewing the videos. The analysis starts with a look at the descriptive statistics, mean and standard deviation, to get a preliminary understanding of the relationships in the data. See Table 5.1 for a summary of these descriptive statistics.

Table 5.1 Results for National Differences in Cognitive Perception

Variables	Means (Standard Errors)		Welch's T-Test		Effect Sizes
	British	*Chinese*	*t*	*df*	*r*
Pump Assembly					
Trial 1	0.057(0.037)	0.037(0.026)	3.534***	103.51	0.328
Trial 2	0.054(0.039)	0.037(0.023)	2.951***	91.945	0.294
Plane Assembly					
Trial 1	0.062(0.026)	0.046(0.026)	3.585***	119.3	0.312
Trial 2	0.061(0.029)	0.045(0.023)	3.508***	110.12	0.317
IBES	0.070(0.027)	0.052(0.028)	3.558***	119.8	0.309

Note: n = 366 trials (level 1) in 122 workers (level 2) for plane assembly task and n = 244 trials (level 1) in 122 workers (level 2) for pump assembly task. * $p < .05$ ** $p < .01$ *** $p < .001$

The assessment of means and standard deviations presented in Table 5.1 demonstrates that on average the British perceived more breakpoints than the Chinese while viewing both the pump (trial 2, μ = 0.054, *SE*= 0.039) and paper airplane (trial 2, μ = 0.061, *SE* = 0.027) manufacturing tasks. This was consistent across all trials. This finding suggests that there may be a systematic difference in perception between both cultural groups, a finding supported by literature (Wang, 2009). There was also a tendency for participants to perceive fewer breakpoints in a manufacturing task in the second viewing of the video. This is evidenced by the lower segmentation scores for Trial 2. This finding supports the concatenation arguments within chunking theory, which suggests that people may merge chunks and therefore rely on fewer breakpoints in perceiving the assemblies in the task (Song & Cohen, 2014).

The results of the t-test showed that the differences in cognitive behaviour between national samples were significant for both the pump and the paper plane tasks. British workers consistently perceived more event segments than Chinese workers. For example, Pump trial 1 $t(103.51) = 3.534$, $\rho < .05$ and paper airplane trial 1 $t(119.3) = 3.585$, $\rho < .05$ event segmentation tasks. These cognitive differences achieved medium effect sizes r = .328 and r = .312, respectively. The t-test is an indication of cultural differences in event segmentation. However, given that the event segmentation trials were repeated measurements, the analysis would be more accurate if all trials were assessed simultaneously. Therefore, the significance of these perceptual trends is probed further using MLM.

Each multilevel assessment begins with an overall assessment of the improvements in fit for each model. This is followed by a detailed look at the relationships contained in the model. The fit of the model is assessed using likelihood ratios which are presented in Table 5.2.

Table 5.2 Assessing Model Fit for the Pump Task Segmentation

Model	Degrees of freedom (df)	Log-Likelihood	Fit comparison	Chi-Square (χ^2)
Baseline	4	571.987		
1	5	572.619	Base vs 2	1.265
2	6	573.029	2 vs 3	0.820
3	7	573.031	3 vs 4	0.004
4	8	578.873	4 vs 5	11.683***
5	9	579.477	5 vs 6	1.209

*Note: * p < .05 ** p < .01 *** p < .001*

The likelihood ratios for each consecutive model were compared to determine whether adding each variable to the model improved its fit or prediction of segmentation scores. As discussed in the methodology, the likelihood ratio uses a chi-squared distribution (χ^2) which allows for convenient significance testing. Therefore, a 5% level of significance is used to determine whether a consecutive model has a better fit or predictive power than its predecessor. A null model (baseline) for the dependent variable is assessed in MLM and contains only a constant term and no predictors. Five subsequent models were evaluated for the manufacturing task. The first model included a dummy coded variable to identify the segmentation score for each trial. The control variables of gender and age were included in Model 2 and Model 3, respectively. Then the categorical variable representing worker nationality was introduced in Model 4 to test whether British workers created more segments than Chinese workers. Whether this relationship was consistent across trials was tested in an interaction between *Trials* and *Nationality* in Model 5.

Comparing the baseline model with the dummy variable representing the two trials (Model 1) revealed that the variance between trials was not significant $\chi^2(5) = 1.265$, $\rho > .05$. Therefore, segmentation scores in both trials were similar, which made the identification of trial means unnecessary. This finding corroborates the test for consistency in segmentation scores presented in the methodology to justify the use of

event segmentation as a measure of perception. Participants' gender and age were added to Models 2 and 3 as control variables. Including gender and age in the model did not significantly improve prediction, $\chi^2(6) = 0.820$, $\rho > .05$, $\chi^2(7) = 0.004$, $\rho > .05$.

Hypothesis 1 was tested by regressing the segmentation scores on nationality in Model 4. Accounting for participants nationality significantly improved the prediction of segmentation, $\chi^2(8) = 11.683$, $\rho < .001$, which was the greatest improvement made to the fit of the model. There was no interaction between the segmentation trials and the workers' nationality $\chi^2(9) = 1.208$ $\rho < .05$. Therefore, the significant differences in segmentation between the British and Chinese samples were present in both segmentation trials for the pump task. This finding strengthens the argument of consistency in segmentation, as all participants, despite cultural group, created a similar number of breakpoints in each trial of viewing the instructions.

Table 5.3 provides a detailed result of each model. The main model for the analysis in Model 5, but Models 1 to 4 are discussed to show trends in the findings.

Table 5.3 Results of Pump Task Segmentation Analysis

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Trials					
Trial (2)	-0.002(0.002)	-0.002(0.002)	-0.002(0.002)	-0.002(0.002)	-0.003(0.002)
Individual Differences					
Gender (Male)		0.005(0.006)	0.005(0.006)	0.002(0.006)	0.002(0.006)
Age			0.000(0.001)	0.001(0.001)	0.001(0.001)
Main effects					
Nationality (Chinese)				-0.020(0.006)***	-0.025(0.007)***
Interaction					
Trial (2) x Nationality (Chinese)					0.003(0.003)
Note: n = 244 trials (level 1) in 122 workers (level 2) in the pump task. Coefficients (β) are reported with standard errors in parentheses. * p < .05 ** p < .01 *** p < .001					
Pseudo R^2	0.005	0.005	0.005	0.007	0.012

The mean segmentation scores between trial 1 and 2 did not differ markedly for the pump manufacturing task, $\beta = -0.003$, $t(120) = -1.560$, $\rho > .05$. However, participants identified fewer breakpoints in production for trial 2 compared to trial 1. This result

was also present in Model 1 to Model 4 and shows that while segmentation patterns are consistent for a particular segmentation task, there may be less perception of breakpoints as learning takes place. The effect of gender on segmentation scores was insignificant, $\beta = 0.002$, $t(118) = 0.277$, $\rho > .05$. This result suggests that both men and women identify similar breakpoints in perception, although men seem to identify more breakpoints in perception given the positive relationship between segmentation scores and gender.

Workers tended to create noticeably more breakpoints as they got older, $\beta = 0.001$, $t(118) = 1.027$, $\rho > .05$. This result was consistent between all models except Model 3. The finding replicates previous ones that suggest that as people age, they create more breakpoints to improve memory (Zacks & Sargent, 2010). However, this relationship was not significant in this study.

Overall, the influential factor in explaining differences in segmentation was nationality. Chinese workers perceived substantially fewer segments in the production task than did British workers, $\beta = -0.025$, $t(118) = - 3.378$, $\rho < .05$ (Model 4). The interaction terms were not significant in the analysis. Therefore, the differences in segmentation between both cultural groups remained consistent between the trials, $\beta = 0.003$, $t(120) = 1.088$, $\rho > .05$ (Model 5). These results confirm the changes in the model fit assessment presented prior to the detailed analysis. These results confirm hypothesis 1 in the pump assembly task, which posits that Chinese workers perceive fewer breaks in the task assembly than the British workers. This is in line with other studies on event segmentation and differences in cultural perception, which showed that that perception was different across cultures in daily events (Masuda & Nisbett, 2001; Chua et al., 2005; Nisbett & Miyamoto, 2005). However, this is the first known study to confirm these cultural differences in the manufacturing context.

Finally, the effect sizes presented earlier at the bottom of Table 5.3 are discussed. As discussed in Section 4.5.3 of the Methodology, the pseudo R^2 by Snijders and Bosker (1999) will be used to estimate effect sizes for the multilevel analysis. Identifying separate means for each segmentation trial in viewing the pump task resulted in a 0.5% reduction of error for predicting the event segmentation scores. In essence, compared to the baseline model, Model 1 improved the prediction of segmentation scores.

Adding gender and age, in Model 2 and Model 3 did not reduce much error beyond Model 1 (pseudo R^2 = 0.005). Including nationality in Model 4 accounted for 0.2% more of the variance in segmentation scores than the control variables when compared to the null model (pseudo R^2 = 0.007). Finally, accounting for the interaction between trials and the nationality of workers achieved the highest proportional reduction of error for predicting event segmentation (pseudo R^2 = 0.012). The greatest increases in pseudo R^2 resulted in Models 4 and 5 when nationality was accounted for and when the effect of the relationship between nationality and the trials was assessed. This suggests that these specifications had the greatest effect in predicting event segmentation. A similar analysis ensues for the event segmentation of the paper airplane task.

Segmentation of the paper airplane **assembly visual instructions**

The segmentation analysis of the paper airplane task uses the same structure and method of analysis as the pump task assessment. Like the pump task, the paper airplane simulation had two trials. In addition, participants created event segments using the IBES software (see description in Section 3.4 of the Methodology). The multilevel assessment begins with an overall assessment of the improvements in fit for each model. This is followed by a detailed look at the relationships contained in the model. The fit of the model is assessed using likelihood ratios which are presented in Table 5.4.

Table 5.4 Assessing Model Fit for the Paper Plane Task Segmentation

Model	Degrees of freedom (df)	Log-Likelihood	Fit comparison	Chi-Square (χ^2)
Baseline	4	860.9315		
1	6	869.3765	Base vs 2	16.890***
2	7	869.4115	2 vs 3	0.079
3	8	869.5781	3 vs 4	0.333
4	9	879.4639	4 vs 5	19.772***
5	11	879.4865	5 vs 6	0.045

*Note: * p < .05 ** p < .01 *** p < .001*

The likelihood ratios for each consecutive model were compared to determine whether adding each variable to the model improved its fit or prediction of segmentation

scores. As discussed in the Methodology, the likelihood ratio uses a chi-squared distribution (χ^2) which allows for convenient significance testing. Therefore, a 5% level of significance is used to determine whether a consecutive model has a better fit or predictive power than its predecessor. A null model (baseline) for the dependent variable is assessed in MLM and contains only a constant term and no predictors. Five subsequent models were evaluated for the manufacturing task. The first model included a dummy coded variable to identify the segmentation score for the three trials. The control variables of gender and age were included in Model 2 and Model 3, respectively. Then the categorical variable representing worker nationality was introduced in Model 4 to test whether British workers created more segments than Chinese workers. Whether this relationship was consistent across trials was tested in an interaction between *Trials* and *Nationality* in Model 5.

Assessment of a baseline or null model for participants' segmentation of the plane task revealed that the variance between the three trials was significantly different χ^2 (6) = 16.890, $\rho<.05$. This difference results from the propensity to increase segmentation caused by using the IBES software. This finding was anticipated as an effect of participants being able to plan production. This finding is discussed further in the Discussion chapter. Adding the participant's gender and age to the model did not have a notable effect on improving prediction, $\chi^2(7) = 0.070$, $\rho > .05$ and $\chi^2(8) = 0.333$, $\rho > .05$, respectively.

Hypothesis 1 was tested by regressing the segmentation scores on nationality in Model 4. Nationality improved the prediction of segmentation significantly, $\chi^2(9) = 19.772$, $\rho < .05$. This demonstrates nationality is a key predictor of event segmentation. Including the interaction between trials and nationality did not significantly improve the fit of the model, $\chi^2(11) = 0.045$ $\rho > .05$. This suggests that segmentation scores remained consistent across all trials, as in the case of the pump task. Therefore, the significant differences in segmentation between the British and Chinese samples were present in the two video viewings (trial 1 and 2) and the IBES viewing. This finding strengthens the argument of consistency in segmentation, as all participants, despite cultural group, created a similar number of breakpoints in each trial of viewing the instructions. In addition, the cultural differences in perception are not just consistent within tasks but between tasks as both production tasks scenarios had similar fits in

the model. Table 5.5 provides a detailed result of each model. The main model for the analysis is Model 5, but Models 1 to 4 is discussed to show trends in the findings.

Table 5.5 Results of Plane Task Segmentation Analysis

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Trials					
Trial (2)	-0.001(0.002)	-0.001(0.002)	-0.001(0.002)	-0.001(0.002)	-0.001(0.003)
Trials vs IBES	0.007(0.002)***	0.007(0.002)***	0.007(0.002)***	0.007(0.002)***	0.008(0.003)*
Individual Differences					
Gender (Male)		0.001(0.005)	0.001(0.005)	-0.003(0.004)	-0.003(0.004)
Age			0.001 (0.002)	0.004(0.002)	0.004(0.002)
Main Effect					
Nationality (Chinese)				-0.020(0.004)***	-0.019(0.005)***
Interactions					
Trial (2) x Nationality (Chinese)					0.000(0.004)
Trials vs IBES x Nationality (Chinese)					-0.001(0.004)
Note: n = 366 trials (level 1) in 122 workers (level 2) in the plane task. Coefficients (β) are reported with standard errors in parentheses. * p < .05 ** p < .01 *** p < .001					
Pseudo R^2	0.032	0.032	0.032	0.036	0.037

There are three trials in which event segmentation is tested in the paper plane instructions. Therefore, contrasts are used to compare trials. In Model 5, the mean segmentation scores between trial 1 and 2 did not differ markedly for the plane manufacturing task, $\beta = -0.0001$, $t(240) = -0.325$, $\rho > .05$. This is a similar result to that for the pump task. Participants identified fewer breakpoints in production for trial two (2) compared to trial one (1). This result was also present in Model 1 to Model 4 and shows that while segmentation patterns are consistent for a particular segmentation task, there may be less perception of breakpoints as learning takes place. Participants tended to identify more breakpoints when the IBES software was used, $\beta = 0.008$, $t(240) = 2.444$, $\rho < 0.05$. This finding may have resulted from the self-pacing of the assembly instructions compared to the other two trials, which utilised online segmentation – segmentation of an ongoing flow of events. What is important for this study is that both cultural groups were stimulated by the use of the IBES software, β

= -0.0008, t(240) = -0.176, ρ > .05. As such, the perceptual differences between both cultural groups were preserved in the IBES trial.

Individual differences did not affect segmentation scores. The effect of gender on segmentation scores was insignificant, β = -0.003, t(118) = -0.577, ρ > 0.05. This result suggests that both men and women identify similar breakpoints in perception. Unlike the pump scenario there was no consistent trend in the effect of gender on the segmentation of plane assembly task as while male participants seem to make more segmentation in Models 1 through 3, when nationality is accounted for, female participants make more segments than male participants. This inconsistency possibly results from the fact that, on average Chinese females (μ = 0.050) perceived more breakpoints than males (μ = 0.040) in the plane task, while British females (μ = 0.063) perceived fewer breakpoints than males (μ = 0.067) in the plane task. Workers tended to create noticeably more breakpoints as they got older, β = 0.004, t(118) = 1.874, ρ > .05. This result confirms the findings in the pump task and alludes to previous findings that as people age, they create more breakpoints to improve memory (Zacks & Sargent, 2010). However, this relationship was not significant in this study, although it was consistent between all models (see Table 5.5).

National culture, represented by the participants' nationality, remained the influential factor in explaining differences in segmentation. Chinese workers perceived substantially fewer breakpoints in production than did British workers, β = -0.019, t(118) = - 3.917, ρ < .05. The interaction terms were not significant in the analysis. Therefore, the differences in segmentation between both cultural groups remained consistent between both online trials, β = 0.000, t(240) = 0.015, ρ > .05 and between the online trials and the use of the IBES software β = -0.001, t(240) =-0.176, ρ > .05. These results confirm hypothesis 1 in the plane task, which posits that Chinese workers perceive fewer breaks in the task assembly than the British workers. This is in line with other studies on event segmentation and differences in cultural perception, which showed that that perception was different across cultures in daily events (Masuda & Nisbett, 2001; Chua et al., 2005; Nisbett & Miyamoto, 2005). However, this is the first known study to confirm these cultural differences in the manufacturing context. In

addition, these cultural differences in perception were demonstrated across different manufacturing tasks.

The effect sizes are reported in Table 4.5, presented earlier, using the pseudo R^2 by Snijders and Bosker (1999), which was discussed in Section 3.5.3 of the Methodology. Identifying separate means for each segmentation trial for the plane task resulted in a 3.2% reduction of error for predicting the event segmentation scores. In essence, compared to the baseline model, Model 1 improved the prediction of segmentation scores. Adding both gender and age, in Models 2 and 3 did not improve the prediction of event segmentation scores by over Model 1 (pseudo R^2 = 0.032). Including nationality in Model 4 accounted for 0.4% more of the variance in segmentation scores than the control variables when compared to the null model (pseudo R^2 = 3.6). Finally, accounting for the interaction between trials and the nationality of workers did not reduce the error for predicting event segmentation. This results from the fact that the findings in Model 4 are consistent across trials. The greatest increases in pseudo R^2 resulted in Models 4 when nationality was included in the model. This suggests that these specifications had the greatest effect in predicting event segmentation.

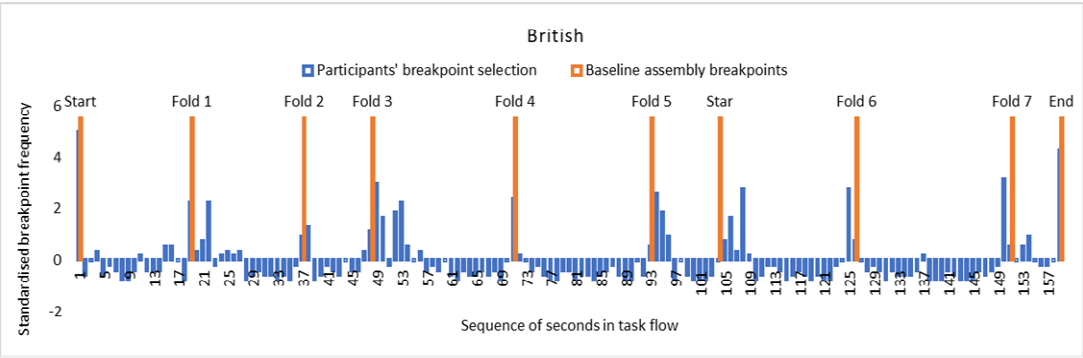
Overall, the segmentation results between pump manufacturing and the paper plane simulation were consistent, and hypothesis 1 was confirmed in both contexts. Chinese workers perceived significantly fewer breakpoints than did British workers for the same task. Understanding the differences in segmentation patterns between both cultural groups can be achieved by comparing the physical assembly breakpoints with the perceptual breakpoints or event segments identified by the sample. The following section explores the differences in perception for a manufacturing task between cultures.

Repetitive assemblies and task segmentation

Perceptual segmentation patterns were analysed for the paper plane simulation because this was the task performed by participants. Each segment made by participants while watching the instructional video was rounded to its closest second (1000ms). The frequency of breakpoints for each second was calculated. Then the mean and standard deviation for the frequency of breakpoint selection per second was

determined. These values were used to standardise the frequency of segmentation for each second shown in the video. This computation allows for the graphical representation of breakpoint frequencies in the event segmentation analysis in Figure 5.1.

The graphical analysis of segmentation patterns allows for delays in reaction times to be easily considered. The higher the frequency of segmentation in a particular second, the farther away it is from the sample mean. In essence, the taller the “blue” lines in the analysis, the more participants selected that second as a breakpoint for segmentation. For example, the 50th second was chosen as a breakpoint with a frequency of more than two standard deviations from the mean by both cultural groups. This finding suggests that the majority of the sample perceived the 50th second of the instruction video as a breakpoint in production. This was one second after the identified baseline breakpoint at the 49th second. This results from delayed action. It can also be seen that several breakpoints were created within proximity to the baseline, thereby supporting the notion that this point is perceived by the sample as a break in the assembly.



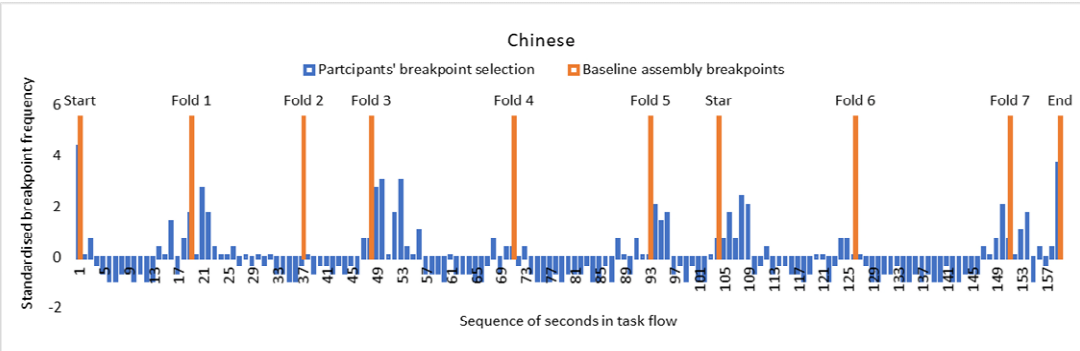


Figure 5.1 Graphical Analysis of Segmentation Pattern

As discussed in Section 4.2, the paper airplane comprised eight assemblies. These assemblies resulted from the seven folds in making the paper plane and the placement of the star sticker. These eight assemblies were considered as the baseline breakpoints or benchmarks for this graphical analysis. Therefore, the sample breakpoints, or the breakpoints made by the participants, were compared to the baseline assembly breakpoints to detect the cultural differences in breakpoint perception. For completeness, the start and endpoints of the video were included as breakpoints. Thus, the ten baseline breakpoints were Start, Folds one to seven, Star placement, and End (see Figure 4.1 for assembly instructions which show the folds in the task). The baseline assemblies were identified in the production video as the closest second to the final movement in completing the assembly and are shown in "orange" in Figure 5.1. The horizontal axis of the graph contains all the seconds in the paper airplane instruction video. For example, the nearest second to the end of Fold 1 is 19 seconds.

A distinction between assembly breakpoints was also made to assist in the classification of the differences in perception. Assembly breakpoints at the end of symmetric assemblies and the beginning of an asymmetric assembly are referred to as coarse breakpoints. As discussed in the "Literature Review", Section 3.2, coarse breakpoints constitute the greatest change in stimuli and could be more disruptive to perception. Breakpoints between two symmetric assemblies are considered as fine breakpoints because symmetry reduces the drastic change in stimuli. See Kolbeinsson et al. (2017) for the use of this classification in an assembly task. Also, seconds with frequencies close to zero or negative can be categorised as non-breakpoints. These are points in the assembly task that most participants agree are not breakpoints (Newtson & Engquist, 1976). As presented in the "Methodology", Section 4.2, a coarse breakpoint would be at the end of Fold 1, which would transition into the beginning of fold 2. This is a coarse breakpoint because Fold 1 and Fold 2 are different styles of folds. A fine breakpoint would be at the end of Fold 2, which transitions into the beginning of Fold 3 between both these folds are identical. Therefore, Fold 1, Fold 3, Fold 5, Star and Fold 7 are the coarse breakpoints, while Fold 2, Fold 4 and Fold 6 are the fine assembly breakpoints.

This analysis reveals that the Chinese created fewer breakpoints by only perceiving one coarse breakpoint per pair of symmetric folds. By contrast, the British perception

was more aligned with the baseline assembly breakpoints. The British workers perceived all folds as having breakpoints. All groups seemed to create breakpoints at the placement of the “star”. This behaviour confirms the premise that the configuration of the task can influence perception, as the star was a unique stimulus; even though the Chinese were making larger segments, the “star” interrupted their perception. Hence, coarse breakpoints are more robust across nationalities because they mark the end or beginning of major activities and constituted the points with the greatest changes in stimuli (Zacks et al., 2007).

Summary of findings on task segmentation

The segmentation results between pump manufacturing and the paper plane simulation were consistent. Hypothesis 1 was confirmed. Chinese workers perceived significantly fewer breakpoints than did British workers for the same task. There were signs of chunk concatenation, which results in the reduction of breakpoint perception, between trials 1 and 2 as workers learned the instructions. While this feature of chunking and creating segments was not the focus of the investigation, it became apparent that as workers learn the task, they seem to rely less on breakpoints for memory and are able to merge chunks (Song & Cohen, 2014). Workers seem to create more segments when they have more control over their instructions. This tendency suggests that the intent or plan to learn stimulates segmentation, but over time, it is expected that the reliance on these breakpoints decreases. Additionally, segmentation seems to increase with age. Importantly, segmentation scores were a consistent measure of differences in perception between cultural groups. These scores are, therefore, used to assess the impact of perception on task performance.

Having completed the cognitive test for task segmentation, workers moved to the production simulation. Chapter 6 will detail the results of Experiment 2 and predict worker productivity from the cognitive behaviours analysed in Chapter 5 and the social behaviours measured in Experiment 2.

Chapter 6 Results – Experiment 2: Predicting Productivity for British and Chinese Workers

This chapter contains results for hypotheses 2 to 4. First, the national differences in social behaviours (H2) are assessed. This is followed by the descriptive analysis of performance, including a preliminary look at the national differences in productivity and quality conformance. The third set of analyses will incorporate the outcomes of H1 and H2 to understands how cultural differences in perception moderate the impact task configuration on production (i.e. productivity and conformance) (H3) and how the cultural differences in social behaviour moderate the impact of task configuration on performance (H4).

6.1 Assessing National Differences in Social Behaviour (H2)

This section examines the impact of national culture on social behaviours (H2) for the one hundred and twenty participants who took part in the simulation and the accompanying questionnaire. See Table 6.1 for the means of these behaviours and the reported Welch's t-test and effect sizes for each variable.

Table 6.1: Results for National Differences in Social Behaviour

Variable	**Means (Standard Errors)**		**Welch's T-Test**		**(Effect Sizes)**
	British	*Chinese*	*t*	*df*	*r*
Social Support	4.823(1.413)	5.878(1.071)	-4.583***	108.09	0.403
Direct Feedback	4.649(1.334)	5.681(1.164)	-4.491***	114.35	0.387

Note: n =120 (British = 60 and Chinese = 60). * p < .05 ** p < .01 *** p < .001. Standard errors contained in parentheses.

Social behaviours were measured by two variables, Social Support and Feedback, which were measured on a 7-point Likert scale (see Appendix II). In addition, Social Support was measured by two items on the questionnaire, communicating with others and the friendliness of others. Therefore, the reliability of these items is measured using Cronbach's α (Cortina, 1993). These measures of Social Support were highly

reliabilities, Cronbach's α = .812. Both Social Support and Feedback are tested for national differences.

The Chinese sample had the highest level of social support (μ= 5.878, *SE*= 1.071) and direct feedback from co-workers (μ=5.681, *SE*=1.164). This result is not surprising, as numerous cultural studies have highlighted the collective nature of the Chinese culture, as members tend to pursue group goals rather than individual success (Nisbett et al., 2001; House et al., 2004; Hofstede & Hofstede, 2005). The results of the t-test showed that these differences in social behaviours between national samples were significant for both social support $t(108.09) = -4.583$, $\rho < .05$ and direct feedback $t(114.35) = -4.491$, $\rho < .05$. These social behaviours achieved medium to large effect sizes r = .387 and r = .403, respectively. These social behaviours are incorporated in models to predict manufacturing performance.

6.2 Descriptive Summary of Performance

This section develops multilevel models to predict productivity and quality conformance in relation to H3 and H4. Hypothesis 3 states that national culture moderates the effect of event segmentation on manufacturing performance within different task configurations. Hypothesis 4 states that national culture moderates the effect of social behaviours (i.e. social support and feedback) on manufacturing performance within different task configurations. Performance is measured within each task configuration at level 1 of the hierarchical analysis and is repeated within each worker at level 2 of the analysis. Workers completed the paper plane simulation in three task configurations: Craft, Mass, and Lean. The Craft task was characterised by longer task content, and the Mass and Lean tasks contained shorter task content. Perception is measured by segmentation scores gathered from the previous analysis.

One hundred and twenty-two participants took part in the paper airplane manufacturing simulation. Two participants were removed from analysis due to technical issues with recording data. Therefore, the analysis was completed for 60 British and 60 Chinese participants. The analysis starts with a look at the descriptive

statistics. Table 6.2 illustrates the means (μ) and standard errors (*SE*) for the performance measures under investigation.

Table 6.2: Means (μ) and Standard Error (*SE*) of Productivity Analysis

Variables	**Mean (Standard Error)**		**Welch's T-Test**		**Effect Sizes**
	British	*Chinese*	*t*	*df*	*R*
Craft	79.402(4.725)	67.197(3.478)	2.080*	108.42	0.196
Mass	82.972(2.848)	89.863(4.486)	-1.297	99.903	0.129
Lean	67.617 (3.039)	81.143(3.731)	-2.810**	113.37	0.255

** p< .05 ** p < .01 *** p < .001*

The Mass task configuration maintained the highest average productivity for both the British (μ= 82.972, *SE* = 2.848) and Chinese (μ= 89.863, *SE* = 4.486) workers. The second highest level of productivity for the British workers was achieved in the Craft configuration (μ=79.402, *SE*= 4.725), followed by Lean (μ=67.617, *SE*=3.039). The Chinese, however, achieved their second highest level of productivity in the Lean task configuration (μ= 81.143, *SE* = 3.731) followed by Craft (μ=67.197, *SE*= 3.478).

Therefore, on average, workers were more productive in the Mass configuration, and there was no significant difference between workers from different nationalities, $t(99.903) = -1.297$, $\rho > .05$, $r = .2$. This finding is expected as workers benefitted from higher levels of specialisation in the Mass configuration, with a low level of interdependence as inventory build-up between workers was possible. There are two further findings. British workers tended to perform better than Chinese workers in the Craft task configuration $t(108.42) = 2.080$, $\rho < .05$, $r = .1$, but had significantly lower levels of productivity in the Lean configuration than the Chinese, $t(113.37) = -2.810$, $\rho < .05$, $r = .3$. While the effect size for the finding in the Craft task is small, the cultural differences in performance on the Lean task achieved medium effect. This finding, therefore, suggests that the relationship between productivity and the configuration of production tasks is not universal, but may be dependent on the cultural influence of the worker. These production trends are probed further using MLM.

6.3 Assessing the Fit of Multilevel Models for Productivity

Each multilevel assessment begins with an overall assessment of the improvements in fit for each model. This is followed by a detailed look at the relationships contained in the model. The fit of the model is assessed using likelihood ratios which are presented in Table 6.3.

Table 6.3 Assessing Model Fit for Manufacturing Performance (Productivity)

Model	Degrees of freedom (df)	Log-Likelihood	Fit comparison	Chi-Square (χ^2)
Baseline	4	-1725.715		
1	6	-1715.768	Base vs 1	19.893***
2	10	-1698.943	1 vs 2	33.651***
3	15	-1694.834	2 vs 3	8.217
4	16	-1590.314	3 vs 4	209.040***
5	17	-1590.223	4 vs 5	0.183
6	18	-1585.702	5 vs 6	9.040**
7	19	-1585.008	6 vs 7	1.388
8	25	-1574.651	7 vs 8	20.715**
9	26	-1572.453	8 vs 9	4.400
10	21	-1573.858	9 vs 10	2.810

*Note: * p < .05 ** p < .01 *** p < .001*

As in the previous analysis, MLM was employed. The likelihood ratios for each consecutive model were compared to determine whether adding each variable to the model improved its fit or prediction of segmentation scores, using a 5% level of significance estimated by the chi-squared distribution (χ^2). A null model (baseline) for the dependent variable is assessed in MLM and contains only a constant term and no predictors. Eleven subsequent models of performance were evaluated. The first model included a dummy variable to identify the three tasks. The control variables for line characteristics and individual differences were included in Model 2 and Model 3, respectively. Then variable representing co-worker performance was introduced in Model 4, followed by nationality (Model 5), segmentation scores (Model 6), social support and feedback (Model 7). The effect of the interaction between nationality, task configuration and segmentation scores on productivity is tested in Model 8 (hypothesis

3). Model 9 accounts for the three-way interaction between nationality, task configuration and social characteristics (hypothesis 4). Model 10 introduces results that are robust against endogeneity. Therefore, Model 10 is the main model of interest. Model 11 includes no demographic predictors. This model is presented only for comparison and is discussed in the section on the validation of findings.

Comparing the baseline model with no predictors, with Model 1 which includes the dummy coded variable that identifies the three task configurations showed that the latter model improved the prediction of productivity, $\chi^2(6) = 19.893$, $\rho < .05$. This indicates that the variance between tasks was significant; therefore, specifying a random intercept multilevel model which separated the mean for each task configuration was appropriate. There were two groups of control variables included in the analysis. The first set related to the production line, workers' position in the line and the number of workstations, (Model 2). The second group pertained to the demographic characteristics of the workers' age, gender, aptitude, experience and length stay in the UK, (Model 3). The length of stay in the UK is meant to control for any cultural assimilation in the Chinese group. As such, the length of stay for British participants was replaced with the sample mean. Adding line characteristics to the model significantly improved productivity, $\chi^2(10) = 33.651, \rho < .05$, but workers' individual differences $\chi^2(15) = 8.217, \rho > .05$ did not significantly improve the prediction of productivity. This finding suggests that accounting for production line characteristics improved the prediction of productivity.

The behavioural variables of interest were added in consecutive models. First, accounting for co-worker productivity (Model 4) improved the explanation of individual performance, $\chi^2(16) = 209.040, \rho < .05$. Accounting for the workers' nationality independently (Model 5) $\chi^2(17) = 0.183,\ \rho > .05$ did not significantly improve the prediction of productivity. However, the interaction between nationality and segmentation score is significant in the prediction of performance (Model 8) $\chi^2(27) = 20.715,\ \rho < .05$. Segmentation scores, which were added in Model 6, substantially improved the prediction of the workers' productivity, $\chi^2(18) = 9.040, p < .05$. The inclusion of feedback and social support (Model 7) did not improve the prediction of performance, $\chi^2(20) = 1.388,\ \rho > .05$. As noted earlier

the including the interactions between nationality task configuration and cognitive behaviour (Model 8) $\chi^2(27) = 20.715, \rho < .05$. However, including the interaction between nationality, task configuration and social behaviours did not improve the prediction of performance (Model 9), $\chi^2(37) = 3.622, \rho > .05$. Adjusting the model for endogeneity also did not improve prediction (Model 10), $X^2(38) = 2.810, \rho > .05$.

The fitting of these consecutive models alludes to some interesting findings to be explored in more detail in subsequent paragraphs. What is clear is that production line characteristics (task characteristics) which form part of the control variables are significant in predicting performance. Of importance is the indirect feedback facilitated by co-worker visibility in the production line. The overall fitting of the model suggests that cognitive behaviour, in the form of event segmentation, made more improvement in predicting productivity than social behaviours. Further, the significance of the interaction between nationalities, segmentation and task configuration suggests that productivity is not only dependent on production line characteristics or individual differences but is affected by worker behaviours. The inference garnered from fitting the models is explored further in the following section by looking at the details of each model in predicting productivity.

6.4 Predicting Productivity from the Task Configuration and Control Variables

The results are presented in three tables. Table 6.4 provides a detailed result of Model 1 to Model 3. These set of models detail the introduction of the task configurations and the control variables for line characteristics and individual differences. Table 6.5 shows the results of the consecutive introduction of the behavioural variables (Models 4 – 7) and Table 6.6 shows the introduction of the interaction terms into the model, including the final robust model (Model 10). Although these models are presented separately, they may need to be cross-referenced for relationship comparisons. Combined, these models present the successive building of a predictive model of productivity taking account of cognitive and social behaviours by addressing Hypotheses 3 and 4.

Table 6.4 Results of MLM for Worker Productivity (Models 1- 3)

	Model 1	Model 2	Model 3
Task Configuration			
Groups (Mass and Lean) vs Craft	2.366(0.927)**	2.366(0.932)*	2.366(0.939)**
Groups (Mass vs Lean)	6.019(1.606)***	6.019(1.615)***	6.019(1.626)***
Line Characteristics			
Positions 1 vs Position 3		-4.551(3.250)	-4.817(3.183)
Position 2 vs Position 3		-3.521(2.832)	-3.269(2.790)
Positions 3vs Position 4		-10.231(3.092)***	-9.718(3.072)**
Workstations		-0.600(2.121)	-0.762(2.093)
Individual Differences			
Male			-0.836(3.811)
Age			-0.231(0.246)
Aptitude			3.852(1.681)*
Experience			-6.079(5.638)
Stay in UK			-0.107(0.094)

Note: n = 360 tasks (level 1) in 120 workers (level 2) in a repeated measure design. Coefficients are reported with standard errors in parentheses. * p < .05 ** p < .01 *** p < .001

Pseudo R^2	0.038	0.048	0.051

Model 1 identifies that productivity was measured for three separate task configurations. The task configuration a contextual variable which introduces dependency in the measurement of productivity. Thus, each observation is no longer independent as it is anticipated that productivity levels will vary more between task configurations than within configurations (i.e. the task configuration has an impacted on the productivity of the workers). The degree of influence that the task configuration has had on performance can be gleaned from the interclass correlation (ICC). The ICC measures the variation in output caused by the contextual variable as a ratio of the total variation (variance between configurations and variance within configurations). As such a measure of 0 would indicate no variance among task configurations and a measure of 1 would indicate variance among configurations, but no variance within configurations). The ICC value was 0.71, indicating that the variability in performance between task configurations was large compared to variability within task configurations. As such, identifying the three task configurations (i.e. as opposed to a general average) was appropriate.

Also, in Model 1, contrasts were used to compare the means for the two specialised tasks, Mass and Lean, with the Craft task, which represented a task configuration with increased flexibility. The Mass and Lean tasks significantly improved production compared to the Craft task, $\beta = 2.366, t(238) = 39.413,\ \rho < .05$ (see Table 4.8). The Mass task configuration significantly improved productivity over the Lean $\beta = 6.019, t(238) = 1.606,\ \rho < .05$. Therefore, task specialisation significantly explained increases in the productivity of workers. However, this significance is lost when co-worker performance was included in Model 4 (see Table 6.5).

The control variables for the production line characteristics were added first in Model 2 (Table 6.4). By design, the worker in the third line position has more work to do in the tasks configured with specialisation. This creates a situation where worker four is often left waiting for work, which is revealed by the significantly better performance of workers in position three compared to position 4, $\beta = -10.231, t(115) = -3.309,\ \rho < .05$. However, the number of workers in the production line did not significantly affect performance in any of the models, $\beta = -0.600, t(115) = -0.283,\ \rho > .05$. Controlling for demographic differences in Model 3 showed that aptitude correlated positively with productivity, $\beta = 3.852, t(110) = 1.681,\ \rho < .05$, but this relationship disappeared in subsequent models. The exposure of workers to their co-worker's productivity forms a part of the production line characteristics. However, given the observation that co-worker performance motivates individual performance, then this variable is assessed as one of the behavioural variables in the subsequent section.

6.5 Assessing the Relationship between Worker Behaviour and Productivity

As previously mentioned, the behavioural variables of interest were added, starting with Model 4 (see 6.5). The influence of co-worker performance was included in the study because of the inherent characteristic of production lines to have co-workers visible to each other (see Schultz et al., 2010). Co-worker performance had a significantly positive relationship with productivity $\beta = 0.777, t(237) = 16.646,\ \rho < .05$. Therefore, the average productivity of the other members in the

production line positively influenced the productivity of the individual worker. This relationship was consistently significant in all subsequent models.

Table 6.5 Results of MLM for Worker Productivity (Models 4 – 7)

	Model 4	**Model 5**	**Model 6**	**Model 7**
Task Configuration				
Groups (Mass and Lean) vs Craft	0.646(0.739)	0.646(0.740)	0.642(0.741)	0.637(0.743)
Groups (Lean vs Mass)	0.444(1.311)	0.443(1.312)	0.432(1.313)	0.416(1.317)
Line Characteristics				
Positions 1 vs Position 3	-4.764(2.205)*	-4.799(2.208)*	-3.531(2.171)	-3.674(2.168)
Position 2 vs Position 3	-3.101(1.932)	-3.117(1.934)	-3.935(1.885)*	-4.119(1.888)*
Positions 3vs Position 4	-13.490(2.140)***	-13.388(2.155)***	-13.972(2.088)***	-13.825(2.085)***
Workstations	-1.077(1.450)	-1.087(1.451)	-0.665(1.406)	-0.358(1.428)
Individual Differences				
Male	-1.642(2.640)	-1.563(2.648)	-3.030(2.600)	-3.708(2.696)
Age	-0.072(0.170)	-0.075(0.171)	-0.019(0.166)	-0.041(0.166)
Aptitude	0.724(1.179)	0.749(1.182)	0.723(1.140)	0.942(1.153)
Experience	0.250(3.923)	-0.022(3.979)	0.100(3.838)	0.091(3.839)
Stay in UK	-0.051(0.065)	-0.039(0.072)	-0.015(0.070)	-0.016(0.07)
Main Effects				
Co-worker performance	0.777(0.047)***	0.777(0.047)***	0.778(0.046)***	0.781(0.046)***
Nationality		1.109(2.640)	-2.444(2.808)	-1.152(3.016)
Segmentation Score			-240.498(80.169)**	-234.479(80.701)**
Feedback				-0.407(1.247)
Social Support				-0.832(1.25)

Note: n = 360 tasks (level 1) in 120 workers (level 2) in a repeated measure design. Coefficients are reported with standard errors in parentheses. * p<0.05 ** p<0.01 *** p<0.001

Pseudo R^2	0.274	0.274	0.282	0.283

Workers' nationality was introduced in Model 5 and was not a significant predictor of performance as a main effect, $\beta = 1.109, t(109) = 0.420, \ \rho > .05$. However, it has a significant interaction effect in later models. As such, the effect of national culture on performance must be interpreted conditional on worker behaviour and task configuration.

Model 6 and Model 7 included the cognitive and social behaviours of workers consecutively. The cognitive behaviour of event segmentation had a significant overall relationship with productivity $\beta = -240.498, t(108) = -3.0,\ \rho < .05$. Perceiving fewer segments in a task related to higher levels of productivity. However, social behaviours such as feedback and social support did not significantly influence productivity, $\beta = -0.407, t(106) = -0.326,\ \rho > .05, \beta = -0.832,\ t(106) = -0.665,\ \rho > .05$. The significance of the relationship between cognitive behaviour and the overall level of productivity was reduced once the interaction between national culture and task configuration was introduced in Model 8 (see Table 6.6). This suggests that the strength of the relationship between cognitive behaviour and productivity was not the same across task configurations for Chinese and British workers.

6.6 How National Culture Moderates the Effect of Worker Behaviour on Productivity within different Task Configurations

The testing of interaction effects addresses hypotheses 3and 4 and begins with Model 8, which is presented in Tale 6.6. The inclusion of these interactions investigates whether national culture moderates the effect of worker behaviours on their productivity for different task configurations. The three-way interaction produces lower-level relationships such as the main effect for the three main variables and their two-way interactions. However, only significance at the highest order of the interaction should be interpreted.

Table 6.6 Results of MLM for Worker Productivity (Models 8 – 11)

	Model 8	Model 9	Model 10	Model 11
Task Configuration				
Groups (Mass and Lean) vs Craft	-0.541(1.135)	0.05(1.245)	-0.109(1.26)	-0.109(1.251)
Groups (Lean vs Mass)	1.539(2.011)	1.315(2.185)	1.704(2.235)	1.704(2.218)
Line characteristics				
Positions 1 vs Position 3	-3.399(2.199)	-3.106(2.266)	-3.099(2.266)	-3.35(2.248)
Position 2 vs Position 3	-4.042(1.902)*	-3.999(1.923)*	-3.994(1.923)*	-4.044(1.909)*
Positions 3vs Position 4	-14.24(2.16)***	-14.521(2.192)***	-14.765(2.211)***	-14.471(2.15)***
Workstations	-0.291(1.438)	-0.372(1.499)	-0.426(1.5)	-0.211(1.494)
Individual Differences				
Male	-3.978(2.733)	-3.96(2.775)	-4.119(2.781)	
Age	-0.045(0.167)	-0.039(0.17)	-0.033(0.17)	
Aptitude	1.103(1.164)	0.95(1.182)	0.772(1.201)	
Experience	-0.08(3.865)	0.229(3.913)	0.541(3.93)	
Stay in UK	-0.009(0.071)	0.002(0.072)	0.007(0.072)	
Main Effects				
Co-worker performance	0.762(0.048)***	0.777(0.05)***	0.737(0.068)***	0.737(0.068)***
Nationality	-1.315(3.039)	-1.74(3.096)	-1.751(3.096)	-1.403(2.918)
Segmentation score	-160.262(108.393)	-156.188(109.45)	-153.498(109.478)	-149.136(109.149)
Feedback	-0.38(1.256)	-0.013(1.574)	-0.204(1.59)	0.336(1.531)
Social support	-0.767(1.263)	-1.396(1.42)	-1.388(1.42)	-1.345(1.417)
Mean Co-worker performance			0.083(0.1)	0.081(0.097)
Two-way Interactions				
Nationality x Groups vs Craft	3.921(1.658)*	3.586(1.878)†	3.985(1.939)*	3.985(1.924)*
Nationality x Groups	-2.172(2.785)	-2.53(3.143)	-2.729(3.154)	-2.729(3.13)
Nationality x Seg. score	-163.574(159.708)	-207.003(166.324)	-220.19(167.039)	-194.418(164.828)
Groups vs Craft x Seg. score	72.078(67.037)	70.559(67.904)	74.914(68.156)	74.914(67.638)
Groups x Seg. score	-109.904(115.863)	-106.876(117.363)	-111.385(117.578)	-111.385(116.684)
Nationality x Feedback		-2.153(2.903)	-2.148(2.902)	-2.568(2.876)
Groups vs Craft x Feedback		0.785(0.942)	0.709(0.947)	0.709(0.94)
Groups x Seg. Feedback		0.178(1.625)	0.123(1.628)	0.123(1.615)
Nationality x Social support		3.182(3.073)	3.504(3.096)	3.751(3.049)
Groups vs Craft x Social support		0.266(0.886)	0.236(0.888)	0.236(0.881)
Groups x Social support		-0.292(1.535)	-0.246(1.537)	-0.246(1.526)
Three-way Interactions				
Nationality x Groups vs Craft x Seg. score	195.905(96.342)*	205.425(100.141)*	201.895(100.308)*	201.895(99.545)*
Nationality x Groups x Seg. score	-26.046(166.723)	-33.904(173.334)	-30.394(173.519)	-30.394(172.199)
Nationality x Groups vs Craft x Feedback		-0.974(1.76)	-0.866(1.766)	-0.866(1.753)
Nationality x Groups x Feedback		0.871(3.05)	1.068(3.061)	1.068(3.038)
Nationality x Groups vs Craft x Social support		-0.621(1.881)	-0.605(1.883)	-0.605(1.868)
Nationality x Groups x Social support		0.141(3.265)	-0.032(3.274)	-0.032(3.249)
Pseudo R^2	0.305	0.308	0.309	0.307

Note: n = 360 tasks (level 1) in 120 workers (level 2) in a repeated measure design. Coefficients are reported with standard errors in parentheses. * p < .05 ** p < .01 *** p < .001

The effect of the task configuration on productivity was significantly different for Chinese and British workers. This was confirmed in a two-way interaction, $\beta = 3.921, t(231) = 2.364,\ \rho = < .05$ (Model 8). This finding confirms earlier findings

of the t-test analysis in the descriptive summary which showed that British workers were significantly more productive in the Craft configuration than Chinese workers, but was also less productive in the Lean configuration that Chinese workers. Therefore, the impact of the task configuration on productivity was not universal across nationalities. This relationship between nationality and task configuration remind significant in subsequent models, except in Model 9 when it achieved a p-value of .0575. This two-way interaction, however, forms part of the three-way interaction, which is the main investigation. As such, this higher order interaction was explored.

The first three-way interaction addressed the context within which cognitive behaviour related to productivity. This interaction confirmed that national culture moderates the effect of event segmentation on productivity within different task configurations, in such a way that this cognitive behaviour only affects performance for Chinese workers in the most flexible task configuration, $\beta = 205.425, t(223) = 2.051,\ p = < .05$ (Model 9). This interaction remained significant in the final model (Model 10), $\beta = 201.895, t(223) = 2.055,\ p = < .05$. Thus hypothesis 3 is confirmed for productivity. To further probe this significant result, the interaction effect in Figure 4.2 was plotted and assess the moderating relationship using a simple slope analysis.

The second three-way interaction addressed the context within which social behaviour related to productivity. This interaction was not confirmed as national culture did not moderate the effect of feedback or social support on productivity within different task configurations, $\beta = -0.974, t(223) = -0.553,\ \rho > .05$ and $\beta = -0.621, t(223) = -0.330,\ \rho > .05$ (Model 9). This interaction remained insignificant in the final model (Model 10), and there were no significant relationships at the lower levels of the interactions. Thus hypothesis 4 is not confirmed for productivity. Before probing the significant interaction, the reduction in model errors or the effect sizes were assessed through the pseudo R^2.

The effect sizes were presented earlier at the bottom of Table 6.4, Table 6.5 and Table 6.6. As discussed in Section 4.5.3 of the Methodology, the pseudo R^2 by Snijders and Bosker (1999) was used to estimate the model effect for the multilevel analysis. Identifying the mean productivity for each task in Model 1 explained 3.8% more variance than the null model (pseudo R^2= 0.038). Including line characteristics in

Model 2 explained 1% more of the variance in the productivity over merely accounting for the task configurations in Model 1 (pseudo R^2=0.048). Likewise, including demographic differences in the prediction of productivity (Model 3) accounted for 0.3% more variability (pseudo R^2 = 0.051).

Accounting for the workers' behaviours achieved larger reductions in model error. Therefore, a pseudo R^2 of 0.274 was achieved when co-worker performance was included in the model. This represented an additional 22.3% of explanation of the variation in productivity compared to just including the control variables in Model 4. Although there were previous findings in the literature on how workers could be motivated to work harder through co-worker performance (Schultz et al., 2010), which in this case was synonymous with the visibility of buffer, arguably this variable was surprisingly the largest behavioural predictor of performance. Adding the other behavioural variables also reduced the error in prediction but arguably to a lesser extent. Including nationality, event segmentation and social behaviours contributed a change in pseudo R^2 of 0.9% (Model 7, pseudo R^2 of 0.283). Therefore, while each behavioural variable improved prediction, co-worker performance had the most influence in reducing prediction error. The addition of the interaction terms starting with Model 8 continued to improve prediction with the main model, Model 10, achieving a pseudo R^2 = 0.309. These measures of accuracy in the model specification demonstrate that there was a continued improvement in the predictive capacity of the model predicting productivity. The highest reduction in error in predicting productivity was achieved by including co-worker performance in the model, followed by line characteristics and the interaction terms. A closer look at the significant interaction term follows.

Simple Slope Analysis for Productivity

A simple slope analysis was performed for each regression line to determine whether the slope was significantly different from zero and to ascertain whether the relationship between segmentation scores and nationality within a specific task was significant (Aiken & West, 1991). This simple slope analysis is presented in Figure 6.1.

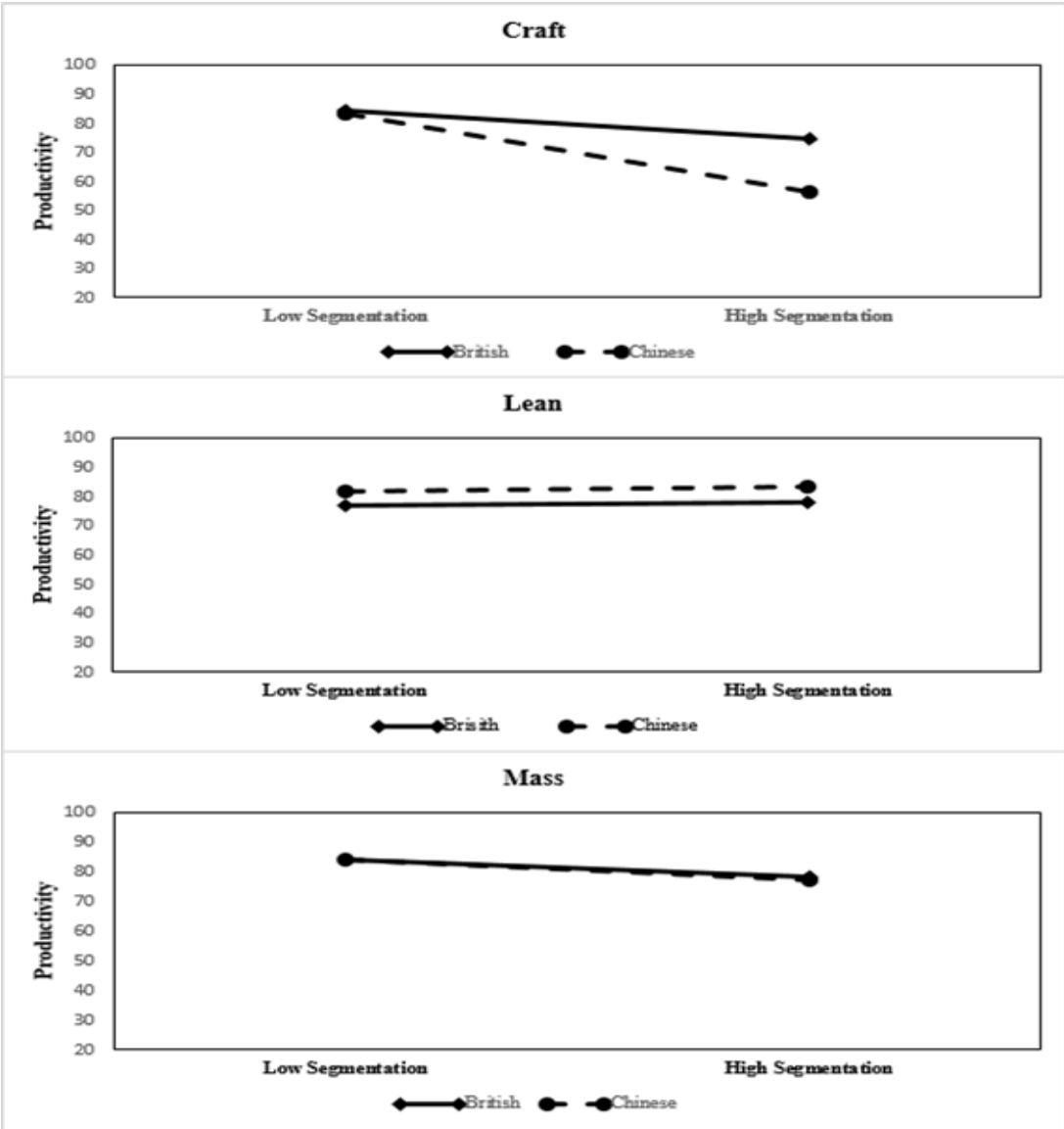


Figure 6.1 Slope Analysis for Interaction (Nationality, Event Segmentation and Task Configurations)

The relationship between segmentation scores and productivity was negative when the Chinese performed the Craft task (t = -30.186, $\rho < .05$). Under conditions of increased specialisation, the relationship between segmentation scores and productivity for the Chinese was reduced. On average, there is no relationship between segmentation scores and productivity when the Lean and Mass tasks are assessed together. However, using post hoc tests, the tasks were assessed separately. The relationship between segmentation and productivity was neutral in the Lean task (t = 1.659, n.s.), but the Mass task showed a significantly negative relationship (t = -8.821, $\rho < .05$). However, the magnitude of the relationship between segmentation and productivity was smaller

in the Mass task than the Craft (see Figure 6.1). For the British workers, like the Chinese, the relationship between segmentation scores and productivity was significantly negative in the Craft configuration (t = -15.517, $\rho < .05$) and the Mass configuration (t = -11.057, $\rho < .05$). There was no significance in the Lean configuration of the task (t = 1.909, n.s.).

Notably, the effect of segmentation on productivity for British workers was less affected by changes in the configuration. However, the consistency in the magnitude of the relationships between the British sample and the Chinese sample for each task suggests that the behavioural effect is most pronounced in the Craft configuration. However, a slope difference test in the Craft configuration revealed that although the relationships between segmentation scores and productivity are negative for both groups, the magnitude of the relationship differed significantly between both groups (t = 4.211, $\rho < .05$). These results provide support for hypothesis 3.

6.7 Assessing Quality Conformance

Measuring quality in the paper airplane simulation within the context of an experiment was constrained by the low level of task complexity. Also, for comparative purposes, all participants made the same model airplane. However, variation in quality can be measured as conformance or the precision with which the paper planes were made. The analysis of conformance used the same methods as outlined in the main analysis of productivity. As outlined in the Methodology (Section 4.5.1), conformance is measured as an index of the precision in making the folds and placing the stick-on star (insignia). The analysis starts with a look at the descriptive summary.

Descriptive summary of performance

Table 6.7 illustrates the means (μ) and standard errors (*SE*) for the performance measures under investigation. Quality conformance was measured for all participants in the Craft configuration. However, the quality measures used were only related to workers in position 3 and 4 in the Mass and Lean configurations. Therefore, quality

conformance was only measured for 55 workers (British = 28 and Chinese = 27) in the Lean and Mass configurations.

Table 6.7 Means (μ) and Standard Error (*SE*) of Quality Conformance

Variables	**Mean(Standard Error)**		**Welsh's T-Test**		**Effect Sizes**
	British	*Chinese*	*t*	*df*	*r*
Craft	0.730(0.025)	0.795(0.025)	-1.903	117.83	0.173
Mass	0.849(0.019)	0.864(0.025)	-0.509	52.229	0.070
Lean	0.879 (0.013)	0.883(0.072)	-0.041	52.645	0.006

** p<0.05 ** p<0.01 *** p<0.001*

The specialised task configurations yielded the highest level of quality conformance, with the Lean task configuration maintained the highest average quality conformance for both the British (μ= 0.879, *SE* = 0.013) and Chinese (μ= 0.883, *SE* = 0.072) workers. Although Chinese workers achieved higher levels of quality conformance, the differences between nationalities was not significant, $\mathrm{t}(117) = -1.903, \rho > .05, \mathrm{r} = .2, \mathrm{t}(52.229) = -0.509, \rho > .05, \mathrm{r} = .1$ and $\mathrm{t}(52.645) = -0.041, \rho > .05, \mathrm{r} = .0$ > .05, r = .0. However, the small effect sizes suggest that difference in Nationality was not a strong predictor of quality conformance. The manufacturing performance models estimated for productivity are reproduced for quality conformance to view the effect that task configuration, line characteristics and demographics may have on quality conformance. The effect of cognitive and social behaviours on quality conformance is also investigated as a secondary analysis.

Assessing the fit of multilevel models for quality conformance

Each multilevel assessment begins with an overall assessment of the improvements in fit for each model. This is followed by a detailed look at the relationships contained in the model. The fit of the model is assessed using likelihood ratios which are presented in Table 6.8.

Table 6.8 Assessing Model Fit for Manufacturing Performance (Quality Conformance)

Model	Degrees of freedom (df)	Log-Likelihood	Fit comparison	Chi-square (χ^2)
Baseline	4	100.7681		
1	6	117.7856	Base vs 1	34.035***
2	10	119.0464	1 vs 2	2.522
3	15	125.3779	2 vs 3	12.663*
4	16	132.4932	3 vs 4	14.231***
5	17	133.4486	4 vs 5	1.911
6	18	133.5749	5 vs 6	0.253
7	20	133.9712	6 vs 7	0.793
8	27	135.0065	7 vs 8	2.071
9	37	139.2647	8 vs 9	8.516
10	38	139.4891	9 vs 10	0.449

*Note: * p < .05 ** p < .01 *** p < .001*

As in the previous analysis, MLM was employed, and the models include the same predictors as the main productivity analysis. A comparison of the baseline model with no predictor with the variable that identifies the three task configurations revealed that accounting for separate task means significantly improved the fit of the model, $\chi^2(6) = 34.035$, $\rho < .05$. This indicates that the variance between tasks was significant; therefore, specifying a random intercept multilevel model which separated the mean for each task configuration was appropriate. There were two other significant adjustments in predicting quality conformance, including workers' individual differences, $\chi^2(15) = 12.663$, $\rho < .05$, and co-worker productivity $\chi^2(16) = 14.231$, $\rho < 0.05$. The fitting of a model for quality conformance alludes to the fact that task configuration, at least one individual difference and co-worker performance has had the most influence on quality conformance. An assessment of these and other relationships ensues in the following sections.

Predicting quality conformance from the task configuration, individual differences and worker behaviours

Selected results are presented in two tables. Table 6.9 provides a detailed result of Model 1 to Model 3. These set of models detail the introduction of the task configurations and the control variables for line characteristics and individual differences. Table 6.10 shows the results of the consecutive introduction of the behavioural variables (Models 4 – 7). The models showing interactions are not shown

as they do not improve the prediction of quality conformance. Although these models are presented separately, they may need to be cross-referenced for relationship comparisons. Combined, these models present a supplementary analysis of the most influential variables in predicting conformance in the manufacturing simulation.

Table 6.9 Selected Results of MLM for Quality Conformance (Models 1- 3)

	Model 1	**Model 2**	**Model 3**
Task Configuration			
Groups (Mass and Lean) vs Craft	0.035(0.006)***	0.036(0.006)***	0.036(0.006)***
Groups (Mass vs Lean)	-0.009(0.011)	-0.009(0.011)	-0.009(0.011)
Line Characteristics			
Positions 1 vs Position 3		0.036(0.027)	0.038(0.026)
Position 2 vs Position 3		-0.022(0.023)	-0.015(0.023)
Positions 3vs Position 4		-0.005(0.022)	-0.012(0.022)
Workstations		-0.007(0.016)	-0.011(0.016)
Individual Differences			
Male			-0.039(0.028)
Age			0.001(0.002)
Aptitude			0.035(0.012)**
Experience			0.015(0.039)
Stay in UK			0(0.001)
Pseudo R^2	0.11	0.116	0.131

Note: n = 233 tasks (level 1) in 120 workers (level 2) in a repeated measure design. Coefficients are reported with standard errors in parentheses. * p < .05 ** p < .01 *** p < .001

Model 1 differentiates the means of each task configuration. Contrasts were used to compare the means for the two specialised tasks, Mass and Lean, with the Craft task, which represented a task configuration with increased flexibility. The Mass and Lean tasks significantly improved conformance, $\beta = 0.035, t(111) = 6.102,\ p = < .05$ (see Table 4.12). The Lean task produced higher conformance than the Mass task, $\beta = -0.004, t(196) = -0.377,\ p = > .05$, but there was no significant difference in conformance between both the Lean and Mass. These results were maintained in all models. In essence, increased control in the task configuration due to specialisation also increases quality conformance. Neither the position of the worker nor the number

of workstations in the assembly line was significantly related to quality conformance. However, the aptitude of the worker was significant in predicting quality conformance. Workers with higher aptitude scores were keener in achieving quality conformance, $\beta = 0.0347, t(110) = 2.899,\ p = < .05$.

The behavioural variables were added, starting with Model 4. While increases in co-worker productivity significantly reduced quality conformance, $\beta = -0.001, t(110) = -3.731,\ p = < .05$, Model 7 showed that quality conformance was similar across Nationalities $\beta = 0.035, t(110) = 1.121,\ p = > .05$ and segmentation scores were not related $\beta = 0., t(110) = 0.534,\ p = > .05$. The effect sizes through pseudo R^2 are subsequently reported.

Table 6.10 Results of MLM for Quality Conformance (Models 4 - 7)

	Model 4	**Model 5**	**Model 6**	**Model 7**
Task Configuration				
Groups (Mass and Lean) vs Craft	0.038(0.006)***	0.038(0.006)***	0.038(0.006)***	0.038(0.006)***
Groups (Lean vs Mass)	0.002(0.012)	0.002(0.011)	0.002(0.012)	0.002(0.012)
Line Characteristics				
Positions 1 vs Position 3	0.032(0.025)	0.031(0.025)	0.029(0.026)	0.03(0.026)
Position 2 vs Position 3	-0.015(0.022)	-0.016(0.022)	-0.014(0.022)	-0.014(0.022)
Positions 3 vs Position 4	-0.001(0.021)	0.002(0.021)	0.003(0.021)	0.002(0.021)
Workstations	-0.011(0.016)	-0.01(0.016)	-0.011(0.016)	-0.012(0.016)
Individual Differences				
Male	-0.031(0.027)	-0.031(0.026)	-0.029(0.027)	-0.022(0.028)
Age	0.001(0.002)	0.001(0.002)	0(0.002)	0.001(0.002)
Aptitude	0.041(0.012)***	0.042(0.012)***	0.042(0.012)***	0.041(0.012)***
Experience	-0.002(0.038)	-0.011(0.038)	-0.011(0.038)	-0.008(0.039)
Stay in UK	0.000(0.001)	0(0.001)	0(0.001)	0(0.001)
Main Effects				
Co-worker performance	-0.001(0)***	-0.001(0)***	-0.001(0)***	-0.001(0)***
Nationality		0.035(0.026)	0.041(0.029)	0.035(0.031)
Segmentation Score			0.396(0.808)	0.435(0.816)
Feedback				0.01(0.013)
Social Support				-0.003(0.012)

Note: n = 233 tasks (level 1) in 120 workers (level 2) in a repeated measure design. Coefficients are reported with standard errors in parentheses. * p < .05 ** p < .01 *** p < .001

Pseudo R^2	0.148	0.151	0.150	0.152

The effect sizes presented earlier at the bottom of Table 6.9 and Table 6.10, are discussed. Following earlier analysis, the pseudo R^2 by Snijders and Bosker (1999) will be used to estimate the model effect for the multilevel analysis. Accounting for the three task configurations separately explained 11% of the variance in the quality conformance that the baseline model (pseudo R^2=0.11). Following this effect, the main improvements in the prediction of quality conformance came in Model 3 (Δ pseudo R^2=0.025) and Model 4 (Δ pseudo R^2=0.012). This finding conforms that worker specialization, worker aptitude and the motivation of the pace of other workers was most influential in predicting quality conformance.

6.8 Validation of Findings

Several supplementary analyses were performed to test the assumptions of MLM and establish the robustness of the results presented. Homoscedasticity and normality for residuals were confirmed using scatterplots, Q-Q plots and the Levene's test of homogeneity of variance. In addition, the same analysis was conducted without the control variables for individual differences between workers under the assumption that the within-group samples were randomly selected. These results are presented in Model 11 of Table 6.6 and are comparable to the findings on hypotheses 1 and 3 presented in Model 9 of the productivity analyses. Model 11 omits the control variables for individual differences to test whether the main relationships still hold. A similar analysis is pursued by Glaser et al. (2016) to validate their findings. Therefore, the main behavioural relationships in the model are independent of demographic differences for the participants. This is a signal of the predictive strength of the findings.

Numerous OM scholars have called for the treatment of endogeneity in regression analysis (Ketokivi & McIntosh, 2017; Lonati et al., 2018; Lu et al., 2018). Endogeneity arises when predictors are correlated with the error term in a regression analysis. Such a correlation reduces the magnitude of relationships estimated in regressions by decreasing the accuracy of coefficients (Ketokivi & McIntosh, 2017). However, the timidity of researchers in testing for endogeneity in empirical work is influenced by the challenges in assessing endogeneity and finding its source. Arguably, the absence

of endogeneity requires that the correlation between the predictor and error term be zero. In the case of MLM, addressing endogeneity is complex because endogeneity can be present at different levels of the analysis. Therefore, it is not desirable to have level 1 predictors correlated with the level 1 error (i.e. covariance (X_{it}, ε_{it}) = 0) or the level 2 predictors correlated with level 2 errors (covariance (Z_i, r_i) =0). In addition, level 1 predictors should not be related to level 2 errors (i.e. covariance (X_{it}, r_i) = 0) and level 2 predictors should not be related to level 1 errors (covariance (Z_i, ε_{it}) =0). However, this condition cannot truly be satisfied. Hence, there is validity in the proposal of Ketokivi and McIntosh (2017) that endogeneity assessments should be guided by strong theoretical and pragmatic assumptions.

There are no theoretical findings that purport any endogeneity issues for this study. However, a robust version of the analysis is run to see whether the main findings are affected by endogeneity. This endogeneity problem is the cross-level assumption that the level one independent variable, co-worker productivity, is correlated with the random effect on the intercept or the error measured at level two of the model. The concern is that there is a correlation between co-worker performance, which is a level 1 predictor because it is measured for each task configuration and the residual from the subject level predictors in level 2 of the model. This expression could also be specified as robust measures against the effect of any unobservable worker characteristics present in the error term that is correlated with the observable co-worker performance.

This study uses the Mundlak (1978) endogeneity-robust approach adopted to multilevel estimation by Hanchane and Mostafa (2012). Mundlak (1978) proved that the solution for endogeneity would be to include level 2 means of level one predictors in the analysis. Consequently, including a task-invariant measure of co-worker performance ($\bar{X}_i$) in Model 9 created a robust analysis of Model 8. The inclusion of this predictor separates the between worker and within worker effects (Snijders & Berkhof, 2008). As such, ($\bar{X}_i$) can be viewed as the overall co-worker effect. The robust results presented in Model 9 of Table 6.6 are found to be consistent with the non-robust analyses.

6.9 Summary of Findings

This study constitutes a behavioural investigation into the national culture moderates cognitive and social worker behaviours and how this relationship between national culture and worker behaviour affects productivity within different manufacturing task configurations. This assessment compared the cognitive perception of the paper airplane manufacturing simulation by Chinese and British workers and found that Chinese workers perceived significantly fewer segments in a manufacturing task. This cognitive behaviour was also significant in predicting productivity. While task segmentation achieved a significant main effect in predicting worker productivity, this cognitive behaviour was significantly more influential on productivity within the most flexible task configuration (i.e. Craft). National culture also differentiated the social behaviours of workers. Chinese workers were more inclined to offer feedback and social support to co-workers. However, these behaviours did not significantly affect productivity. Therefore hypotheses 1, 2, and 3 were confirmed, but hypothesis 4 was not.

These investigations yielded results beyond the findings. Firstly, a major predictor of worker performance was the performance of their co-workers. Workers seemed to be motivated by the pace of their colleagues as workgroups seemed to produce similar output even when tasks were not interdependent. Preliminary tests showed that there were productivity differences between Nationalities and British workers performed significantly better in the Craft configuration than Chinese workers. However, Chinese workers performed significantly better in the Lean task configurations. This suggests that there may be cultural affinities embedded in task configurations that should be considered when developing production systems. Overall, the specialised Mass and Lean task configurations improved productivity.

A supplemental assessment of quality conformance was undertaken to assess the precision of workers within production. The findings signalled that conformance significantly increased with task specialisation. In addition, conformance had a positive relationship with worker aptitude, while co-worker productivity reduced quality conformance. The importance of these findings will be explored in the Discussion chapter.

Chapter 7 Discussion

Research on the impact of worker behaviour on performance has been examined under different disciplines and topics. To survive in this increasingly globalised production environment requires an understanding of how the global context affects the behaviour of workers and how production systems and the tasks configured within these systems elicit these behaviours. One such contextual variable is national culture. The effect of national culture on operations performance is well documented (Kull et al., 2014; Eckerd et al., 2016; Lee Park & Paiva, 2018; Lee et al., 2018). Findings from this study indicate that national culture differentiates the behaviour of workers. This finding supports the continued inclusion of national culture in studies of behavioural operations (Loch & Wu, 2005). Further, national culture moderates the effect of cognitive worker behaviour on productivity. As the relationship between cognitive behaviour and productivity was curbed by tasks configured for increased specialisation, the important role of task configuration in controlling the impact of worker behaviour on operations performance was demonstrated. While cognitive and social behaviours were the focus of this investigation, worker productivity was motivated by their co-workers' performance, which acted as an indirect method of performance feedback. These and other supplementary findings are discussed in this section.

7.1 Cultural Differences in Cognitive Behaviour

A major decision in configuring production tasks is determining how to segment products and processes into parts, assemblies and task assignments. These task breakpoints result from strategic decisions. Managers rely on workers to perceive these breakpoints as cues to shift production goals. Findings from a sample of British and Chinese workers support event segmentation as a reliable measure of perception as manufacturing task segmentation remained consistent between trials and between tasks. Therefore, event segmentation was investigated as the cognitive behaviour of this study and the cultural differences in event segmentation were confirmed.

Event segmentation was found to be a consistent measure of perception within the worker and between manufacturing tasks. Event segmentation as a measure of perception is an essential neuropsychological function that aids in the storage and recall of a flow of information. The premise of event segmentation is that perception aids prediction and, subsequently, performance. As such, given the same stimuli, individuals are consistent in their segmentation (Zacks & Sargent, 2010). Participants identified a similar number of breakpoints twice for the same manufacturing stimuli for two different manufacturing tasks. The fact that the segmentation score findings found in the pump task were replicated in the plane task supports the paper airplane manufacturing simulation as a suitable representation of a manufacturing task.

This argument does not contravene the proposition that segments concatenate over time (Song & Cohen, 2014), as there was also indirect evidence of concatenation in the findings. Therefore, consistency means that workers reasonably identify similar breakpoints for the same stimulus, even though the number of breakpoints can be reduced as workers become more efficient at remembering and predicting the flow of action. Although segmentation scores in the second trials were not remarkably different from those in the first trial, the workers created fewer segments in the second trial for both tasks. This finding signals that as workers got used to the task, the need to create segments for learning diminished.

Hypothesis 1 was confirmed as workers from different cultural groups segmented their production tasks in markedly different ways. The Chinese identified more breakpoints in perception, thereby creating larger chunks of event. The breakpoint analysis in Figure 5.1 illustrates that the Chinese were likely to view symmetric assemblies as one event segment. This perspective was the opposite for British workers who exhibited analytical perceptual behaviour and created significantly more event chunks. The British viewed each fold as a break in perception. The robustness of segmentation theory is reaffirmed by the fact that both samples create segments for the star. The placement of the star is a unique step in the assembly task and creates a shift in task goal. The star requires unique motion (compared to creating the folds) and introduces new material to the production process. As a result, it is no surprise that this step creates a compelling cue for a break in perception (creation of the event boundary). After the placement of the star, the systematic difference in segmentation between the

British and the Chinese reappears. This study is the first to offer a cross-cultural examination of event segmentation in operations task and substantiates earlier studies on perception.

The findings are consistent with the holistic versus analytical perceptual patterns that other researchers have found in Asians and Westerners (Masuda & Nisbett, 2001; Nisbett et al., 2001; Nisbett & Miyamoto, 2005). Since Asians tend to perceive the objects and events as more related, they create larger chunks of information, which results in fewer breakpoints in a flow of information. Westerners focus on objects rather than relationships; the consequence is the creation of more breakpoints and shorter chunks in a flow of task information (Ji et al., 2000; Chua et al., 2005). Wang (2009) argues that the Asians' perception of fewer event segments results in the need for fewer units of encoded information required for memory. This tendency has implications for manufacturing in several ways.

Creating fewer event segments may reduce cognitive processing for workers as fewer stimuli need to be perceived for memory and recall. This may improve speed and reduce movement breakpoint, which may also slow the worker. This relationship between segmentation and performance will be discussed further in the subsequent discussion on manufacturing performance. A significant implication for the findings of this study concerns how to use breakpoints strategically in the assembly. One possible application is the use of symmetric assemblies or parts to improve efficiency.

The intent of symmetric assemblies is to reduce the cognitive load of workers as they make decisions on how to execute their tasks. If the Chinese are less susceptible to breakpoints in the task configuration, then symmetric designs may be more effective for this group of workers. However, since British workers seem more susceptible to breakpoints in the assembly, more effort is required to subdue breaks in the assembly that are not intended to signal a shift in assembly goals. The converse is also true. Given that Asians are less susceptible to the breakpoints and tend to perceive larger chunks, there is a heightened need to amplify cues in the production process that are intended to signal to workers a change in goals. The literature (e.g. Erlandson et al., 1998; Gold et al., 2016) reveals that various methods have been used to manipulate

cue perception, including cultural priming and making event boundaries more salient through boundary manipulation and perceptual cueing.

In instances where workers are bi-cultural, priming the desired culture has indicated promising results. Biases, consistent with the primed culture, have been shown to affect the completion of tasks (Miyamoto et al., 2006; Wang et al., 2010). This intervention is more suited to operations in diverse labour markets where factors such as immigration have created a multicultural workforce.

Using event segmentation training to improve the perception of task boundaries is substantiated by research in psychology. Since breakpoints in a task represent anchors in one's memory, the manipulation of these boundaries could improve task perception and memory. Boltz (1992) found that observers' memory of a film was improved by placing commercials at breakpoints. However, as participants' memory was not enhanced when commercials were placed at non-breakpoints or when no commercials were included, the commercial was used to amplify breakpoints, which improved memory. Breakpoint manipulation has been used in assembly tasks for the strategic placement of messaging for workers (Iqbal & Bailey, 2008; Kolbeinsson et al., 2017). This research found that sending messages on the production floor to workers was most successful at significant breakpoints in the assembly.

Perceptual cueing has also been used to draw attention toward specific parts of a movie by using an arrow, ringing a bell, or changing the replay speed (Gold et al., 2016). Cueing the event boundaries and forcing the participants to segment the activities resulted in improved memory and recall. This practice of cueing perception is not foreign to operations management and is akin to the use of the quality management tool, poka-yoke. Poka-yoke is any mechanism that helps the worker avoid mistakes by drawing attention to potential errors. For example, designing place holders for tools in an assembly kit to avoid leaving tools on the production line or in a product. Poka-yoke minimises the overall "physical and cognitive demands of a task" that may be related to the search for specific parts or tools (Erlandson et al., 1998, p. 269). By directing perception to specific areas of the task, poka-yoke results in improvements in performance such as the reduction in the probability of errors. By enhancing production cues, poka-yoke serves as a behavioural training technique that allows the

worker to avoid making errors. In the previous example, replacing all tools in the kit becomes a natural part of the assembly process. Thus, poka-yoke can also be used to alter the perception of assembly breakpoints by attracting attention to important breakpoints.

As workers segment their production tasks differently across cultures, then insights from the cognitive behaviours of workers can be used to enhance the perception of assemblies and task cues as operations expand to new cultural contexts. Another element of this discussion is how national culture may affect social behaviours. Therefore, the following section explores the relationship between national culture and social behaviours.

7.2 Cultural Differences in Social Behaviour

One way of facilitating efficiency in production is making resources visible. One such resource that is often visible in production is the shop-floor worker. Efficiency is facilitated by increased plant utilisation, task interdependence and positive social behaviours such as feedback to improve performance. However, the open-plan nature of production can engender social behaviours that result from the interaction of workers and the behavioural responses that workers may think are socially acceptable. Often times, while these social behaviours are taken for granted and are not included as part of the task description, they facilitate performance improvement through greater interdependence and learning (Katz & Kahn, 1966; Perlow & Weeks, 2002).

Findings from the sample of British and Chinese workers demonstrated that social behaviour in the form of social support and feedback from co-workers was significantly higher for Chinese workers. Therefore, national culture does differentiate social behaviours in production, confirming the second hypothesis of this study. Social behaviour is even more important to configurations with less standardisation (Bell, 1973). Instances of this include production tasks required some flexibility or configurations which require high levels of interdependence such as lean production. Thus, tasks and responsibilities cannot be cleanly divided up, which creates opportunities for consultations or helping behaviour (Perlow, 2002). Social behaviours manifest in production circumstances within groups to ensure that outputs produced

by one person are consistent with inputs required by another to facilitate efficiency, flexibility and learning (see Malone & Rockart, 1991; Nickerson, 1992).

Previous findings support the notion that the collective culture of the Chinese facilitates greater social support and feedback, where workers from more individualistic cultures such as the British may be less inclined. For example, Western cultures place emphasis on rewarding individual productivity and not social behaviours (Wadel, 1979; Daniels, 1987; Perlow, 1997; Fletcher, 1999). Using different samples of collective and individualistic cultures, Perlow (2002) found similar evidence, but cautions that the effects of national culture should not be interpreted in isolation as incentives and opportunities to help may also facilitate social behaviour.

It is important that the take-away point is not that the Chinese should be less collective in task configurations where social behaviours are undesirable, or the British should be less individualistic in task configurations where feedback and support boost efficiency. Rather this finding exposed the often undocumented ways in which culture differentiates social behaviours, thus guiding when and why these behaviours are elicited during production. Therefore, these social behaviours and the previously discussed cognitive behaviours were used to predict productivity. A discussion of these findings follows.

7.3 National Culture as a Moderator of the Impact of Worker Behaviour on Productivity in different Task Configurations

One of the key objectives of this thesis is the linking of the cultural influences on worker behaviour, previously discussed, on manufacturing performance. Hypotheses 3 and 4 tested the previous objective using three-way interactions between nationality, worker behaviour (i.e. cognitive and social) and task configuration. Social behaviours did not have a significant relationship with productivity; neither did culture moderate the effect of the behaviour on productivity. This could be due to the fact that the experimental design may have limited the overall opportunity and effects of social behaviour. On the contrary, a relationship was discovered between cognitive

behaviour and productivity, and this relationship was moderated by national culture. The discussion that ensues will address this finding.

In assessing the three-way interaction among nationality, cognitive behaviour and task configuration, the relationship between perceptual event segmentation and performance was only significant in the more flexible task configuration. Event segmentation had a negative relationship with productivity in the most flexible task configuration (Craft). This finding can be explained as the result of a relationship between the physical features of manufacturing breakpoints or assemblies and the behavioural responses that result from the perception of these breakpoints in assembly.

Arguments on the alignment of the physical parts of an entity with its perceptual structure can be extended to manufacturing processes (see Hoffman & Richards, 1984; Tversky & Hemenway, 1984; Zacks & Tversky, 2001). The structural decomposition and organisation of an entity or knowledge into its basic units is a partonomy (Tversky & Hemenway, 1984). Part boundaries, by design, have salient perceptual features which correspond to their functionality, as salience and functionality are required standards of part quality. This link between perception and the objective world is reflected in how parts are named to reflect salient features and functionality. These parts further underlie how behaviour is executed and characterised because the sub-goals of behaviour often correspond to an action or reaction to the parts of an entity (i.e. object or process).

This discussion on partonomy can be used to explain behaviours elicited from perceiving events (Tversky and Hemenway, 1984; and Zacks and Tversky, 2001). The vital feature of a part is where it ends, and the other part begins, as it is the discontinuity in the process that allows us to organise and categorise the parts for construction into wholes. Perceptual boundaries are typically formed from part boundaries because it is usually at this point in the process where the highest number of physical features are changing (Zacks & Tversky, 2001). Therefore, the more parts perceived, the more behavioural responses could be generated to cope with the change in stimuli. For example, research by Newtson (1973) shows that individuals were able to detect missing information more at breakpoints than at points in an event without any breakpoints.

First, the segmentation literature highlights that the additional memory encoding needed at segment boundaries to create units of perception leads to cognitive load for individuals (Hard, 2006). Further, this cognitive load can cause increased process variability through pausing production or creating other wasteful actions such as reorienting posture (Barker & Wright, 1955; Newtson et al., 1977; Hard et al., 2006). Also, assembly workers were more alert at coarse breakpoints in assembly than non-breakpoints in the assembly (Kolbeinsson et al., 2017). Thus, it is proposed that this additional variability might slow down the production process, resulting in a negative relationship between perceiving assembly breakpoints and productivity.

National culture moderated the impact of worker behaviour on performance. The magnitude of the behavioural effect of event segmentation on productivity is measured by the slope of the relationship for both Chinese and British workers (see Figure 6.1). The relationship between event segmentation and productivity was strongest for Chinese workers and was only significant in the most flexible task configuration. However, the British workers seemed to be less affected by the increased flexibility.

These findings have numerous implications for task configuration. Due to their proclivity to see tasks with more breakpoints in assembly, British workers may be more tolerant than the Chinese to changes in assembly breakpoints. However, adding assembly breakpoints in the task environment may have a more significant effect of disrupting the perception of the Chinese because they tend to see more relationships than boundaries in events. Thus, more effort might be required to smooth task boundaries in the case of the Chinese. Undoubtedly, further research on the symmetry between assemblies and perceptual event segmentation is required to understand how to manipulate this relationship for performance gains.

Undoubtedly, the efficiency benefits of the specialised task configurations have been evidenced. However, the restriction of worker behaviour is not always desired. The findings confirm that facilitating flexibility in the manufacturing process can facilitate behavioural effects that are otherwise controlled by specialisation. Ultimately, having established these findings on the relationship between national culture, cognitive behaviour and task configurations, this research is promising and important for

operations that want to reconcile manufacturing performance across multinational plants.

7.4 Co-Worker Performance as a Motivator of Worker Productivity

An additional finding of this study is the influence of co-worker performance on individual performance. Workers' speed and quality were significantly influenced by co-workers' speed. The average co-worker speed was used to represent a team or line effect on performance. Certain characteristics have facilitated the efficacy of co-worker performance in this simulation. In the paper airplane simulation, as with many assembly tasks, co-worker performance is visible. Co-worker performance can be signalled to the worker by the number of finished products or buffer being produced (Schultz et al., 1998). The effect of co-worker performance can be positive or negative given the situational factors (Schultz et al., 2010). Therefore, some of the contextual features in the simulation may have facilitated a positive relationship.

First, the simulation is a simple manufacturing task involving repeated folds and the placing of a star. Thus, at no point would workers become demotivated by co-workers' performance or by feeling that the task was unattainable (see Linderman et al., 2003). The production environment in the experiment controls for much of the noise in the realistic operations environment, as such workers can benefit from synchronicity, even in the absence of a Kanban system, by being able to 'feel' the tempo of the work in such a controlled environment. Since all workers face the same working constraints and share training and learning abilities, workers can be motivated to improve productivity if the fastest workers are made visible to the production line (Doerr et al., 2004).

The influence of co-worker production rate had a surprising effect on the supplemental analysis of worker precision or quality conformance. Co-worker performance is negatively related to conformance as workers were less consistent in their folds and star placement in the simulation as co-worker productivity increased. As noted earlier, co-workers' performance could be viewed as the average pace of the production line. Therefore, it is reasonable to assume that conformance may decrease with pace. Workers who are motivated to meet the quota of their co-workers' may sacrifice

conformance in the absence of a quality feedback channel, which was absent from this simulation. Therefore, while co-worker performance can be a strategic way to motivate workers (Hirst, 1988; Bendoly & Hur, 2007), the possible reduction in quality conformance or precision of the worker must be controlled through further configuration decisions.

7.5 Summary of Discussion

Overall, national culture influenced both cognitive and social worker behaviours. Chinese and British workers perceived significantly different assembly breakpoints in their task, as Chinese workers consistently perceived fewer assembly breaks that British workers. In regards to social behaviours, Chinese workers were significantly more likely to offer social support or feedback. These cognitive and social behaviours can be linked to the collective and individualistic differences between the Chinese and British cultures. Workers from more collective cultures may perceive fewer assembly breakpoints because they see the world as more connected and involving more relationships. In contrast, workers from more individualistic cultures may see the world in more parts with a focus more on specialisation and objects, rather than relationships.

This study links worker behaviour to productivity. As such, how national culture moderates the effect of cognitive or social behaviours on productivity in different task configurations was investigated. There was no significant relationship between social behaviours and productivity. This lack of significance could have resulted from the controlled nature of the experiment, which, by design, is intended to limit social interaction. However, there was a significant moderating relationship for cognitive behaviour. Cognitive behaviour was significantly related to productivity for Chinese workers. In addition, this significance was only observed in the flexible Craft design. Both operations management and other related disciplines have explored the role of discretion and decision making on performance. Given the era of aggressive global competition and the need for increased flexibility and customisation, the effect of increased process flexibility on worker behaviour is an important consideration.

There are numerous worker behaviours that are present within the production environment; some of which are stimulated by the configuration of the production system. It is the role of behavioural operations to identify persistent or systematic behaviours that can be operationalised. One such behaviour is the response of workers to the performance of other workers. Workers productivity increased with that of their peers, suggesting that they were motivated by the indirect feedback of co-worker performance. However, conformance may be reduced as workers were less precise in assembly with increases in co-worker productivity.

Overall, these findings demonstrate that worker behaviour can affect manufacturing performance. In addition, the systematic effects of worker behaviour between workers from different cultures and tasks configured for different production systems highlight that worker behaviour is not universal. This realisation becomes increasingly important as we expand operations globally and require the comparison of manufacturing performance across national borders. Understanding how national culture may differentiate worker behaviour and how task configuration can be used to control these behaviours is therefore critical.

Chapter 8 Conclusions

This research aims to understand whether national culture influences worker behaviour and whether national culture moderates the impact of worker behaviour on manufacturing performance in different task configurations. The research used a multilevel analysis of manufacturing performance in an experimental design to control the numerous and complex relations in the production environment. In so doing, the research contributes to insights on cultural differences in worker behaviour that may affect performance. The motivation for this investigation arose from the lack of behavioural research of how cultural differences in worker behaviour may affect workers in different task configurations (i.e. Craft, Mass, Lean). This was deemed important due to the multinational nature of many production systems today. Furthermore, there is a lack of theoretical engagement on different elements of production systems and national culture in behavioural operations. Therefore, the remainder of this section restates the hypotheses and their results as well as the contributions to theory, pedagogy and practice that have been made by this study.

8.1 Hypotheses Testing

The goal of the global expansion of operations is to reduce production costs and greater access to consumers. As this expansion occurs, the operations must be evaluated as a multinational entity. Such an evaluation requires a comparative analysis of production systems in cultures that may be markedly different from each other. Decision-makers within multinational operations create synergies within and between production plants by managing the relationships, resources and strategies between the plants. However, the effect that the cultural context has on manufacturing performance and the cognitive and social processes through which this context affects workers is obscure. To improve these decisions, we explored forms of cognitive and social behaviours that have been linked to national culture. Cultural differences in cognitive behaviour were examined as differences in event segmentation for Chinese and British workers. Likewise, social behaviours were examined as the level of social support and feedback in the cultural workgroups. Specifically, the following hypotheses were tested:

H1. National culture influences cognitive behaviour, as workers from the more collectivistic East Asian culture will perceive fewer event segments than workers from the more individualistic Western culture.

H2. National culture influences social behaviour (i.e. social support and feedback), as workers from the more collectivistic East Asian culture will give more social support and feedback than workers from the more individualistic Western culture.

H3. National culture moderates the effect of cognitive behaviour on manufacturing performance, in such a way that this task segmentation only significantly relates to performance for East Asian workers in the most flexible task configuration.

H4. National culture moderates the effect of social behaviour on manufacturing performance in such a way that feedback and social support only significantly relate to performance for East Asian workers in the most flexible task configuration.

Hypothesis 1 and 2 were confirmed. Chinese workers perceived significant fewer event segments in their manufacturing task than British workers, thus demonstrating significant cultural differences in cognitive behaviour. For hypothesis 2, Chinese workers were more inclined to offer social support and feedback. Again, this demonstrated a cultural difference in social behaviour. A relationship between worker behaviour and manufacturing performance was only established for cognitive behaviour. As such, hypothesis 3 was confirmed, but hypothesis 4 was not. National culture moderated the relationship between event segmentation and productivity in such a way that this behaviour was only observed for Chinese workers within the most flexible task configuration (i.e. Craft). Having discussed the implications of these outcomes in the Discussion chapter, the rest of this chapter will focus on the contributions of this study.

8.2 Contributions to Theory

This thesis makes a theoretical contribution to behavioural operations with a specific contribution to understanding the relationship between culturally moderated worker behaviours, manufacturing task configuration and performance. The operations task is the point at which the worker adds value to the operations. Hence, operations tasks are designed to aid performance. As workers execute these tasks, certain cognitive and social processes may influence their performance. While cognitive processes have been explored in various other areas of the operations, including the supply chain and inventory planning (Eckerd et al., 2016; Lee et al., 2018), little specific attention has been paid to operations management in terms of cognition in designing manufacturing tasks. This is also true of social behaviours within production groups (Perlow & Weeks, 2002). Nonetheless, research indicates that behavioural considerations can improve the task configuration and workflows (e.g. Doerr et al., 2002; Doerr et al., 2004).

Consequently, this research contributes to the existing literature by demonstrating that there are systematic differences in cognitive and social worker behaviours between national cultures and that national culture moderates the effect of cognitive behaviour on manufacturing performance in flexible task configurations. This research is not just an examination of the cultural differences in performance, but an investigation into the behavioural mechanism through which culture affects the operations and under what general task configurations is performance more influences by these behaviours. The impact of national culture on worker behaviour is an even greater concern as we compare performance globally. This contribution has also led to two supplemental contributions to theory.

Interdisciplinary research and learning from other disciplines

Investigating worker behaviours in manufacturing requires appropriate measures. For example, behavioural studies have assessed the perception of fairness in supply chains, (Eckerd et al., 2016; Lee et al., 2018), but measuring the perception of assemblies in the manufacturing process requires an innate perceptual measure. A class of chunking theory, event segmentation, is deployed to explain the relationship between perception

and the manufacturing task. Chunking theories have been applied to linguistics, music, psychology and other disciplines to understand how a continuous flow of information or events is understood in parts. Nonetheless, the absence of chunking theory from the operations literature is puzzling given its ingrained synergy with the core tenets of operations management, such as specialisation, process/part design, assembly layout, and so on. This study also incorporates theories of national culture and job design which are more familiar to the field of operations management but still require further investigation in behavioural operations. Therefore, this research broadens the theoretical scope of behavioural operations.

Assessing the behaviour of shop-floor manufacturing workers

The focus of this study is the behaviour of the shop floor or frontline worker. Work in behavioural operations or multinational networks often overlooks the frontline worker in favour of the manager who is seen as the decision-maker. This is understandable, as data collection reduces productive time and organisations prefer to curtail information flow to 'outsiders'. However, the manager does not actually create the product or execute the service. In such instances, it is the frontline worker who engages in production and must react to the configuration of the task. This study indicates that the behaviour of these workers affects their performance. Hence, this research provides needed insight into the behaviours of the workers who engage in production and how their behaviours may differ across cultures in multinational operations. In addition, although British and Chinese nationals care used for cultural comparison, both these cultures have greatly influenced what is known as Western or Asian thought. As such, research from these two cultures can offer insight into the behaviours of workers from many other countries.

8.3 Contributions to Pedagogy

A multinational and behavioural perspective of operations is often not central in business-related courses at undergraduate and postgraduate level. Teaching the theoretical underpinning of these areas can be achieved with a commitment to broadening the scope of operations pedagogy. However, it will require a concerted

effort to incorporate these perspectives into simulations, which are important in making the real operating context more accessible for students and practitioners (Lewis & Maylor, 2007).

The use of simulations to elicit worker behaviour requires more control than the often competitive and emotional execution of simulations in the classroom. Hence, there are some considerations that must be included in simulations to facilitate the teaching of behavioural operations. First, more preparation will be required to simplify the appraisal tools to capture performance in simulations. This effort may also necessitate ensuring that students understand the basic appraisal mechanisms and software before attending the lecture. Importantly, there will need to be more control over the task setting to be able to attribute behaviour.

The drawback to introducing more control is the possible reduction in the elevated levels of competitiveness and motivation often associated with these simulations. Although these elements may be affected, it can be argued that emphasis on the impact of behaviour through adequate debriefing will keep students engaged. Debriefing is an important aspect of experimentation. It allows for reflective learning. It also encourages students to explore how behaviour may affect performance, especially in instances where systematic behavioural reactions to tasks are unknown to the participants. This debriefing is also an important way to collect feedback. The observational data gathered from this study indicate that participants tended to feel more fulfilled after the debriefing process. They believed that they contributed to a meaningful operations objective of learning and research. Thus, a behavioural perspective of simulations can enhance motivation and commitment from students beyond the classroom.

Increasingly the classroom, like operations management, is becoming more diverse. This creates the perfect opportunity to teach with a multicultural perspective. This approach not only complements the thrust for inclusion and diversity in universities but also provides an opportunity for multinational behavioural insights. Starr (1997) pondered whether operations curricula should be more global in nature. This research has supported the view that there are systematic differences in cognitive and social behaviours across cultures. Therefore, the diverse classroom provides an opportunity

for learning and updating the assumptions held about international behaviours. In many instances, students comprise the samples in behavioural studies. As such, a link between pedagogy and research is not far-fetched. It can be argued that this research makes a pedagogical contribution by demonstrating how to adjust a traditional simulation to study the impact of worker behaviour on operating performance.

8.4 Contributions to Practice

The theoretical and pedagogical inferences from this research are equally relevant to practitioners. This point is highlighted by presenting some examples of application. The findings can inform practitioners as they plan and test production in new cultural settings. A great deal of planning goes into organising a factory or plant for production. Even after facilities have been built production needs a period of testing and streamlining before a full ramp-up is pursued (Terwiesch & Bohn, 2001). The strategies of the home country may not be as effective when plants are located in new countries. Therefore, understanding worker behaviour is not just important for the theorist. It is also necessary that the practitioner designing the operations system understand the impact of worker behaviour on performance. This research provides a framework to measure cognitive and social behaviours in the operations and demonstrates the features of task configuration that need to be considered in managing the impact of worker behaviour. This study proposed the configuration of production tasks as behavioural cues for workers, inciting a discussion as to how these behavioural cues can be managed to achieve desired operations performance across cultures.

The growing need for flexible processes in order to maintain competitive advantage, must not overshadow the reason why task features, such as specialisation and the restriction of variety, were initially introduced. This research shows that more flexibility in manual assembly increases performance variability and allows cognitive behaviour to influence manufacturing performance. Therefore, these increasingly complex production systems must include investigations of worker behaviour, particularly in production systems where tasks are configured to relax production control.

8.5 Limitations of the Study and Future Research

Since a doctoral thesis is an arduous research project involving both learning and knowledge creation, a necessary part of the process is reflection. Through that process, inherent limitations become apparent. In the research, workers were not part of a longitudinal study allowing for the testing of other organisational effects on task performance such as organisational culture. While this would have been desirable, it was also important to first understand the cultural differences at the national level to be able to measure the effect of organisational culture on manufacturing performance in future research. For example, Perlow and Weeks (2002) were unable to untangle some of the effects of national culture on worker behaviour from organisational culture. As such, presenting an experimental case reduces the confounding factors of organisational culture.

Another limitation that has been hinted at throughout the project is the fact that the investigation took place only at one level of task complexity. The paper airplane simulation can be considered as a non-complex task requiring no prior experience gained over a considerable time. However, a non-complex task setting was necessary to act as a baseline for future investigation. It also reduced the resource demand, which would have been required to train participants or recruit participants with higher levels of experience for a more complex task.

Future work to address the limitations of this study could be promising. Having established that culture affects worker behaviour, future work may assess how organisational culture and training, in general, modify the effects of culture over time. Also, investigating worker behaviour at higher levels of task complexity may reveal greater influences for education and experience. Likewise, improving the environmental fidelity of the simulation by testing a cross-section of operations tasks would improve the inferences from this research. This could be used to refine the generalisability of these findings by identifying task scenarios that do and do not conform to the findings of this research. Furthermore, future research can expand the knowledge gained from the systematic differences in cognitive and social behaviours to evaluate services. Additional findings of systematic differences in perception

between cultural groups can be used to understand the effectiveness of repetitive tasks on different cultural groups and possible implications on error detection.

Finally, there is theoretical work that can be done to refine the model on how national cultural influences worker behaviour in the production environment. Such a model could draw on the influences of the behavioural framework of Eckerd and Bendoly (2015). This is an important step in the operationalising the effects of national culture on production.

References

Abernathy, W. J., Clark, K. B., & Kantrow, A. M. (1981). The new industrial competition. *Harvard Business Review, 59*(5), 68-81.

Adler, P. S., & Kwon, S. (2002). Social capital: Prospects for a new concept. *Academy of Management Review, 27*, 17-40.

Aiello, J. R., & Kolb, K. J. (1995). Electronic performance monitoring and social context: Impact on productivity and stress. *Journal of Applied Psychology, 80*(3), 339-353. doi:10.1037/0021-9010.80.3.339

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Thousand Oaks, CA: Sage.

Alderfer, C. P., & Smith, K. K. (1982). Studying intergroup relations embedded in organizations. *Administrative Science Quarterly, 27*, 35-65.

Alessi, S. (2000). Simulation design for training and assessment. In H. J. O'Neil & D. H. Andrews (Eds.), *Aircrew training and assessment*. Erlbaum: Mahwah, NJ.

Aranda, J., & Easterbrook, S. (2005). Anchoring and adjustment in software estimation. *ACM Sigsoft Software Engineering Notes, 30*, 346-355. doi:10.1145/1095430.1081761

Arthur, W., Jr., Edwards, B. D., Bell, S. T., Villado, A. J., & Bennett, W. (2005). Team task analysis: Identifying tasks and jobs that are team based. *Human Factors, 47*, 654-669.

Baggett, P., & Ehrenfeucht, A. (1988). Conceptualizing in assembly tasks. *Human Factors, 30*(3), 269-284. doi:10.1177/001872088803000302

Bailey, B. P., & Konstan, J. A. (2006). On the need for attention aware systems: Measuring effects of interruption on task performance, error rate, and affective state. *Computers in Human Behavior, 22*(4), 709-732.

Bailey, C. D. (1989). Forgetting and the learning curve: A laboratory study. *Management Science, 35*(3), 340.

Bailey, D. E. (1998). Comparison of manufacturing performance of three team structures in semiconductor plants. *IEEE Transactions on Engineering Management, 45*(1), 20-32. doi:10.1109/17.658658

Baldwin, D. A., & Baird, J. A. (1999). Action analysis: A gateway to intentional inference. In P. Rochat (Ed.), *Early social cognition: Understanding others in the first months of life*. Mahwah, NJ: Lawrence Erlbaum Associates.

Bannert, M. (2002). Managing cognitive load - recent trends in cognitive theory. *Learning and Instruction, 12*(1), 139-146. doi:10.1016/S0959-4752(01)00021-4

Bansal, S., & Moritz, B. (2015). Perceived versus actual value of product substitution flexibility: An experimental investigation. *Journal of Operations Management, 38*, 56-70.

Barker, R. G., & Wright, H. F. (1955). *Midwest and its children*. Evanston, IL: Row, Peterson, and Co.

Baron, J. (2008). *Thinking and deciding* (1st ed.). New York: Cambridge University Press.

Bauer, D. J., & Curran, P. J. (2005). Probing interactions in fixed and multilevel regression: Inferential and graphical techniques. *Multivariate Behavioral Research, 40*(3), 373-400.

Bearden, J. N., Murphy, R. O., & Rapoport, A. (2008). Decision biases in revenue management: Some behavioral evidence. *Manufacturing & Service Operations Management, 10*(4), 625-636.

Beaubien, J. M., & Baker, D. P. (2004). The use of simulation for training teamwork skills in health care: How low can you go? *Quality and Safety in Health Care, 13*(suppl 1), i51. doi:10.1136/qshc.2004.009845

Bell, D. (1973). *The coming of post industrial society*. New York: Basic Books.

Bendoly, E. (2006). Incorporating behavioral theory in om empirical models. *Journal of Operations Management, 24*(6), 735-736. doi:10.1016/j.jom.2006.09.003

Bendoly, E., Donohue, K., & Schultz, K. (2006). Behavior in operations management: Assessing recent findings and revisiting old assumptions. *Journal of Operations Management, 24*(6), 737-752. doi:10.1016/j.jom.2005.10.001

Bendoly, E., & Hur, D. (2007). Bipolarity in reactions to operational 'constraints': Om bugs under an ob lens. *Journal of Operations Management, 25*(1), 1-13. doi:10.1016/j.jom.2005.08.004

Bendoly, E., van Wezel, W., & Bachrach, D. G. (2015). *The handbook of behavioral operations management*.

Berggren, C. (1994). Nummi vs. Uddevalla. *Sloan Management Review, 35*(2), 37-45.

Blanchard, B. S. (1991). *System engineering management*. New York: John Wiley & Sons.

Bolton, G. E., & Katok, E. (2008). Learning by doing in the newsvendor problem: A laboratory investigation of the role of experience and feedback. *Manufacturing & Service Operations Management, 10*(3), 519-538.

Bolton, G. E., Ockenfels, A., & Thonemann, U. W. (2012). Managers and students as newsvendors. *Management Science, 58*(12), 2225-2233.

Boltz, M. (1992). Temporal accent structure and the remembering of filmed narratives. *Journal of Experimental Psychology: Human Perception and Performance, 18*, 90-105.

Bostian, A. J. A., Holt, C. A., & Smith, A. M. (2008). Newsvendor "pull-to-center" effect: Adaptive learning in a laboratory experiment. *Manufacturing & Service Operations Management, 10*(4), 590-608.

Bostrom, R. P., & Heinen, J. S. (1977). Mis problems and failures: A socio-technical perspective. Part i: The causes. *MIS Quarterly, 1*(3), 17-32. doi:10.2307/248710

Boudreau, J., Hopp, W., McClain, J. O., & Thomas, L. J. (2003). On the interface between operations and human resources management. *Manufacturing & Service Operations Management, 5*(3), 179-202.

Boyd, R., & Richerson, P. J. (2005). *The origin and evolution of cultures*. Cary: Oxford University Press, Incorporated.

Brannen, M. Y., Liker, J. K., & Fruin, W. M. (1999). Recontextualization and factory-to-factory knowledge transfer from japan to the united states. In J. K. Liker, W. M. Fruin, & P. S. Adler (Eds.), *Remade in america*. New York: Oxford University Press.

Brass, D. J. (1981). Structural relationships, job characteristics, and worker satisfaction and performance. *Administrative Science Quarterly, 26*, 163-182.

Brolin, A., Thorvald, P., & Case, K. (2017). Experimental study of cognitive aspects affecting human performance in manual assembly. *Production and Manufacturing Research: An Open Access Journal*(1), 141. doi:10.1080/21693277.2017.1374893

Buckley, P. J. (1990). Problems and developments in the core theory of international business. *Journal of International Business Studies, 21*(4), 657-665.

Buffa, E. S. (1980). Research in operations management. *Journal of Operations Management, 1*(1), 1-7. doi:http://dx.doi.org/10.1016/0272-6963(80)90005-4

Burchill, G., & Fine, C. H. (1997). Time versus market orientation in product concept development: Empirically-based theory generation. *Management Science, 43*(4), 465-478. doi:10.1287/mnsc.43.4.465

Button, K. S., Ioannidis, J. P. A., Mokrysz, C., Nosek, B. A., Flint, J., Robinson, E. S. J., & Munafò, M. R. (2013). Power failure: Why small sample size undermines the reliability of neuroscience. *Nature Reviews Neuroscience, 14*(5), 365-376. doi:10.1038/nrn3475

Campion, M. A. (1988). Interdisciplinary approaches to job design: A constructive replication with extensions. *Journal of Applied Psychology, 73*(3), 467-481.

Cappelli, P. (2000). A market-driven approach to retaining talent. *Harvard Business Review(january-February 2000),* 103-111.

Castañeda, J. A., & Gonçalves, P. (2015). Kicking the "mean" habit: Joint prepositioning in debiasing pull-to-center effects. In E. Bendoly, W. V. Wezel, & D. G. Bachrach (Eds.), *The handbook of behavioural operations management: Social and psychological dynamics in production and service settings*. New York, NY: Oxford University Press.

Chakravarty, A. K., Ferdows, K., & Singhal, K. (1997). Global operations and technology management: A note from the editors of the special issue. *Production and Operations Management, 6*(2), 99-101.

Chen, L., Olhager, J., & Tang, O. (2014). Manufacturing facility location and sustainability: A literature review and research agenda. *International Journal of Production Economics, 149*, 154-163. doi:https://doi.org/10.1016/j.ijpe.2013.05.013

Chen, Y.-S., Ro, Y., & Su, H.-C. (2014). Mirror, mirror on the wall...Who's the most opportunistic and compliant of them all. *American Journal of Business, 29*(1), 43-60.

Cheng, Y., Farooq, S., & Johansen, J. (2015). International manufcaturing networks: Past, present, and future. *International Journal of Operations & Production Management, 35*(3), 392-429.

Cherns, A. (1976). The principles of sociotechnical design. *Human Relations, 29*(8), 783-792.

Cherns, A. (1987). Principles of sociotechnical design revisited. *Human Relations, 40*, 153-161.

Chi, M. T. H., Feltovich, P. J., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices*. *Cognitive Science, 5*(2), 121.

Chua, H. F., Boland, J. E., & Nisbett, R. E. (2005). Cultural variation in eye movement during scene perception. *Proceedings of the National Academy of Sciences of the United States of America, 102*, 12629-12633. doi:10.1073/pnas.0506162102

Clegg, C. W. (2000). Sociotechnical principles for system design. *Applied Ergonomics, 31*, 463-477.
Cohen, G., Kiss, G., & Voi, M. L. (1993). *Memory: Current issues* (2nd ed.). Maidenhead, Philadelphia: Open University Press.
Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155-159. doi:10.1037/0033-2909.112.1.155
Colotla, I., Shi, Y., & Gregory, M. (2003). Operation and peformance of international manufcatiring networks. *International Journal of Operations & Production Management, 23*(10), 1184-1206.
Cooper, C. L. (1982). Review of the book culture's consequences by g. Hofstede. *Journal of Occupational Behaviour, 3*(2), 123.
Cortina, J. M. (1993). What is coefficient alpha? An examination of theory and applications. *Journal of Applied Psychology, 78*(1), 98-104.
Croson, R., & Donohue, K. (2006). Behavioral causes of the bullwhip effect and the observed value of inventory information. *Management Science, 52*(3), 323-336.
Croson, R., Schultz, K., Siemsen, E., & Yeo, M. L. (2013). Behavioral operations: The state of the field. *Journal of Operations Management, 31*(1–2), 1-5. doi:http://dx.doi.org/10.1016/j.jom.2012.12.001
Crystal, D. (Ed.) (2012). *Why english? The cultural legacy* (2 ed.). Cambridge: Cambridge University Press.
D'souza, D. E., & Williams, F. P. (2000). Toward a taxonomy of manufacturing flexibility dimensions. *Journal of Operations Management, 18*, 577-593.
D'Andrade, R. (1995). *The development of cognitive anthropology*. New York: Cambridge University Press.
Dabhilkar, M., & Ahlstrom, P. (2013). Converging production models: The sts versus lean production debate revisited. *International Journal of Operations & Production Management, 33*(8), 1019-1039. doi:10.1108/ijopm-08-2012-0316
Damasio, A. R. (2000). *The feeling of what happens : Body and emotion in the making of consciousness*. San Diego: Harcourt.
Daniels, A. K. (1987). Invisible work. *Social Problems, 34*, 827 - 847.
De Treville, S., & Antonakis, J. (2006). Could lean production job design be intrinsically motivating? Contextual, configurational, and levels-of-analysis issues. *Journal of Operations Management, 24*(2), 99-123. doi:https://doi.org/10.1016/j.jom.2005.04.001
Dean, J. W., Jr, & Snell, S. A. (1991). Integrated manufacturing and job design: Moderating effects of organizational inertia. *Academy of Management Journal, 34*(4), 776-804. doi:10.2307/256389
Deaux, K. (1976). The behaviour of women and men. *Journal of Personality and Social Psychology, 28*, 28-38.
Deaux, K., & Farris, E. (1975). Complexity, extremity and affect in male and female judgments. *Journal of Personality, 43*, 379-389.
Deaux, K., & Major, B. (1977). Sex-related patterns in the unit of perception. *Personality and Social Psychology Bulletin, 3*(2), 297-300. doi:10.1177/014616727700300230
Dekker, S. (2011). *Drift into failure: From hunting broken components to understanding complex systems*. Surrey: Ashgate.

DiMaggio, P. (1997). Culture and cognition. *Annual Reviews Sociology, 23*, 263-287.

Doerr, K. H., Freed, T., Mitchell, T. R., Schriesheim, C. A., & Zhou, X. H. (2004). Work flow policy and within-worker and between-workers variability in performance. *Journal of Applied Psychology, 89*(5), 911-921. doi:10.1037/0021-9010.89.5.911

Doerr, K. H., Mitchell, T. R., Kiastorin, T. D., & Brown, K. A. (1996). Impact of material flow policies and goals on job outcomes. *Journal of Applied Psychology, 81*(2), 142-152. doi:10.1037/0021-9010.81.2.142

Doerr, K. H., Mitchell, T. R., Schriesheim, C. A., Freed, T., & Zhou, X. H. (2002). Heterogeneity and variability in the context of flow lines. *Academy of Management Review, 27*(4), 594-607. doi:10.2307/4134405

Dyer, J., & Chu, W. (2011). The determinants of trust in supplier-automaker relationships in the u.S., japan, and korea. *Journal of International Business Studies, 42*, 10-27. doi:10.1057/jibs.2010.34

Eckerd, S., & Bendoly, E. (2015). The study of behavioral operations. In E. Bendoly, W. Van Wezel, & D. G. Bachrach (Eds.), *The handbook of behavioural operations management* (pp. 4-23). New York: Oxford University Press.

Eckerd, S., Boyer, K. K., Qi, Y., Eckerd, A., & Hill, J. A. (2016). Supply chain psychological contract breach: An experimental study across national cultures. *Journal of Supply Chain Management, 52*(3), 68-82.

Eckerd, S., Hill, J., Boyer, K. K., Donohue, K., & Ward, P. T. (2013). The relative impact of attribute, severity, and timing of psychological contract breach on behavioral and attitudinal outcomes. *Journal of Operations Management, 31*, 567-578. doi:10.1016/j.jom.2013.06.003

Edwards, E., & Lees, F. P. (1971). The development of the role of the human operator in process control. *IFAC Proceedings Volumes, 4*(3), 138-144. doi:https://doi.org/10.1016/S1474-6670(17)68589-6

Edwards, J. R., Scully, J. A., & Brtek, M. D. (2000). The nature and outcomes of work: A replication and extension of interdisciplinary work-design research. *Journal of Applied Psychology, 85*(6), 860-868. doi:10.1037/0021-9010.85.6.860

Enns, J. T., & Lleras, A. (2008). What's next? New evidence for prediction in human vision. *Trends in Cognitive Sciences, 12*(9), 327-333. doi:10.1016/j.tics.2008.06.001

Ettlie, J. E. (1997). Quality, technology, and global manufacturing. *Production and Operations Management, 6*(2), 150-166. doi:10.1111/j.1937-5956.1997.tb00423.x

Fallon, M. (2016). *Writing up quantitative research in the social and behavioral sciences* (Vol. 6). Rotterdam: Sense Publishers.

Ferdows, K. (1997). Made in the world: The global spread of production. *Production & Operations Management, 6*(2), 102-109.

Ferdows, K. (2018). Keeping up with growing complexity of managing global operations. *International Journal of Operations & Production Management, 38*(2), 390-402.

Fletcher, J. K. (1999). *Disappering acts: Gender, power and relational practices at work.* Cambridge: MIT Press.

Fonollosa, J., Neftci, E., & Rabinovich, M. (2015). Learning of chunking sequences in cognition and behavior. *PLoS Comput Biol, 11*(11), e1004592. doi:10.1371/journal.pcbi.1004592

Frank, R. H. (1984). Interdependent preferences and the competitive wage structure. *The RAND Journal of Economics, 15*(4), 510-520. doi:10.2307/2555522

Frederick, S. (2005). Cognitive reflection and decision making. *Journal of Economic Perspectives, 19*(4), 25-42. doi:10.1257/089533005775196732

Fried, Y., & Ferris, G. R. (1987). The validity of the job characteristics model: A review and meta-analysis. *Personnel Psychology, 40*(2), 287-322. doi:10.1111/j.1744-6570.1987.tb00605.x

Fripp, J. (1993). Learning through simulations: A guide to the design and use of simulations in business and education,. In. London: McGraw-Hill Training Series.

Garland, H. (1990). Throwing good money after bad: The effect of sunk costs on the decision to escalate commitment to an ongoing project. *Journal of Applied Psychology, 75*(6), 728-731.

Gelman, A. (2006). Multilevel (hierarchical) modeling: What it can and cannot do. *Technometrics, 48*(3), 432-435.

Gelman, A., & Hill, J. (2007). *Data analysis using regression and multilevel/hierarchical models*. New York: Cambridge University Press.

Germain, R., Droge, C., & Christensen, W. (2001). The mediating role of operations knowledge in the relationship of context with performance. *Journal of Operations Management, 19*, 4553-4569.

Gersick, C. J. G., Bartunek, J. M., & Dutton, J. E. (2000). Learning from academia: The importance of relationships in professional life. *Academy of Management Journal, 43*, 1026-1044.

Gerwin, D. (1987). An agenda for research on the flexibility of manufacturing processes. *Internationl Journal of Operations and Production Management, 7*(1), 38-49.

Gigerenzer, G. (1991). How to make cognitive illusions disappear: Beyond heuristics and biases. In W. Stroebe & M. Hewstone (Eds.), *Europea review of social psychology* (Vol. 2, pp. 83-115). New York: WIley.

Gilbreth, F. B., & Gilbreth, L. (1916). *Fatigue study: The elimination of humanity's greatest waste; a first step in motion study*. New York: Sturgis and Walton Company.

Gilchrist, A. L. (2015). How should we measure chunks? A continuing issue in chunking research and a way forward. *Front Psychol, 6*, 1456. doi:10.3389/fpsyg.2015.01456

Gino, F., & Pisano, G. (2008). Toward a theory of behavioral operations. *Manufacturing & Service Operations Management, 10*(4), 676-691. doi:10.1287/msom.1070.0205

Giorgi, S., Lockwood, C., & Glynn, M. A. (2015). The many faces of culture: Making sense of 30 years of research on culture in organization studies. *The Academy of Management Annals, 9*(1), 1-54. doi:10.1080/19416520.2015.1007645

Glaser, L., Stam, W., & Takeuchi, R. (2016). Managing the risks of proactivity: A multilevel study of initiative and performance in the middle management context. *Academy of Management Journal, 59*(4), 1339-1360.

Gobet, F. (2016). Entrenchment, gestalt formation, and chunking. In *Entrenchment and the Psychology of Language Learning: How We Reorganize and Adapt Linguistic Knowledge*.

Gobet, F., Lane, S. C., Cheng, P. C.-H., Jones, G., Oliver, I., & Pine, J. M. (2001). Chunking mechanism in human learning. *Trends in Cognitive Sciences, 5*(6), 236-243.

Gobet, F., Lloyd-Kelly, M., & Lane, P. C. (2016). What's in a name? The multiple meanings of "chunk" and "chunking". *Frontiers Psychology, 7*, 102. doi:10.3389/fpsyg.2016.00102

Godøy, R. I. (2008). *Chunking sound for musical analysis.* Paper presented at the Computer Music Modeling In Sound And Music: Genesis Of Meaning In Sound And Music, Copenhagen, Denmark.

Goffman, E. (1974). *Frames analysis: An essay on the organisation of experience*. Cambridge Mass.: Harvard University Press.

Gold, D. A., Zacks, J. M., & Flores, S. (2016). Effects of cues to event segmentation on subsequent memory. *Cognitive Research: Principles and Implications, 2*, 1-15.

Goldstein, D. G., & Gigerenzer, G. (2002). Models of ecological rationality: The recognition heuristic. *Psychological Review, 102*, 75-90.

Goldstein, H. (2003). *Multilevel statistical models* (3rd ed.). London: Arnold.

Goodenough, W. H. (1971). *Culture, language and society*. Reading, MA: Addison-Wesley.

Gooderham, P., & Nordhaug, O. (2001). Are cultural differences in europe on the decline? *Economic Business Forum*(8), 48-53.

Goodstein, L. D. (1981). Commentary: Do american theories apply abroad? *Organizational Dynamics, 10*(1), 49-54.

Grant, A. M. (2007). Relational job design and the motivation to make a prosocial difference. *Academy of Management Review, 32*(2), 393-417. doi:10.5465/AMR.2007.24351328

Grant, A. M., Fried, Y., & Juillerat, T. (2011). Work matters: Job design in classic and contemporary perspectives. In S. Zedeck (Ed.), *Apa handbook of industrial and organizational psychology, vol 1: Building and developing the organization* (Vol. 1): American Psychology Association.

Griffin, R. W. (1987). Towards and integrated theory of task design. In B. Staw & L. L. Cummings (Eds.), *Research in organizational behaviour* (Vol. 9, pp. 79-120). Grreenwich, CT: JAI Press.

Groop, J., Ketokivi, M., Gupta, M., & Holmström, J. (2017). Improving home care: Knowledge creation through engagement and design. *Journal of Operations Management, 53-56*, 9-22. doi:https://doi.org/10.1016/j.jom.2017.11.001

Hackman, J. R., & Lawler, E. E. (1971). Employee reactions to job characteristics. *Journal of Applied Psychology, 55*, 259-286.

Hackman, J. R., & Oldham, G. R. (1975). Development of the job diagnostic survey. *Journal of Applied Psychology, 60*(2), 159-170. doi:10.1037/h0076546

Hackman, J. R., & Oldham, G. R. (1976). Motivation through the design of work: Test of a theory. *Organizational Behavior & Human Performance, 16*(2), 250-279.

Hackman, J. R., & Oldham, G. R. (1980). *Work redesign*. Reading, MA: Addison-Wesley.

Haire, M., Ghiseli, E., & Porter, L. (1966). *Managerial thinking: An international study*. New York: Wiley.
Hanchane, S., & Mostafa, T. (2012). Solving endogeneity problems in multilevel estimation: An example using education production functions. *Journal of Applied Statistics, 39*(5), 1101-1114. doi:10.1080/02664763.2011.638705
Hansen, C. (1983). *Language and logic in ancient china*. Ann Arbor: University of Michigan Press.
Hard, B. (2006). *Reading the language of action: Hierarchical encoding of observed behaviour.* (Doctor of Philosophy). Standard University, (3235280)
Hard, B., Tversky, B., & Lang, D. S. (2006). Making sense of abstract events: Building event schemas. *Memory & Cognition, 34*(6), 1221.
Hayes, R., Pisano, G., Upton, D., & Wheelwright, S. C. (2005). *Operations, strategy and technology: Pursuing the competitive edge*. New York: John Wiley.
Hayes, R., Wheelwright, S. C., & Clark, K. (1988). *Dynamic manufacturing*. New York: The Free Press.
Heider, F. (1958). *The psychology of interpersonal relations*. New York: Wiley and Sons.
Heineke, J., & Davis, M. M. (2007). The emergence of service operatons management as an academic discipline. *Journal of Operations Management, 25*, 364-374.
Hertwig, R., & Ortmann, A. (2001). Experimental practices in economics: A methodological challenge for psychologists? *Behavioral and Brain Sciences, 24*(3), 383-451.
Herzberg, F., Mausner, B., & Snyderman, B. B. (1959). *The motivation to work.* New York: Wiley.
Hilbert, M. (2012). Toward a synthesis of cognitive biases: How noisy information processing can bias human decision making. *Psychological Bulletin, 138*(2), 211-237. doi:http://dx.doi.org/10.1037/a0025940
Hill, J. A., Eckerd, S., Wilson, D., & Greer, B. (2009). The effect of unethical behavior on trust in a buyer–supplier relationship: The mediating role of psychological contract violation. *Journal of Operations Management, 27*, 281-293. doi:10.1016/j.jom.2008.10.002
Hirst, M. K. (1988). Intrinsic motivation as influenced by task interdependence and goal setting. *Journal of Applied Psychology, 73*(1), 96-101. doi:10.1037/0021-9010.73.1.96
Hoffman, D. D., & Richards, W. A. (1984). Parts of recognition. *Cognition, 18*, 65-96.
Hofstede, G. (1980). *Culture's consequences: International differences in work-related values*. Beverly Hills: London: Sage Publications.
Hofstede, G. (1983). The cultural relativity of organizational practices and theories. *Journal of International Business Studies, 14*(2), 75-89.
Hofstede, G. (1993). Cultural constraints in management theories. *Academy of Management Executive, 7*(1).
Hofstede, G. (2001). *Culture's consequences: Comparing values, behaviors, institutions, and organization across nations*. London: Sage Publications Ltd.
Hofstede, G., & Hofstede, G. J. (2005). *Cultures and organizations: Software of the mind*: McGraw-Hill.

Hofstede, G., Hofstede, G. J., & Minkov, M. (2010). *Cultures and organizations: Software of the mind : Intercultural cooperation and its importance for survival*: McGraw-Hill.
Hollins, B., & Shinkins, S. (2006). *Managing service operations: Design and implementation*. doi:10.4135/9781446214220
Holman, D., Chissick, C., & Totterdell, P. (2002). The effects of performance monitoring on emotional labor and well-being in call centers. *Motivation and Emotion, 26*, 57-81.
Holweg, M. (2007). The genealogy of lean production. *Journal of Operations Management, 25*(2), 420-437. doi:http://dx.doi.org/10.1016/j.jom.2006.04.001
Holweg, M., Davis, J., De Meyer, A., Lawson, B., & Schmenner, R. W. (2018). *Process theory: The principles of operations management*. New York: NY: Oxford University Press.
Hoover, H. C., & Hoover, L. H. (1950). *De re metallica translated from the first latin edition of 1556*. New York, NY: Dover Publications.
Hopp, W. J. (2004). Fifty years of management science. *Management Science, 50*(1), 1-7. doi:10.1287/mnsc.1030.0181
House, R. J., Hanges, P. J., Javidan, M., Dorfman, P. W., & Gupta, V. (2004). *Culture, leadership, and organizations: The globe study of 62 societies*. Thousand Oaks, CA: Sage.
Huang, X., & Van De Vliert, E. (2003). Where intrinsic job satisfaction fails to work: National moderators of intrinsic motivation. *Journal of Organizational Behavior,, 24*, 159-179.
Huber, V. L., & Brown, K. A. (1991). Human resource issues in cellular manufacturing: A socio-technical analysis. *Journal of Operations Management, 10*(1), 138-159.
Humphrey, S. E., Nahrgang, J. D., & Morgeson, F. P. (2007). Integrating motivational, social, and contextual work design features: A meta-analytic summary and theoretical extension of the work design literature. *J Appl Psychol, 92*(5), 1332-1356. doi:10.1037/0021-9010.92.5.1332
Hunt, J. W. (1981). Applying american behavioral science: Some cross-cultural problems. *Organizational Dynamics, 10*(1), 55-62. doi:https://doi.org/10.1016/0090-2616(81)90012-7
Hymer, S. (1976). *The international operations of national firms: A study of direct investment*. Cambridge, MA: MIT Press.
Ilgen, D. R. (1999). Teams embedded in organizations: Some implications. *American Psychologist, 54*, 129-139.
Inglehart, R. (2008). Changing values among western publics from 1970 to 2006. *Western European Politics, 31*(1/2), 130-146.
Iqbal, S. T., & Bailey, B. P. (2008). *Effects of intelligent notification management on users and their tasks*. Paper presented at the Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, ACM.
Jacobsen, P., Pedersen, L. F., Jensen, P. E., & Witfelt, C. (2001). Philosophy regarding the design of production systems. *Journal of Manufacturing Systems, 20*(6), 405-415.
Jacobsen, P., & Rudolph, C. (1997). *Description, modeling and design of production systems*. Paper presented at the 32nd International Matador Conference 1997.

Jarque, C. M., & Bera, A. K. (1980). Efficient tests for normality, homoscedasticity and serial independence of regression residuals. *Economics Letters, 6*(3), 255-259. doi:https://doi.org/10.1016/0165-1765(80)90024-5

Ji, L.-J., Peng, K., & Nisbett, R. E. (2000). Culture, control, and perception of relationships in the environment. *Journal of Personality and Social Psychology, 78*(5), 943-955. doi:10.1037/0022-3514.78.5.943

Johanson, J., & Vahlne, J. (1977). The intrnationalization process of the firm: A model of knowledge development and increasing foreign market commitments. *Journal of International Business Studies, 8*(1), 23-32.

Johns, G. (2006). The essential impact of context on organizational behavior. *Academy of Management Review, 31*, 386-408.

Juran, D. C., & Schruben, L. W. (2004). Using worker personality and demographic information to improve system performance prediction. *Journal of Operations Management, 22*(4), 355-367. doi:http://dx.doi.org/10.1016/j.jom.2004.05.003

Kadefors, R., Engström, T., Petzäll, J., & Sundström, L. (1996). Ergonomics in parallelized car assembly: A case study, with reference also to productivity aspects. *Applied Ergonomics, 27*(2), 101-110. doi:https://doi.org/10.1016/0003-6870(95)00064-X

Kahneman, D., Slovic, P., & Tversky, A. (1982). *Judgment under uncertainty*.

Karasek, R. A. (1979). Job demands, job decision latitude, and mental strain: Implications for job redesign. *Administrative Science Quarterly, 24*, 285-308.

Karasek, R. A., Triantis, K. P., & Chaudhry, S. S. (1982). Co-worker and supervisor support as moderators of associations between task characteristics and mental strain. *Journal of Occupational Behaviour, 3*, 181-200.

Kathuria, R., & Partovi, F. Y. (1999). Workforce management practices for manufacturing flexibility. *Journal of Operations Management, 18*(1), 21-39.

Katok, E. (2011). Using laboratory experiments to build in operations management models. *Foundations and Trends in Technology, Information and Operations Management, 5*(1), 1-86.

Katsikopoulos, K. V., & Gigerenzer, G. (2013). Behavioral operations management: A blind spot and a research program. *Journal of Supply Chain Management, 49*(1), 3-7.

Katz, D., & Kahn, R. L. (1966). *The psychology of organizations*. New York: Wiley.

Ketokivi, M., & McIntosh, C. N. (2017). Addressing the endogeneity dilemma in operations management research: Theoretical, empirical, and pragmatic considerations. *Journal of Operations Management, 52*, 1-14. doi:10.1016/j.jom.2017.05.001

Kilduff, M., & Regan, D. T. (1988). What people say and what they do: The differential effects of informational cues and task design. *Organizational Behavior and Human Decision Processes, 41*(1), 83-97. doi:https://doi.org/10.1016/0749-5978(88)90048-9

Kitayama, S., Duffy, S., Kawamura, T., & Larsen, J. T. (2003). Perceiving an object and its context in different cultures: A cultural look at new look. *Psychological Science, 14*(3), 201 - 206.

Kitayama, S., & Murata, A. (2013). Culture modulates perceptual attention: An event-related potential study. *Social Cognition, 31*(6), 758-769.

Kluckhohn, F., & Strodtbeck, F. L. (1961). *Variations in value orientations*. Evanston, IL: Row, Peterson.

Koffka, K. (1935). *The principles of gestalt psychology*. New York, NY: Hardcourt, Brace and World.

Kogut, B. (1991). *Country competitiveness and the organization of work and technology*. London: Macmillian.

Kolbeinsson, A., Lindblom, J., & Thorvald, P. (2017). Missing mediated interruptions in manual assembly: Critical aspects of breakpoint selection. *Applied Ergonomics, 61*, 90-101. doi:10.1016/j.apergo.2017.01.010

Kolus, A., Wells, R., & Neumann, P. (2018). Production quality and human factors engineering: A systematic review and theoretical framework. *Applied Ergonomics, 73*, 55-89. doi:10.1016/j.apergo.2018.05.010

Kortmann, S., Gelhard, C., Zimmermann, C., & Piller, F. T. (2014). Linking strategic flexibility and operational efficiency: The mediating role of ambidextrous operational capabilities. *Journal of Operations Management, 32*(7-8), 475-490. doi:10.1016/j.jom.2014.09.007

Koste, L. L., & Malhotra, M. K. (1999). A theoretical framework for analyzing the dimensions of manufacturing flexibility. *Journal of Operations Management, 18*, 75-93.

Kulkarni, S. S., Magazine, M. J., & Raturi, A. S. (2004). Risk pooling advantages of manufacturing network configuration. *Production & Operations Management, 13*(2), 186-199.

Kull, T. J., Yan, T., Liu, Z., & Wacker, J. G. (2014). The moderation of lean manufacturing effectiveness by dimensions of national culture: Testing practice-culture congruence hypotheses. *International Journal of Production Economics, 153*, 1-12. doi:https://doi.org/10.1016/j.ijpe.2014.03.015

Kurby, C., & Zacks, J. M. (2011). Age differences in the perception of hierarchical structure in events. *Memory & Cognition, 39*(1), 75-91. doi:10.3758/s13421-010-0027-2

Kurby, C. A., & Zacks, J. M. (2008). Segmentation in the perception and memory of events. *Trends Cogn Sci, 12*(2), 72-79. doi:10.1016/j.tics.2007.11.004

Lager, T. (2002). Product and process development intensity in process industry: A conceptual and empirical analysis of the allocation of company resources for the development of process technology. *International Journal of Innovation Management, 6*(2), 105. doi:10.1142/S1363919602000537

Lam, S. K., Schaubroeck, J., & Aryee, S. (2002). Relationship between organizational justice and employee work outcomes: A cross-national study. *Journal of Organizational Behavior, 23*(1), 1-18.

Lee Park, C., & Paiva, E. L. (2018). How do national cultures impact the operations strategy process? *International Journal of Operations & Production Management, 38*(10), 1937-1963. doi:10.1108/IJOPM-03-2017-0145

Lee, Y. S., Ribbink, D., & Eckerd, S. (2018). Effectiveness of bonus and penalty incentive contracts in supply chain exchanges: Does national culture matter? *Journal of Operations Management, 62*(1), 59-74. doi:10.1016/j.jom.2018.09.002

Letmathe, P., Schweitzer, M., & Zielinski, M. (2012). How to learn new tasks: Shop floor performance effects of knowledge transfer and performance feedback. *Journal of Operations Management, 30*(3), 221-236. doi:http://doi.org/10.1016/j.jom.2011.11.001

Leung, K. (Ed.) (2001). *Different carrots for different rabbits: Effects of individualism-collectivism and power distance on work motivation.* Mahwah, NJ: Erlbaum.

Lewis, M. A. (2007). Charles babbage: Reclaiming an operations management pioneer. *Journal of Operations Management, 25*(2), 248-259. doi:http://dx.doi.org/10.1016/j.jom.2006.08.001

Lewis, M. A., & Maylor, H. R. (2007). Game playing and operations management education. *International Journal of Production Economics, 105*(1).

Li, X., Chen, L. G., & Chen, J. (2018). Individual and cultural differences in newsvendor decision making. *International Journal of Operations & Production Management, 39*(1), 164-186. doi:10.1108/IJOPM-01-2018-0042

Liker, J. K., Fruin, W. M., & Adler, P. S. (Eds.). (1999). *Remade in america: Transplanting and transforming japanese management systems*. New York: Oxford University Press.

Lin, L., Drury, C. G., & Kim, S. W. (2001). Ergonomics and quality in paced assembly lines. *Human Factors and Ergonomics in Manufacturing & Service Industries, 11*(4), 377-382. doi:10.1002/hfm.1020

Lindblom, J., & Thorvald, P. (2014). *Towards a framework for reducing cognitive load in manufacturing personnel*.

Linderman, K., Schroeder, R. G., Zaheer, S., & Choo, A. S. (2003). Six sigma: A goal-theoretic perspective. *Journal of Operations Management, 21*(2), 193-203. doi:10.1016/S0272-6963(02)00087-6

Liu, G., Shah, R., & Schroeder, R. G. (2006). Linking work design to mass customization: A sociotechnical systems perspective*. *Decision Sciences, 37*(4), 519-545. doi:10.1111/j.1540-5414.2006.00137.x

Loch, C. H., & Wu, Y. (2005). Behavioral operations management. *Foundations and Trends® in Technology, Information and Operations Management, 1*(3). doi:10.1561/0200000009

Loch, C. H., & Wu, Y. (2008). Social preferences and supply chain performance: An experimental study. *Management Science, 54*(11), 1835-1849. doi:10.1287/mnsc.1080.0910

Loewenstein, G. F., Weber, E. U., Hsee, C. K., & Welch, N. (2001). Risk as feelings. *Psychological Bulletin, 127*, 267–286. doi:10.1037/0033-2909.127.2.267

Loher, B. T., Noe, R. A., Moeller, N. L., & Fitzgerald, M. P. (1985). A meta-analysis of the relation of job characteristics to job satisfaction. *Journal of Applied Psychology, 70*(2), 280-289. doi:10.1037/0021-9010.70.2.280

Lonati, S., Quiroga, B. F., Zehnder, C., & Antonakis, J. (2018). On doing relevant and rigorous experiments: Review and recommendations. *Journal of Operations Management, 64*, 19-40. doi:10.1016/j.jom.2018.10.003

Long, S. (2018). *Socioanalytic methods: Discovering the hidden in organisations and social systems*. New York: Routledge.

Longoni, A., Pagell, M., Johnston, D., & Veltri, A. (2013). When does lean hurt? – an exploration of lean practices and worker health and safety outcomes. *51*(11), 3300-3320. doi:10.1080/00207543.2013.765072

Lu, G., Ding, X., Peng, D. X., & Hao-Chun Chuang, H. (2018). Addressing endogeneity in operations management research: Recent developments, common problems, and directions for future research. *Journal of Operations Management, 64*, 53-64. doi:https://doi.org/10.1016/j.jom.2018.10.001

Lummus, R. R. (1995). A simulation analysis of sequencing alternatives for jit lines using kanbans. *Journal of Operations Management, 13*(3), 183-191. doi:https://doi.org/10.1016/0272-6963(95)00026-O

Maas, C. J. M., & Hox, J. J. (2004). Robustness issues in multilevel regression analysis. *Statistica Neerlandica, 58*(2), 127-137. doi:10.1046/j.0039-0402.2003.00252.x

Machuca, J. A. D., & Barajas, R. P. (2004). The impact of electronic data interchange on reducing bullwhip effect and supply chain inventory costs. *Transportation Research: Part E, 40*(3), 209-228.

Malone, T. W., & Rockart, J. F. (1991). Computers, networks and the corporation. *Scientific America, 265,* 128 -136.

Mandler, G. (1979). Organization and repetition: An extension of organizational principles with special reference to rote learning. In L. G. Nilsson (Ed.), *Perspectives on memory research*. Hillsdale, NJ: Erlbaum.

Martin, J. (1992). *Cultures in organizations: Three perspectives*. New York: Oxford University Press.

Martínez-Jurado, P. J., Moyano-Fuentes, J., & Pilar Jerez, G. (2013). Hr management during lean production adoption. *Management Decision, 51*(4), 742-760. doi:http://dx.doi.org/10.1108/00251741311326545

Masuda, T., & Nisbett, R. E. (2001). Attending holistically versus analytically: Comparing the context sensitivity of japanese and americans. *Journal of Personality & Social Psychology, 81*(5), 922-934. doi:10.1037//0022-3514.81.5.922

Mayo, E. (1933). *The human problems of industrial civilization*. New York, NY: MacMillan.

McGatlin Kristen, C., Newberry Kimberly, M., & Bailey Heather, R. (2018). Temporal chunking makes life's events more memorable. In *Open Psychology* (Vol. 1, pp. 94).

McLaughlin, C., & Fitzsimmons, J. (1996). Strategies for globalizing service operations. *International Journal of Service Industry Management, 7*(4), 43-57.

Meijboom, B., & Voordijk, H. (2003). International operations and location decision: A firm level approach. *Tijdschrift voor Economische en Sociale Geografie, 94*(4), 463-476.

Merriam, S. B. (2014). *Qualitative research: A guide to design and implementation*. Indianapolis, IN: Jossey-Bass.

Meshkati, N. (1991). Human factors in large-scale technological systems accidents: Three miles island, bhopal, chernobyl. *Organization & Environment, 5*(2), 133-154.

Metters, R., Zhao, X., Bendoly, E., Jiang, B., & Young, S. (2010). "The way that can be told of is not an unvarying way": Cultural impacts on operations management in asia. *Journal of Operations Management, 28*(3), 177-185. doi:10.1016/j.jom.2009.10.004

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychology Review, 63*, 81-97.

Minkov, M., & Hofstede, G. (2011). The evolution of hofstede's doctrine. *Cross Cultural Management: An International Journal, 18*(1), 10-20.

Mitchell, T. R., & Silver, W. S. (1990). Individual and group goals when workers are interdependent: Effects on task strategies and performance. *Journal of Applied Psychology, 75*(2), 185-193. doi:10.1037/0021-9010.75.2.185

Miyamoto, Y., Nisbett, R. E., & Masuda, T. (2006). Culture and the physical environment. *Psychological Science (0956-7976), 17*(2), 113-119. doi:10.1111/j.1467-9280.2006.01673.x

Moorman, R. H., & Blakely, G. L. (1995). Individualism-collectivism as an individual difference predictor of organizational citizenship behavior. *Journal of Organizational Behavior, 16*(2), 127-142. doi:10.1002/job.4030160204

Morgeson, F. P., & Campion, M. A. (2002). Minimizing tradeoffs when redesigning work: Evidence from a longitudinal quasi-experiment. *Personnel Psychology, 55*(3), 589-612. doi:10.1111/j.1744-6570.2002.tb00122.x

Morgeson, F. P., & Campion, M. A. (2003). Work design. In W. Borman, D. Ilgen, & R. Klimosk (Eds.), *Handbook of psychology: Industrial and organizational psychology* (Vol. 12, pp. 423-452). New Jersey: Wiley.

Morgeson, F. P., & Humphrey, S. E. (2006). The work design questionnaire (wdq): Developing and validating a comprehensive measure for assessing job design and the nature of work. *Journal of Applied Psychology, 91*(6), 1321-1339. doi:http://dx.doi.org/10.1037/0021-9010.91.6.1321

Morgeson, F. P., & Humphrey, S. E. (2008). Job and team design: Toward a more integrative conceptualization of work design. *Research in Personnel and Human Resources Management, 27*, 39-91. doi:10.1016/S0742-7301(08)27002-7

Mukherjee, A., Mitchell, W., & Talbot, F. B. (2000). The impact of new manufacturing requirements on production line productivity and quality at a focused factory. *Journal of Operations Management, 18*(2), 139-168. doi:https://doi.org/10.1016/S0272-6963(99)00023-6

Mundlak, Y. (1978). On the pooling of time series and cross-sectional data. *Econometrica, 46*, 69-86.

Münsterberg, H. (1913). *Psychology and industrial efficiency*. New York: Houghton Mifflin Co.

Mura, K., Petersen, N., Huff, M., & Ghose, T. (2013). Ibes: A tool for creating instructions based on event segmentation. *Frontiers in Psychology, 4*(994). doi:10.3389/fpsyg.2013.00994

Myers, D. G. (Ed.) (1999). *Close relationships and quality of life*. New York: Sage Foundation.

Nesse, R. M., & Berridge, K. C. (1997). Psychoactive drug use in evolutionary perspective. *Science, 278*(5335), 63-66. doi:10.1126/science.278.5335.63

Netland, T. H., & Aspelund, A. (2014). Multi-plant improvement programmes: A literaure review and research agenda. *International Journal of Operations & Production Management, 34*(3), 390-418.

Neumann, W. P., Winkel, J., Medbo, L., Magneberg, R., & Mathiassen, S. E. (2006). Production system design elements influencing productivity and ergonomics. *International Journal of Operations & Production Management, 26*(8), 904-923. doi:10.1108/01443570610678666

Newtson, D. (1973). Attribution and the unit of perception of ongoing behavior. *Journal of Personality and Social Psychology, 28*(1), 28-38. doi:10.1037/h0035584

Newtson, D. (1976). Foundations of attributions: The perception of ongoing behavior. In J. H. Harvey, W. J. Ickes, & R. F. Kidd (Eds.), *New directions in attribution research*. Hillsdale, New Jersey: Earlbaum.

Newtson, D., Engquist, G., & Bois, J. (1977). The objective basis of behavior units. *Journal of Personality and Social Psychology, 35*(12), 847-864.

Nickerson, R. S. (1992). *Looking ahead: Human factors challneges in a changing world*. Hillsdale, NJ: Lawrence Earlbaum Associates.

Nisbett, R. E., & Miyamoto, Y. (2005). The influence of culture: Holistic versus analytic perception. *Trends in Cognitive Sciences, 9*(10), 467-473. doi:http://dx.doi.org/10.1016/j.tics.2005.08.004

Nisbett, R. E., Peng, K. P., Choi, I., & Norenzayan, A. (2001). Culture and systems of thought: Holistic versus analytic cognition. *Psychological Review, 108*(2), 291-310.

Nishida, H., Hammer, M. R., & Wiseman, R. L. (1998). Cognitive differences between japanese and americans in their perceptions of difficult social situations. *Journal of Cross-Cultural Psychology, 29*(4), 499-524.

Norenzayan, A., Choi, I., & Peng, K. (2007). Perception and cognition. In S. Kitayama & D. Cohen (Eds.), *Handbook of cultural psychology* (pp. 569-594). New York: Guilford Press.

O'Reilly, C. A., & Caldwell, D. F. (1979). Informational influence as a determinant of perceived task characteristics and job satisfaction. *Journal of Applied Psychology, 64*(2), 157-165. doi:10.1037/0021-9010.64.2.157

Ohno, T. (1988). *Toyota production system: Beyond large-scale production.* Portland, Oregon: Productivity Press.

Oldham, G. R., & Hackman, J. R. (2010). Not what it was and not what it will be: The future of job design research. *Journal of Organizational Behavior*(2/3), 463.

Ong, A. (1987). *Spirits of resistance and capitalist discipline: Factory women in malaysia*. Albany, NY: State University of New York Press.

Ovchinnikov, A., Moritz, B., & Quiroga, B. F. (2015). How to compete against a behavioral newsvendor. *Production & Operations Management, 24*(11), 1783-1793. doi:10.1111/poms.12361

Pagell, M., & Chwen, S. (2001). Buyer behaviours and the performance of the supply chain: An international exploration. *International Journal of Production Research, 39*(13), 2783-2801. doi:10.1080/00207540110051923

Pagell, M., Katz, J. P., & Sheu, C. (2005). The importance of national culture in operations management research. *International Journal of Operations & Production Management, 25*(4), 371-394. doi:10.1108/01443570510585552

Parker, S. K., & Wall, T. D. (1998). *Job and work design: Organizing work to promote well-being and effectiveness*. doi:10.4135/9781452231518

Parker, S. K., Wall, T. D., & Cordery, J. L. (2001). Future work design research and practice: Towards an elaborated model of work design. *Journal of Occupational & Organizational Psychology, 74*(4), 413.

Parker, S. K., Wall, T. D., & Jackson, P. R. (1997). "That's not my job": Developing flexible employee work orientations. *The Academy of Management Journal, 40*(4), 899-929. doi:10.2307/256952

Parks, C. D., & Vu, A. D. (1994). Social dilemma behavior of individuals from highly individualist and collectivist cultures. *Journal of Conflict Resolution, 38*(4), 708-718. doi:10.1177/0022002794038004006

Pasmore, W., Francis, C., Haldeman, J., & Shani, A. (1982). Sociotechnical systems: A north american reflection on empirical studies of the seventies. *Human Relations, 12*, 1179-1204.

Pawar, K. S., Menon, U., & Riedel, J. C. K. H. (1994). Time to market. *Journal of Manufacturing Technology Management (Previously Published as: Integrated Manufacturing Systems), 5*(1), 14-22.

Penrose, E. (1959). *The theory of the growth of the firm*. New York, NY: John Wiley & Sons.

Perlow, L. (1997). *Finding time: How coporations, individuals and families can benefit from new york practices*. Ithaca: Cornell University Press.

Perlow, L., & Weeks, J. (2002). Who's helping whom? Layers of culture and workplace behavior. *Journal of Organizational Behaviour, 23*, 345-361.

Pfeffer, J. (1994). *Competitive advantage through people: Unleashing the power of the workforce*. Boston: Harvard Business School Press.

Pfeffer, J. (Ed.) (1981). *Management as symbolic action: The creation and maintenance of organisational paradigms* (Vol. 3). Greenwich: CT JAI Press.

Pfister, H.-R., & Böhm, G. (2008). The multiplicity of emotions: A framework of emotional functions in decision making. *Judgment and Decision Making, 3*, 5–17.

Pil, F. K., & MacDuffie, J. P. (1999). Transferring competive advantage across borders: A study of japanse auto transplants in north america. In J. K. Liker, W. M. Fruin, & P. S. Adler (Eds.), *Remade in america*. New York: Oxford University Press.

Pilling, B. K., Crosby, l. A., & Jackson, J., Donald W. (1994). Relational bonds in industrial exchange: An experimental test of the transaction cost economic framework. *Journal of Business esearch, 30*, 237-251.

Pisano, G. P., & Wheelwright, S. C. (1995). The new logic of high-tech r&d. *Harvard Business Review, 73*(5), 93-105.

Pontrandolfo, P., & Okogbaa, O. (1999). Global manufcaturing: A review and a framework for planning in a global corporation. *International Journal of Production Research, 37*(1), 1-19.

Powell, G. N., & Johnson, G. A. (1980). An expectancy-equity model of productive system performance. *Journal of Operations Management, 1*(1), 47-56. doi:https://doi.org/10.1016/0272-6963(80)90011-X

Prasad, S., & Babbar, S. (2000). International operations management research. *Journal of Operations Management, 18*(2), 209-247. doi:10.1016/S0272-6963(99)00015-7

Prasad, S., Babbar, S., & Motwani, J. (2001). International operations strategy: Current efforts and future directions. *International Journal of Operations & Production Management, 21*(5/6), 645-665.

Preacher, K. J., Curran, P. J., & Bauer, D. J. (2006). Computational tools for probing interactions in multiple linear regression, multilevel modeling, and latent curve analysis. *Journal of Educational and Behavioral Statistics, 31*(3), 437-448.

Ragin, C. C. (2014). *The comparative method : Moving beyond qualitative and quantitative strategies*. Berkeley, UNITED STATES: University of California Press.

Ramasesh, R. V., & Jayakumar, M. D. (1991). Measurement of manufacturing flexibility: A value based approach. *Journal of Operations Management, 10*(4), 446-468. doi:https://doi.org/10.1016/0272-6963(91)90005-I

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Thousand Oaks, CA:: Sage Publications, Inc.

Rayner, K., Li, X., Williams, C. C., Cave, K. R., & Well, A. D. (2007). Eye movements during information processing tasks: Individual differences and cultural effects. *Vision research, 47*(21), 2714-2726. doi:10.1016/j.visres.2007.05.007

Read, G. J., Salmon, P. M., Lenne, M. G., & Stanton, N. A. (2015). Designing sociotechnical systems with cognitive work analysis: Putting theory back into practice. *Ergonomics, 58*(5), 822-851. doi:10.1080/00140139.2014.980335

Ren, Y., Croson, D., & Croson, R. (2017). The overconfident newsvendor. *The Journal of the Operational Research Society, 68*(5), 496-506. doi:http://dx.doi.org/10.1057/s41274-016-0103-5

Ribbink, D., & Grimm, C. M. (2014). The impact of cultural differences on buyer–supplier negotiations: An experimental study. *Journal of Operations Management, 32*(3), 114-126. doi:http://dx.doi.org/10.1016/j.jom.2014.01.004

Richmond, L. L., Gold, D. A., & Zacks, J. M. (2017). Event perception: Translations and applications. *Journal of Applied Research in Memory and Cognition, 6*(2), 111-120. doi:10.1016/j.jarmac.2016.11.002

Riis, J. O., & Mikkelsen, H. (Eds.). (1995). *Simulation games and learning in production management*. London: Chapman and Hall.

Robert, C., Probst, T. M., Martocchino, J. J., Drasgow, F., & Lawler, J. L. (2000). Empowerment and continuous improvement in the united states. *Journal of Applied Psychology, 85*, 643-658.

Roberts, K. H., & Glick, W. (1981). The job characteristics approach to task design: A critical review. *Journal of Applied Psychology, 66*(2), 193-217. doi:10.1037/0021-9010.66.2.193

Roe, R. A., Zinovieva, I. L., Dienes, E., & Ten Horn, L. A. (2000). Comparison of work motivation in bulgaria, hungary, and the netherlands: Test of a model. *Applied Psychology: An International Review, 49*, 658-687.

Roethlisberger, F. J., & Dickson, W. J. (1939). *Management and the worker: An account of a research program conducted by the western electric company, hawthorne works, chicago*. Cambridge, Mass: Harvard University Press.

Rokeach, M. (1973). *The nature of human values*. New York: Free Press.

Ronen, S., & Shenkar, O. (1985). Clustering countries on attitudinal dimensions: A review and synthesis. *Academy of Management Review, 10*(3), 435-454. doi:10.5465/amr.1985.4278955

Rossi, I., & O'Higgins, E. (Eds.). (1980). *The development of theories of culture*. New York: Praeger.

Rousseau, D. M., & Fried, Y. (2001). Location, location, location: Contextualizing organizational behavior. *Journal of Organizational Behavior, 22*, 1-15.

Rumelhart, D. E. (1977). Understanding and summarizing brief stories. In D. L. S. J. Samuels (Ed.), *Basic processes in reading: Perception and comprehension*. Hillsdale, NJ: Erlbaum.

Rungtusanatham, M., Wallin, C., & Eckerd, S. (2011). The vignette in a scenario-based role-playing experiment. *Journal of Supply Chain Management, 47*(3), 9-16.

Ryan, R. M., & Deci, E. L. (2001). On happiness and human potentials: A review of research on hedonic and eudaimonic well-being. *Annual Review of Psychology, 63,* 513-517.

Salancik, G. R., & Pfeffer, J. (1977). An examination of need-satisfaction models of job attitudes. *Administrative Science Quarterly, 22*(3), 427-456. doi:10.2307/2392182

Salancik, G. R., & Pfeffer, J. (1978). A social information processing approach to job attitudes and task design. *Administrative Science Quarterly, 23*(2), 224-253. doi:10.2307/2392563

Salas, E., Rozell, D., Mullen, B., & Driskell, J. E. (1999). The effect of team building on performance: An integration. *Small Group Research, 30,* 309-329.

Sanderson, P. M., & Grundgeiger, T. (2015). How do interruptions affect clinician performance in healthcare? Negotiating fidelity, control, and potential generalizability in the search for answers. *International Journal of Human-Computer Studies, 79,* 85-96. doi:10.1016/j.ijhcs.2014.11.003

Sargent, J. Q., Zacks, J. M., Hambrick, D. Z., Zacks, R. T., Kurby, C. A., Bailey, H. R., . . . Beck, T. M. (2013). Event segmentation ability uniquely predicts event memory. *Cognition, 129*(2), 241-255. doi:10.1016/j.cognition.2013.07.002

Schmenner, R. W. (1979). Look beyond the obvious in plant location. *Harvard Business Review, 57*(1), 126.

Schmenner, R. W. (1982). *Making business location decisions*. Englewood Cliffs, N.J.: Prentice-Hall.

Schmenner, R. W. (1997). The erosion in european manufacturing. *Production and Operations Management, 6*(2), 110-113. doi:10.1111/j.1937-5956.1997.tb00419.x

Schmenner, R. W., & Swink, M. L. (1998). On theory in operations management. *Journal of Operations Management, 17*(1), 97-113. doi:http://dx.doi.org/10.1016/S0272-6963(98)00028-X

Schultz, K., Johnson, S. C., Schoenherr, T., Nembhard, D., & Marcus, I. (2006). Equity theory effects on worker motivation and speed on an assembly line. 1-40.

Schultz, K., Juran, D. C., & Boudreau, J. W. (1999). The effects of low inventory on the development of productivity norms. *Management Science, 45*(12), 1664-1678.

Schultz, K., Juran, D. C., Boudreau, J. W., McClain, J. O., & Thomas, L. J. (1998). Modeling and worker motivation in jit production systems. *Management Science, 44*(12-part-1), 1595-1607. doi:10.1287/mnsc.44.12.1595

Schultz, K., McClain, J. O., & Thomas, L. J. (2003). Overcoming the dark side of worker flexibility. *Journal of Operations Management, 21*(1), 81-92. doi:10.1016/S0272-6963(02)00040-2

Schultz, K., Schoenherr, T., & Nembhard, D. (2010). An example and a proposal concerning the correlation of worker processing times in parallel tasks. *Management Science, 56*(1), 176-191. doi:10.1287/mnsc.1090.1080

Schwab, K. (2016). *The fourth industrial revolution*. Geneva, Switzerland: World Economic Forum.
Schwan, S., & Garsoffky, B. (2004). The cognitive representation of filmic event summaries. *Applied Cognitive Psychology, 18*, 37-55.
Schwartz, S. H. (1994). Are there universal aspects in the structure and contents of human values? *Journal of Social Issues, 50*(4), 19-45. doi:10.1111/j.1540-4560.1994.tb01196.x
Schwartz, S. H. (2006). A theory of cultural value orientations: Explications and application. *Comparative Sociology, 5*, 137-182.
Schweitzer, M. E., & Cachon, G. P. (2000). Decision bias in the newsvendor problem with a known demand distribution: Experimental evidence. *Management Science, 46*(3), 404-420.
Seers, A., McGee, G. W., Serey, T. T., & Graen, G. B. (1983). The interaction of job stress and social support: A strong inference investigation. *Academy of Management Journal, 26*, 273-284.
Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Boston, MA, US: Houghton, Mifflin and Company.
Shah, R., & Ward, P. T. (2007). Defining and developing measures of lean production. *Journal of Operations Management, 25*(4), 785-805. doi:https://doi.org/10.1016/j.jom.2007.01.019
Shein, E. H. (1992). *Organisational culture and leadership* (2nd Ed.). San Francisco: Jossey-Bass.
Sheu, C., & Wacker, J. (2001). Effectiveness of planning and control systems: An empirical study of us and japanese firms. *International Journal of Production Research, 39*, 887-905. doi:10.1080/00207540010009705
Shi, Y., & Gregory, M. (1998). International manufacturing networks—to develop global competitive capabilities. *Journal of Operations Management, 16*(2), 195-214. doi:https://doi.org/10.1016/S0272-6963(97)00038-7
Shi, Y., Gregory, M., & Naylor, M. (1997). International manufacturing configuration map: A self-assessment tool of international manufacturing capabilities. *Integrated Manufacturing Systems, 8*(5), 273-282.
Sickles, R. C., & Zelenyuk, V. (2019). *Measurement of productivity and efficiency: Theory and practice*. Cambridge: Cambridge University Press.
Simon, H. A. (1953). *A behavioral model of rational choice*. Santa Monica, Calif.: Rand Corporation.
Simon, H. A. (1956). Rational choice and the structure of the environment. *Psychological Review, 63*(2), 129-138. doi:10.1037/h0042769
Slack, N. (1983). Flexibility as a manufacturing objective. *International Journal of Operations & Production Management, 3*(3), 4-13. doi:10.1108/eb054696
Slack, N. (1987). The flexibility of manufacturing systems. *International Journal of Operations & Production Management, 7*(4), 35-45. doi:10.1108/eb054798
Slack, N., Brandon-Jones, A., & Johnston, R. (2016). *Operations management* (8th ed.). United Kingdom: Pearson Education Limited.
Slocum, J. W. (1971). A comparative study of the satisfaction of american and mexican operatives. *Academy of Management Journal, 14*, 89-97.
Smircich, L. (1983). Concepts of culture and organisational analysis. *Administrative Science Quarterly, 28*(3), 339-358.

Smith, E. E., & Kosslyn, S. M. (2009). *Cognitive psychology: Mind and brain*. Upper Saddle River, NJ: Pearson Prentice Hall.
Snijders, T. A., & Berkhof, J. (2008). *Diagnostic checks for multilevel models*. New York: Springer.
Snijders, T. A., & Bosker, R. J. (1999). *Multilevel analysis: An introduction to basic and advanced multilevel modeling*. London, UK: Sage.
Sondergaard, M. (1994). Research note: Hofstede's consequences: A study of reviews, citations and replications. *Organization Studies (Walter de Gruyter GmbH & Co. KG.), 15*(3), 447.
Song, M., & Parry, M. E. (1997). Challenges of managing the development of breakthrough products in japan. *Journal of Operations Management, 17*, 665-688.
Song, S., & Cohen, L. (2014). Impact of conscious intent on chunking during motor learning. *Learning & Memory, 21*(9), 449-451. doi:10.1101/lm.035824.114
Sorensen, C. E., & Williamson, S. T. (2006). *My forty years with ford*. Detroit, UNITED STATES: Wayne State University Press.
Speer, N. K., Swallow, K., & Zacks, J. M. (2003). Activation of human motion processing areas during event percpetion. *Cognitive, Affective & Behavioral Neuroscience, 3*, 335-345.
Sprague, L. G. (2007). Evolution of the field of operations management. *Journal of Operations Management, 25*, 219-238. doi:10.1016/j.jom.2007.01.001
Spreitzer, G. M. (1995). Psychological empowerment in the workplace: Dimensions, measurement and validation. *Academy of Management Journal, 38*, 1442-1465.
Starr, M. K. (1997). Pedagogical challenge: Teaching international production and operations management courses. *Production and Operations Management, 6*(2), 114-121. doi:10.1111/j.1937-5956.1997.tb00420.x
Stedham, Y. E., & Yamamura, J. H. (2004). Measuring national culture: Does gender matter? *Women in Management Review, 19*(5), 233-243.
Sterman, J. D. (1989). Misperceptions of feedback in dynamic decision making. *Organisational Behaviour and Human Decision Processes, 43*(3), 301-335.
Stevens, C. K. (2011). Questions to consider when selecting student samples. *Journal of Supply Chain Management, 47*(3), 19-21.
Su, X. (2008). Bounded rationality in newsvendor models. *Manufacturing & Service Operations Management, 10*(4), 566-589.
Susman, G. (Ed.) (1992). *Integrating design and manufacturingfor competitive advantage*. New York: Oxford University Press.
Sweller, J. (1994). Cognitive load theory, learning difficulty, and instructional design. *Learning and Instruction, 4*(4), 295-312. doi:https://doi.org/10.1016/0959-4752(94)90003-5
Swidler, A. (1997). *Talk of love: How americans use their culture*. Chicago: University of Chicago Press.
Szakonyi, R. (1998). Leading r&d: How much progress in 10 years? *Research Technology Management, 41*(6), 25-29.
Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics, 5th ed.* Boston, MA: Allyn & Bacon/Pearson Education.
Taylor, F. W. (1911). *The principles of scientific management*. New York: Harper & Brothers.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509-533.
Terwiesch, C., & Bohn, R. E. (2001). Learning and process improvement during production ramp-up. *International Journal of Production Economics, 70*(1), 1-19. doi:https://doi.org/10.1016/S0925-5273(00)00045-1
Thaler, R. (1980). Toward a positive theory of consumer choice. *Journal of Economic Behaviour and Organization*, 39-60.
Torraco, R. J. (2005). Work design theory: A review and critique with implications for human resource development. *Human Resource Development Quarterly, 16*(1), 85-109. doi:10.1002/hrdq.1125
Toyota. (2019). 75 years of toyota. Retrieved from https://www.toyota-global.com/company/history_of_toyota/75years/data/index.html
Triandis, H. C. (2004). The many dimensions of culture. *Academy of Management Executive, 18*(1), 88-93. doi:10.5465/ame.2004.12689599
Trist, E. L., & Bamforth, K. W. (1951). Some social and psychological consequences of the longwall method of coal getting: An examination of the psychological situation and defences of a work group in relation to the social structure and technological content of the work system. *Human Relations, 4*(3), 3-38.
Trompenaars, F., & Hampden-Turner, C. (1997). *Riding the waves of culture: Understanding cultural diversity in business*. London: Nicholas Brealey Publishing.
Tuckman, B. W. (1965). Developmental sequence in small groups. *Psychological Bulletin, 63*, 384-399.
Turner, A. N., & Lawrence, P. R. (1965). *Industrial jobs and the worker*. Boston: Harvard University Press.
Turner, W. C. (1993). *Introduction to industrial and systems engineering* (3rd ed.). Englewood Cliffs, N.J.; London: Prentice Hall.
Tversky, A., & Kahneman, D. (1974). Judgement under uncertainty: Heuristics and biases. *Science, 185*(4157), 1124-1131.
Tversky, B., & Hemenway, K. (1984). Objects, parts, and categories. *Journal of Experimental Psychology: General, 113*(2), 169-197.
Tyler, T. R., Lind, E. A., & Huo, Y. J. (2000). Cultural values and authority relations: The psychology of conflict resolution across cultures. *Psychology, Public Policy, and Law, 6*(4), 1138-1163. doi:10.1037/1076-8971.6.4.1138
UNCTAD. (2019). *World investment report 2019: Special economic zones*. New York: UN.
Upton, D. M. (1994). The management of manufacturing flexibility. *California Management Review, 36*(2), 72-89. doi:10.2307/41165745
Van der Vegt, G. S., & Janssen, O. (2003). Joint impact of interdependence and group diversity on innovation. *Journal of Management, 29*(5), 729-751. doi:10.1016/S0149-2063_03_00033-3
Van Maanen, J. (1973). Observations on the making of policemen. *Human Organization, 32*, 407-418.
Vecchi, A., & Brennan, L. (2011). Quality management: A cross-cultural perspective based on globe. International journal of operations & production management. Vol. 3, no.5, pp. 527- 553. *International Journal of Operations & Production Management, 3*(5), 527-553.

Venaik, S., & Brewer, P. (2008). *Contradictions in national culture: Hoftsede vs globe*. Paper presented at the 50th Annual Meeting of the Academy of International Business (AIB), Milan, Italy.

Vinchur, A. J., & Koppes, L. L. (2011). A historical survey of research and practice in industrial and organizational psychology. In *Apa handbook of industrial and organizational psychology, vol 1: Building and developing the organization.* (pp. 3-36). Washington, DC, US: American Psychological Association.

Voss, C. (1984). Production/operations management-a key discipline and area for research. *Omega, 12*(3), 309-319. doi:10.1016/0305-0483(84)90026-4

Voss, C. (1995). Operations management - from taylor to toyota - and beyond? *British Journal of Management, 6*(Special Issue), S17-S29.

Voss, C. (2007). Learning from the first operations management textbook. *Journal of Operations Management, 25*(2), 239-247. doi:http://dx.doi.org/10.1016/j.jom.2006.05.013

Wacker, J. G. (1998). A definition of theory: Research guidelines for different theory-building research methods in operations management. *Journal of Operations Management, 16*(4), 361-385.

Wadel, C. (Ed.) (1979). *The hidden work of everyday life*. London: Academic Press.

Walker, C. R., & Guest, R. H. (1952). *The man on the assembly line*. Cambridge, MA: Harvard University Press.

Walker, G. H., Stanton, N. A., Salmon, P. M., Jenkins, D. P., & Rafferty, L. (2010). Translating concepts of complexity to the field of ergonomics. *Ergonomics, 53*(10), 1175-1186.

Wall, T. D., Kemp, N. J., Jackson, P. R., & Clegg, C. W. (1986). Outcomes of autonomous workgroups: A long-term field experiment. *The Academy of Management Journal, 29*(2), 280-304. doi:10.2307/256189

Wang, Q. (2009). Are asians forgetful? Perception, retention, and recall in episodic remembering. *Cognition, 111*, 123-131. doi:10.1016/j.cognition.2009.01.004

Wang, Q., Shao, Y., & Li, Y. J. (2010). “My way or mom’s way?” the bilingual and bicultural self in hong kong chinese children and adolescents. *Child Development, 81*(2), 555-567. doi:10.1111/j.1467-8624.2009.01415.x

Weiss, H. M., & Shaw, J. B. (1979). Social influences on judgments about tasks. *Organizational Behavior and Human Performance, 24*(1), 126-140. doi:https://doi.org/10.1016/0030-5073(79)90020-5

Wheelwright, S. C. (1994). Accelerating the design-build-test cycle for effective product development. *International Marketing Review, 11*(1), 32-46. doi:10.1108/02651339410057509

Wheelwright, S. C., & Clark, K. B. (1992). *Revolutionizing product development : Quantum leaps in speed, efficiency, and quality*. New York: Free Press : Maxwell Macmillan.

Whyte, G. (1991). Diffusion of responsibility: Effects on the escalation tendency. *Journal of Applied Psychology, 76*(3), 408-415.

Wiengarten, F., Fynes, B., Pagell, M., & De Búrca, S. (2011). Exploring the impact of national culture on investments in manufacturing practices and performance. *International Journal of Operations & Production Management, 31*(5), 554-578. doi:10.1108/01443571111126328

Williamson, O. E. (1971). The vertical integration of production: Market failure considerations. *American Economic Review, 61*(2), 112-123.

Willis, P. (1977). *Learning to labour*. New York: Columbia Univ. Press.
Womack, J. P., & Jones, D. T. (2003). *Lean thinking: Banish waste and create wealth in your corporation*. New York: Free Press.
Womack, J. P., Jones, D. T., & Roos, D. (1990). *The machine that changed the world*. Macmillan: New York, NY.
Wrong, D. H. (1961). The oversocialized conception of man in modern sociology. *American Sociological Review, 26*(2), 183-193. doi:10.2307/2089854
Wrzesniewski, A., Dutton, J. E., & Debebe, G. (Eds.). (2003). *Interpersonal sensemaking and the meaning of work* (Vol. 25). Amsterdam: Elsevier.
Xue, J., & Zuo, W. (2013). English dominance and its influence on international communication. *Theory and Practice in Language Studies, 3*(12), 2262-2266. doi:http://dx.doi.org/10.4304/tpls.3.12.2262-2266
Yeung, A. C. L. (2008). Strategic supply management, quality initiatives, and organizational performance. *Journal of Operations Management, 26*(4), 490-502. doi:10.1016/j.jom.2007.06.004
Zacks, J. M., Braver, T. S., Sheridan, M. A., Donaldson, D. I., Snyder, A. Z., Ollinger, J. M., . . . Raichle, M. E. (2001). Human brain activity time-locked to perceptual event boundaries. *Nature Neuroscience, 4*(6), 651-655.
Zacks, J. M., & Sargent, J. Q. (2010). Event perception: A theory and its application to cinical neuroscience. In B. H. Ross (Ed.), *The psychology of learning and motivation* (Vol. 53, pp. 253-299). Burlington: Academic Press.
Zacks, J. M., Speer, N. K., & Reynolds, J. R. (2009). Segmentation in reading and film comprehension. *Journal of Experimental Psychology: General, 138*(2), 307-327.
Zacks, J. M., Speer, N. K., Swallow, K., Braver, T. S., & Reynolds, J. (2007). Event perception: A mind-brain perspective. *Psychological Bulletin, 133*(2), 273-293.
Zacks, J. M., Speer, N. K., Vettel, J. M., & Jacoby, L. L. (2006). Event understanding and memory in healthy aging and dimentaia of the alzheimers type. *Psychology and Aging, 21*, 466-482.
Zacks, J. M., & Swallow, K. (2007). Event segmentation. *Curr Dir Psychol Sci, 16*(2), 80-84. doi:10.1111/j.1467-8721.2007.00480.x
Zacks, J. M., & Swallow, K. M. (2007). Event segmentation. *Current Directions in Psychology Science, 16*(2), 80-84.
Zacks, J. M., & Tversky, B. (2001). Event structure in perception and conception. *Psychological Bulletin, 127*(1), 3.
Zacks, J. M., Tversky, B., & Iyer, G. (2001). Perceiving, remembering, and communicating structure in events. *Journal of Experimental Psychology: General, 130*(1), 29-58.
Zhang, Q., Vonderembse, M. A., & Lim, J.-S. (2003). Manufacturing flexibility: Defining and analyzing relationships among competence, capability, and customer satisfaction. *Journal of Operations Management, 21*(2), 173-191. doi:10.1016/S0272-6963(02)00067-0
Zhao, X., Flynn, B. B., & Roth, A. V. (2006). Decision sciences research in china: A critical review and research agenda—foundations and overview. *Decision Sciences, 37*(4), 451-496. doi:10.1111/j.1540-5414.2006.00135.x
Zijlstra, F. R. H., Roe, R. A., Leonora, A. B., & Krediet, I. (1999). Temporal factors in mental work: Effects of interrupted activities. *Journal of Occupational and Organizational Psychology, 72*, 163-185.

Appendix I: Example of Text Segmentation in Pilot Study

Read the paragraph below titled “Jitsu Motors Production Plant” and segment the text into meaningful events, inserting the symbol “⊥” to highlight wherever, in your judgment, you think one meaningful event ended. For example,” John made pizza by flattening the dough, ⊥ adding pepperoni, peppers and pineapples⊥ ….”

British

⊥Today was my first day working at the Jitsu manufacturing plant, where I will join the car assembly team.⊥ My first task was to tour the facility and see how the cars are made. After the sub-assemblies of the floor pan and the motor are created elsewhere, they brought to the factory floor and welded into their final location.⊥ A flat vehicle body arrives and additional assemblies are added to give the vehicle body both height and width. This gives the car a rough shape, but it still lacks the external body panels ⊥that make it look like the final product, there is no roof, and none of the swinging metal parts like doors, hood, trunk. In one of the more complex operations in the body shop the body sides are placed onto the vehicle. ⊥ This is typically the largest single piece of sheet metal used in a vehicle. It runs from the headlights to the taillights and gives the external shape to the car. ⊥ While being held in position a number of robots will weld the left and right sides into place. Also,⊥ there are sparks flying everywhere when you weld, and⊥ I absolutely love to see the sparks!⊥ The metal for the roof is placed on top of the welded structure. This is one of the⊥ defining features of a vehicle. The doors are built up in separate sub-assembly line ⊥and are placed on a conveyor to be mounted onto the rest of the body.⊥ These doors are then lifted via a specially designed piece of tooling to lift them and locate them accurately to the car body. Bolts are twisted, and verified, to a specific value to mount the doors.⊥ The hoods and deck-lids are placed in a similar manner to doors. At this point the Jitsu looks like a car without wheels, a chassis, or an interior. But it's the right shape. Next,⊥ imagine a tunnel of fluorescent light fixtures with cars running down its centre and people on both side of the assembly line at 20 feet intervals. The⊥ purpose is to identify and fix any problems or defects that would show up once painted.⊥ Workers sand and smooth the body panels to ensure no problems occur once painted.⊥ It's far easier to fix things at this point than to remove paint. Then the car gets to ride on a conveyor belt to the paint shop where it is coated not once, not twice but three times with vibrant paint. Oh what a beauty!⊥

Chinese/

⊥Today was my first day working at the Jitsu manufacturing plant, where I will join the car assembly team. My first task was to tour the facility and see how the cars are made. After the sub-assemblies of the floor pan and the motor are created elsewhere, they brought to the factory floor and welded into their final location.⊥ A flat vehicle body arrives and additional assemblies are added to give the vehicle body both height and width. ⊥This gives the car a rough shape, but it still lacks the external body panels that make it look like the final product, there is no roof, and none of the swinging metal parts like doors, hood, trunk.⊥ In one of the more complex operations in the body shop the body sides are placed onto the vehicle. This is typically the largest single piece of sheet metal used in a vehicle. It runs from the headlights to the taillights and gives the external shape to the car.⊥ While being held in position a number of robots will weld the left and right sides into place. Also, there are sparks flying everywhere when you weld, and I absolutely love to see the sparks!⊥ The metal for the roof is placed on top of the welded structure. This is one of the defining features of a vehicle.⊥ The doors are built up in separate sub-assembly line and are placed on a conveyor to be mounted onto the rest of the body. These doors are then lifted via a specially designed piece of tooling to lift them and locate them accurately to the car body.⊥ Bolts are twisted, and verified, to a specific value to mount the doors.⊥ The hoods and deck-lids are placed in a similar manner to doors.⊥ At this point the Jitsu looks like a car without wheels, a chassis, or an interior. But it's the right shape.⊥ Next, imagine a tunnel of fluorescent light fixtures with cars running down its centre and people on both side of the assembly line at 20 feet intervals.⊥ The purpose is to identify and fix any problems or defects that would show up once painted. Workers sand and smooth the body panels to ensure no problems occur once painted.⊥ It's far easier to fix things at this point than to remove paint. Then the car gets to ride on a conveyor belt to the paint shop where it is coated not once, not twice but three times with vibrant paint.⊥ Oh what a beauty!⊥

Appendix II: Participant Social Behaviour Survey

Please indicate the extent to which you agree with each statement using the scale provided.

Social Support

1. I felt comfortable to communicate with co-workers.
2. The people I worked with were friendly.

Feedback

3. My co-workers were helpful in ensuring that I follow instructions.

Appendix III: Extract of Data for Analysis

Observation	Subject	Task	Nationality	Assemblies Produced	Quality Index	Average Team Assemblies	Paper plane Segmentation Score_Trial 1	Paper plane Segmentation Score_Trial 2	Segmentation Score_IBES
1	B212	CRAFT	British	41	0.88	42.67	0.08	0.08	0.07
2	B212	LEAN	British	44	1.00	51.33	0.08	0.08	0.07
3	B212	MASS	British	66	1.00	81.33	0.08	0.08	0.07
4	B213	CRAFT	British	84	0.78	28.33	0.09	0.13	0.08
5	B213	LEAN	British	66	0.95	44.00	0.09	0.13	0.08
6	B213	MASS	British	114	0.96	65.33	0.09	0.13	0.08
7	B214	CRAFT	British	25	0.93	48.00	0.06	0.08	0.08
8	B214	LEAN	British	42	0.83	52.00	0.06	0.08	0.08
9	B214	MASS	British	64	0.83	82.00	0.06	0.08	0.08
10	B231	CRAFT	British	104	0.82	105.00	0.12	0.09	0.08
11	B231	LEAN	British	80	1.00	92.67	0.12	0.09	0.08
12	B231	MASS	British	80	1.00	84.00	0.12	0.09	0.08
13	B232	CRAFT	British	105	0.78	104.67	0.03	0.03	0.04
14	B232	LEAN	British	80	1.00	92.67	0.03	0.03	0.04
15	B232	MASS	British	74	1.00	86.00	0.03	0.03	0.04
16	B233	CRAFT	British	105	0.69	104.67	0.06	0.06	0.08
17	B233	LEAN	British	120	0.87	79.33	0.06	0.06	0.08
18	B242	CRAFT	British	41	0.72	68.50	0.04	0.04	0.04
19	B242	LEAN	British	38	1.00	44.00	0.04	0.04	0.04
20	B242	MASS	British	72	1.00	61.50	0.04	0.04	0.04
21	B243	CRAFT	British	65	0.83	56.50	0.03	0.04	0.04
22	B243	LEAN	British	54	0.89	36.00	0.03	0.04	0.04
23	B243	MASS	British	75	0.89	60.00	0.03	0.04	0.04
24	B244	CRAFT	British	72	0.96	53.00	0.07	0.07	0.06
25	B244	LEAN	British	34	0.93	46.00	0.07	0.07	0.06
26	B244	MASS	British	48	0.93	73.50	0.07	0.07	0.06
27	B252	CRAFT	British	136	0.75	113.00	0.08	0.06	0.06
28	B252	LEAN	British	102	1.00	126.50	0.08	0.06	0.06
29	B252	MASS	British	68	1.00	78.00	0.08	0.06	0.06
30	B253	CRAFT	British	113	0.79	124.50	0.06	0.06	0.07
31	B253	LEAN	British	125	0.96	101.00	0.06	0.06	0.07
32	B253	MASS	British	96	1.00	64.00	0.06	0.06	0.07
33	B254	CRAFT	British	113	0.64	124.50	0.12	0.12	0.06
34	B254	LEAN	British	100	0.80	127.50	0.12	0.12	0.06
35	B254	MASS	British	60	0.80	82.00	0.12	0.12	0.06
36	B261	CRAFT	British	96	0.63	125.67	0.05	0.04	0.05
37	B261	LEAN	British	56	1.00	61.67	0.05	0.04	0.05
38	B261	MASS	British	110	1.00	97.00	0.05	0.04	0.05
39	B262	CRAFT	British	97	0.60	125.33	0.05	0.03	0.04
40	B262	LEAN	British	52	1.00	63.00	0.05	0.03	0.04
41	B262	MASS	British	86	1.00	105.00	0.05	0.03	0.04
42	B263	CRAFT	British	144	0.61	109.67	0.03	0.03	0.04
43	B263	LEAN	British	81	0.80	53.33	0.03	0.03	0.04
44	B263	MASS	British	123	0.85	92.67	0.03	0.03	0.04
48	C144	CRAFT	Chinese	96	0.85	82.33	0.03	0.03	0.04
49	C144	LEAN	Chinese	92	0.84	109.33	0.03	0.03	0.04
50	C144	MASS	Chinese	102	0.80	144.67	0.03	0.03	0.04
51	C151	CRAFT	Chinese	81	0.96	44.67	0.04	0.03	0.03
52	C151	LEAN	Chinese	72	1.00	81.00	0.04	0.03	0.03
53	C151	MASS	Chinese	90	1.00	116.33	0.04	0.03	0.03
54	C152	CRAFT	Chinese	56	0.89	53.00	0.07	0.06	0.06
55	C152	LEAN	Chinese	70	1.00	81.67	0.07	0.06	0.06
56	C152	MASS	Chinese	126	1.00	104.33	0.07	0.06	0.06
57	C153	CRAFT	Chinese	49	0.90	55.33	0.03	0.02	0.03
58	C153	LEAN	Chinese	105	0.79	70.00	0.03	0.02	0.03
59	C153	MASS	Chinese	135	0.40	101.33	0.03	0.02	0.03
60	C194	CRAFT	Chinese	97	0.92	80.50	0.09	0.07	0.03
61	C194	LEAN	Chinese	72	0.96	92.50	0.09	0.07	0.03
62	C194	MASS	Chinese	66	0.99	91.50	0.09	0.07	0.03
63	C202	CRAFT	Chinese	113	0.70	75.50	0.05	0.04	0.03
64	C202	LEAN	Chinese	48	1.00	59.00	0.05	0.04	0.03
65	C202	MASS	Chinese	112	1.00	66.50	0.05	0.04	0.03
66	C204	CRAFT	Chinese	81	1.00	91.50	0.06	0.07	0.04
67	C204	LEAN	Chinese	46	0.95	60.00	0.06	0.07	0.04
68	C204	MASS	Chinese	52	0.92	96.50	0.06	0.07	0.04
69	C211	CRAFT	Chinese	66	0.65	110.33	0.03	0.03	0.04
70	C211	LEAN	Chinese	68	1.00	75.33	0.03	0.03	0.04
71	C211	MASS	Chinese	62	1.00	63.00	0.03	0.03	0.04
72	C212	CRAFT	Chinese	104	0.80	97.67	0.03	0.03	0.04
73	C212	LEAN	Chinese	66	1.00	76.00	0.03	0.03	0.04
74	C212	MASS	Chinese	56	1.00	65.00	0.03	0.03	0.04
75	C214	CRAFT	Chinese	120	0.65	86.33	0.04	0.04	0.04
76	C214	LEAN	Chinese	64	0.83	76.67	0.04	0.04	0.04
77	C214	MASS	Chinese	52	0.82	66.33	0.04	0.04	0.04
78	C221	CRAFT	Chinese	96	0.80	59.33	0.03	0.02	0.05
79	C221	LEAN	Chinese	36	1.00	39.00	0.03	0.02	0.05
80	C221	MASS	Chinese	66	1.00	60.00	0.03	0.02	0.05