Ambidextrous Production Teams: The Productivity Dilemma Revisited

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Abstract

Ways to simultaneously achieve objectives such as efficiency and flexibility or consistency and adaptability fascinate many OM scholars. In this paper, we use the concept of "contextual ambidexterity" to explore how small production teams can resolve such trade-offs. Using data from 68 student teams we investigate how *discipline*, *stretch* and *trust-support* are related to productivity, quality and dependability. We find little evidence of trade-offs per se; rather, there is an underlying capability that supports all three aspects of performance. Discipline and trust-support show strong, significant relationships to performance; stretch is related to productivity but not quality or dependability.

Keywords: Productivity; trade-offs; ambidexterity

Scholars of organization and operations have long been fascinated by dilemmas and trade-offs. This interest stems from a recognition that, organizationally speaking, it is difficult to have it all. Organizations that are designed or evolve in order to achieve particular outcomes are likely to find it harder to achieve others. This problem has been dubbed the "the productivity dilemma" (Abernathy, 1978). The essence of this dilemma is that actions to achieve greater control and efficiency often come with undesirable side-effects, such as a diminution of the capacity to adapt and innovate.

In the field of Operations Management (OM) this idea has been expressed in the concept of trade-offs (Skinner, 1974, Banks and Wheelwright, 1979). The trade-off concept assumes that choices must be made about what dimensions of performance to prioritize amongst potentially multiple possibilities, for example, quality, cost,

dependability and lead time. In the world of trade-offs, superior performance against one objective must of necessity come at the cost of lower performance on another (Da Silveira and Slack, 2001). OM scholars have largely focused on the trade-offs between different dimensions of operational performance such as quality, efficiency and flexibility.

There have been periodic challenges to the assumption that operational trade-offs are inevitable, and indeed to the exploration-exploitation dichotomy more widely. One prominent example of this came in the form of the "lean" production practices of Japanese manufacturers, in particular Japanese automakers (Womack et al., 1990). Lean production challenged many of the taken-for-granted precepts of OM, because of the ability of lean automakers to achieve high levels of efficiency, quality and product variety simultaneously. Toyota stood out as the exemplar and has continued to be portrayed as such (Adler, 1993, Adler et al., 1999, Adler et al., 2009).

How can the resolution of trade-offs be explained? One theory is that capabilities are cumulative, so that good performance with respect to say, quality, enables good performance on other measures, such as dependability (Ferdows and De Meyer, 1990). The cumulative model explains why units can perform well on several dimensions simultaneously, because good performance on one enables good performance on another, rather than detracting from it.

Whilst the Operations Management community has tended to focus on trade-offs, the general management community has emphasized 'ambidexterity'(Duncan, 1976). The ambidexterity literature addresses the more general ability of organisations to do disparate things at the same time. This encompasses operational trade-offs, but it also covers more strategic issues. Amongst the general management community, this is seen as a dichotomy between exploitation and exploration (March, 1991) and is often represented as the tension between innovation (ie the exploration of new possibilities in terms of products, markets and customers) and the exploitation of existing resources. Much of this work adopts a macro-organizational perspective, emphasizing structural solutions to the ambidexterity problem, specifically the partitioning of different activities via structural separation (ie different organizational subunits focus on different priorities) to avoid the problem of crowding out of some objectives by others (Benner and Tushman, 2003, O'Reilly and Tushman, 2013).

However, other streams of theorizing about ambidexterity exist. One focuses on the ability of production systems to combine efficiency and consistency with learning, adaption and improvement. Like the exploration-exploitation dichotomy, this stream recognizes that "the capabilities that enable consistent execution can also hinder learning and innovation, leaving organizations rigid and inflexible" (Adler et al., 2009). Adler's concept of the "learning bureaucracy" (Adler, 1993) and related analyses of how efficiency co-exists with flexibility (Adler and Borys, 1996, Adler et al., 1999, Adler et al., 2009, MacDuffie, 1995) epitomize this work. 'Exploration' in this context refers not to radical innovations in products or markets, but rather the constant adaption and adjustment of existing systems. Temporal separation of activities can also occur, with disciplined production activities occasionally punctuated by intense problem-solving activity. Toyota and its network of suppliers again appear as case examples in this literature.

A further stream of theorizing is based on the concept of "contextual ambidexterity" (Gibson and Birkinshaw, 2004). A shared feature of both structural ambidexterity and learning bureaucracies is 'partitioning', in which exploitation and exploration occur at the same time but in different places (structural separation) or in the same place but at different times (temporal partitioning). Gibson and Birkinshaw argue that contextual

ambidexterity represents "the behavioural capacity to *simultaneously* demonstrate alignment and adaptability across an entire business unit" (Gibson and Birkinshaw, 2004) and that this is achieved by "building a business unit context that encourages individuals to make their own judgments as to how best divide their time between the conflicting demands for alignment and adaptability. (Gibson and Birkinshaw, 2004). Drawing on the work of Ghosal and Bartlett, Gibson and Birkinshaw argue that contextual ambiguity is supported by four conditions, namely:

Discipline – which encourages actors to strive to meet the expectations placed upon them. It is fostered by clear standards of performance, candid and rapid feedback and a consistent application of sanctions.

Stretch – a willingness to take on ambitious objectives, reinforced by shared ambition and a strong collective identity.

Support – a willingness of actors to help each other out.

Trust – the ability to rely on the commitments made by others.

The concept of contextual ambidexterity is particularly relevant to smaller units that face competing pressures, such as production and project teams operating in turbulent, changeable conditions. Yet remarkably little work has been conducted on the dynamics of ambidexterity in smaller units. This is a curious oversight, because although the exploration-exploitation tension may be more acute in larger organizations, there is no reason to believe it is absent in smaller ones. Smaller units still have to make choices how they allocate their attention and other resources between current, existing activities and future, potential ones, but may lack institutional mechanisms to enable this.

Research Questions

This paper therefore examines ambidexterity in small production units. We address the question "To what extent does contextual ambidexterity enable the performance of production teams operating in the face of challenging, dynamic conditions?" We have several objectives. First, we seek to understand the characteristics of units that face demands to operate efficiently and accurately (ie for exploitation) whilst simultaneously requiring adaption and even innovation (ie exploration). Secondly, we empirically explore whether contextual ambidexterity is associated with superior performance.

Methods

We use a simulation based on 68 post graduate student teams each comprising 7-10 members. The exercise subjects the student teams to competing pressures and tensions and tests their ability to handle these. The exercise generates objective data on team performance and therefore starkly reveals the ability to be both efficient and adaptable.

For a "trading period" of about half a day, teams of 7-10 participants select orders for simple products (greetings cards) from a bank of orders and physically produce the cards to rigorous quality standards (creating a requirement for accurate, high-quality production) and strict deadlines (ie dependability). Orders come in batch sizes of 4, 8 or 12 identical cards. Each order is for a particular occasion (Birthday, New Year etc), and the order specifies the colour, card, size, number of lines of verse, the time available, in minutes, to produce the batch (15, 20, 25, 30 minutes or open orders) and the price. Theoretically around 30,000 variants of order are possible.

Teams produce the cards using only equipment and materials that they purchase from the Game's Controllers. Completed orders are delivered to inspectors who check that the order is on-time, complete and meets the quality standards. Teams are paid in cash (with counterfeit banknotes) for each successful order. Preparation begins about a month before

the trading period. Participants take part in the exercise as part of an Organizational Behaviour course and are randomly assigned to their teams.

Every team is required to develop a strategic plan ahead of the trading period. This plan covers the types of orders they will pursue (most teams choose to specialize in particular colour/size/ leadtime combinations, although this is their choice), the organization and design of their manufacturing and other business processes and the capital equipment and materials they wish to purchase prior to the trading period. Equipment and materials can also be purchased for cash during the trading period. There is a depreciation rate of 70% on all equipment and materials, so teams must earn significant income in order to recoup this – this creates a strong requirement for high productivity.

The trading period comes as a shock to many teams. The trading room is noisy and busy. Each team is provided with a table that can seat all its members at which production takes place. At one end of the room is the Controllers' area. This area contains an order-board which displays 10-20 orders at any one time; a receiving area for completed orders where the cards are inspected by the controllers and teams paid for orders that meet the quality standards; and a procurement station, from which teams order additional equipment and materials.

Orders are assigned to teams on a first-come-first served basis – a team wishing to take a particular order attracts the attention of a controller who will then sign the order out to them, recording the time at which it is due. At times, there is much shouting as the order-takers try to obtain their preferred orders. The order board is continually replenished from a bank of orders, but the "realized market" (ie what is on the board at any one time) is determined by the independent order-taking strategies of the teams in the Game. This is a significant source of uncertainty in the Game – the realized market can be quite different to what the teams were expecting. Teams may therefore not be able to obtain the orders for which they had planned, forcing adaption.

Nearly all teams practice production during the preparation phase, but actual production conditions are often rather different to those in rehearsals. The time pressure caused by the strict delivery deadlines can be stressful, inducing production errors. The environment is noisy and sometimes chaotic as team members run between their tables and the order board, delivery and procurement stations. Teams shout information across the room to each other as they try and coordinate order-taking, production capacity and inventory levels. In post-game de-briefs participants describe stressors such as the difficulty of obtaining the orders they want, the tight delivery deadlines, anxiety about making mistakes and the noise in the room. Within the team of Controllers, quality-control inspectors check each received order and if any faults are found the whole order is rejected. When an inspector rejects an order, a loud whistle is blown which can be heard by all teams, creating further stress. Even teams that have practiced extensively in the preparation phase often find that actual production conditions are quite different to their test environment. It is often at this point that many teams realize that they have not fully understood the quality criteria given in the brief, or that they are not capable of achieving the standard consistently under trading conditions. Teams must therefore quickly adapt to the conditions of the trading period. This adaptation takes a number of forms, such as switching product mix in the light of the market, identifying emergent bottlenecks and quality problems and adjusting processes to address these. For some teams, this means swift reappraisal of their strategy and organization.

In terms of the trade-offs discussed in the introduction, the exercise generates pressures for productivity, quality and dependability simultaneously whilst carefully controlling

their costs. Moreover, teams must produce in a dynamic environment that they cannot fully predict, forcing adaption. The exercise therefore creates many of the conditions that allow us to observe trade-offs and ambidexterity.

Data Collection

Both quantitative and qualitative data were collected. The quantitative data come from two main sources. First, five measures of objective performance were taken for each team. These were: 1) number of cards delivered per head; 2) value of sales per head; 3) percentage of orders rejected; 4) percentage of orders that did not meet the delivery deadline; 5) profit/loss per head. Measures 1) and 2) indicate productivity; measure 3 indicates quality; measure 4 indicates dependability; and measure 5) provides on overall indication of how well strategy, operations and financial decisions are brought together.

Second, participants completed two questionnaires, one a few days before the trading period and a second questionnaire immediately after trading but before the trading results had been calculated and released. These questionnaires covered a number of team attributes and processes relevant to how teams deal with difficult conditions and included team resilience (Stephens et al., 2013), mindful organizing (Vogus and Sutcliffe, 2007, Weick and Sutcliffe, 2007), psychological well-being (Warr, 1990), team potency (Guzzo et al., 1993) and transactive memory systems (Lewis, 2003). We explain how we used these scales later in the paper.

Qualitative data were collected in a number of ways. First, during the exercise itself the authors, who also served as controllers during the trading period, were able to directly observe the activities of the teams. In some cases, video recordings were also made. Second, about a week after the trading period, each team was required to make a short presentation to the whole class, in which they reported their performance and analysed the reasons behind it. At least one, and sometimes two or three of the authors attended all 68 presentations. Finally, approximately three weeks after trading, each participant produced a reflective report on the exercise, which was graded. Two of the authors were responsible for reviewing and grading the reports, which were anonymized. The reports revealed a great deal about what took place in the teams. The exercise was run seven times between 2015 and 2017, with 4-16 teams in each Game, producing data on 68 teams and 545 participants.

Results

We first examine the extent to which the objective measures of performance discriminate between the teams. As explained previously, our choice of measures was guided by key measures of performance found in the OM literature, namely productivity, quality and dependability, but for completeness we also show financial measures. These are shown in Table 1.

As can be seen, the measures discriminate very significantly between teams, with a 4:1 difference in productivity (cards delivered per person) between the best and worst teams, quality (reject) rates that vary from 0% to 67% and dependability (non-fulfilment) rates that vary between 0% and 54%. Profitability also varies enormously from a loss of £6879 to a profit of £5478.

Table 1: Summary Performance Data

	Minimum	**Mean**	**Maximum**	**SD**
Number of cards produced and delivered per team	32	98.9	184	32.2
Number of cards produced and delivered per person	4.6	12.3	19.5	3.6
Number of rejected orders per team	0	2.4	7	1.7
Orders rejected as % of orders delivered	0.0%	20.1%	66.7%	15.2
Number of order unfulfilled	0	0.87	7	1.4
Orders unfulfilled as % of orders taken	0.0%	6.7%	53.9%	10.2
Value of sales per person (£)	38.6	523.3	1195.0	222.7
Profit/loss per team (£)	-6879	-1162	+5478	1810
Profit/loss per head (£)	-859.9	-151.9	547.8	222.7

Having demonstrated that significant performance differentials exist, what evidence is there of trade-offs between these different measures? Does good performance on one measure necessarily mean lower performance on another? Table 2 shows little evidence of such trade-offs. The main measure of productivity, cards per head, correlates negatively with reject rate (but not significantly) and negatively and significantly with non-fulfilment rate. As expected, card per head correlates strongly and significantly with value of sales per head and profit/loss per head. Reject rate and non-fulfilment rate correlate positively and significantly.

Table 2: Correlations between the main performance measures

	Variables	**1**	**2**	**3**	**4**	**5**
1	Cards delivered per head	1.00				
2	Reject rate	-.19	1.00			
3	Non-fulfilment rate	-.41***	.37**	1.00		
4	Value of sales per head	.77***	-.54***	-.40***	1.00	
5	Profit (loss) per head	.41***	-.64***	-.56***	.78***	1.00

N= 68, * = $p \leq .05$, ** = $p \leq .01$, *** = $p \leq .001$

Thus, the performance data imply that teams possess (or lack) underlying capabilities that allows some teams to perform well on multiple dimensions of operational performance simultaneously, just as their absence limits the performance of others.

As described in the introduction, the OM literature has focused primarily on trade-offs amongst different dimensions of operational performance. The ambidexterity literature has been more concerned with the exploration-exploitation issue, which at a strategic level sometimes is often expressed as a tension between sticking to proven areas of competence versus innovating. At a more operational level the tension is between efficiency and flexibility, consistency and adaptability.

The trading period creates the conditions for switching, adaptable behaviour in the face of unexpected, challenging and sometimes stressful conditions. We assessed whether this was achieved by asking the participants to report their psychological experience of the trading period. A large majority (78%) reported that they felt tense at least sometime during trading. Moreover, 53% reported unease and 55% that they were worried at least sometimes during trading. We also asked participants if in their view their team had experienced a crisis at any point in the Game. Overall, 51.4% perceived a crisis, but with wide variation across teams. Seven teams were unanimous in reporting that they had had

no crisis; in nine teams all members reported crisis. These data support the idea that for most teams and participants the trading period successfully fostered conditions likely to trigger adaption and adjustment.

Contextual Ambidexterity

As described in the methods section, the overall purpose of this research was to explore how production teams handled difficult conditions. This involved using multiple scales, described in the methods section. Where possible, these were based on scales that had already developed and validated by other studies. In total, 11 scales comprising 69 items were deployed, with an additional 14 items developed specifically for use in this simulation. Although not originally developed to test contextual ambidexterity, many items from these scales appeared relevant to the four dimensions identified by Gibson and Birkinshaw. All 83 items were reviewed and four new scales constructed, on the basis of face validity in the first instance, to assess discipline, stretch, support and trust. These initial scales were then subject to several rounds of factor and reliability analyses. Factor analysis demonstrated that discipline and stretch appeared to be distinct factors, but trust and support were not; these last two were therefore combined into a single combined scale. The resulting scales and their factor and reliability analyses are shown in table 3.

Table 3: Factor and Reliability Analysis of Discipline, Stretch, Trust and Support Scales

		Factor 1	Factor 2	Factor 3
Discipline α = 0.86	We talked about mistakes and ways to learn from them	0.121	0.333	0.817
	When errors happened, we discussed how we could have prevented them	0.135	0.150	0.882
	When a crisis occurred, we rapidly pooled our collective expertise to attempt to resolve it	0.009	0.266	0.820
Stretch α = 0.91	This team believes it can become unusually good at producing high-quality work	0.878	-0.004	-0.025
	This team expects to be known as a high-performing team	0.862	0.033	0.133
	This team believes it can be very productive	0.904	0.054	0.091
	This team can get a lot done when it works hard	0.818	0.199	0.269
	No task is too tough for this team	0.817	0.174	-0.023
Trust and support α = 0.87	I was comfortable accepting procedural suggestions from other team members	0.174	0.645	0.455
	I trusted that other members' knowledge about the project was credible	0.133	0.771	0.409
	I was confident relying on the information that other team members brought to the discussion	0.082	0.803	0.374
	I did not have much faith in other members' "expertise" (rev)	0.058	0.915	-0.006
	There was friction amongst members of our team (rev)	0.066	0.763	0.178

Discipline was assessed by the extent to which teams monitored their processes for errors and took corrective action (crucial to producing cards both rapidly and accurately); the analysis and correction of problems; and the ability of team members to work together efficiently and effectively under pressure. The discipline scale consisted of three items (α = 0.86). *Stretch* was assessed by five items from a team potency scale (Guzzo et al., 1993) which mapped well on to attributes such as ambitious, shared objectives and collective identity (α=0.91). The *Trust and Support* scale comprised five items, four of which were

drawn from a transactive memory systems scale (Lewis, 2003) and one item on team friction developed for this study (α=0.83).

Inter-scale correlations and tests of construct validity and are shown in table 4. The validity of the three constructs was assessed through their relationships to a) well-being (feelings of worry, gloom and enthusiasm); b) perceptions of crisis in each team; c) Teams' forecast value of sales in advance of the trading period; and d) team's assessment of their position vis a vis their competitors.

Table 4: Discipline, Stretch & Support - Construct Validity Correlations

	Discipline	**Stretch**	**Trust & Support**
Feeling worried	-0.29*	0.25*	-0.32**
Feeling gloomy	-0.54***	0.00	-0.62***
Feeling enthusiastic	0.60***	0.25*	0.52***
Percentage of team members perceiving a crisis	-0.33**	0.08	-0.52***
Pre-game forecast value of sales	-0.11	0.56***	-0.16
Pre-game predicted position against competitors	-0.03	0.63***	0.15
Post-game predicted position	0.55***	0.10	0.52***
Discipline	1.00	-	-
Stretch	0.22	1.00	-
Trust and support	0.56***	0.23	1.00

N= 68, * = $p \leq .05$, ** = $p \leq .01$, *** = $p \leq .001$

Table 4 broadly supports the validity of the three constructs. Discipline shows quite strong and significant relationships to well-being and is negatively related to sense of crisis. It shows no relationship to predicted performance before the trading period, perhaps because some rather undisciplined teams made some wildly optimistic production forecasts before the trading period, but correlates quite well with teams' assessment of their performance relative to their competitors before they knew the final results. The trust-support scale correlates in the expected direction with measures of well-being and with perception of crisis.

Stretch shows a positive relationship to 'worry' which is logical as stretch is likely to place more stress on a team. Stretch correlates positively with teams' forecast value of sales as stated in teams' strategic plans and to predicted position vis a vis competitor teams before the trading period, confirming that the stretch scale is detecting ambition. Discipline and trust and support show no significant relationships to the magnitude of forecast sales, demonstrating that strength of ambition in the abstract does not necessarily co-exist with the discipline and/or trust and support necessary to realize it.

In terms of intercorrelations between the three scales, discipline and trust and support show a moderate correlation (0.56, $p \leq .001$). Stretch shows weak but non-significant relationships to discipline and support-trust. Overall, the three constructs appear reasonably distinct and demonstrate acceptable validity and reliability. The final step of the analysis tests the relationships between the constructs of discipline, stretch and support-trust and the objective measures of performance as shown in Table 5.

Starting with discipline, moderate to strong relationships, significant at $p<.001$, are seen with all performance measures apart from cards delivered per head. At first sight the lack of significant relationship to cards per head seems surprising, until one remembers that the exercise demands both speed *and* accuracy. Delivered cards per head indicates speed of production but says nothing about how many cards actually met the

specifications. It is possible to produce a lot of product in a relatively undisciplined way, but in the absence of (and perhaps at the expense of) quality and accuracy. The second productivity measure of 'value of sales per head' accounts for quality, because teams only earn revenue on products that meet the quality standards. Value of sales is therefore positively related to discipline. This measure also encompasses the value of orders taken. Higher value orders are the hallmark of a more aggressive, ambitious strategy but are more difficult to produce and hence require greater discipline.

Table 5: Discipline, Stretch, Support-Trust & Performance

	Discipline	**Stretch**	**Trust & Support**
Delivered cards per head	0.17	0.36**	0.13
Value of sales per head	0.42***	0.33**	0.33**
Reject rate	-0.61***	-0.04	-0.51***
Non-fulfilment rate	-0.38***	-0.02	-0.31**
Profit (loss) per head	0.50***	0.12	0.43***

N= 68, * = $p \leq .05$, ** = $p \leq .01$, *** = $p \leq .001$

Interestingly, the strongest relationship of all is between discipline and reject rate, confirming the importance of discipline to accuracy and consistency and manifested by activities such as process monitoring, control and feedback, Non-fulfilment rate is a proxy for how well teams understand their capacity and capability and are able to match the orders that they take to their capabilities; hence a negative relationship to discipline is to be expected. Profit and loss represents the net consequence of these processes and show a moderate, significant relationship to discipline.

Stretch shows significant relationships to the two productivity measures but no significant relationship to quality, fulfilment or profitability. Our interpretation of this is that ambition, at least in this environment, tends to be interpreted in volume terms ("make as many cards as possible") which drives productivity but produces no benefits in terms of quality, dependability or profitability. Some teams that were high on stretch showed traces of hubris that may have served to undermine discipline.

Finally, trust and support show moderate relationships to all performance measures apart from cards per head. High levels of support and trust made it easier for teams to openly surface and discuss potentially difficult issues (such as mistakes, quality problems or different views on how to approach the exercise) in an open, no-blame manner. Effective corrective action, and hence adaption, is therefore more likely. Several groups spoke of the importance of "constructive challenge". Mutual confidence and trust also supported specialization and therefore allowed deeper pools of expertise to develop. An ethos of support also meant that if an individual was struggling with their task and perhaps becoming a bottleneck, others would observe this and step in to try and help out, again supporting adaptability. This may also be one of the reasons that the trust and support scale correlated with psychological well-being.

Conclusions

In this paper we have sought to advance understanding of how small production teams who face strong and simultaneous requirements for productivity, quality, dependability and adaptability can respond to this. We suggest that the concept of contextual ambiguity, and particularly its three components of discipline, trust and support are helpful understanding and explaining some of the micro dynamics of how teams can meet apparently competing demands. Our results indicate that the relationship of the fourth

component, stretch, to performance is less clear cut. Whilst stretch is positively linked to productivity, it shows no connection to quality or dependability. If this pattern holds outside of our simulated environment, it suggests significant drawbacks to the popular practice of "stretch" targets that many organizations currently use.

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