#### Developing an Implementation Strategy for Workload Control: An Action Research Project

#### Linda Hendry\*, Yuan Huang & Mark Stevenson

Department of Management Science Lancaster University Management School \*e-mail: I.hendry@lancaster.ac.uk





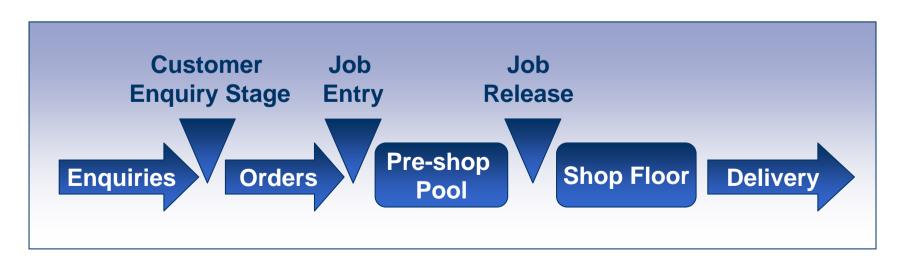
#### Content

- Introduction to Workload Control (WLC)
- Existing WLC implementation framework
- Research questions
- Company overview
- Implementation insights so far
- Conclusion



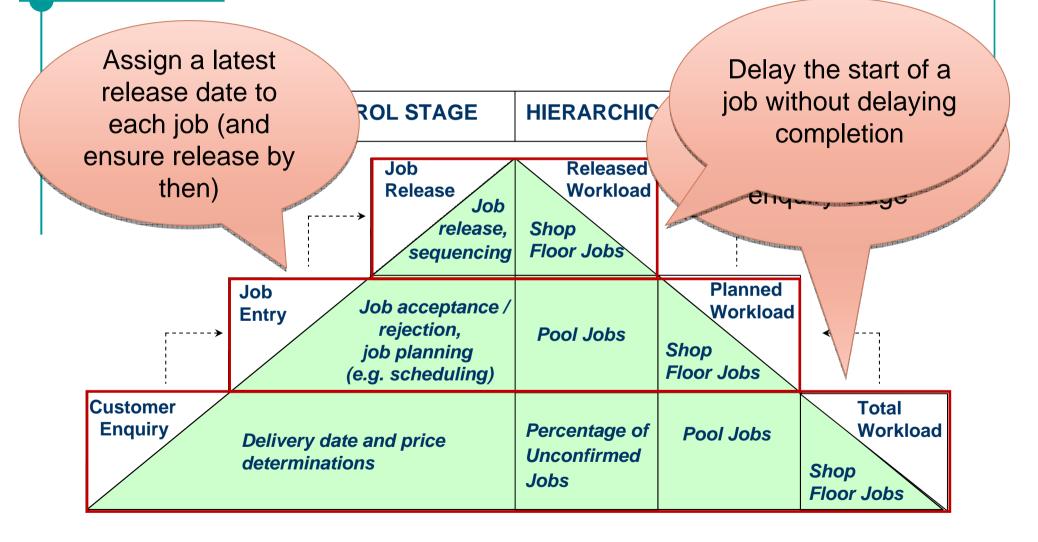
# Workload Control (WLC)

- PPC concept for manufacturers of customised products
  - e.g. Make-To-Order (MTO) companies
- A pre-shop pool and job release function used to regulate queues and Work-In-Process (WIP)
  - Based on the principle of Input/Output Control (I/OC)
  - An alternative to detailed shop floor scheduling





### **Hierarchical WLC Approach**



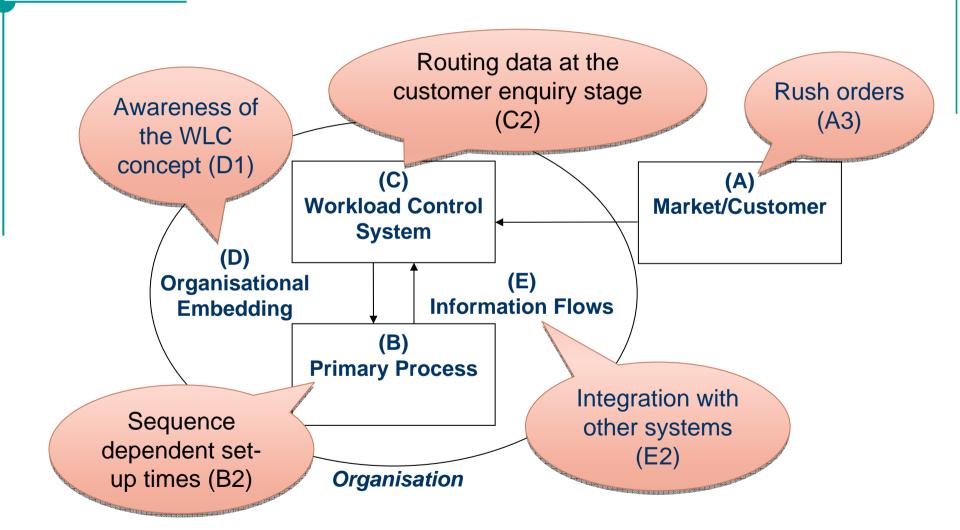


## WLC: State-of-the-Art

- Value of the method demonstrated through simulation
  - e.g., reduces (and stabilises) WIP and lead times
- But few implementations in practice reported
  - Implementation process remains a 'black box'
- Recent contribution made by Hendry et al. (2008):
  - Comparative case study analysis of WLC implementations
  - Identified 17 implementation issues (5 categories, A-E)
  - But concluded that the implementation requirements of WLC require further research



#### **WLC Implementation Framework**



Hendry et al. (2008)



#### **Research Questions**

**RQ1.** Can emerging WLC implementation frameworks be used to successfully embed the concept within organisations?

**RQ2.** Can a WLC system be implemented in practice and achieve performance improvements, as seen in previous simulation studies?



### **Action Research: Company Overview**



Company Size	SME (32 employees, £1.5m/yr turnover)
Market	Precision engineering company; bespoke products; aerospace, commercial and food industry
Shop Configuration	General job shop
Type of Production	Make-to-order "repeaters, strangers and aliens"



# **Action Research: Company Overview**

#### A Reality:

- Limited IT and information management
- Naturalistic decision-making; "constantly fire-fighting"
- Small family firm; "wearing several hats at once"
- Upstream end of supply chains; compete on flexibility "the answer is yes, now what's the question?"
- Prioritization based on "who shouts the loudest" and social capital

Company Size	SME (32 employees, £1.5m/yr turnover)
Market	Precision engineering company; bespoke products; aerospace, commercial and food industry
Shop Configuration	General job shop
Type of Production	Make-to-order "repeaters, strangers and aliens"



## **Action Research: Progress to Date**

#### **INITIAL ASSESSMENT OF FIT**

- Company needs
- Applicability of Workload Control
- Information availability within the company
- Project commitment and support

#### **PRE-IMPLEMENTATION**

- Data collection and analysis
- Business process alignment with WLC system
- Training and awareness (internally and externally)
- Parameter setting process
- Populating the WLC system with job information



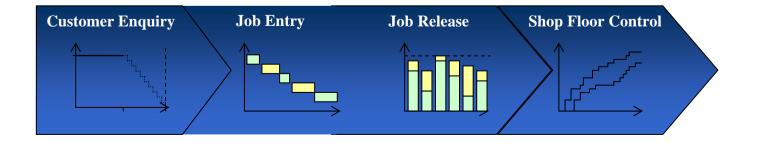


#### **Decision Support System for WLC**

Un	rel	ea	Se	ed	
joł	os	in	th	e	
	р	DO			

4/01/2008 Romer Enguiny Marie	Next I Job Erth	y Job Release Shop	Roor Control							
huminasod John					Job Information					
Job Fiel No	Quantity	Latest RD	Delivery Date	×	Job Reference No		10001	Job Pat No.:	100-NP300-565	3
SinJob00001	339	24/01/2008	09/03/2008		Gutoner		- presspi	Sack (Dava)	0.0	
Sm.Job00010	182 100 4 10		09/02/2008	_				sace tratat	14 1 1	
SmJab00009	185 Cidk ry	dog tige at nature the	05/02/2008		Quartity:	339	1	MAD:	12/01/2008	*
Sm.Job00067	164	26/01/2008	17/03/2008		Ploty:	Normal		ERD		1.00
SmJeb00003	237	27/01/2008	15/02/2008		rivity.	noma		Enu.	Servery and a	
SmJob00054	139	28/01/2008	07/02/2008		First Work Centre:	Work Cr	entre F 🗸 🗸	LRD:	24/01/2008	
SmJab00034	222	29/01/2008	01/02/2008		NOP	C		22 11		
SimJob00059	206	03/02/2008	04/02/2008		The second s	-		Delvery Date:	Carta para	
SimJob00106	173	05/02/2008	14/04/2008		TWC (Hours):	196			Save Re	net i
SmJob00111	110	05/02/2008	15/04/2008						The state of the local diversion of the	100 B
SmJob00060	269	05/02/2008	18/02/2008		Released Workload I	Length Surre	ary l			
Sm.lob00020	295	07/02/2008	03/03/2008		Work Centre Relea	sed Workics	d Length Chat			
	394	08/02/2008	23/03/2008							
SmJob00036										
	285	10/02/2008	07/04/2008		1 1 2 -					
SmJob00120	286 175	10/02/2008 25/02/2008	07/04/2008		30			-	THE PART	
SmJob00120					25-		-	-	-	
SimJob00120 SimJob00110 SimJob00078	175	25/02/2008	05/04/2008		25-		8	-		
SmJob00120 SmJob00110 SmJob00078 SmJob00075	175 283	25/02/2008 25/02/2008	05/04/2008 05/04/2008		25-	÷ +		-		
SenJab00120 SenJab00110 SenJab00078 SenJab00075 SenJab00074	175 283 187	25/02/2008 25/02/2008 25/02/2008	05/04/2008 05/04/2008 15/04/2008		20 2	ė ė		-		
SenJab00120 SenJab00110 SenJab00078 SenJab00075 SenJab00074	175 283 187 383	25/02/2008 25/02/2008 25/02/2008 27/02/2008	05/04/2008 05/04/2008 16/04/2008 23/03/2008		And the state	ţ.			÷ Î	Wark
SmJab00120     SmJab00110     SmJab00078     SmJab00075     SmJab00074     SmJab00068	175 283 187 383 175	25/02/2008 25/02/2008 25/02/2008 27/02/2008 28/02/2008	05/04/2008 05/04/2008 15/04/2008 23/03/2008 15/03/2008		25-				NC# WEE WED	Want
SmJob00120 SmJob00110 SmJob00078 SmJob00075 SmJob00074 SmJob00068 SmJob00068 SmJob00115	175 283 187 383 175 128	25/02/2008 25/02/2008 25/02/2008 27/02/2008 28/02/2008 28/02/2008	05/04/2008 05/04/2008 16/04/2008 23/03/2008 15/03/2008 31/03/2008		And the state				÷ Î	Wark Centr
SenJob00120 SenJob00110 SenJob00078 SenJob00075 SenJob00074 SenJob00068 SenJob00119 SenJob00116	175 283 187 383 175 128 352	25/02/2008 25/02/2008 25/02/2008 27/02/2008 28/02/2008 28/02/2008 29/02/2008	05/04/2008 05/04/2008 15/04/2008 23/03/2008 13/03/2008 31/03/2008 15/04/2008		And the state		WEL WEJ WE		÷ Î	Wan Canto
SenJob00120     SenJob00110     SenJob00078     SenJob00075     SenJob00074     SenJob00068     SenJob00119     SenJob00116     SenJob00117	175 283 187 383 175 128 352 239	25/02/2008 25/02/2008 25/02/2008 27/02/2008 28/02/2008 28/02/2008 29/02/2008 29/02/2008	05/04/2008 05/04/2008 15/04/2008 23/03/2008 15/03/2008 15/04/2008 15/04/2008 15/04/2008		Released Worklose	l Length Sur	WEL WE WE	a week week	wc# WC# wco	Cent
SenJob00120 SenJob00078 SenJob00078 SenJob00074 SenJob00074 SenJob00018 SenJob00116 SenJob00117 SenJob00118	175 283 187 383 175 128 352 239 290	25/02/2008 25/02/2008 25/02/2008 27/02/2008 28/02/2008 28/02/2008 29/02/2008 29/02/2008 29/02/2008 29/02/2008	05/04/2008 05/04/2008 15/04/2008 23/03/2008 31/03/2008 15/04/2008 15/04/2008 15/04/2008 21/03/2008 21/03/2008		Feleased Worklose Work Centres	(Length Sur RW (Hs)	WEL WEJ WE	RWL (Dens)	Max RWL (Days)	Certi RWL + Jobe
SenJob00120 SenJob00078 SenJob00078 SenJob00074 SenJob00074 SenJob00175 SenJob00119 SenJob00117 SenJob00118 SenJob00118	175 283 187 383 175 128 352 239 240 142	25/02/2008 25/02/2008 27/02/2008 28/02/2008 28/02/2008 28/02/2008 28/02/2008 29/02/2008 02/03/2008 02/03/2008 02/03/2008	05/04/2008 05/04/2008 15/04/2008 23/03/2008 15/03/2008 15/04/2008 15/04/2008 18/03/2008 21/03/2008 21/03/2008		Released Worklose	l Length Sur	WEL WE WE	a week week	Max RWL (Days)	Wase Centr RWL + Jobe 19 7
Senkeb0120 Senkeb0010 Senkeb0005 Senkeb0005 Senkeb0005 Senkeb0015 Senkeb0016 Senkeb0017 Senkeb0017 Senkeb0017 Senkeb0012	175 283 187 383 175 128 352 239 239 2390 142 185	25-02/2008 25-02/2008 25-02/2008 27-02/2008 28-02/2008 28-02/2008 28-02/2008 28-02/2008 28-02/2008 02/03/2008 02/03/2008 06-03/2008	05/04/2008 05/04/2008 15/04/2008 23/03/2008 15/03/2008 15/03/2008 15/03/2008 21/03/2008 21/03/2008 23/03/2008 17/03/2008		Felesed Woldse Work Centres Work Centres Work Centres	FW (Hs) 216 200 115	WEL WE WE	RWL (Dens)	Max RWL (Days)	Certi RWL + Jobe
Smkeb00120 Smkeb00110 Smkeb00078 Smkeb00078 Smkeb00074 Smkeb00016 Smkeb00116 Smkeb00116 Smkeb00118 Smkeb00112 Smkeb00112 Smkeb00112 Smkeb00112	175 283 187 383 175 128 352 239 290 142 195 199	25:02/2008 25:02/2008 25:02/2008 27:02/2008 28:02/2008 28:02/2008 28:02/2008 28:02/2008 28:02/2008 02:01/2008 05:01/2008 05:01/2008	05/04/2008 05/04/2008 15/04/2008 23/03/2008 15/03/2008 15/04/2008 15/04/2008 18/03/2008 21/03/2008 21/03/2008 21/03/2008 30/03/2008		Felesed WorkCenters A Work Centers C Work Centers C	RW (Hm) 216 200 115 124	WEL WE WE	RWL (Dens)	Max RWL (Days)	Certi RWL + Jobe
Senkeb00120 Senkeb00110 Senkeb00176 Senkeb00078 Senkeb00074 Senkeb00018 Senkeb00115 Senkeb00115 Senkeb00117 Senkeb00112 Senkeb00121 Senkeb00125 Senkeb00125 Senkeb0012	175 283 187 383 175 128 352 299 290 142 195 199 233	25/02/2008 25/02/2008 25/02/2008 25/02/2008 28/02/2008 28/02/2008 29/02/2008 23/02/2008 02/03/2008 02/03/2008 05/03/2008 06/03/2008	05/04/2008 05/04/2008 15/04/2008 22/03/2008 15/03/2008 15/03/2008 15/04/2008 15/04/2008 15/04/2008 20/03/2008 20/03/2008 05/03/2008		Released WorkCentres Work Centres Work Centres Work Centre 8 Work Centre 8 Work Centre 8 Work Centre 8 Work Centre 8 Work Centre 8	Flw (Hs) 216 200 115 124 65	WEL WE WE	RWL (Days) 12 6 6 5 3	Max RWL (Days)	Centr RWL + Jobe 19 7 9 9 3
Smikeb0120     Smikeb0110     Smikeb00110     Smikeb00175     Smikeb00075     Smikeb00075     Smikeb00075     Smikeb00119     Smikeb00117     Smikeb00117     Smikeb00112     Smikeb00125     Smikeb00055     Smikeb00075     Smikeb00075	175 283 187 383 175 128 352 239 240 142 195 199 233 329	25/02/2008 25/02/2008 25/02/2008 27/02/2008 28/02/2008 28/02/2008 28/02/2008 28/02/2008 02/03/2008 02/03/2008 05/03/2008 05/03/2008 05/03/2008 05/03/2008	05/04/2008 05/04/2008 15/04/2008 15/04/2008 13/03/2008 13/03/2008 13/03/2008 13/03/2008 13/03/2008 13/03/2008 17/03/2008 13/03/2008 30/03/2008		Feleased WorkCartes Work Cartes Work Cartes Work Cartes Work Cartes Work Cartes Work Cartes Work Cartes	RW (Hs) 216 200 115 124 65 274	WEL WE WE	RWL (Days) 12 6 5 3 15	Max RWL (Days)	Centr RWL + Jobe 19 7 9 9 3 20
Smikeb0120 Smikeb0110 Smikeb00110 Smikeb0075 Smikeb0075 Smikeb0075 Smikeb00119 Smikeb00119 Smikeb00117 Smikeb00118 Smikeb0012 Smikeb0015 Smikeb0005 Smikeb00072 Smikeb00075	175 283 187 383 175 128 239 280 142 155 139 233 233 235	25/02/2008 25/02/2008 25/02/2008 28/02/2008 28/02/2008 28/02/2008 28/02/2008 28/02/2008 02/01/2008 06/03/2008 06/03/2008 06/03/2008 06/03/2008 06/03/2008	05/04/2008 05/04/2008 15/04/2008 22/03/2008 15/03/2008 15/04/2008 15/04/2008 15/04/2008 15/04/2008 20/03/2008 20/03/2008 05/03/2008 05/03/2008 05/03/2008		Released WorkCentres Work Centres Work Centres Work Centre 8 Work Centre 8 Work Centre 8 Work Centre 8 Work Centre 8 Work Centre 8	Flw (Hs) 216 200 115 124 65	WEL WE WE	RWL (Days) 12 6 6 5 3	Max RWL (Days)	Cent RWL + Jobe 19 7 9 9 3







## **Original 17 Implementation Issues**

Category	17 Key Implementation Issues	
A. Market/Customer	Characteristics of order quotations (A1)	
	Uncertainty at the customer enquiry stage (A2)	
	Rush orders (A3)	
	Seasonality and volume growth (A4)	
	Hybrid production (A5)	
B. Primary Process	Assembly requirements (B1)	
	Sequence dependent set-up times (B2)	
	Alternative shop floor routings (B3)	
	Industry-specific process (B4)	
C. WLC System	WLC-related start-up issues (C1)	
	Incomplete routing data at customer enquiry (C2)	
	Time-span-dependent critical resources (C3)	
D. Organizational	Awareness of the concept of WLC (D1)	
Embedding	User visibility (D2)	
	Support of task structures (D3)	
E. Information Flow	System-related start-up issues (E1)	
	Integration with other systems (E2)	



## 12 of Original 17 Issues Encountered

Category		17 Key Implementation Issues
A. Market/Customer	-	Characteristics of order quotations (A1)
	-	Uncertainty at the customer enquiry stage (A2)
	×	Rush orders (A3)
		Seasonality and volume growth (A4)
		Hybrid production (A5)
B. Primary Process	×	Assembly requirements (B1)
		Sequence dependent set-up times (B2)
	<b>√</b>	Alternative shop floor routings (B3)
	<b>√</b>	Industry-specific process (B4)
C. WLC System	×	WLC-related start-up issues (C1)
	<b>~</b>	Incomplete routing data at customer enquiry (C2)
		Time-span-dependent critical resources (C3)
D. Organizational	×	Awareness of the concept of WLC (D1)
Embedding	<b>√</b>	User visibility (D2)
	<b>~</b>	Support of task structures (D3)
E. Information Flow	-	System-related start-up issues (E1)
		Integration with other systems (E2)



# 12 of Original 17 Issues Encountered

Category		17 Ke	y Im	elementation Issues			
A. Market/Customer	Ch	Characteristics of order quotations (A1)					
		Rush vers (A3)	e gro	wth (A4)			
	• Little planning undertaken at the (B How can unrealistic and						
	uiry stage.It-uunspecified due dates bee dates fromutirthroughout the order ptomers.s (E(Through gradual ch						
influential cus				•			
			s (E	(Through gradual ch			
		S.	s (E sue: a at c	(Through gradual ch			
		S.	s (E sue a at c critic	(Through gradual ch sustomer enquiry (C2) al resources (C3)			
influential cus		S. Incomplete routing data Time-span-dependent	s (E sue a at c critic	(Through gradual ch sustomer enquiry (C2) al resources (C3)			
<b>influential cus</b> D. Organizational	stomer	S. Incomplete routing data Time-span-dependent Awareness of the cond	s (E sue: a at c critic cept c	(Through gradual ch sustomer enquiry (C2) al resources (C3) f WLC (D1)			
<b>influential cus</b> D. Organizational	stomer	S. Incomplete routing data Time-span-dependent Awareness of the cond User visibility (D2)	s (E sue a at c critic cept c res (	(Through gradual ch eustomer enquiry (C2) al resources (C3) f WLC (D1)	nange)		



## **6 New Implementation Issues Identified**

Category	23 Key Implementation Issues	
A. Market/Customer	✓ Characteristics of order quotations (A1)	
	✓ Uncertainty at the customer enquiry stage (A2)	
	✓ Rush orders (A3)	
	Seasonality and volume growth (A4)	
	Hybrid production (A5)	
B. Primary Process	✓ Assembly requirements (B1)	
	Sequence dependent set-up times (B2)	
	✓ Alternative shop floor routings (B3)	
	✓ Industry-specific process (B4)	
	✓ Uncertainty after the order release stage (B5*)	
C. WLC System	✓ WLC-related start-up issues (C1)	
	✓ Incomplete routing data at customer enquiry (C2)	
	Time-span-dependent critical resources (C3)	
	✓ Output control management (C4*)	
D. Organizational	✓ Awareness of the concept of WLC (D1)	
Embedding	✓ User visibility (D2)	Issues
	✓ Support of task structures (D3)	encountere
	✓ End-user choice and involvement (D4*)	·· / ??
	✓ Accommodating functionality requests (D5*)	
	✓ Timely implementation procedure (D6*)	
	✓ Performance measurement and review (D7*)	New issues "
E. Information Flow	✓ System-related start-up issues (E1)	
	Integration with other systems (E2)	



## **6 New Implementation Issues Identified**

Category	23 Key Implementation Issues	
A. Market/Customer	<ul> <li>Characteristics of order quotations (A1)</li> <li>High precision engineering and production leads to scrap and</li> </ul>	
3. Primary Process	<ul> <li>Overproduction also sometime</li> <li>Alternative</li> <li>Industry-specific rocess (B4)</li> </ul>	es evident
C. WLC System	certainty after the order release s         Time-span-depe       ot critical resources (C3)         ✓       Output control m       ot (C4*)	stage (B5*
	Awareness of the n the WLC concept be made ible enough to cope with	
uncert	ainties after jobs have been eased to the shop floor?	



## **Response to Implementation Issues**

Key Issues	Concept	Implementation Strategy
A2: Uncertainty at the customer enquiry stage		$\checkmark$
A3: Rush orders	$\checkmark$	
B4: Industry-specific processes	$\checkmark$	$\checkmark$
B5*: Uncertainty after the order release stage	$\checkmark$	
D3: Support of task structures		$\checkmark$
D5*: Accommodating functionality requests		$\checkmark$
D6*: Timely implementation procedure		$\checkmark$
D7*: Performance measurement and review		$\checkmark$



## **Response to Implementation Issues**

ŀ	Key Issues	Concept	Implementation Strategy	
A2: Uncertainty at	<i>"orders for replacement part huge costs involved in keep</i>			
A3: Rush orders B4: Industry-speci	• Reserve capacity for rush orders with tight due dates (Hendry <i>et al.</i> , 2008)			
B5*: Uncertainty a	But here, arrival rate of rus	sh orders is too	unpredictable	
D3: Support of tas D5*: Accommodat	Conduct rush order 'impact			
D6*: Timely impler D7*: Performance	<ul> <li>Determine the knock-on-ef (e.g., delay to other jobs o</li> </ul>	ffect of a rush or	rder	



## Insights from Use of WLC to Date

- Too soon to assess impact of WLC on performance (RQ2); however, information system improves:
  - Traceability: provides an audit trail important, e.g., in aerospace sector
  - **Responsiveness:** more information readily available for responding to customer queries
  - **Decision making:** support provided for daily planning meetings (e.g., information fed-back before orders released)
  - **Problem diagnosis:** improved understanding of shop floor constraints (e.g., distribution of workload on the shop floor)



# Insights from Use of WLC to Date

- Too soon to assess impact of WLC on performance (RQ2); however, information system improves:
  - Traceability: provides an audit trail important, e.g., in aerospa
  - Respons respond
  - Decisior meeting
  - Problem constraints (e.g.,

"We don't tend to do much planning unless we're pretty sure we're going to win an order. Our strike rate can be as low as 20% ... we'd be wasting 80% of our time"

of workload on the shop floor)

- Ongoing Issues:
  - Data entry at the customer enquiry stage
  - Ensuring all work is planned using the system



#### Conclusion

- Enhanced existing implementation framework (RQ1)
  - 12 issues previously identified by Hendry *et al.* encountered; other 5 may yet emerge (or be relevant elsewhere)
  - A total of 23 implementation issues identified (from 17)
  - Conceptual refinement



#### Conclusion

- Enhanced existing implementation framework (RQ1)
  - 12 issues previously identified by Hendry *et al.* encountered; other 5 may yet emerge (or be relevant elsewhere)
  - A total of 23 implementation issues identified (from 17)
  - Conceptual refinement
- Current & Future Research:
- Assess impact of Workload Control on performance (RQ2)
- Generality (another company = a different set of issues?):
  - Building up a body of cases
  - Cross-sectional survey of implementation issues



#### Linda Hendry\*, Yuan Huang & Mark Stevenson

Department of Management Science Lancaster University Management School \*e-mail: I.hendry@lancaster.ac.uk

