

Introduction to LEKIN

Gareth Beddoe

LEKIN®

Flexible Job Shop Scheduling System



1

Introduction to LEKIN

- What is LEKIN?
- Machine Environments
- Methods Employed
- Graphical User Interface
- Setting up the Environment
- 2 Examples
 - Single Machine Environment
 - Flow Shop Environment

2

What is LEKIN?

- Interactive scheduling system for machine environments
- Ideal for research and teaching
 - Graphical Interface
 - Built in dispatching rules and simple heuristic methods
 - User-defined algorithms can be added
- Educational Version:
 - 50 jobs, 20 work-centres maximum
 - Windows 98 or NT

3

Who wrote LEKIN?

- Stern School of Business, NYU
 - Michael Pinedo et. al.
 - <http://www.stern.nyu.edu/om/pinedo/>
- Download (educational version):
 - <http://www.stern.nyu.edu/om/pinedo/lekin>
- Reference:

Pinedo M, *Scheduling: Theory, Algorithms, and Systems (2nd Edition)*,
Prentice Hall 2002: pp 493-499

4

Machine Environments

- Single Machine
 - Parallel Machines

 - Flow Shop
 - Job Shop

 - Flexible Flow Shop
 - Flexible Job Shop
- } Generalisations: more than one machine of each type

5

Methods: Dispatching Rules

- EDD, MS, LPT, SPT, WSPT
- FCFS: (F)irst (C)ome (F)irst (S)erve
- ATCS: Apparent Tardiness Cost (with Setups).
 - Optimizes the Total Weighted Tardiness.
 - Trade-off between MS and WSPT
- CR: Critical Ratio rule.
 - Schedules jobs according to the ratio of the time left until the due date and the remaining processing time.
 - Trade-off between EDD and LPT.

6

Methods: Built-in Heuristics

- Shifting Bottle-neck Heuristics
 - General SB Routine (most objectives)
 - Objective Specific routines:
 - SB/sum wT: Total Weighted Tardiness
 - SB/Tmax: Maximum Tardiness, Makespan
- Local Search Heuristic
 - For all objectives
- Hybrid Method:
 - SB-LS: Combination of Shifting Bottle-neck and Local Search heuristics

7

Methods: User-defined Heuristics

- Users can write new heuristics methods and use the “plug-in” feature
- Operation as external executables with standardised input and output parameters
- Allows researchers to test and develop new algorithms in an interactive environment.
- Facilitates comparison between various methods

8

Objectives

- Makespan C_{\max}
- The Maximum Tardiness T_{\max}
- The Total Number of Late Jobs $\sum U_j$
- The Total Flow Time $\sum C_j$
- The Total Tardiness $\sum T_j$
- The Total Weighted Flow Time $\sum w_j C_j$
- The Total Weighted Tardiness $\sum w_j T_j$

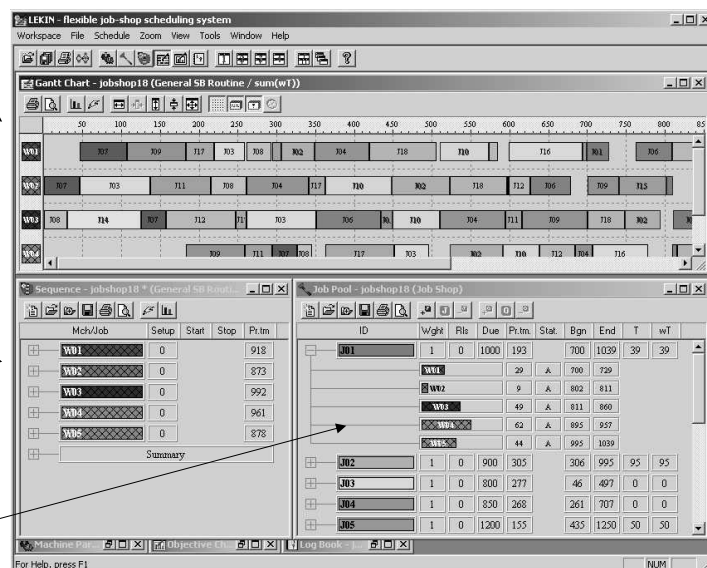
9

Graphical User Interface

Solution
Schedule

Machine
Information

Job
Information



10

Job Pool Window

Job statistics and settings

ID	Wght	Rls	Due	Pr. tm	Stat	Bgn	End	T	wT
J01	1	0	1000	193		700	1039	39	39
W01				29	A	700	729		
W02				9	A	802	811		
W03				49	A	811	860		
W04				62	A	895	957		
W05				44	A	995	1039		
J02	1	0	900	305		306	995	95	95
W01				43	A	306	349		
W02				75	A	448	523		
W03				69	A	523	592		
W04				46	A	749	795		
W05				72	A	923	995		
J03	1	0	800	277		46	497	0	0

Jobs

Sequence through machines and start and end times for each machine

Sequence Window

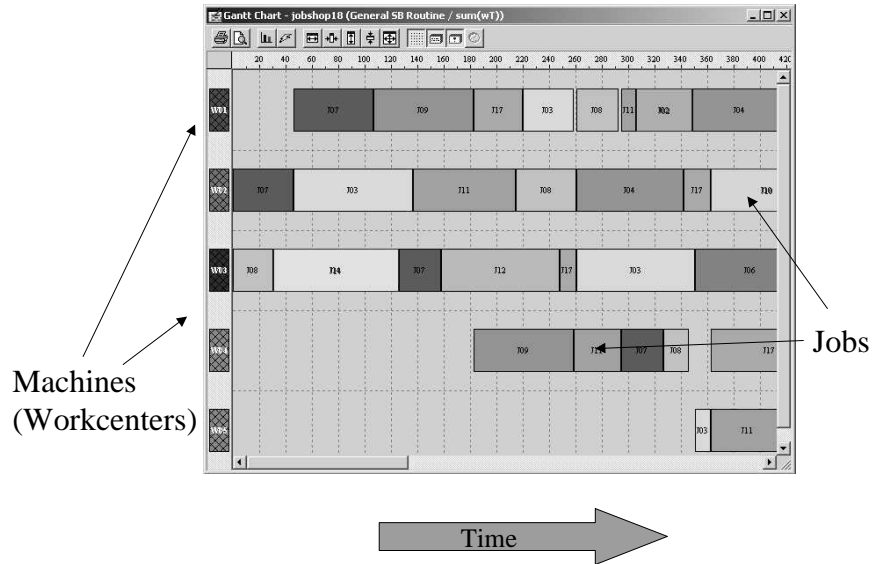
Mch/Job	Setup	Start	Stop	Pr. tm
W01	0			918
J07	0	46	107	61
J09	0	107	183	76
J17	0	183	220	37
J02	0	220	259	39
J08	0	261	293	32
J11	0	293	306	11
J03	0	306	349	43
J04	0	349	420	71
J18	0	420	506	86
J10	0	510	574	64
J12	0	574	585	11
J16	0	599	694	95
J13	0	694	700	6
J01	0	700	729	29
J06	0	763	810	47
J15	0	810	895	85
J14	0	895	994	99
J05	0	1079	1104	26
W02	0			873
J08	0	0	46	46
J03	0	46	137	91
J11	0	137	215	78
J09	0	215	261	46

Machines (Workcenters)

Sequence of jobs through machine and start and end times

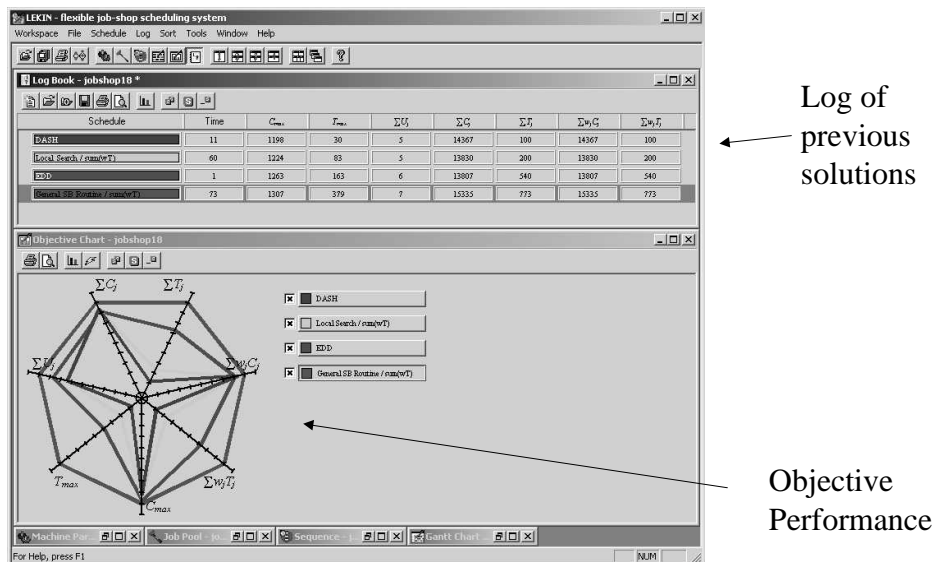
12

Gantt Chart (Schedule) Window



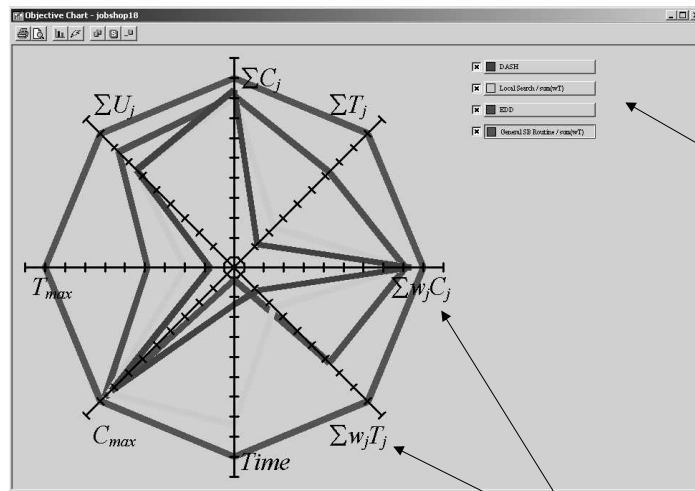
13

Displaying Results



14

Performance Comparisons



Various
Solutions

Objectives

15

Basic Setup Procedure

- 1) Enter Machine Information
 - Number of Machines
 - Availability Time
 - Setup Time Information
- 2) Enter Job Information
 - Number of Jobs
 - Release Dates, Due Dates, Weight, and Route
- 3) Select a dispatching rule or heuristic and generate schedule

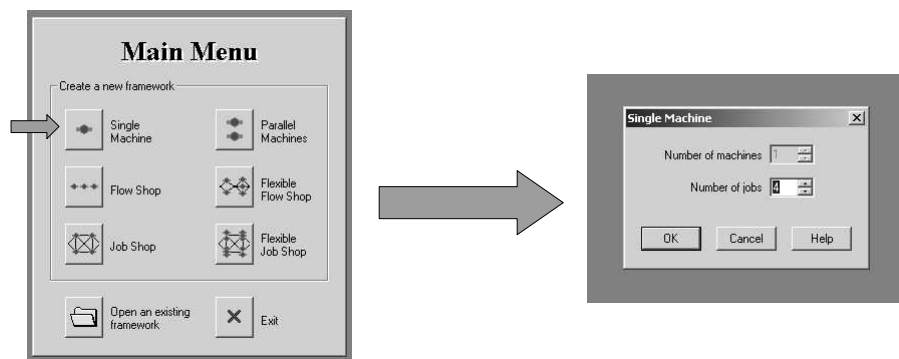
16

Example 1: Single Machine

jobs	1	2	3	4
p_j	10	10	13	4
d_j	4	2	1	12
w_j	14	12	1	12

17

Setting up the problem (1)



- 1) Choose Single Machine Environment
- 2) Number of machines already set (= 1)
- 3) Choose number of jobs (= 4)

18

Setting up the problem (2)

Job ID: J01

Comments:

Number of jobs to add: 1

Style:

Release date: 0

Processing Time: 10

Due date: 4

Status: A

Weight: 14

OK Cancel Help

- For each job:
 - Enter Due Date, Processing Time, and Weight
 - Click OK

19

Environment Display

LEKIN - flexible job-shop scheduling system

Workspace File Schedule Job Operation Sort Tools Window Help

Machine Park - Machines * (1)

ID	MCs	Avail	Status
Uno	1	0	A

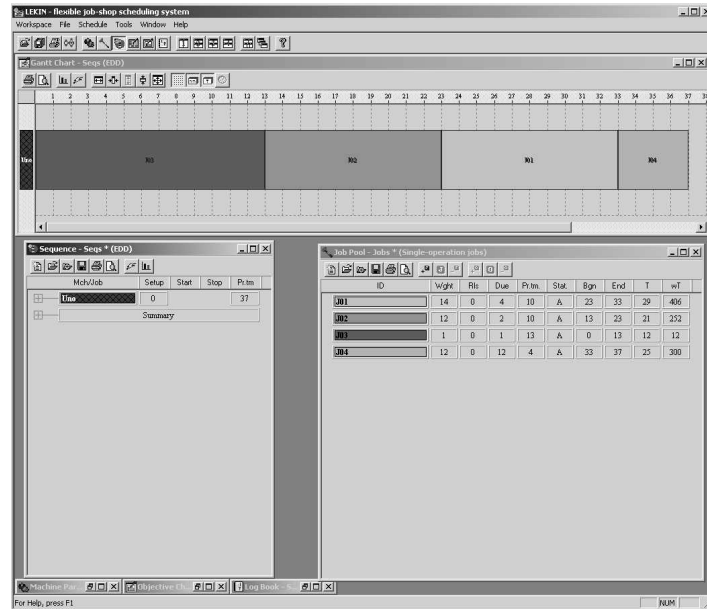
Job Pool - Jobs * (Single-operation jobs)

ID	Wght	Rls	Due	Pr.tn	Stat
J01	14	0	4	10	A
J02	12	0	2	10	A
J03	1	0	1	13	A
J04	12	0	12	4	A

For Help, press F1

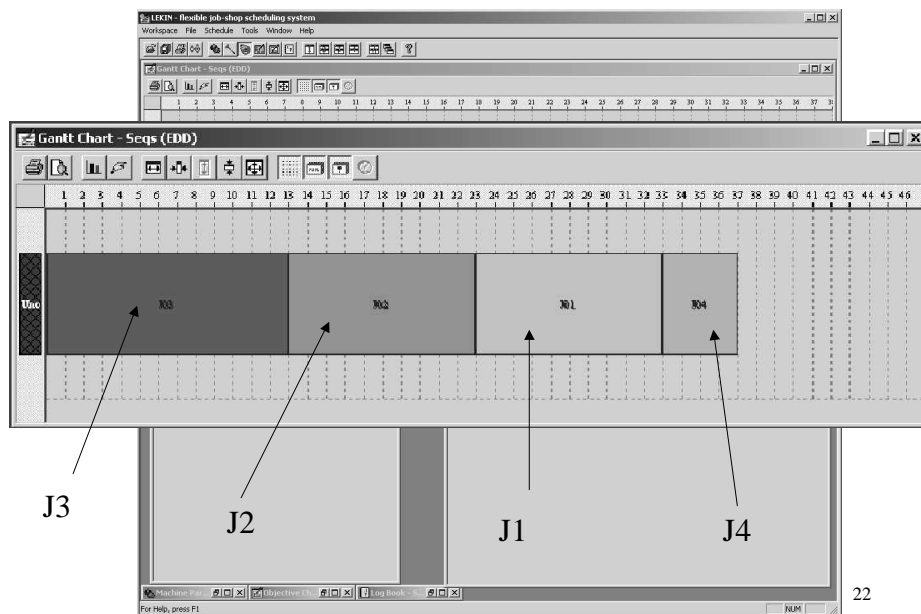
NUM

Schedule!



21

Schedule!

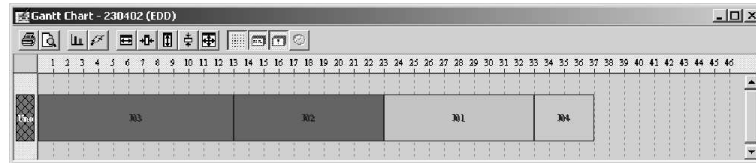


22

More Solutions

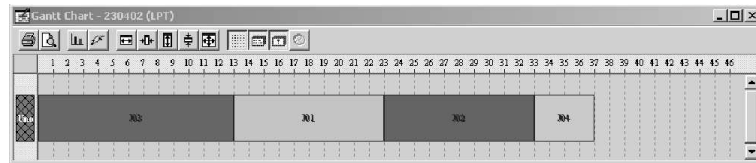
EDD:

(3214)



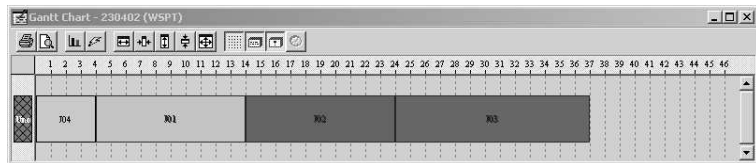
LPT:

(3124)



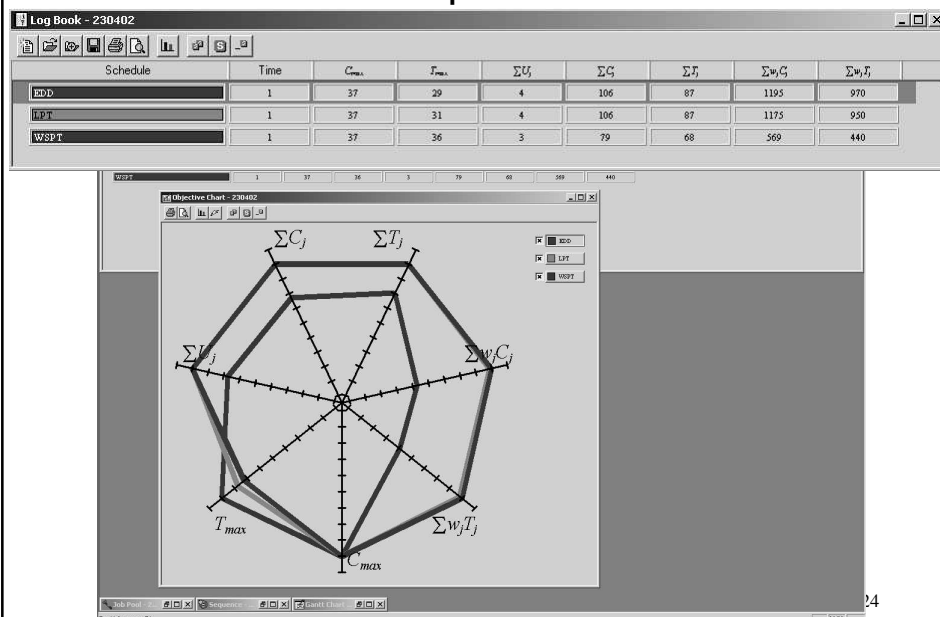
WSPT:

(4123)



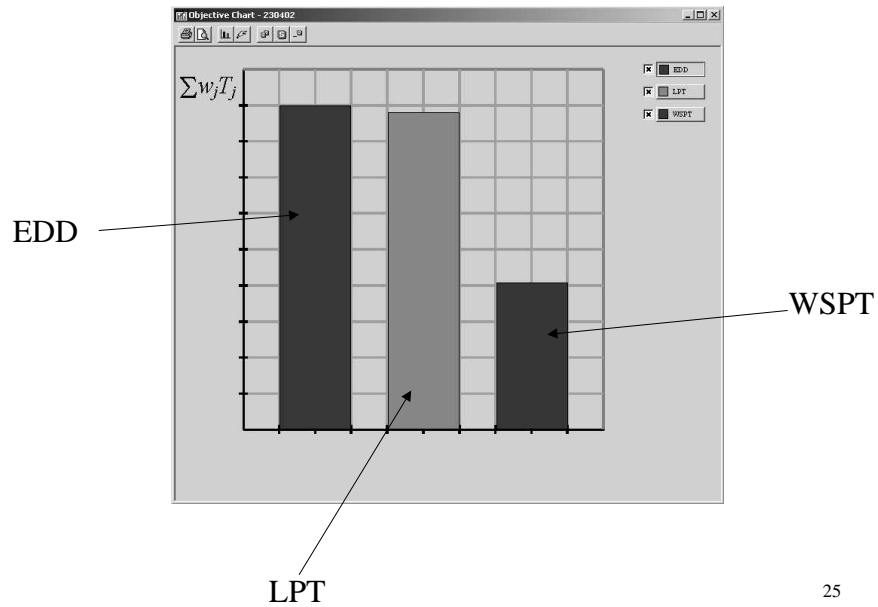
23

Comparison



24

More Comparison



25

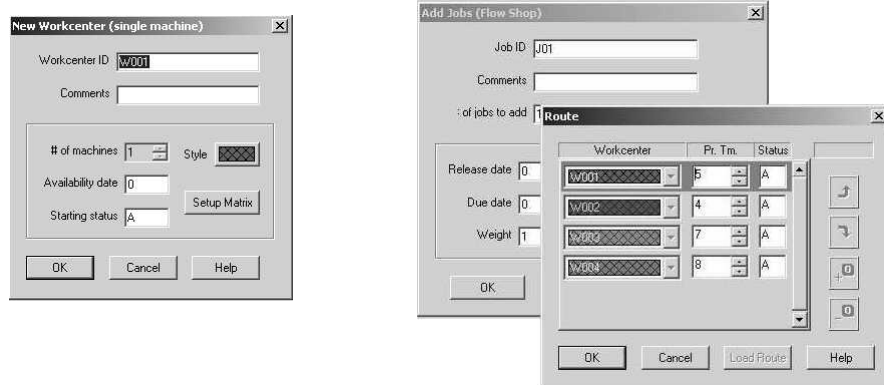
Example 2: Flow Shop

jobs	1	2	3	4	5
p_{1j}	5	3	6	4	9
p_{2j}	4	8	2	9	13
p_{3j}	7	8	7	6	5
p_{4j}	8	4	2	9	1

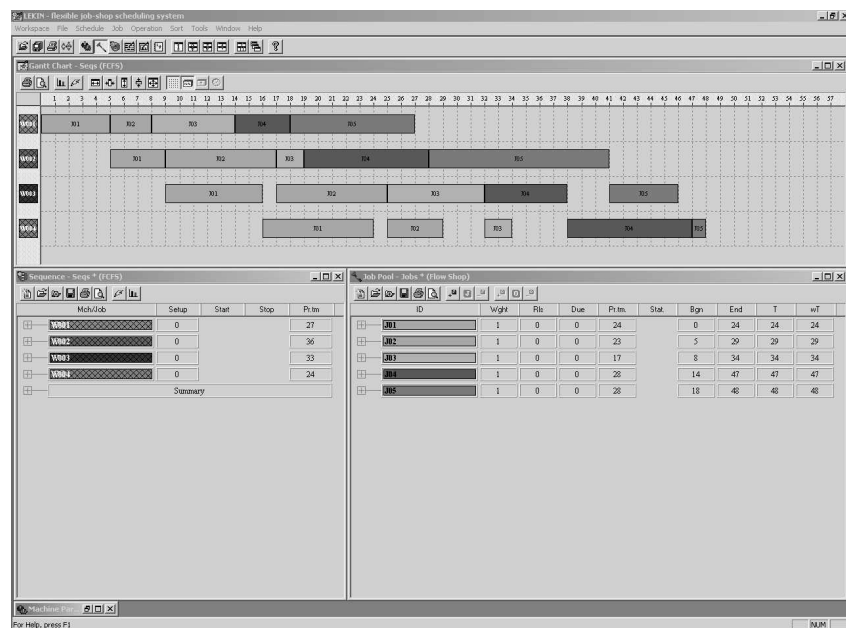
26

Setting up the problem

- Machine (Workcenter) setup
- Establishing machine route for jobs



Schedule!



Other LEKIN features

- Manual Schedule Adjustment
 - useful for determining neighbourhood definitions in local search development
- Large library of standard problems included in package
- Industrial version currently in development
 - will be able to handle a much larger machine environment
 - will include considerably more dispatching rules and built in heuristics

29

Summary

- Graphics based interactive machine shop scheduling system
- Ability to schedule a number of different machine environments
- Valuable as an educational and research tool
- Extendible with new heuristic techniques

30