New dispatching rule in furniture production scheduling for reducing weather impacts

Wang Ruihua[1,2] Fei Shumin[1] Liu Qingqing[3]

([1] School of Automation, Southeast University, Nanjing 210096, China)
([2] School of Automation Engineering, Qingdao University of Technology, Qingdao 266520, China)
([3] School of Information and Control, Nanjing University of Information and Technology, Nanjing 210044, China)

Abstract: In order to reduce the possibility that quality problems occur resulting from "bad" weather, a new dispatching rule is designed for the job sequencing problem in the machine shop of a wood furniture factory. First, two indices including risky duration and risk magnitude are established to characterize the weather conditions. Based on these two indices, the job suitability under the future air state is derived by the fuzzy decision method, and integrated with a traditional heuristic to compute the dispatching priority of each job. Then, a new measure matching degree is constructed to evaluate the effectiveness of the dispatching rule. The greater the matching degree, the smaller the possibility that the quality problems of wood products occur. Finally, simulation experiments show that the dispatching rule can greatly increase the matching degree while maintaining low weighted tardiness.

Key words: dispatching rule; fuzzy decision; suitability; relative humidity

DOI: 10.3969/j. issn. 1003 − 7985. 2016. 03. 020

Scheduling was defined in Ref. [1] as sequencing each job and allocating time for it. In recent years, many methods and techniques[2–5] have been designed to solve the scheduling problems including heuristics, meta-heuristics, knowledge-based systems, fuzzy logic, neural networks and multi-agent systems, etc. However, practical scheduling problems are often very complex[2], so it is not always possible to find an optimal solution in a reasonable amount of time. In practice, heuristic methods[3] are common and effective for solving scheduling problems. Although heuristic methods cannot guarantee that the optimal solution can be obtained, the near-optimal solution can be found in a relatively short time. Dispatching rules are a common heuristic technique, such as weighted shortest processing time (WSPT) and minimum slack (MS) heuristic. The Rachamadugu and Morton (R&M) heuristic[6] was designed by combining WSPT and MS rules. It consistently has performed well in weighted tardiness problems relative to competing heuristics[7].

Various uncertainties and disturbances have been investigated extensively and intensively in the past research of production scheduling including resource-related ones[8–13] and job-related ones[14–17]. In the presence of raw material shortage uncertainties, Refs. [9 − 10] presented a fuzzy logic based decision support system for parallel machine scheduling/rescheduling. Ref. [11] used a robust optimization approach to solve the production scheduling problem for a sawmill plant subject to final product demand and material supply uncertainties. The supply of each raw material was modeled as an uncertain parameter that takes values in an interval. Refs. [12 − 13] studied dynamic scheduling problems under power consumption uncertainties with the purpose of minimizing the sum of energy cost and tardiness penalties.

In our previous paper[18], it has been pointed out that weather conditions can seriously influence production scheduling. Compared with other uncertainties and disturbances, weather is very vague, and hence very difficult to describe. It is a challenge to consider weather impacts when dispatching jobs for shops. On the other hand, we notice that human schedulers pay much attention to weather conditions when arranging furniture production. For instance, furniture factories in the south of China generally do not produce furniture in the rainy season which will be sold to Beijing, unless they have to produce the furniture because of some unavoidable practical reasons, such as rush jobs. In fact, if a wood product is produced in "bad" weather conditions, it is very likely that quality problems may occur in the final wood product, such as deformations and cracks. However, as far as we know, there has been no scheduling research focusing on disturbances of weather up to now. Our aim is to design a scheduling method to ensure as much as possible that each product is not produced in "bad" weather conditions.

1 Problem Formulation

The problem under consideration is a real-life production scheduling problem from a furniture factory of Nan-

Received 2015-11-27.

Biography: Wang Ruihua(1985—), female, doctor, lecturer, 123.wrh@163.com.

Foundation item: The National Natural Science Foundation of China (No. 61273119).

Citation: Wang Ruihua, Fei Shumin, Liu Qingqing. New dispatching rule in furniture production scheduling for reducing weather impacts[J]. Journal of Southeast University (English Edition), 2016, 32(3): 379 − 384. DOI: 10.3969/j. issn. 1003 − 7985. 2016. 03. 020.

jing in China. Concerning furniture production, three procedures including machining, assembling and painting are executed in turn, and at the end the completed wood products are delivered after packaging. The whole process is referred to as a production cycle. In the factory, the next order is not started until the previous one is finished. Once an order is started, it cannot be interrupted until it is delivered. Since machining is the first procedure, the scheduling of the machine shop determines the processing sequences of other shops to a great extent.

The job sequencing of the machine shop is to sequence n jobs, J_j, $j = 1, 2, \ldots, n$. The job processing times are p_j, $j = 1, 2, \ldots, n$. A common target is to minimize the job weighted tardiness. The job weighted tardiness is described as

$$\sum_{j=1}^{n} \omega_j T_j$$

where $\omega_j (j = 1, 2, \ldots, n)$ are the weights of job J_j; $T_j (j = 1, 2, \ldots, n)$ represent the tardiness of job J_j. The magnitude of ω_j stands for the importance of job J_j relative to other jobs. $T_j = \max(C_j - d_j, 0)$, where $C_j (j = 1, 2, \ldots, n)$ are the completion times of job J_j and $d_j (j = 1, 2, \ldots, n)$ are the due dates of job J_j

In order to explain the other aim of our work, the concept-equilibrium moisture content (EMC) needs to be introduced. When lumber is placed in a certain environment, its moisture content (MC) will tend to reach an equilibrium value over sufficient time, which is called the environment's EMC. It should be pointed out that at a fixed temperature, the lumber EMC significantly increases with the rising relative humidity. For example, when the temperature is 40 ℃, the EMC can reach 28% at relative humidity 100%; EMC is just 9% at relative humidity 50%. If the lumber MC is higher than the environment's EMC, the lumber will lose moisture and contract; otherwise, it will absorb moisture and expand. This can result in deformations and cracks, which can seriously affect the use and life of wood products. To avoid the phenomena, the lumber must be also dried and maintained at a certain MC during the production process, which is determined according to the purpose, usage environment, materials and quality demand, etc. All these show the reason why human schedulers pay much attention to the weather conditions in furniture production. More importantly, it should be noted that, for different wood products, weather has different impact on their production. The weather conditions at times come to have less impact on the production of one wood product; however, for the other wood products, the weather conditions can be adverse for their production. If a wood product is produced in its "bad" weather conditions, it is very likely that its lumber MC cannot reach the prescribed standard. As a result, quality problems may occur. In this paper, our target is to reduce the possibility that quality problems occur due to the fact that lumber MCs do not reach standards, while ensuring the low weighted tardiness.

Based on MC requirements, the production cycle should be shortened as far as possible. The limit of each production cycle is set to be 3 d. A large order may be split into smaller orders to reduce their production time.

2 New Dispatching Rule

First, let us recall the R&M heuristic in Ref. [6]. The R&M heuristic is a composite that combines the WSPT rule and the MS rule as follows:

$$\pi_j = \frac{\omega_j}{p_j} \exp\left(\frac{-\max(d_j - p_j - t, 0)}{k p_a} \right)$$

where π_j is the priority of job J_j; k is a tuning parameter; p_a denotes the average processing time of unscheduled jobs. Each time one job is completed, job priorities are computed for all the remaining jobs and the highest priority job is selected next. It has been found that the R&M rule performs well in the weighted tardiness problems. In the following, we will design a dispatching rule based on the R&M heuristic, which is devoted to reducing the impact that the air relative humidity variability has on lumber MCs.

2.1 Risk duration and risk magnitude

As mentioned above, the "bad" air relative humidity can give wood products the risk that considerable changes of lumber MCs occur and thus related quality problems occur. The relative humidity has different impact on different products. The relative humidity state for some time brings no risk to one type of products; however, for the other type there is a risk period. The adverse impacts of the relative humidity on the lumber MC are represented from two aspects: risk duration and risk magnitude, as shown in Fig. 1. Two indices are used to describe job J_j: $(D_j, R_j)^{\mathrm{T}}$, where D_j denotes the risk duration over the production cycle of its order, and R_j represents the magnitude of the risk that job J_j will face during the risk duration.

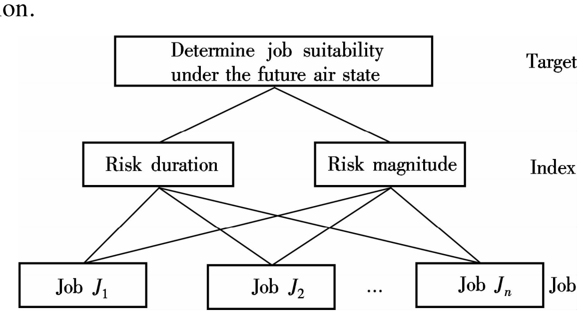

Fig. 1 Determination of job suitability

Under artificial assistance, the risk duration D_j is first determined in accordance with weather data. It should be highlighted that the risk duration is distinguished from the order production cycle, not from the job processing time. After the risk duration is determined, we can obtain the responding EMC based on the average temperature and relative humidity during the risk duration. For job J_j, the responding EMC is written as REMC_j. The initial lumber MC for job J_j before being progressed is IMC_j. We utilize the following expression

$$R_j = \left| \mathrm{REMC}_j - \mathrm{IMC}_j \right| \times 100$$

to measure the magnitude of the risk that job J_j will face.

2.2 Suitability

In our work, the concept suitability denotes the degree that the job is suitable for production under the future air state. Fig. 1 illustrates how to derive the suitability S_j of job J_j at the decision point. Specifically, Fig. 1 shows how to determine the job suitability at the first decision point, i. e., $t = 0$. In the following, we will use the fuzzy decision method to determine the suitability of every job.

The index matrix is formed as

$$\boldsymbol{M} = \begin{bmatrix} D_1 & D_2 & \cdots & D_n \\ R_1 & R_2 & \cdots & R_n \end{bmatrix}$$

Set

$$M_{D\max} = \max\{D_1, D_2, \dots, D_n\}$$
$$M_{R\max} = \max\{R_1, R_2, \dots, R_n\}$$
$$M_{D\min} = \min\{D_1, D_2, \dots, D_n\}$$
$$M_{R\min} = \min\{R_1, R_2, \dots, R_n\}$$
$$D = \frac{M_{D\max} - M_{D\min}}{1 - 0.1}$$
$$R = \frac{M_{R\max} - M_{R\min}}{1 - 0.1}$$
$$V_{D_j} = 0.1 + \frac{M_{D\max} - D_j}{D}$$
$$V_{R_j} = 0.1 + \frac{M_{R\max} - R_j}{R}$$

As a result, we obtain the fuzzy evaluation matrix:

$$\boldsymbol{V} = \begin{bmatrix} V_{D_1} & V_{D_2} & \cdots & V_{D_n} \\ V_{R_1} & V_{R_2} & \cdots & V_{R_n} \end{bmatrix}$$

The index weight coefficients are $a_D = 0.5$ and $a_R = 0.5$. Then, the weighted average model can be applied to obtain the job suitability S_j:

$$[S_1 \quad S_2 \quad \cdots \quad S_n] = [a_D \quad a_R] \begin{bmatrix} V_{D_1} & V_{D_2} & \cdots & V_{D_n} \\ V_{R_1} & V_{R_2} & \cdots & V_{R_n} \end{bmatrix}$$

Finally, we give the dispatching rule:

$$\max_j \pi_j^*$$
$$\pi_j^* = S_j \pi_j = S_j \frac{\omega_j}{p_j} \exp\left(\frac{-\max(d_j - p_j - t, 0)}{k p_a} \right)$$

where π_j^* denotes the priority of job J_j under the new dispatching rule. As shown above, the job of the maximum priority is chosen as the next to be produced.

3 Matching Degree

Through $n-1$ decisions, the resulting schedule is obtained. A new measure will be established to assess the performance and potential of our dispatching heuristic. The matching degree is defined as

$$\frac{1}{n} \sum_{j=1}^{n} \min\left(\frac{\mathrm{IMC}_j}{\mathrm{MEMC}_j}, \frac{\mathrm{MEMC}_j}{\mathrm{IMC}_j} \right)$$

where MEMC_j denotes the mean EMC over the order (responding to job J_j) production cycle. MEMC_j can be computed by using daily average relative humidity and temperature. The notationmin(·) stands for the matching level of job J_j with its production environment.

In our work, the main target is to reduce the possibility (risk) that quality problems occur due to the fact that lumber MCs do not reach the standards. The matching degree reflects the average matching level of a job in the schedule with the production environment. The greater the matching degree, the smaller the risk that quality problems occur.

4 Experiments

The experimental objective is to verify that the newly designed dispatching rule can largely reduce the risk that lumber MCs do not achieve standards while guaranteeing that the weighted tardiness is low. As shown in Tab. 1, the experimental background is set as the circumstance

Tab. 1 Weather, DAT, DARH and EMC

Date	Weather	DAT/℃	DARH/%	EMC/%
11-16	Cloudy	10.20	45.33	8.71
11-17	Sunny	8.70	56.44	10.58
11-18	Sunny	10.00	71.00	13.68
11-19	Cloudy	11.30	72.67	14.09
11-20	Cloudy	14.67	76.00	14.95
11-21	Cloudy	17.00	70.67	13.40
11-22	Cloudy	17.30	87.00	19.06
11-23	Rain	12.30	93.00	22.74
11-24	Light rain	10.30	95.00	24.28
11-25	Light rain	11.70	83.00	17.48
11-26	Cloudy	12.30	90.00	20.84
11-27	Light rain	10.70	79.33	16.14
11-28	Overcast	12.00	91.00	21.44
11-29	Shower	10.67	94.00	22.79
11-30	Cloudy	5.00	49.00	9.35
12-01	Fair	2.30	56.33	10.64
12-02	Fair	3.67	66.00	12.58
12-03	Sleet	3.33	63.00	11.94
12-04	Sunny	2.33	58.00	10.95
12-05	Fair	5.20	57.00	10.74
12-06	Cloudy	7.00	57.67	10.85
12-07	Cloudy	5.00	55.30	10.44
12-08	Sunny	7.33	68.00	13.00
12-09	Cloudy	6.00	89.30	20.61

of the daily average temperature (DAT) and daily average relative humidity (DARH) from November 16th to December 9th in 2014 in Nanjing. The daily EMC is also listed in the last column of Tab. 1. Two design factors are used:

1) Dispatching heuristics including the new dispatching rule and the R&M dispatching rule.

2) The due date function is $d_j = p_j$ Uniform$[x, y]$. Interval endpoints $[x, y]$ carry two dispersing conditions shown in Tab. 2. According to Tab. 2, No. 1-13 are responding to the mean values: 2, 2.5, 3, ⋯, 8, respectively. The greater the mean value, the softer the schedule.

Each combination is replicated 500 times to vary random numbers within the 10-job stream. Within each replication, the processing times are obtained via Normal(8, 2), the initial lumber MCs IMC_j are assigned elements of the set {6%, 7%, 8%, 10%, 12%, 13%} at random, and the job weights w_j, from the set {1, 2, 3, 4, 5}, are given randomly.

Tab. 2 Due date dispersing conditions

No.	Widely dispersing	Narrowly dispersing
1	[0,4]	[1,3]
2	[0.5,4.5]	[1.5,3.5]
3	[1,5]	[2,4]
4	[1.5,5.5]	[2.5,4.5]
5	[2,6]	[3,5]
6	[2.5,6.5]	[3.5,5.5]
7	[3,7]	[4,6]
8	[3.5,7.5]	[4.5,6.5]
9	[4,8]	[5,7]
10	[4.5,8.5]	[5.5,7.5]
11	[5,9]	[6,8]
12	[5.5,9.5]	[6.5,8.5]
13	[6,10]	[7,9]

Tabs. 3 and 4 display the mean matching degree under the two above types of due date dispersing conditions, and the maximum difference of two matching degrees corresponding to the new dispatching rule and R&M dispatching rule within 500 replications, respectively. From Tab. 3, we find that the new dispatching rule outperforms the R&M dispatching rule by about 1%. It means that the total matching degree of the whole schedule rises by about 10%. Sometimes, the total matching degree even jumps by 79%. This can greatly reduce the risk that quality problems occur. Hence, it is very significant to consider the weather factor when studying furniture production scheduling problems.

Tab. 3 Mean matching degree Ⅰ %

Widely dispersing	R&M dispatching rule	New dispatching rule	Difference	Maximum difference
[0,4]	58.44	59.55	1.11	6.11
[0.5,4.5]	58.45	59.47	1.03	7.90
[1,5]	58.49	59.51	1.02	6.74
[1.5,5.5]	58.10	59.14	1.04	6.45
[2,6]	58.66	59.73	1.07	6.44
[2.5,6.5]	58.54	59.62	1.08	6.65
[3,7]	58.32	59.39	1.07	5.40
[3.5,7.5]	58.25	59.34	1.09	5.99
[4,8]	58.69	59.70	1.02	5.80
[4.5,8.5]	58.46	59.56	1.10	5.56
[5,9]	58.71	59.80	1.09	6.70
[5.5,9.5]	58.51	59.58	1.07	7.45
[6,10]	58.39	59.43	1.04	5.70

Tab. 4 Mean matching degree Ⅱ %

Narrowly dispersing	R&M dispatching rule	New dispatching rule	Difference	Maximum difference
[1,3]	58.12	59.22	1.10	5.89
[1.5,3.5]	58.27	59.27	1.00	6.99
[2,4]	57.93	59.06	1.13	5.92
[2.5,4.5]	58.14	59.19	1.05	5.64
[3,5]	58.39	59.42	1.04	4.96
[3.5,5.5]	58.68	59.88	1.20	7.44
[4,6]	58.41	59.44	1.03	6.15
[4.5,6.5]	58.09	59.16	1.07	6.12
[5,7]	58.33	59.42	1.09	6.19
[5.5,7.5]	58.40	59.41	1.01	5.64
[6,8]	58.91	59.86	0.95	5.36
[6.5,8.5]	58.70	59.77	1.07	6.66
[7,9]	59.02	59.97	0.95	6.43

Tabs. 5 and 6 show the mean weighted tardiness and the tardiness penalty of the new dispatching rule corresponding to the due date dispersing conditions, respectively. As the softness of due dates climbs, the weighted tardiness measures of both dispatching rules decline rapidly. For each due date dispersing condition, the tardiness penalty of the new dispatching rule first rises and then drops by and large with the softness of due dates up. This is illustrated in Fig. 2. From the figure, we can find that when due dates are very soft, the new dispatching rule underperforms the R&M dispatching rule slightly.

Tab. 5 Mean weighted tardiness Ⅰ

Widely dispersing	R&M dispatching rule	New diapatching rule	Difference	Tardiness penalty/%
[0,4]	554.972 6	618.337 1	63.364 5	11.42
[0.5,4.5]	475.761 1	539.381 3	63.620 3	13.37
[1,5]	397.983 7	455.534 7	57.551 0	14.46
[1.5,5.5]	324.926 7	373.125 5	48.198 8	14.83
[2,6]	262.202 3	310.566 9	48.364 6	18.45
[2.5,6.5]	211.519 8	250.761 7	39.241 9	18.55
[3,7]	169.842 0	206.749 3	36.907 3	21.73
[3.5,7.5]	130.128 7	154.401 4	24.272 7	18.65
[4,8]	100.362 5	118.151 7	17.789 2	17.72
[4.5,8.5]	74.965 1	90.121 5	15.156 4	20.22
[5,9]	55.190 9	64.203 1	9.012 2	16.33
[5.5,9.5]	39.735 6	43.129 6	3.394 0	8.54
[6,10]	29.750 3	30.577 5	0.827 2	2.78

Tab. 6 Mean weighted tardiness Ⅱ

Narrowly dispersing	R&M dispatching rule	New diapatching rule	Difference	Tardiness penalty/%
[1,3]	547.928 3	615.142 9	67.214 6	12.27
[1.5,3.5]	455.453 3	514.765 1	59.311 8	13.02
[2,4]	379.300 1	440.237 4	60.937 3	16.07
[2.5,4.5	308.073 1	362.752 9	54.679 7	17.75
[3,5]	248.998 7	295.433 0	46.434 3	18.65
[3.5,5.5]	196.835 2	235.910 5	39.075 3	19.85
[4,6]	159.218 7	190.759 2	31.540 4	19.81
[4.5,6.5]	118.818 5	136.482 5	17.664 0	14.87
[5,7]	88.706 1	108.635 8	19.929 7	22.47
[5.5,7.5]	67.003 5	77.032 3	10.028 8	14.97
[6,8]	50.464 7	57.104 9	6.640 2	13.16
[6.5,8.5]	34.857 1	36.683 2	1.826 1	5.24
[7,9]	24.083 0	24.526 7	0.443 7	1.84

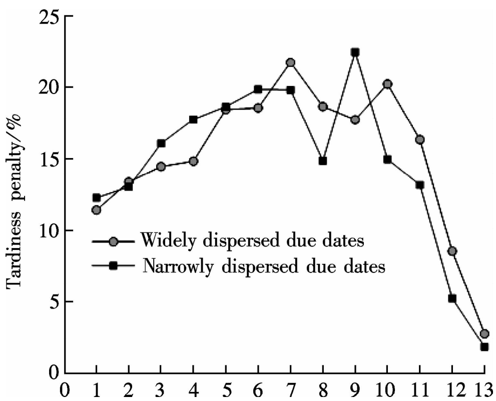

Fig. 2 Tardiness penalty of the new dispatching rule

In summary, by utilizing our dispatching rule, significant performance gains can be obtained while insignificant performance degradation is incurred.

5 Conclusion

In this paper, we propose the new dispatching rule to reduce the impacts of "bad" weather on product quality. At each decision point, we can determine the suitable job to be executed by using the fuzzy decision method. The suitability of each job is integrated with the R&M dispatching rule to develop our dispatching rule. The matching degree is established to evaluate the matching level of the weather and lumber MCs of products. By comparing our method with the R&M dispatching rule, it is shown that our dispatching rule can greatly increase the matching degree while maintaining low weighted tardiness.

References

[1] Vollmann T E, Berry W L, Whybark D C. *Manufacturing planning and control systems*[M]. Homewood, IL, USA: Irwin, 1992: 1 −20.

[2] Stoop P P M, Wiers V C S. The complexity of scheduling in practice[J]. *International Journal of Operations & Production Management*, 1996, **16**(10): 37 −53. DOI: 10.1108/01443579610130682.

[3] Ouelhadj D, Petrovic S. A survey of dynamic scheduling in manufacturing systems[J]. *Journal of Scheduling*, 2009, **12**(4): 417 −431. DOI:10.1007/s10951-008 −0090-8.

[4] Yin Y, Cheng S R, Cheng T C E, et al. Just-in-time scheduling with two competing agents on unrelated parallel machines[J]. *Omega*, 2016, **63**: 41 −47. DOI:10.1016/j.omega.2015.09.010.

[5] Yin Y, Wang Y, Cheng T C E, et al. Two-agent single-machine scheduling to minimize the batch delivery cost [J]. *Computers & Industrial Engineering*, 2016, **92**: 16 −30. DOI:10.1016/j.cie.2015.12.003.

[6] Morton T E, Rachamadugu R M. Myopic heuristics for the single machine weighted tardiness problem, Technical Report CMURI-TR-83-9[R]. Pittsburgh, USA:Graduate School of Industrial Administration, Carnegie-Mellon University, 1983.

[7] Kanet J J, Li X. A weighted modified due date rule for sequencing to minimize weighted tardiness[J]. *Journal of Scheduling*, 2004, **7**(4): 261 −276. DOI:10.1023/b:josh.0000031421.64487.95.

[8] He W, Sun D H. Scheduling flexible job shop problem subject to machine breakdown with route changing and right-shift strategies[J]. *The International Journal of Advanced Manufacturing Technology*, 2013, **66**(1): 501 −514. DOI:10.1007/s00170-012 −4344-4.

[9] Petrovic D, Duenas A. A fuzzy logic based production scheduling/rescheduling in the presence of uncertain disruptions[J]. *Fuzzy Sets and Systems*, 2006, **157**(16): 2273 −2285. DOI:10.1016/j.fss.2006.04.009.

[10] Duenas A, Petrovic D. An approach to predictive-reactive scheduling of parallel machines subject to disruptions [J]. *Annals of Operations Research*, 2008, **159**(1): 65 −82. DOI:10.1007/s10479-007 −0280-3.

[11] Varas M, Maturana S, Pascual R, et al. Scheduling production for a sawmill: A robust optimization approach [J]. *International Journal of Production Economics*, 2014, **150**: 37 −51. DOI:10.1016/j.ijpe.2013.11.028.

[12] Fang K T, Lin B M T. Parallel-machine scheduling to minimize tardiness penalty and power cost[J]. *Computers & Industrial Engineering*, 2013, **64**(1): 224 −234. DOI:10.1016/j.cie.2012.10.002.

[13] Le C V, Pang C K. Fast reactive scheduling to minimize tardiness penalty and energy cost under power consumption uncertainties[J]. *Computers & Industrial Engineering*, 2013, **66**(2): 406 −417. DOI: 10.1016/j.cie.2013.07.006.

[14] Li X, Ishii H, Chen M. Single machine parallel-batching scheduling problem with fuzzy due-date and fuzzy precedence relation[J]. *International Journal of Production Research*, 2014, **53**(9): 2707 −2717. DOI: 10.1080/00207543.2014.975866.

[15] Yin Y, Cheng T C E, Yang X, et al. Two-agent single-machine scheduling with unrestricted due date assignment [J]. *Computers &Industrial Engineering*, 2015, **79**: 148 −155. DOI:10.1016/j.cie.2014.10.025.

[16] Aydilek A, Aydilek H, Allahverdi A. Production in a two-machine flowshop scheduling environment with uncertain processing and setup times to minimize makespan [J]. *International Journal of Production Research*,

2015, **53**(9): 2803 – 2819. DOI: 10.1080/00207543.2014.997403.

[17] Yin Y, Liu M, Hao J, et al. Single-machine scheduling with job-position-dependent learning and time-dependent deterioration[J]. *IEEE Transactions on Systems, Man, and Cybernetics—Part A: Systems and Humans*, 2012, **42**(1): 192 – 200. DOI: 10.1109/tsmca.2011.2147305.

[18] Wang R H, Fei S M. Rescheduling: External environment-related real-time events[J]. *IFAC Proceedings Volumes*, 2014, **47**(3): 10743 – 10747. DOI: 10.3182/20140824-6-za-1003.01792.

为减少天气影响的家具生产分派规则

王瑞华[1,2] 费树岷[1] 刘卿卿[3]

([1] 东南大学自动化学院, 南京 210096)
([2] 青岛理工大学自动化工程学院, 青岛 266520)
([3] 南京信息工程大学信息与控制学院, 南京 210044)

摘要:为解决实木家具厂机加工车间的工作排序问题,设计了一个新的家具生产分派规则, 减小了由于天气“恶劣”而引起质量问题的可能性. 首先, 构造风险持续时间和风险大小 2 个指标来描述天气状况. 基于这 2 个指标, 使用模糊决策方法计算未来空气状况下的工作适合度, 将工作适合度与传统的启发式方法相结合,计算每个工作的分派优先级,得到新的分派规则. 然后, 为评估所得的分派规则的有效性, 设计了一个度量匹配度, 匹配度越大,木制品质量问题发生的可能性越小. 仿真实验表明, 在保证低的加权滞后时间的同时, 所设计的分派规则能大幅提高调度表的环境匹配度.

关键词:分派规则; 模糊决策; 适合度; 相对湿度

中图分类号:TB114.1