**Description of the test examples** (Tempelmeier & Derstroff, 1993; Tempelmeier & Helber, 1994)

**Results: “Tempelmeier, H., & Derstroff, M. (1993) Paper”:** To check the quality of the products described Methods were obtained three groups of problems with different grids Investigated.

**Problem Group A: (K = 10; T = 4; J = 3; no setup times):**

Problem group ‘A’ covers 300 small problems with 10 products, 4 periods, and 3 resources, to which Tempelmeier and Helber [22] have determined exact solutions with the help of Standard Software 9 (LINDO). The individual problems arose through the combination of

* 4 Product and process structures (general and converging, with cyclic and non-cyclic resource graphs),
* 3 Conversions of the final product demand time series (with different coefficients of variations C.V. = {0.1, 0.4, 0.71},
* 5 combinations of medium production cycles of the Products (production cycle profiles, Length of a production cycle between 1 and 4 periods) and
* 5 Combinations of average resources (U = {90%, 70%, 50%}).

A detailed description of the problems can be found in Appendix. For each of these 300 problems, 5 random time series were generated, respectively, so that in total 1500 problem instances, the optimal solutions are known.

The following four product and process structures are presented considered:

**A1: General, non-cyclic resource graph**

|  |  |
| --- | --- |
| **Product and process structure** | **Resource Graph** |
|  |  |

**A2: General, cyclic resource graph**

|  |  |
| --- | --- |
| **Product and process structure** | **Resource Graph** |
|  |  |

**A3: Assembly (Convergent), non–cyclic resource graph**

|  |  |
| --- | --- |
| **Product and process structure** | **Resource Graph** |
|  |  |

**A4: Assembly (Convergent), cyclic resource graph**

|  |  |
| --- | --- |
| **Product and process structure** | **Resource Graph** |
|  |  |

The mean period requirement is for the four End products of general product structures always 70, 30, 50 and 100. An average period requirement of 100 was assumed for the final product of the converging product structures.

**Utilization profiles**

|  |  |  |  |
| --- | --- | --- | --- |
| **Profile** | **Capacity Utilization** | | |
| **U = 90%** | **U = 70%** | **U = 50%** |
| 1 | A,B,C | - | - |
| 2 | - | A,B,C | - |
| 3 | - | - | A,B,C |
| 4 | A | B | C |
| 5 | C | B | A |

**Production Cycles–Profile:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Profile** | **Production cycles** | | |
| 1 | 2 | 4 |
| **Problem Group A1 & A2** | 1 | 1..10 | - | - |
| 2 | - | 1..10 | - |
| 3 | - | - | 1..10 |
| 4 | 1..4 | 5..7 | 8..10 |
| 5 | 8..10 | 5..7 | 1..4 |
| **Problem Group A3 & A4** | 1 | 1..10 | - | - |
| 2 | - | 1..10 | - |
| 3 | - | - | 1..10 |
| 4 | 1 | 2..4 | 5..10 |
| 5 | 5..10 | 2..4 | 1 |

**Problem Group B (K = 10; T = 4; J = 3; setup times):**

The second problem group arises through combination of the 300 Group ‘A’ problems

* Two set-up times

In the first profile, the end product is created (Products) have relatively high operating times, In the second time profile, the operating times of the Products are higher than those of the higher grades Products. Because of the high time effort to the Determination of optimal solutions was only possible a demand time series is generated for each problem. A total of So 600 problems exactly and with the Proposed heuristic method (iteration limit 120).

The problems of group ‘A’ are considered. In addition, the following profile profiles are introduced.

|  |  |  |  |
| --- | --- | --- | --- |
| **Profile** | **Set-up time** | | |
| **5** | **10** | **15** |
| 1 | 7..10 | 1,2,5,6 | 3, 4 |
| 2 | 3, 4 | 1,2,5,6 | 7..10 |

For the calculation of the average utilization was in each case a one-time detent operation.

**Problem group C: (K = 40; T = 16; J = 6; no setup times)**

Problem group C covers 300 problems with 40 products, 16 periods and 6 resources. The individual problems were obtained by combining

* 4 Product and process structures (general and converging, with cyclic and non-cyclic resource graphs),
* 3 The final product demand time series (with different coefficients of variation C.V. = {0.1, 0.5, 0.9}),
* 5 combinations of medium production cycles of the Products (production cycle profiles, length of a production cycle between 1 and 5 periods) and
* 5 Combinations of resource utilization (U = {90%, 70%, 50%})

constructed. A detailed description of the problems is In the Annex.

**Produce and PROCESS STRUCTURES C1 and C2 (General):**



**Allocation of resources to the products:**

|  |  |  |
| --- | --- | --- |
| **Resource** | **C1 - non-cyclical**  **resource graph** | **C2 - cyclic**  **resource graph** |
| Product – Operations  (Products Workflows) | Product – Operations  (Products Workflows) |
| A | 1..3 | 1..3,5 |
| B | 4..6 | 4,6,18,19 |
| C | 7..10 | 7..10 |
| D | 11..19 | 11..15, 25..29, 39,40 |
| E | 20..29 | 16, 17, 20..24, 31 |
| F | 30..40 | 30, 32..38 |

**Product and process structures C3 & C4:**

These are two converging product structures with the final products 1 and 2, which are linked by resource competition. Problem groups C3 and C4 result from the combination of these product structures with a non-cyclical and a cyclical resource draw.

**Produce and PROCESS STRUCTURES C3 and C4 (Assembly):**

****

**Allocation of resources to the products:**

|  |  |  |
| --- | --- | --- |
| **Resource** | **C3 - non-cyclical**  **resource graph** | **C4 - cyclic**  **resource graph** |
|  | Product – Operations  (Products Workflows) | Product – Operations  (Products Workflows) |
| A | 1,2 | 1..3 |
| B | 3..6 | 4,6 |
| C | 7..14 | 5, 7..16 |
| D | 15..22 | 17..20, 27,28,31,32, 37,38 |
| E | 23..30 | 21..23, 33..36 |
| F | 31..40 | 24..26, 29..40 |

**Utilization profiles**

|  |  |  |  |
| --- | --- | --- | --- |
| **Profile** | **Capacity Utilization** | | |
| **U = 90%** | **U = 70%** | **U = 50%** |
| 1 | A..F | - | - |
| 2 | - | A..F | - |
| 3 | - | - | A..F |
| 4 | A,B | C,D | E,F |
| 5 | E,F | C,D | A,B |

**Reference:**

Tempelmeier, H., & Derstroff, M. (1993). Mehrstufige Mehrprodukt-Losgriil enplanung bei beschr/inkten Ressourcen und genereller Erzeugnisstruktur. *OR Spektrum*, *15*(2), 63–73. http://doi.org/10.1007/BF01720518

Tempelmeier, H., & Helber, S. (1994). A heuristic for dynamic multi-item multi-level capacitated lotsizing for general product structures. *European Journal of Operational Research*, *75*(2), 296–311.