ANALYTICS METHODS OF TECHNOLOGICAL DESCRIPTION OF A STATION LAYOUT

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Summary: This article shows the most common ways of describing station layout, serving as the basis for determining the capacity of the layout. Also presents a procedure how to define the basic elements of the station gridiron.

Key words: station capacity, layout element, analytic methods.

INTRODUCTION

Analytic methods for capacity research or timetable scheduling were developed before more than 50 years. Some of them are still being used even now. Of course, some methods were partly changed with regard of technical and technological advance. But the base has stayed the same. Analytical methods are still popular even though simulations are applied more and more frequently, because of their simplicity and computation speed without the high costs. They can often lead to useful results, although they may not be too exact. Considerable attention is devoted to line capacity research in current field experience, and scientific research. On the other hand, stations and junctions are neglected, although they are also an important and integral part of the railway infrastructure.

1. DESCRIPTION OF THE COMPLEXITY OF THE TRACK LAYOUT

Following simplest analytical methods are suitable only for small gridiron and easy transport conditions. These methods do not include certain data, which greatly affect the accuracy of results. Therefore, their use for larger gridiron is not appropriate.

1.1 Route locking rate

Route locking rate is very simple and frequently used method and the standard is usage of route locking table.

In such a locking table all routes are represented by the both a row and column (Fig. 1). For simplification, in difference to normal interlocking nomenclature in this example each route is labeled by a single letter at the entrance and the exit. All the table elements are representing routes which lock to each other are marked with an abbreviation to characterise the kind of locking (crossing, diverting, converging) (1).

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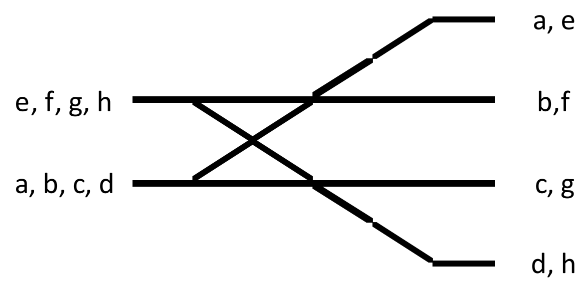


1st Route	2nd Route							
	a	b	c	d	e	f	g	h
a		D	D	D	C	X	X	X
b	D		D	D	C/D	C	X	X
c	D	D		D			C	X
d	D	D	D				C/D	C
e	C	C/D				D	D	D
f	X	C			D		D	D
g	X	X	C	C/D	D	D		D
h	X	X	X	C	D	D	D	

D -diverting routes X - crossing rotes
C - converging routes C/D - converging/diverging routes

Source: Author

Fig. 1 – Route locking table

With help of route locking table we can quickly and easily determine the rate of mutually exclusive train routes.

$$\eta = \frac{\sum (c_{ij})}{n^2} \qquad (1)$$

η rote locking rate

c_{ij} locking state of route combination ij

locked: $c_{ij} = 1$

not locked: $c_{ij} = 0$

n total number of routes

The result for the gridiron in Figure 1:

$\eta = 56/64 = \underline{0{,}875}$ → 87.5% of possible train routes are conflicting

1.2 Weighted route locking rate

The method of route locking rate does not consider the number of trains on the different routes. If the traffic flow on the different routes differs significantly then the route locking rate will not represent the advantage or disadvantage of different layouts very realistically. To achieve better results it is recommended to weigh up the route combinations by the number of trains.

$$\eta_w = \sum (c_{ij}) \cdot \frac{n_i \cdot n_j}{n^2} \qquad (2)$$

η_w weighted up route locking rate

c_{ij} locking state of route combination ij

locked: $c_{ij} = 1$

not locked: $c_{ij} = 0$

n_i number of trains on route i

n_j number of trains on route j

n total number of all trains

1.2.1 Practical example of weighted up route locking rate method

Tab. 1 – Number of trains on different routes

Route	Trains per time	Route	Trains per time
a	20	e	40
b	10	f	80
c	80	g	10
d	40	h	20

Source: Author

Tab. 2 – Calculation sheet

1st Route	2nd Route									
	Trains	a	b	c	d	e	f	g	h	Sum
		20	10	80	40	40	80	10	20	300
a	20	0,004	0,002	0,018	0,009	0,009	0,018	0,002	0,004	0,067
b	10	0,002	0,001	0,009	0,004	0,004	0,009	0,001	0,002	0,033
c	80	0,018	0,009	0,071	0,036			0,009	0,018	0,160
d	40	0,009	0,004	0,036	0,018			0,004	0,009	0,080
e	40	0,009	0,004			0,018	0,036	0,004	0,009	0,080
f	80	0,018	0,009			0,036	0,071	0,009	0,018	0,160
g	10	0,002	0,001	0,009	0,004	0,004	0,009	0,001	0,002	0,033
h	20	0,004	0,002	0,018	0,009	0,009	0,018	0,002	0,004	0,067
Sum	300	0,067	0,033	0,160	0,080	0,080	0,160	0,033	0,067	**0,680**

Source: Author

The result for the gridiron in Figure 1 by weighted up loping rate:
$\eta_w = \underline{0,680} \rightarrow$ 68% of train routes are conflicting

Methods of route locking rate and weighted route locking rate are especially suitable for comparing the merits of different designs of gridirons.

2. GRAPHICAL-ANALYTICAL DESCRIPTION

The weighted up route locking rate method is not suitable for larger station gridirons. Graphical-analytical methods are using for large stations and junctions.

Large junctions and stations are first decomposed into smaller subregions. The subregions are then solved individually according to the optimisation problem. In a last step all local results for lines, junctions, and platforms are integrated in order to obtain a maximal number of trains that can pass the considered region within a given amount of time (3).

2.1 Basic elements

The station gridiron is described by the independent elements for further analysis of the train which runs through it. These basic infrastructure elements are considered to be limiting to the overall capacity. That´s way is very important to properly identify these basic elements.

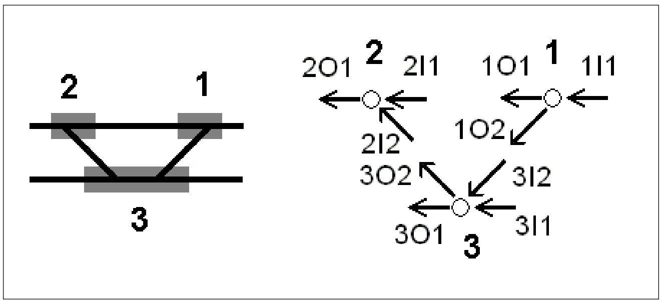
2.1.1 Determining the basic elements

There are several ways to determine the basic elements of the gridiron. It is crucial that every of these basic elements must not contain any possibility for parallel routes. This is one possible procedure for determining the basic elements:

1. Main tracks and other tracks on the input side marked by letters
2. Station tracks on the output side marked by numbers
3. All turnouts, crossings and slip turnouts are initially treated as separate elements
4. First and fallowing turnouts are included in the common element if:
    a. Two turnouts lying points (point parts) against each other and they are not separated by main signal
    b. Two turnouts lying point (point part) and frog part against each other and they are not separated by main signal
5. Point 4 repeat until there are no elements lying point part to next turnout, crossing or slip turnout
6. First and next elements lying frog parts against each other are included in the common element if both elements have dependent inputs and outputs (see 2.1.2)
7. Point 6 repeat until there are no elements lying frog parts against each other, which they have dependent inputs and outputs
8. Create a groups of station tracks on output side – all tracks with a common neighbor (last) element are in the same group

2.1.2 *Verifying the independence of inputs and outputs of the elements*

Each element has one ore more inputs and one or more outputs. Verification of the independence of elements is possible to shows on the following example. (Fig. 2)



Source: Author

Fig. 2 – Verifying the independence of inputs and outputs of the elements

The element 3 has independent input 3I1 and independent output 3O1. Element 3 is independent from the elements 1 and 2. Element 1 has independent input 1I1. Because element 3 is an independent element, we consider only output 1O1. This output is also input into the element 2 (1O1 = 2I1). Element 2 has 2 inputs (2I1 and 2I2). Input 2I2 is the input of independent element 3 and input 2I1 is dependent on the output 1O2 of features element 1. Element 1 doesn´t have any other output than 1O1 and element 2 doesn´t have any other input than 2I1. Therefore, the element 2 is dependent on element 1 - elements 1 and 2 are the same element.

2.1.3 Practical example of determining the basic elements

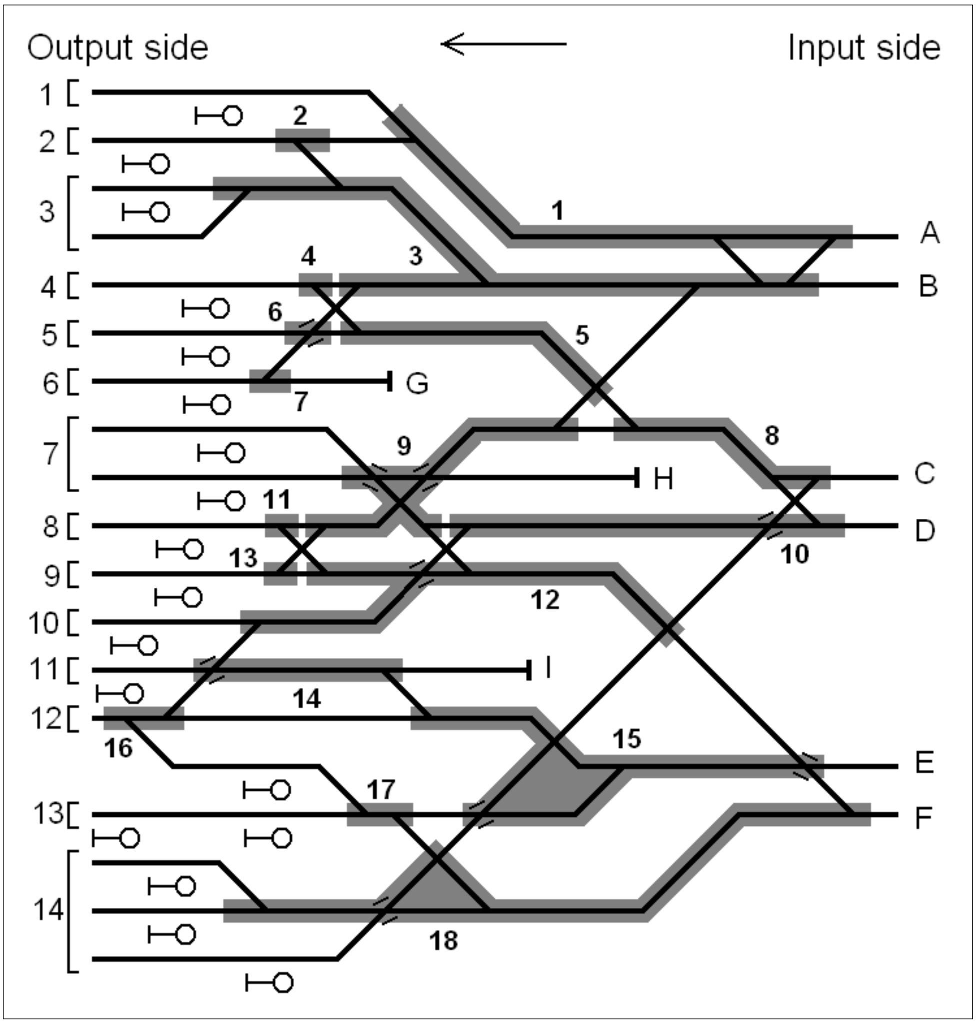


Fig. 3 – Practical example of determining basic elements

Source: Author

3. CONCLUSION

Structural analysis of station layouts and analysis of conflicting train routes are useful tools that serve as the basics for capacity research. These methods are using the basic elements working with the occupation time of elements. Therefore, they are more exact than those previously mentioned. I believe that these tools have the potential for further development. Especially for the larger station would be more appropriate to consider the different types of interlocking systems and regular shunting routes. Ways of describing station gridirons, which was introduced are not taking the location of shunting signals, and the possibility of current shunting routes into account.

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