The method of colourdynamic planning based on Coloroid Colour System

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Abstract: *The method of colourdynamic planning consists of three essential parts. In the first part we decide on the limits of the colour range to be used, based upon the requirements of the subject of planning. The decision on these limits is closely linked to the coordinates of the Coloroid system. In the second part the planner creates harmonic colour scales from the previously selected colour range. In this work he is helped by rules of the Coloroid system, based on harmony thresholds. In the third part the planner selects the colour harmony combinations considered suitable by him. Following that, he finalizes the Coloroid coordinates of the proposed colours most suitable for the project.*
For the presentation of the colourdynamic planning method, based on the Coloroid system, we use a real database of a colourdynamic plan, which was awarded the first prize in an international competition.
Keywords: method of colourdynamic planning, colourdynamic, Coloroid Colour System

Introduction

Nowadays the colour composition of our built environment is created by using various methods. It often happens that one façade of a line of facades is coloured without any preliminary planning. It occurs occasionally that someone selects a colour tint from a manufacturer's colour catalogue without considering the colour schemes of the neighbouring buildings. It also happens that the decision on the use of colour harmony scale is made consciously, based on one particular colour system, but some of the other vital considerations are left out from planning. In other words, they disregard the importance of the right choice of the colour system for the maximum beneficial impact on the final result. Such plans are also created where the planners use computer-generated colour display systems, however, the colour scales created by them only depend on their personal visual culture [1-9]

Like every planning activity, the activity of environment-oriented colourdynamic planning is also a conflict between circumstances, varied requirements and artistic goals. This conflict can take place in many ways, depending on the planner's knowledge and personality. In our article we choose a method that enables us to consider the varied circumstances and simultaneously to fulfil different needs.

Every single building in a row of houses is part of the cityscape. The visual presentation of every one of the facades will affect our visual memory of the city. The colours play a dominant role in this experience.

In the framework of this article, starting from a row of facades, a method of colourdynamic planning, based on Coloroid colour system, will be presented.

Fig .1 Panoramic view of Buda in World Chronicle by Shedel Hartman in 1493.

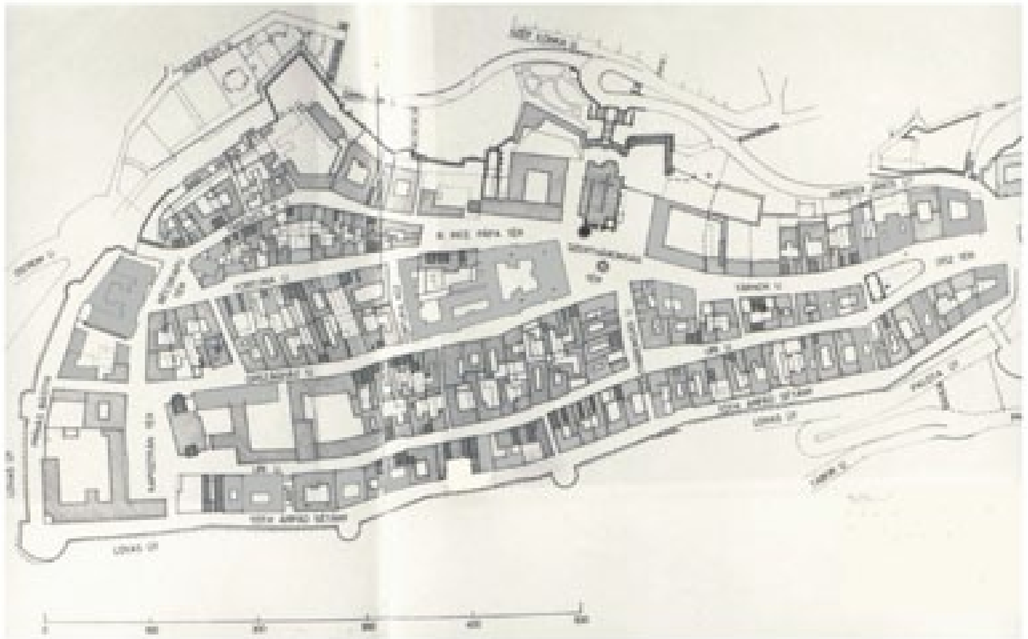

Fig. 2 The present site drawing of Castle District of Buda.

For the presentation of the method, the colourdynamic database of a real plan will be used, which was awarded the first prize in an international competition [10 to 12]. The selected example is the medieval Castle District of Buda, built on a hilly area, ideally suited for the demonstration of the method.

According to the descriptive itinerary of an early renaissance traveller, Europe's three most beautiful cities are Florence on a flat terrain, Venice on water, and Buda on a hillside (Fig.1). The City of Buda mentioned above is now part of Budapest, a city with 2 million inhabitants, with the name of Castle District of Buda. Medieval Buda occupied the same area as the present Castle District and the present surrounding city wall follows the route of the medieval fortifications. The street arrangement, the number, size and locations of the dwellings are still the same as in the medieval age.

Buda had a troubled history, particularly between the Mongol invasions in 1285 and the siege during the Second World War in 1944-1945. Armies of different countries kept it under siege nine times and attacked it with or without success during its history. Within this period, it was under Ottoman occupation for one hundred and fifty years. The destroyed houses were rebuilt time and time again, and the new buildings were kept in the same locations, within the old framework of the area. The new buildings, however, always followed the building style of the current age. As a result, all architectural styles of the last 800 years can be found side by side.

1. The essential colourdynamic characteristics of a city, built on a hill, as a subject of planning.

The Castle District is fully detached from its surrounding area. It is located on the right shore of the river Danube and is built on Castle Hill, which runs along the river. The hillside is 1.5 km long and 400 m wide, accommodating the Castle of Buda (Buda Vara) and the District of Castle. The District of Castle occupies the northern two-third of Castle Hill. The hill emerges from its surrounding by about 700 m. The tabletop of Castle Hill can be reached by car, on a serpentine; or by foot, for which one can use stairs, a funicular or lifts.

The street arrangement of the Castle District is unique. Most of the streets run in north-west, south-east direction, with only a few exceptions. The longest street runs between the two furthest points of the district and is just over 800 m long. The crossover points of the streets have four hobs (Fig.2).

The widths of the streets are approximately the same, so are the heights of the buildings. The ratio between the width of the streets and the height of the buildings varies between 1.5 - 1.8. The heights of the buildings exceed tree levels only in very few cases. Despite that, owing to the orientation of the streets, one side of the buildings is never exposed to the sun directly, and even the sunny side gets some sunshine only at midday.

The buildings in the Castle District originate from various eras. Approximately 15% of the houses are from the Middle Ages, representing the gothic architectural style with the original ornamental painted faces. (Fig. 3) About 75% of the buildings are from the 17^{th} and 18^{th} century. The frontal faces of these buildings project baroque, late baroque and rococo styles (Fig. 4). Regardless of the street arrangement, along the bastille, on the north-west side, there are some larger edifices in neo-classic and romantic style. Only approximately 10% of the buildings were built in modern style. The frontal facades, built in different architectural styles and located closely side by side, create a unified appearance of the street everywhere.

About 90% of the buildings in the Castle District are dwellings. Some of the larger dwellings have been converted by now into museums, restaurants or other establishments with a similar function. In one of the hobs of the street network, there is an original gothic church, from the Middle Ages, restored in the 19^{th} century.

Fig. 3 Frontal part of the gothic style edifice at the address of 14. Tarnok St.

Fig. 4 Frontal part of the baroque edifice at the address of 56. Uri St

1. Coloroid Colour System as an aid for planning environmental colourdynamics

The work of the colour environment designer is generally greatly aided by colour collections, catalogues, colour atlases, colour systems and nowadays computer-based colour displays. These help to finalise the visual realization of the harmonic colour scales, colour collections, regarded as suitable for their plans.

The difficulties with finding the suitable colour collection are listed below:

The colour collections and most of the colour catalogues designed for environmental colour planners are published by paint manufacturers. These colour selections are generally not based on theoretical considerations. They are selections, normally made as evenly changing subtractive mixtures of variable base colours, easily obtainable for the manufacturer. These selections seem to follow more or less monotonous colour scales. The hues and the saturations of these colours however, change monotonously in rare occasions only, despite the fact that this is a necessary condition for creating the colour harmony feeling. Owing to that, colour planners often face insurmountable tasks when selecting harmonic colour groups according to their conceived image [16, 32, 33].

The colour atlases of the various colour systems reflect the results of specific theoretical considerations. When making his choice, the colour designer has access to a number of colour selections of different colour systems. It appears that out of these systems, the optimally suited ones for colour design are the collections of the monotonously scaled Munsel and NCS systems. Their drawbacks are that the scale intervals are not defined at daylight, instead under laboratory conditions, by using experimental subjects with eyes adapted to darkness. As a result, they are dominated by colours of dark tints. We feel the step markers on the scales of dark colours much closer than those of light colours. A further defect of the NCS system is that the colours of different hues are forced into the same geometrical formation. This results in vastly different scale intervals for the various lighter colours, which cannot form harmonic collections any more with each other [16, 32, 33].

In contrast with the atlases and colour collections of the various colour systems, computer-aided displays contain a limited number of colour samples, and they are capable of creating all colours visible for the human eye, both theoretically and practically. The user can only rely on their own visual sensitivity and colour culture when they attempt to create colour combinations with harmony [16, 32, 33].

Optimal assistance is provided by the Coloroid colour system to colourdynamical design. Considering that, the most important attributes of the system are as follows:

The *Coloroid system* is a scheme of surface colours, for people with normal visual reception at *daylight illumination*. The experiments, for getting the scale parameters of the visual perception, were conducted at daylight, reflected from the northern sky, unlike in the Munsell system, where the experiments were carried out in a dark room.

The Coloroid colour system is based on harmonic-colour differences. Fundamentally, it is built on an aesthetically uniform visual sensation. Between the neighbouring surface colours, marked by integer numbers, there is an equal numbers of harmony intervals. It is particularly suitable for describing harmony relations between surface colours.

With its colour coordinates, all possible colours can be defined unambiguously. It can be transformed into a CIE colour measurements scheme.

With its colour coordinates all colours in any colour system, colour atlas, colour collection or colour catalogue can be defined unambiguously. All colours, defined by its coordinates, can be reproduced either on a computer monitor or a printer, because the coordinates can be transformed into RGB or any other computer-driven colour reproducing system.

The *Coloroid system* locates the 3D multitudes of the colour sensations inside a straight cylinder, with circular cross-section. The change in hue happens alongside the circumference of the

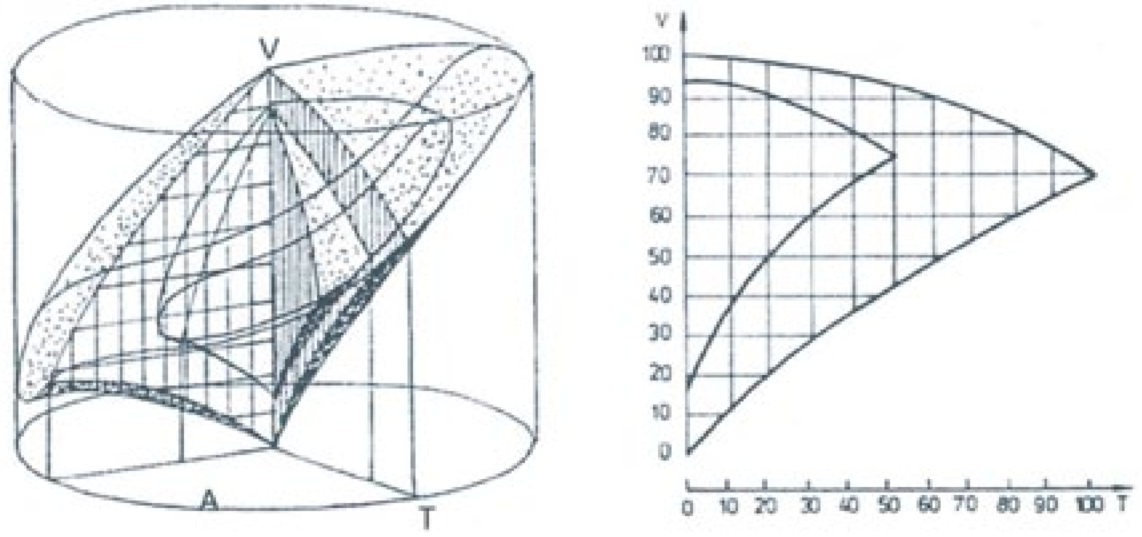

Fig. 5 Spatial model of Coloroid and one of the axis intersections. The hue of all colours of the axis intersecting horizontal lines is identical, Coloroid hue (A). The saturation of the colours on the vertical lines intersecting the axis have the same Coloroid saturation (1). On the border lines of the intersection with the axis are the colours cut out from the Colour space, the inner curvy lines are the bordering lines of the surface colours. The colours in our experiment lie on the surfaces located between the axis with the gray colours on and the inner curvy lines.

Fig. 6 The frontal part of the dwelling at the address of 5 Orszaghaz St, forming the subject of this planning exercise.

cylinder, and the change in saturation shows up on the radius in the direction of its axis (Fig. 5). The Coloroid border colours are located along a closed curve on the surface of the cylinder. Out of the border colours, 48 of them marked by integer numbers form the Coloroid base colours. On the axis of the Coloroid there are the neutral colours. The colours, located in the intersections of the axis, have identical hue and wavelength (λ).

The Coloroid system marks every colour by three independent numerical coordinates (A,T,V). The number with the index *A* marks the hue of the colour, showing whether the colour yellow, orange, red, purple, blue, green or any of these colours are transitory or not. *T* marks the saturation, indicating the location of the colour between the one with identical hue and most saturated and the grey with identical lightness. *V* represents the lightness of the colour, marking the position of the colour between absolute white and absolute black [13, 16].

1. Conception of colourdynamical planning

The outward appearance of a building depends on several factors, one of which is colou Colour is not only the dress of a building but also an integral part of architecture. Function, structur form, and colour are inseparable, which means that the colour of the facade, the harmony formula c a streetscape, or the colour of a city cannot arise from an arbitrary decision. Colour selection inseparable from architectural creation. Function influences structure, structure influences shape, an shape influences colour. However, obviously, the process of creation is too complex to assume single, hierarchic sequence of actions. Colour is directly related not only to shape, but also t structure and function.

We must also record this train of thought because nowadays, more than ever before, people want to see the environment, the entire world built in visual unity, inducing people to adopt integrated colour design, by re-colouring not only streetscapes, but entire districts. And this is a good thing, because our environment badly needs a well thought-out, unified, architecture-derived intervention, reflecting a visual approach.

Nowadays, authentic colour traditions, associated with regions, architectural styles, an functions have been almost completely neglected, giving way to many different, concurrentl existing philosophies of colour design. Colour often becomes a self-expression of the artis alternatively it will only be present as the natural colour of the building material. Some architec either enhance a streetscape with colour, or believe in the existence of "pure" shapes and „pure architecture, independent of colours. Further to that, nowadays the range of colours has becom almost unlimited. Today we have available not only the earth pigments from a particular regio usually in harmony with one another, but also an infinite variety of shades offered by the trade an the paint industry. As a result, some of our towns are deprived of colours, have become gray an bleak, others are over-coloured, showing a gaudy and confusing picture. This can be helped b designing building colouration while taking environment, function, structural design and shape int account. [17, 5, 6]

2. The stages of colourdynamic planning based on Coloroid colour scheme.

The environmental planning method based on the Coloroid system, consists of thre interdependent stages, built on each other. In the first stage the designer selects the suitable colou range for the colour scheme of the colour design of the façade. This part is called colour rang limitation. This activity only slightly depends on the personality of the designer or their notions.

In the second stage the designer creates harmonic collections from the previously limited colour range, matching the particular façades, street network and the whole Castle District. Here it is

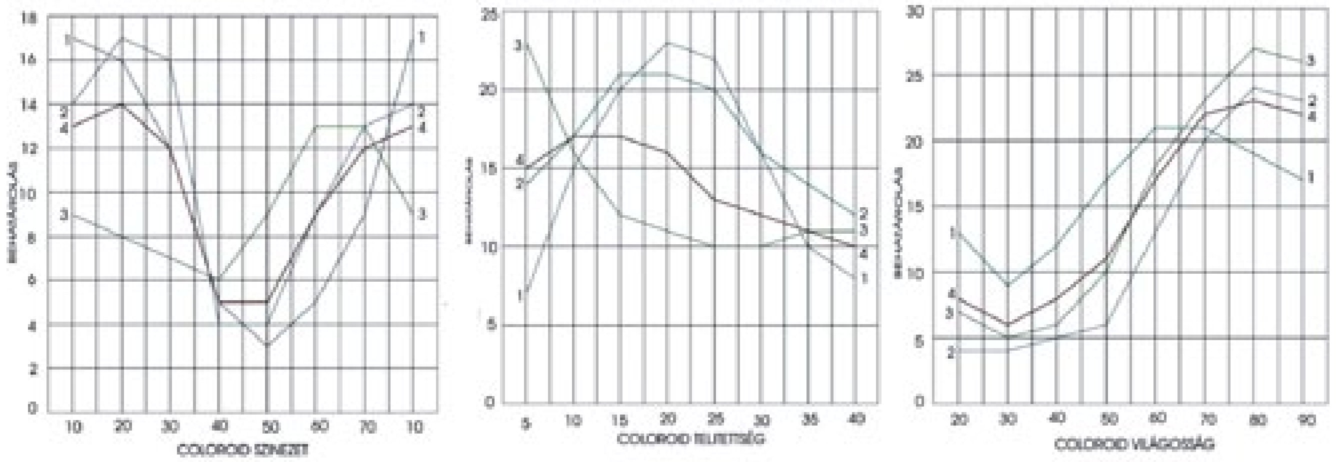

Fig. 7 Colour limitation 1.

"A"Colour selection based on the earlier scheme.

"B"Colour selection required by the architectural style.

"C"Colour selection following the colour taste of modern people.

"D"Colour selection satisfying all requirements from "A" to "C".

			COLOROID			CIELAB		
Surface	Material	Colour	A	T	V	L	a	b
Wall	Plaster	Mineral green	11	15	70	75.45	.3.51	16.70
Surface part	Plaster	Cimoli	13	5	87	89.72	0.03	3.71
Ledge	Plaster	Cimoli	13	5	87	89.72	0.03	3.71
Window frame	Plaster	Cimoli	13	5	87	89.72	0.03	3.71
Blind window	Plaster	Amber colour	13	20	70	75.45	0.15	22.46
Feszton. mező	Plaster	Mineral green	11	15	70	75.45	.3.51	16.70
Gate posts	Send stone	Sepia	13	15	60	66.52	0.14	20.76
Pedestal	Send stone	Sepia	13	15	60	66.52	0.14	20.76
Window-case	Timber	Malachite green	72	10	40	46.97	27.93	30.06
Window.	Timber	Alum white	11	3	90	92.13	0.50	2.17
Gate	Timber	Warm brown	13	10	40	46.97	0.16	26.34
Window lattice	Iron	Malachite green	72	10	40	46.97	27.93	30.06
Guttering	Sheet iron	Malachite green	72	10	40	46.97	27.93	30.06
Downpipe	Sheet iron	Malachite green	72	10	40	46.97	27.93	30.06
Chimnney	Plaster	Cimoli	13	5	87	89.72	0.03	3.71

Table1 Colours designed for the frontal face of the building at the address of 5. Országház St.

with various moods. The selection of the most suitable one mostly depends on the designer' imagination. In stage three the designer finalizes the choice of colours for the constituent parts of th various facades.

4.1 Colour limitation as the first stage of the colourdynamical planning.

The aim of colour limitation is to propose colours satisfying hue (A), saturation (T) and lightnes (V) range requirements in respect of the façade as a whole. Depending on the size of these range this aim is in most cases can be accomplished by a high number of colours. Naturally, the colour not falling into the selected ranges, according to the prevailing aspects, are not recommended fo planning.

For the demonstration of a typical colour limitation, the façade, facing Orszaghaz street, of th building located at the address of 5 Orszaghaz street, Castle District of Buda was selected (Fig. 6 According to archive records, this edifice was built in 1686 on gothic foundations. The presen façade was created in late baroque (copf) style in 1788. The building is on the corner of the street. It height is approximately 910 cm, its width, looking from the street, is 1850 cm and its surface area i 168.3 m^2. In front of it the street is 1200 cm wide. The ratio between street width and height is 1.3 The façade is facing south-west direction and the building is used as a dwelling unit.

The first step in the colour limitation is to decide on the colour scheme of the façade as early a possible. This activity is greatly helped by the remains of the original paints, discovered durin research carried out on the walls of the façade. The lines marked "A" in Fig.7. depict these relation for hue and are described by equations (1), (2) and (3) :

$$A^H \quad y = 7.11 + 17.39x - 8.84x^2 + 1.35x^3 - 0.06x^4 \qquad (1)$$

$$A^S \quad y = 3.16 + 0.51x + 4.57x^2 - 1.15x^3 + 0.07x^4 \qquad (2)$$

$$A^V \quad y = 32.16 - 29.61x + 12.17x^2 - 1.76x^3 + 0.08x^4 \qquad (3)$$

In the second step of the colour limitation, decision is made on the colour selection suitable for the architectural style of the building [3,18,19].This is depicted in the lines marked by „B" in Fig. 7 and described by equations (4), (5) and (6). The graphs show, that the coloured selection, in late baroque style carries very similar hue and saturation to that of earlier styles. The brightness graph also shows the same tendencies as the earlier ones.

$$B^H \quad y = -11.5 + 39.25x - 15.94x^2 + 1.92x^3 + 0.01x^4 - 0.01x^5 \qquad (4)$$

$$B^S \quad y = 11.16 + 1.31x + 1.87x^2 - 0.53x^3 + 0.04x^4 \qquad (5)$$

$$B^V \quad y = 0.23 + 7.44x - 4.68x^2 + 1.11x^3 - 0.07x^4 \qquad (6)$$

In the third step in the colour limitation the colour preference of contemporary persons is considered. We identified the colour preference of contemporary persons earlier, by carrying out a large volume, comprehensive set of experiments. In this set of experiments we recorded 50,000 judgements of experimental subjects [20-22]. The relation of contemporary persons to colours is shown by the lines marked „C" in Fig. 7, and described by equations (7), (8) and (9). The graph shows that the colour preference of the contemporary persons significantly differs from that of persons of earlier eras, particularly regarding hue and saturation.

$$C^H \quad y = 5.79 + 7.03x - 4.75x^2 + 1.04x^3 - 0.07x^4 \qquad (7)$$

$$C^S \quad y = 34.456 - 14.24x + 3.02x^2 - 0.28x^3 + 0.01x^4 \qquad (8)$$

$$C^V \quad y = 14.07 - 9.22x + 2.25x^2 + 0.04x^3 - 0.02x^4 \qquad (9)$$

The colours selected for the three criteria above and their average is shown by the curves marke by „D" in Fig. 7.. The curves are described by equations (10), (11) and (12) below.

$$D^H \quad y = -4.73 + 29.19x - 13.77x^2 + 2.28x^3 - 0.12x^4 \qquad (10)$$

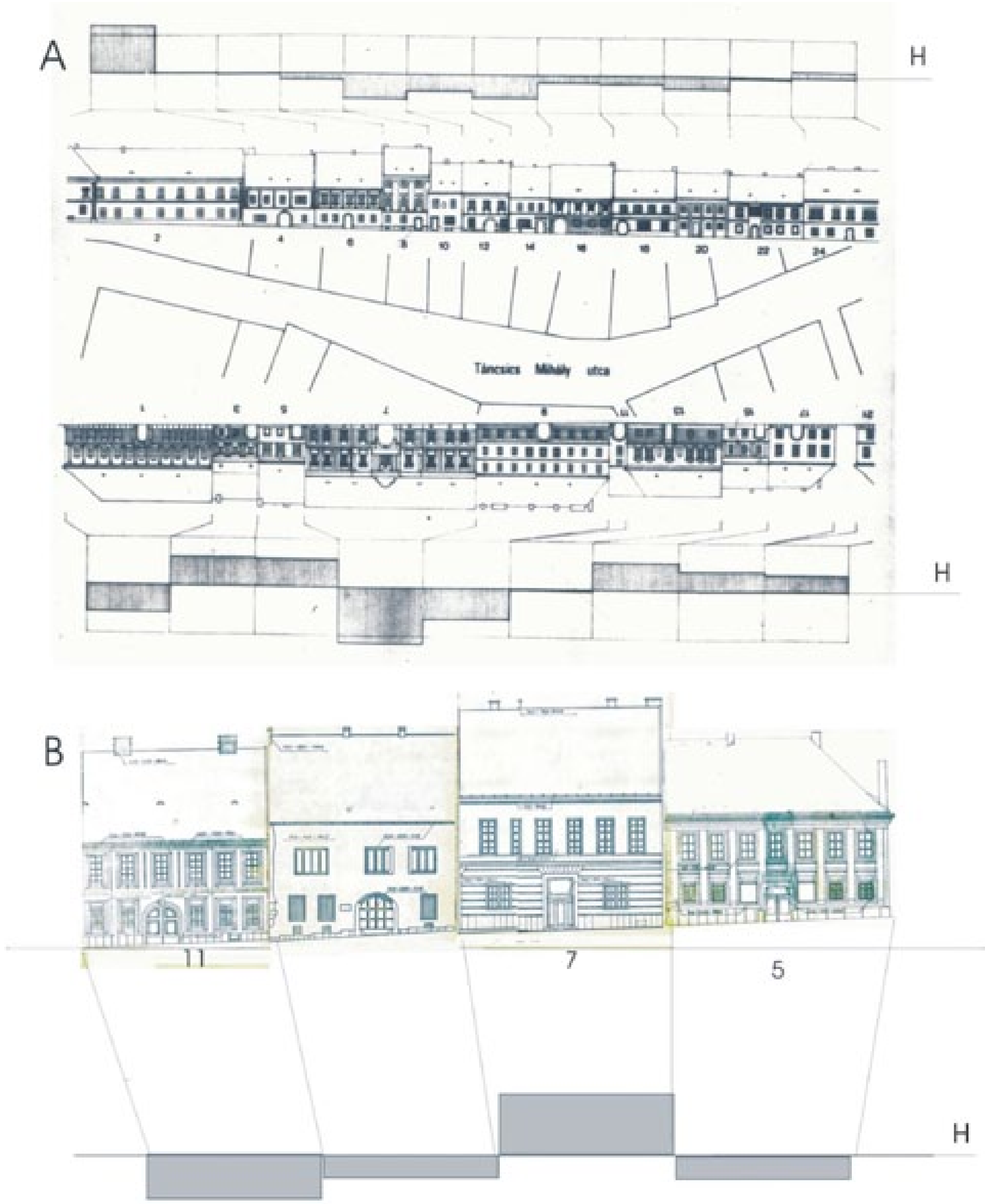

Fig.8 Graph of emphasis.
„A" Opposite facade rows of Tancsics Mihaly St. and the graphs of emphasis of these facade rows.
„B" Facade row created by facades of buildings No. 5, 7, 9, 11 of Orszaghaz St. and the graphs of emphasis of this facade row.

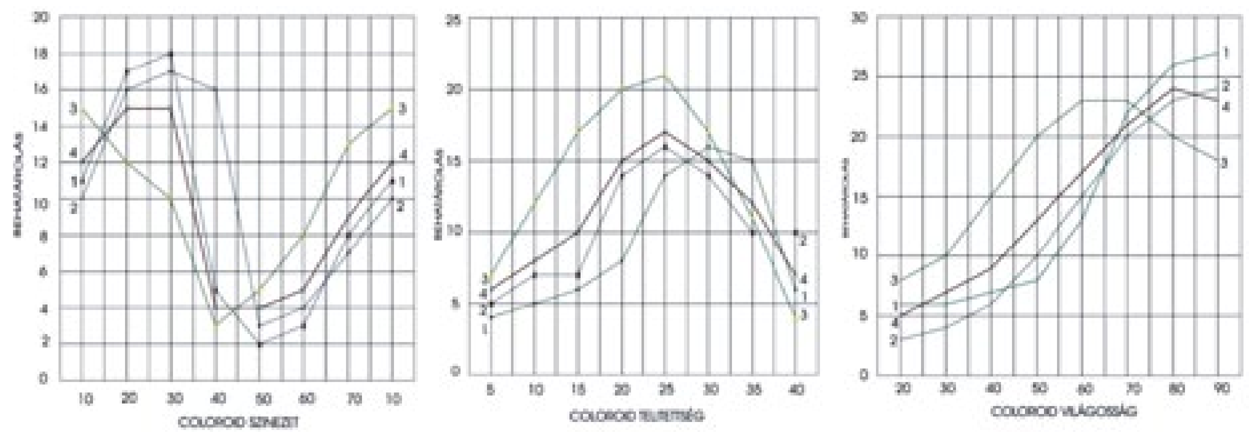

Fig. 9 Colour limitation 2
"A"Colour selection based upon the size of the frontal surface.
"B"Colour selection based on the sunny state of the frontal face.
"C"Colour selection depending on the function of the edifice.
"D"Colour selection satisfying all "A" to "C" requirements.

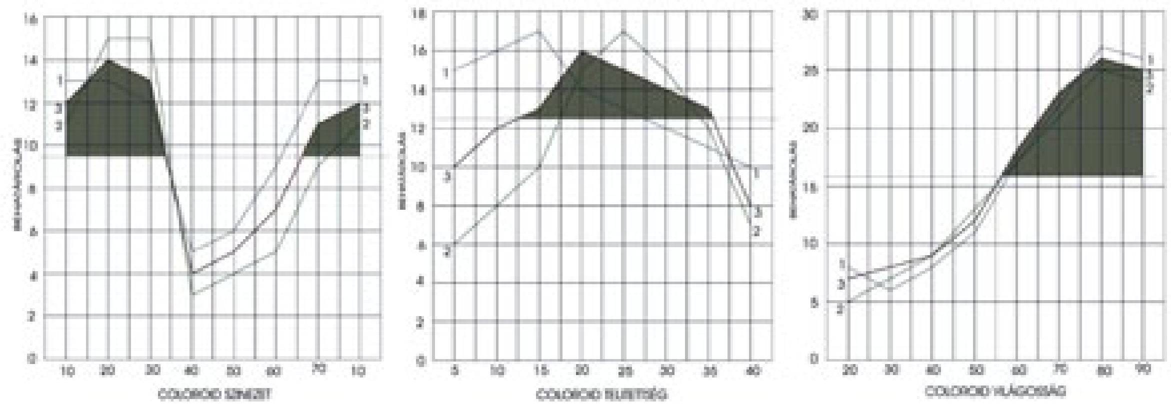

Fig. 10 Colour choice based upon the results of colour limitation recommended for the facade of the dwelling at the address of 5. Orszaghaz St.

$$D^S \quad y = 8.45 + 9.18x - 3.05x^2 + 0.35x^3 - 0.01x^4 \qquad (11)$$
$$D^V \quad y = 15.13 - 9.94x + 3.05x^2 - 0.17x^3 - 0.01x^4 \qquad (12)$$

When deciding on the colour scheme of the facades, in addition to the criteria above, the specific sample facade, as well as the other facades around it, needs to be considered in terms of surface ratios, sunniness (the strength, time and duration of sunshine enjoyed by the facade on various days of the year.) and functions. (For what purpose is the building behind the façade used: i.e. dwelling, restaurant, office, etc.).

Colours enable us to assess a large surface visually as smaller than its real size, or vice versa, t assess a small surface as larger. For a balanced visual impression, the street often requires a colou modification, by changing the visual sizes of the facades in view. (A case in point is when th overwhelming effect of a large façade among smaller ones can be mitigated by the appropriat colouring). A graph of emphasis helps the designer with the analysis of the differences in dimensior **[23]**. The straight lines in Fig. 8 marked as „H" show the average of the surface area sizes of the lin of facades shown above the actual facade. The deviations upwards or downwards of the line sho the average difference of the surface area in positive or negative direction. On Fig. 8 the uppe graphs depict the visual emphasis of two facade lines in Tancsics street. The lower one is linked t the visual emphasis graph of our specific building. The curves marked with „A" in Fig 9. represen the colours with hues, saturations and lightness, magnifying the building's significance. The curve are described by equations (13), (14) and (15).

$$A^H \quad y = 27.0 - 42.66x + 35.54x^2 - 11.19x^3 + 1.46x^4 - 0.07x^5 \qquad (13)$$
$$A^S \quad y = 2.39 + 3.37x - 2.26x^2 + 0.68x^3 - 0.05x^4 \qquad (14)$$
$$A^V \quad y = 0.59 + 9.84x - 5.63x^2 + 1.23x^3 - 0.08x^4 \qquad (15)$$

Red, orange and yellow colours become vibrant in sunshine, while blue and green looks better i the shade, therefore the orientation of the facade is important [23,24]. Our specific building is facin south-west, therefore during most of the day, with the exception of the early morning and lat evening hours, the facade is exposed to sunshine. In Fig. 9 lines marked with „B" illustrate which c the colours are preferable in the design of those picked out from the set colours, identified by th Coloroid coordinates for different hue, saturation and lightness and described by equations (16), (17 and (18).

$$B^H \quad y = -25.77 + 55.62x - 22.54x^2 + 3.32x^3 - 0.16x^4 \qquad (16)$$
$$B^S \quad y = 17.34 - 20.30x + 10.02x^2 - 1.64x^3 + 0.09x^4 \qquad (17)$$
$$B^V \quad y = 0.018 - 1.65x + 0.61x^2 + 0.10x^3 - 0.01x^4 \qquad (18)$$

The choice of colour also depends on the function of the building [23,25]. Warm colours ar more suitable for expressing dynamic functions. The decrease of their saturation results in reduction of their dynamism. The colour lightness affects the intensity of function expression mor strongly than do changes of differences in colour saturations. The expression of the function i usually not achieved by one single colour, rather a collection of interlinked colours. The specifi building is a dwelling unit. The lines marked with „C" in Fig.9 depict the colour requirements of dwelling, as a function described by equations (19), (20) and (21)

$$C^H \quad y = 6.69 + 15.76x - 9.25x^2 + 1.66x^3 - 0.09x^4 \qquad (19)$$
$$C^S \quad y = 6.09 - 2.31x + 4.05x^2 - 0.82x^3 + 0.04x^4 \qquad (20)$$
$$C^V \quad y = 14.88 - 13.19x + 7.53x^2 - 1.22x^3 + 0.06x^4 \qquad (21)$$

The average of the colour choices, selected by the three criteria of colour limitation can be deduce from the curves marked „D" of Fig. 9 described by equations (22), (23) and (24).

$$D^H \quad y = -12.79 + 38.54x - 16.45x^2 + 2.50x^3 - 0.13x^4 \qquad (22)$$
$$D^S \quad y = 11.64 - 10.25x + 5.63x^2 - 0.89x^3 + 0.04x^4 \qquad (23)$$
$$D^V \quad y = 2.80 + 2.91x - 0.98x^2 + 0.32x^3 - 0.03x^4 \qquad (24)$$

The lines marked with „A", „B" and „C" in Fig. 10 depict the results of the procedure of colou limitation. Lines marked with „A" show the Coloroid regions of hue, saturation and lightness of th recommended Coloroid colours, which are based upon the preference of contemporary persons a well as on the early colours and the architectural style of the building. The curves are described i equations (25), (26) and (27).

$$A^H \quad y = 4.50 + 12.67x - 4.38x^2 - 0.06x^3 + 0.15x^4 - 0.01x^5 \qquad (25)$$
$$A^S \quad y = 9.07 + 8.53x - 3.13x^2 + 0.41x^3 - 0.02x^4 \qquad (26)$$
$$A^V \quad y = 5.75 + 0.66x - 11.07x^2 + 0.91x^3 - 0.17x^4 + 0.01x^5 \qquad (27)$$

The curves marked with „B" show Coloroid hue, saturation and lightness regions of the colour proposed on the ground of size, sunniness and function of the building. Their descriptions are i equations (28), (29) and (30).

$$B^H \quad y = -14.00 + 37.09x - 14.97x^2 + 1.87x^3 - 0.02x^4 - 0.01x^5 \qquad (28)$$
$$B^S \quad y = 5.75 + 0.67x - 1.07x^2 + 0.91x^3 - 0.17x^4 + 0.01x^5 \qquad (29)$$
$$B^V \quad y = 5.25 - 1.88x + 2.18x^2 - 0.58x^3 + 0.09x^4 - 0.01x^5 \qquad (30)$$

The curves marked with „C" summarize the colours recommended for the planner, based on th results of the colour limitation process and described by equations (31), (32) and (33).
The darkened areas of the diagrams mark the colour regions of colours with suitable Coloroid hu Coloroid saturation and Coloroid lightness, recommended to the planner. The diagram shows selection of warm, mid-saturated and bright colours, from which the colour should be selecte suitable for the specific facade. The selection can be helped by the mathematical equations (31), (32 and (33).

$$C^H \quad y = -5.75 + 27.50x - 11.29x^2 + 1.38x^3 + 0.01x^4 - 0.01x^5 \qquad (31)$$
$$C^S \quad y = 15.00 - 11.02x + 8.00x^2 - 2.14x^3 + 0.25x^4 - 0.01x^5 \qquad (32)$$
$$C^V \quad y = -2.00 + 17.04x - 10.67x^2 + 2.94x^3 - 0.33x^4 + 0.01x^5 \qquad (33)$$

The collated information from the statistical data of judgements (y) of the experimental subjects (x) was transferred into graphical form (dotted line). To these graphical data, one by one, a best fitting curve (solid line) was calculated, by using a different polynomial of 5 degrees in each case. For all calculations, in this process, the "Mathematica" package was used.

The second step of the colourdynamical planning; the creation of the harmonic colour collection

Within the defined limits, the number of colours is huge, therefore a high number of colou collections can be created from it. These all satisfy the criteria of the colour requirements of th edifice. The colour limitation marks the colours with Coloroid coordinates. These coordinates ar suitable to give a numerical value to the harmonic relations.

Experience shows that the size of intervals between saturations and lightness of the colours in th compositions influences the harmony content of the compositions. [27, 28] The differences i lightness and saturation of the colour pairs selected for the facade have a significant effect on th facade's harmonic appearance. The harmony content of the of colour sets with different saturatio marked by an interval, is influenced by the colour set's hue and lightness [26, 27].

In a cityscape, for the purpose of consonant colour formation, considering the facades and facade groups' hues, the most suitable combinations are primarily the monochromic, dichromic or trichromic harmonic combinations. The colours of the monochromic harmonies have identical

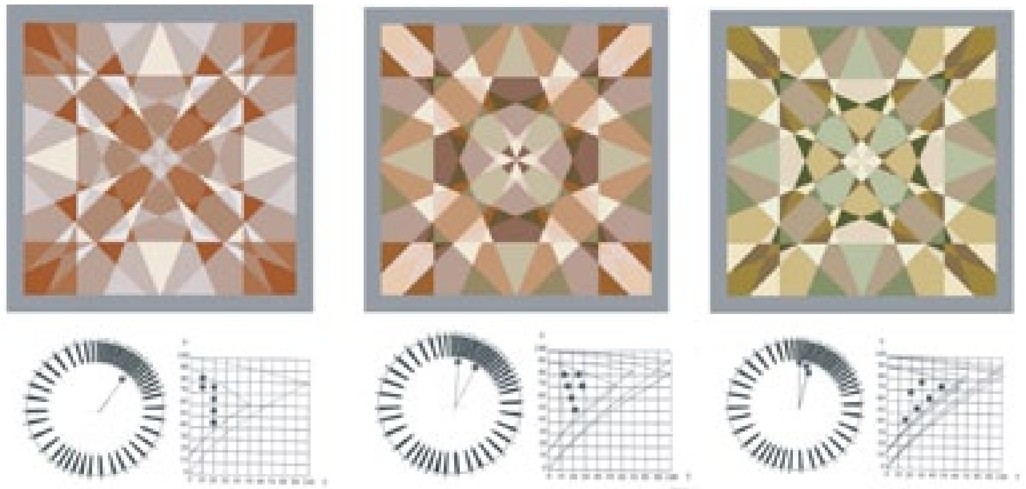

Fig 11 The locations of the colours in the Coloroid system, recommended for the compositions and colour selections of the face of the building at the address of 5. Orszaghaz St, resulting from the colour limitation exercise. The round areas in the diagrams refer to hues, the square areas to saturation and lightness of the colours. The colours of compositions A form monadic, of B diadic and of C triadic harmony groups.

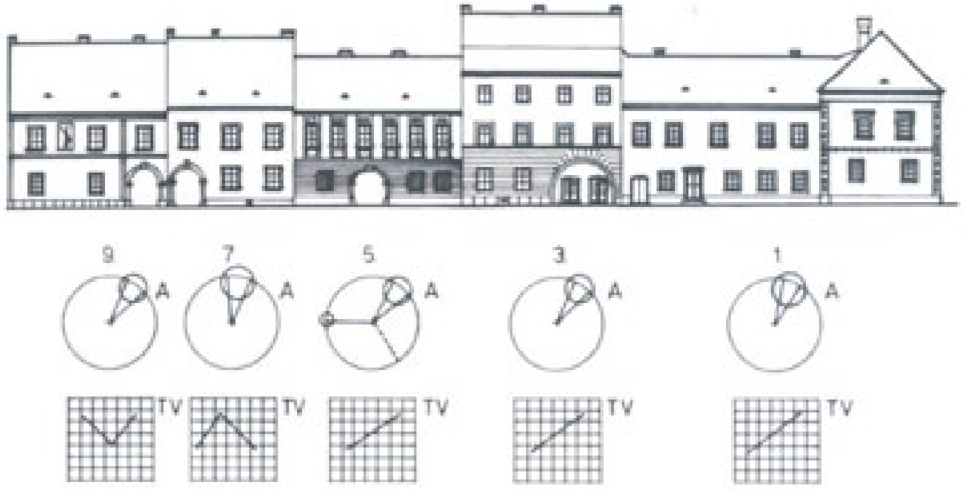

Fig. 12 The harmony order of the line of facades in Fortuna St.

Coloroid hues and in the Coloroid system they sit on the same colour plane (on the intersection of th Coloroid axis). The numerical Coloroid coordinates marking of their saturation and lightness, forı arithmetic or geometric progressions. This rule is applicable to the dichromic and trichromi harmonies as well [28,29].

Monochromic harmonies usually carry a pronounced emotional message. This message is set by th emotional content, associated with the common hue of the individual members of their harmony. Th message is refined by the characteristic order between the saturation and the brightness of th colours. This order presents itself in the form of monotonous scales of saturation and lightness, in th colour arrangement of the frontal face. The colours of the dichromatic harmonies are located on tw different colour planes of the Coloroid. When the colour scheme of the facade is designed, it advantageous to choose these two planes with only a small angular inclination between them. Th trichromatic harmonies are versatile, but their content of mood is not so obvious. Those colour come from three different hues. In a cityscape design it is advantageous, when in the Coloroi domain the planes of the hues deviate only by a small angle. Fig. 11 depicts monochromatic (A dichromatic (B) and trichromatic (C) harmony collections. Fig. 12 shows the harmony scal recommended for a facade composition [30 to 32].

4.3 The third step in the colourdynamical planning; colour selection.

As the last step in planning, the designer selects colours from the recommended colour sets, fc the various elements of the facade, such as wall, surface parts, plinth, window frame etc. He can g help for this task from the diagrams of Fig.13. These diagrams summarize the results of lon observations as well as theoretical investigations. The architectural elements, decorative parts, plintl pillars and doors are related in various ways to each other, as well as to the wall surfaces. Thes relations are characterised by their functions as well as their aesthetic purpose. Streets without character can gain some meaningful feelings as soon as the colours of window frames and windo receive the right relations with those of the walls. The illustration depicts some of the architectur elements' relations to the wall surfaces, expressed in Coloroid hue, saturation and lightness conten The diagram presents the case of the advantage of having the colours of windows, door frames, othe parts and plinths in a colour similar to that of the wall, but with a substantially different saturatio and lightness. It is advantageous to have such colours for the doors, windows opening wings that ar different in hue from those of the wall colour [23].

Depending on the richness of the architecture, the colours of the walls or those of other parts ar more characteristic of the facade. In some cases, particularly in narrow streets, the viewing angle c the facade is the deciding factor for the importance of the colour information carried by a certai wall section or the wall as a whole. The visual significance of the colour of the wall is higher tha that of a section, provided that the viewing angle of the facade is not lower by 30^0, than the optimur and the relief decoration does not exceed 8 cm. Fig. 14 depicts the viewing angle to the facade, fro optimal viewing position [23]. Finally, each of the coordinated colour drawings has to be prepare (Fig. 15, Table 1) for the facades with the coloured pictures of the facade complex of the whole cit (Fig.16).

1. Results

The principal stages of this method, described in the paper, are summarised in the following.

1. Three steps, built on one another, are forming the method. In the first step the planner sets the limits of the ranges of the Coloroid colour space, selected for their suitability. The limits are influenced by the size, feature formations, function, location of the building and the occupier personal colour preference. In the next step the planner selects harmonic colour sets from the already limited colour ranges, primarily for the coloured surfaces of the individual buildings, following that, he does it for all rows the facades.

The efforts of the planner in the colour limitation is helped by the index numbers signifying the colours in the colour plane, suitable to influence the size of the building, expressing its

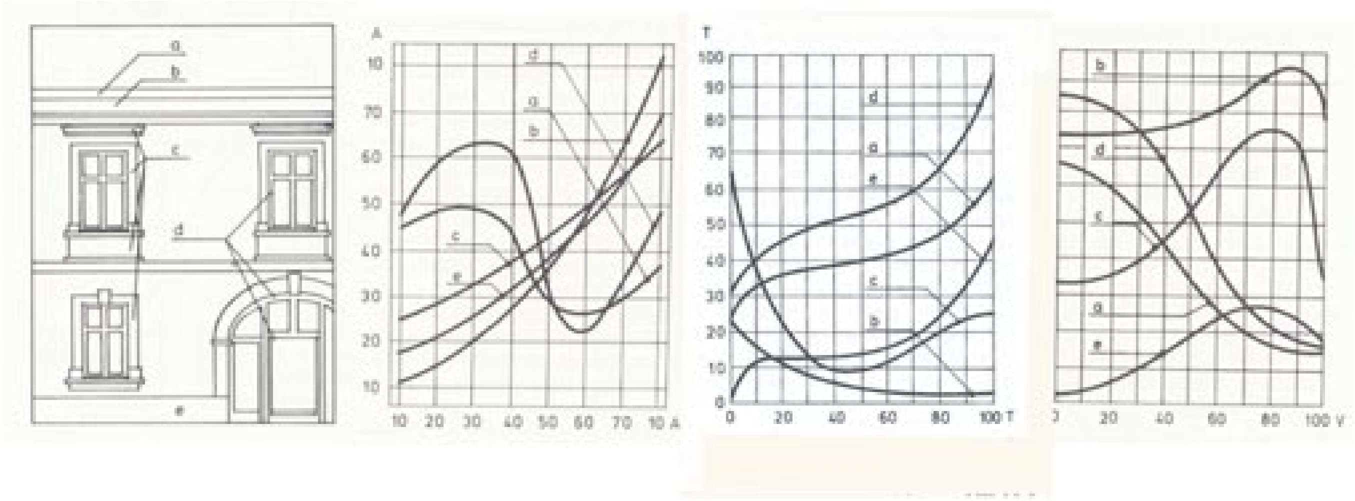

Fig. 13 The curves illustrate, for facades of various wall hues, and colours with advantageous hue (A), saturation (T) and lightness (V). The „a" lines relate to gutters, „b" lines to cornices, „c" lines to building members, „d" lines to doors and windows, and finally „e" lin to plinths. The horizontal axis is calibrated in hues of wall colour for the first diagram, calibrated in saturation of the wall colour in the second one and calibrated in lightness for th third diagram. On the vertical axis the scale is calibrated in hue, in saturation and in lightne of the elements of the frontal face for the first, second and third case accordingly.

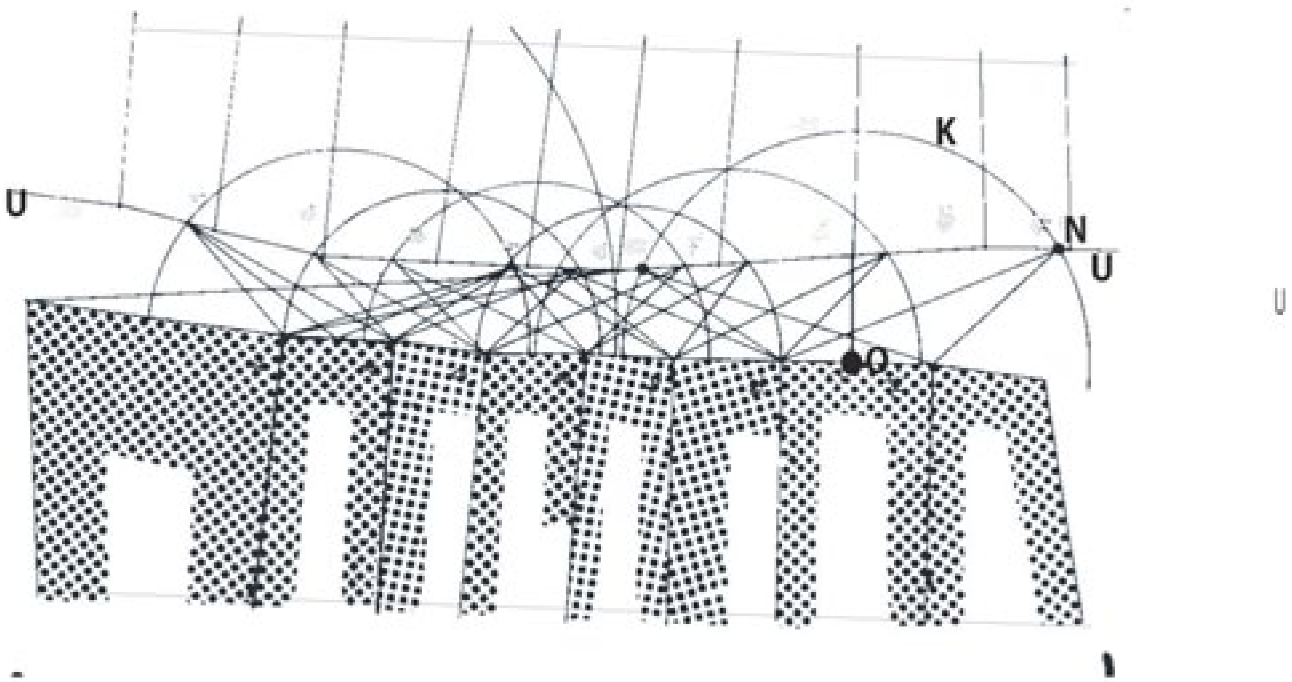

Fig.14 The optimal locations (o) for an optimal view of frontal face of a line of facades. The optimal viewing positions are in the intersections of base line of the frontal faces on one side and the 2 and a half times of the length of the line of frontal faces opposite.

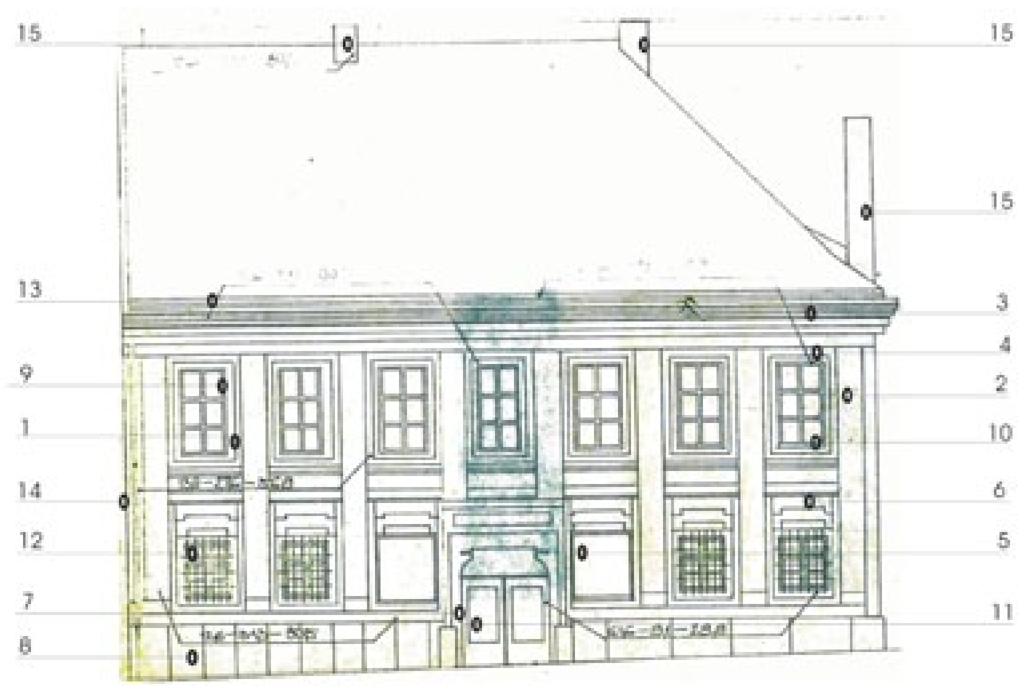

Fig. 15 The marker collection of the edifice at the address of 5. Orszaghaza St. The meaning of the numbers is shown in Table 1.

Fig. 16 Some of the painted frontal faces in the Castle District of Buda, resulted from the Planning process described here.

1. function and satisfying the colour preference of the dweller. These index numbers are the results of a statistical survey, carried out earlier, by using 50,000 experimental subjects. (i.e. Colour preference number recording).
2. Harmonic sets of colours are selected after that, from colours with appropriate Coloroid markings. Coloroid harmony is based on thresholds, meaning that those sets are harmonic whose *"T"* and *"V"* coordinates form arithmetic or geometric progressions. Their *"A"* coordinate is set by the Coloroid colour space.

Due to the nature of the method, the goodness of the environmental colour planning, based on the Coloroid colour system, cannot be judged by exact scientific process, such as statistical surveys. It cannot be compared to other planning methods either.

Failing this it is necessary to find some other methods to make the comparison to other systems.

The Colour Dynamic plan of the Castle District of Buda was founded on the colour dynamic planning method, based on the Coloroid colour system and the facades of the buildings in this District were painted following the plane. A detailed document was made, which included diagrams, photos of the plane and everything facilitated by the plane.

This documentation of the plane was submitted to the „2. Internationaler Farb-Design-Preis" held in Stutgard in 1984. Colour dynamic planes were submitted by Australian, Argentinean, American (USA), Belgian, Canadian, Danish, French, Irish, Japanese, German, Norwegian, Hungarian, Italian, Austrian, Spanish, Swiss and Swedish colour planners. The first prize was awarded to the Colour Dynamic plane of Castle District, using the described planning method, based on the Coloroid Colour system.

In 1986 on the 42nd International Biennale Art Exhibition, whose motto was "Relationship between art and science", a monumental Colorium construction was put on display in the central hall, presenting the inner relations of the Coloroid colour system.

1. Conclusion

The colour planning method, based on the Coloroid system, described in this paper, is based on the results of the science of colourdynamics. It covers the following tasks:

It works out a colour system, approximating, as nearly as possible, an aesthetically uniform colour region. It discovers a link between persons and the coloured environment, one that can be transferred into other situations. It searchis for the complex relations between colour, persons and architectural space. It is working on the problems of colour and space, colour and persons, colour and form, colour and function, as well as colour and lighting. It is finding ways to compensate harmful environmental impacts by colours and deciding on the content levels of the concept of colour harmony. By establishing such links in colour compositions, derived from previously discovered connections, decides which can be used in practice. It finds the most effective method for colour planning by searching for the most effective way to apply the discovered results in practice, in relation to colour, people and environment. Finally it draws conclusions from the experience of the already finalized colour plans [23,29].

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			COLOROID			CIELAB		
Surface	Material	Colour	A	T	V	L	a	b
Wall	Plaster	Mineral green	11	15	70	75.45	.3.51	16.70
Surface part	Plaster	Cimoli	13	5	87	89.72	0.03	3.71
Ledge	Plaster	Cimoli	13	5	87	89.72	0.03	3.71
Window frame	Plaster	Cimoli	13	5	87	89.72	0.03	3.71
Blind window	Plaster	Amber colour	13	20	70	75.45	0.15	22.46
Feszton. mező	Plaster	Mineral green	11	15	70	75.45	.3.51	16.70
Gate posts	Send stone	Sepia	13	15	60	66.52	0.14	20.76
Pedestal	Send stone	Sepia	13	15	60	66.52	0.14	20.76
Window-case	Timber	Malachite green	72	10	40	46.97	27.93	30.06
Window.	Timber	Alum white	11	3	90	92.13	0.50	2.17
Gate	Timber	Warm brown	13	10	40	46.97	0.16	26.34
Window lattice	Iron	Malachite green	72	10	40	46.97	27.93	30.06
Guttering	Sheet iron	Malachite green	72	10	40	46.97	27.93	30.06
Downpipe	Sheet iron	Malachite green	72	10	40	46.97	27.93	30.06
Chimnney	Plaster	Cimoli	13	5	87	89.72	0.03	3.71

Table1 Colours designed for the frontal face of the building at the address of 5. Országház St.