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Identification of spatial features that may support the integration of students with autism spectrum disorder in primary schools: case studies

Abstract

The number of students on the autism spectrum in mainstream schools is increasing. These students may require therapeutic support and appropriate adjustments to the school environment. The aim of this study is to identify spatial features that may affect the functioning of students on the autism spectrum in primary schools.

A literature review was conducted to identify spatial features that may positively influence students on the spectrum. Five schools within the Danish education system were selected for our case studies. This system is characterized by a high inclusion rate of individuals with autism into special, non-integrative classes in mainstream primary schools. The selection criteria for the facilities were based on data from the international report by the European Agency for Special Needs and Inclusive Education.

The case study of five selected Danish primary schools identifies spatial features that can support the integration of students on the autism spectrum in mainstream schools. The selected designs implemented rules, sequencing with consideration of the physical properties of zones, and spatial divisions for social activities.

Key words: autism, architecture, design

Introduction

The built environment exerts a dual influence on individuals, with both positive and negative effects, a phenomenon particularly pronounced in neurodivergent populations, including individuals with autism spectrum disorder. Environmental factors have the potential to either exacerbate the frequency of maladaptive behaviours or attenuate them. Sensory processing dysfunctions may significantly hinder a child's capacity to participate in daily activities such as learning, play, and social interaction. Consequently,

a well-designed, supportive school environment – encompassing both its physical and social dimensions – should be meticulously tailored to foster the holistic development and well-being of every student (Schaffer 2006).

The aim of the study is to identify selected spatial characteristics, derived from a review of the literature, that support the functioning of individuals with autism. In the studied schools, students attend special classes but are encouraged to participate in broader school activities. Spatial features were selected according to the literature research. In the hosting schools, students attend separated special classes but are encouraged to participate in school life. Students have the opportunity to be educated in general classes by attending certain lessons or workshops for a specified number of hours per week and during extracurricular activities organized in shared spaces.

In the selected schools, most of the spatial features described in the literature can be identified. To better understand

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the needs of students with autism, the authors aimed to extract lessons from exemplary school environments and apply them in other contexts. Differences are observed in the methods of implementation and the extent of their application. In the educational clusters, there are spatial divisions where students can spend time according to their needs for social interaction; there are multiple spaces dedicated to restrain oneself and for calming down and for spending time in smaller or larger groups. Not all schools have a clear division into separate codes for specific activity zones.

Methods

The study involves analysing case studies of facilities using criteria selected by experts. The research scope includes a review of literature to identify environmental components that may support the functioning of individuals with autism in schools, as well as an attempt to identify these components in the educational clusters of five selected Danish schools with special classes for students on the autism spectrum. Selected research techniques were applied, such as document analysis, description, explanation, and interpretation (Niezabitowska 2014).

Effective intervention for a child with autism spectrum disorder should always include both social (supportive) and spatial (architectural) dimensions. Consequently, the selection of facilities for the study was based on findings from the European Agency for Special Needs and Inclusive Education report, which highlights that Danish schools have the highest rate of enrolling students with special needs in separate, non-inclusive classes within mainstream schools (Københavns Kommune 2023), and all selected primary schools were rebuilt or expanded after 2018.

Research background

According to information published by the Social-og Boligstyrelsen; 2.5% of Danish school children from grades 0 to 9¹ have been diagnosed with autism spectrum disorder, 12% of vulnerable students, and 1.4% of non-vulnerable students. Research findings published in 2023 indicate that 17% of diagnoses in the age group 0–17 years involve both autism spectrum disorder and developmental disability, and 83% involve only autism spectrum disorder. These data come from hospital diagnoses, so the number of individuals with autism in schools may be higher (Social-og Boligstyrelsen 2023).

The Danish parliament passed the Inclusive Education Act for students on the autism spectrum in 2012. In the 2008/2009 school year, 14.3% of all primary school students received special education. Niels Egelund, along with a team of education researchers, consulted on changes related to the inclusion of students with special needs in mainstream schools, setting an inclusion rate of 96%.

This benchmark was aligned with the inclusive policies of Sweden and Norway and the country's economic situation following the 2008 crisis (Ministeriet for Børn og Undervisning 2013). In 2021, a report on student experiences of inclusion was commissioned by the Children's Education Council. According to the report, more than half of the students felt that teachers devoted more time to some students than others, 64% of students did not speak during lessons, and 32% of students considered changing classes or schools (Rådet for Børns Læring 2021). The inclusion rate has returned to the pre-2012 level, and the authorities no longer maintain such a strict policy. The concept of inclusion is being replaced by a hybrid approach called "mellemløber", which combines methods from special and general education (Weirsøe 2021).

Inclusive education is a crucial element shaping Danish schools (European Agency for Special Needs and Inclusive Education 2020/2021). Models are being sought to include some students with autism/ADHD into mainstream schools. The way inclusion is implemented in mainstream schools can vary depending on the student's needs. The aim is to strengthen the individual student's ability to navigate and function in social communities and contexts. Over time, this may lead to full inclusion in a regular class (Long, Guo 2023).

State of research

The developmental presentation and diagnosis of children with autism are based on the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5), with the European equivalent being the International Classification of Diseases 11th Revision (ICD-11). The ICD-11 manual describes the diagnosis of individuals with autism under the code 6A02.

Autism is a neurodevelopmental disorder characterized by a spectrum of manifestations. The term "spectrum" refers to the wide range of difficulties, which vary significantly from person to person. These include profound challenges in daily functioning as well as subtle differences in environmental perception (Lord et al. 2020). Comorbid conditions affect 70–80% of individuals on the autism spectrum and may include sensory difficulties, ADHD, anxiety disorders, mood disorders, and epilepsy (Simonoff et al. 2008).

Individuals on the spectrum can be expressed as hypersensitivity or hyposensitivity to sensory stimuli. This condition can manifest itself through atypical interest in sensory aspects of the environment, such as negative reactions to certain sounds or textures, or visual fascination with light or movement. An individual with autism may experience extreme anxiety with small changes in their environment or daily schedule. Individuals with autism often have fixed interests of unusual intensity, adhere inflexibly to routines, or exhibit ritualized patterns of behaviour (World Health Organization 2022). Fred Volkmar and Brian Reichow, a specialist in neurodevelopmental disorders and co-author of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV) diagnostic manual published by the American Psychiatric Association (APA), described effective therapeutic strategies for individuals

¹ In Denmark, the mandatory curriculum is implemented within primary and lower secondary schools, covering students aged 5 to 15. For individuals with autism, this framework can be adapted based on their individual needs.

on the autism spectrum. These strategies include recommendations for the therapeutic environment for individuals who have problems with attention, sequencing, organization, and understanding social situations. Volkmar and Reichow particularly emphasizes learning in context, using visual aids, schedules, and structured work environments (Volkmar, Reichow 2013).

To determine the spatial features that may affect the functioning of children with autism, a scoping review was conducted using the method developed by Hilary Arksey and Lisa O'Malley (Arksey, O'Malley 2005). Databases such as Web of Science, Scopus, and Science Direct were searched. A total of 2033 articles related to the phrase "autism, design, environment" were found. The scope of the search was narrowed by applying additional inclusion criteria. Thirteen peer-reviewed articles containing theories on the design of primary schools were selected for analysis. The results of the scoping review were structured, and the selected spatial features were assigned to three groups: rules, activities, sequences.

Spatial sequencing was described in the context of utilizing the affinity of individuals with autism for routine and predictability. Sequencing requires that areas be organized logically, based on typical planned and stable use of space. Implementing these assumptions into space can be achieved by creating an identification system for zones, which can help with spatial orientation and limit the occurrence of undesirable behaviours (Mostafa 2018; Irish 2022; McAllister, Sloan 2016; Kanakri et al. 2017).

Activity zones are essential for individuals with autism, as they provide clear associations between specific areas and designated activity. They divide the space into areas such as quiet zones for solitude, observation areas, and integration zones for small groups in quiet or noisy areas. Spatial divisions do not have to be strongly demarcated but can be defined by furniture arrangement, floor covering differences, level changes, and lighting variations (Mostafa 2018; Irish 2022; McAllister, Sloan 2016; Kanakri et al. 2017).

Key rules in designing for individuals with autism involves the use of patterns and solutions that minimize sensory overload. This includes implementing colour schemes, reducing reverberation, preventing glare, and avoiding disruptive lighting effects (Nair et al. 2022; Shareef, Farivar-sadri 2018).

Appropriately designed spaces can support therapeutic goals in line with the concept of a therapeutic environment and promote the physical and mental health of individuals within them. Spaces can contribute to sensory overload, feelings of confusion, disarray, stress, or hyperactivity. As evidenced by the literature review, undesirable effects of using school spaces can be minimized.

Case studies

The case study involves identifying the features of shared spaces within educational clusters in five schools in Copenhagen. The selected schools are mainstream institutions where education for students on the autism spectrum is organized in special classes.

In Denmark, each municipality maintains a register of facilities that support special education, categorized by type of disability. The chosen schools are listed by the Copenhagen Municipality as institutions accommodating students with autism. Additionally, children attending these schools can benefit from the municipality's program for organizing children's leisure time, known as KKFO – Københavns Kommunes Fritidsordning.

Depending on the internal organization of the institution, activities are conducted either inclusively or within the framework of special education. During extracurricular activities, children have the opportunity to use the school's infrastructure and become familiar with it (Københavns Kommune 2024).

Rosenvængets Skole

The school is located in the Østerbro district, designed by architects Nøhr and Sigsgaard and Sweco, with landscape architecture by LYTT and Kragh and Berglund. For the new school, which was completed in 2023, two buildings with a total area of 4,900 m² were adapted, with a budget of 120 million DKK. The school accommodates 120 students with normal abilities but various functional disorders within the autism spectrum and ADHD (Nøhr & Sigsgaard 2024; Rosenvængets Skole 2024).

Special classes are organized around a common space (Fig. 1A), where clearly designated areas serve fixed and unchanging functions. The divisions of activities exhibit significant spatial variability. There are sheltered zones for escape and calming down (Fig. 1P), partially sheltered zones, areas for spending time in small groups in semi-open spaces (Fig. 1K), table zones (Fig. 1F), as well as rest zones with loungers. Activity zones are clearly separated by solid or semi-transparent walls. Background colors are of low intensity, with activity zones marked by higher intensity colours. Matte, non-reflective materials are used. The space is bright, illuminated by natural light.

Dyvekeskolen

The school is located in Amager and was designed by SWECO. It was renovated in 2015, with an investment of 118 million DKK covering 10,640 m². The school has 667 students, with 32 in special classes for category 3 for kids with autism spectrum from zero to 9th grade, with plans to expand the educational offer for students with autism to 72 students (Sweco 2024; Dyvekeskolen 2024).

The spatial layout clearly separates quiet and noisy integration zones. Classrooms are organized along corridors (Fig. 1B), which have been widened in some areas to create common spaces for small group activities (Fig. 1G). Corridors are colour-coded for identification. Larger group activity areas are located in common spaces accessible to students from all educational clusters along the corridors (Fig. 1L). The school uses light colours with low intensity. Spaces in front of classrooms are naturally lit through skylights above integration zones (Fig. 1G). Non-reflective, sound-absorbing materials are used. The spatial design prevents changes in arrangement.

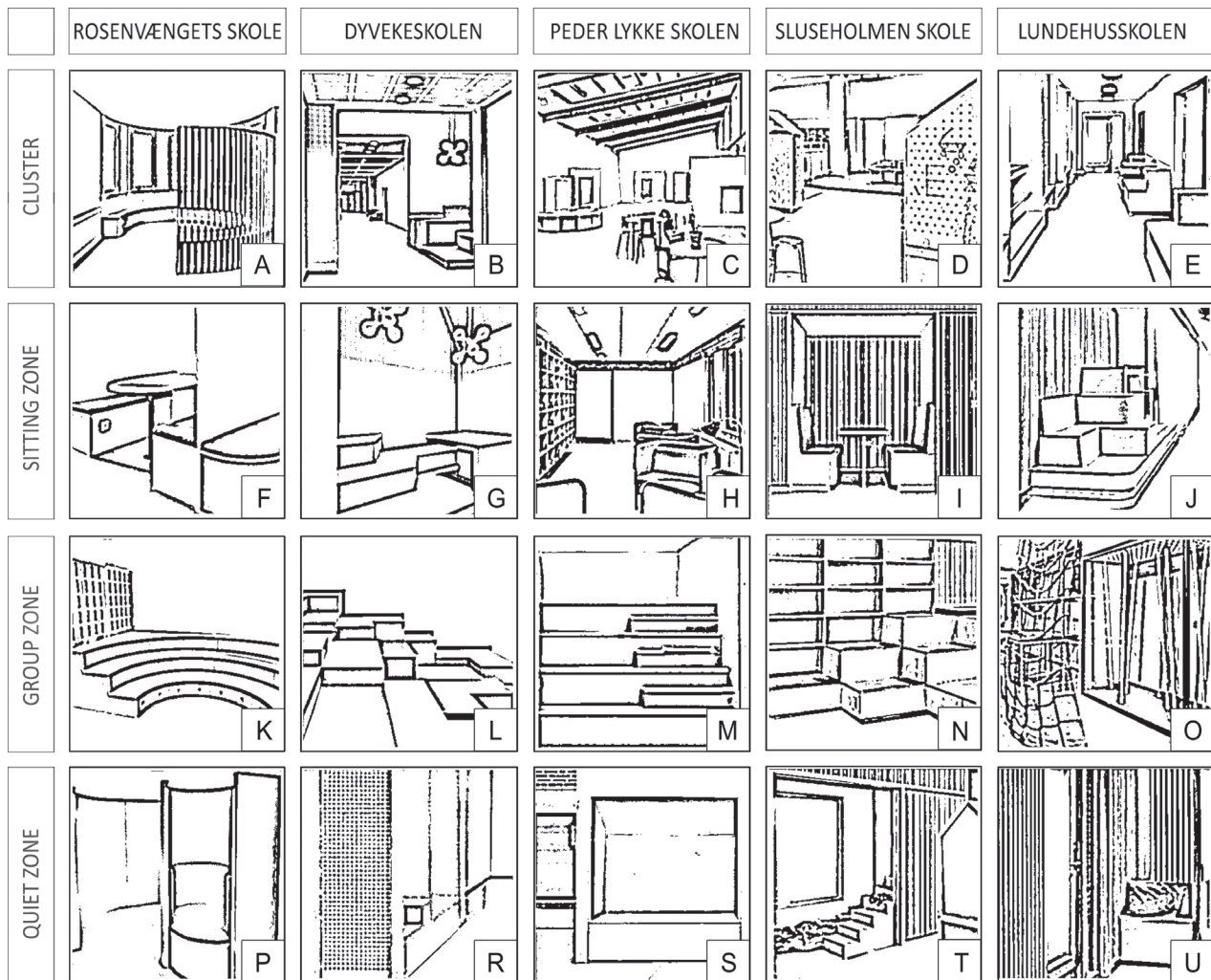


Fig 1. Common areas in educational clusters of mainstream schools with classes for individuals on the autism spectrum (elaborated by K. Mentel based on: Nøhr & Sigsgaard 2024; Sweco 2024; JJW ARKITEKTER 2023; 2024; Sweco 2021)

II. 1. Części wspólne w klastrach edukacyjnych szkół ogólnodostępnych z klasami dla osób ze spektrum autyzmu (oprac. K. Mentel na podstawie Nøhr & Sigsgaard 2024; Sweco 2024; JJW ARKITEKTER 2023; 2024; Sweco 2021)

Peder Lykke Skole

The school is located in the Amager district and was built in 1974, renovated by EKJ in cooperation with Nøhr & Sigsgaard and Sweco and LYTT for landscape architecture. The school, completed in 2020, involved the renovation of 12,000 m², with a new building of 2,000 m² and a budget of 180 million DKK. The school has 695 students, including 26 with autism spectrum and ADHD, with plans to accept more students with special needs (JJW ARKITEKTER 2023; Peder Lykke Skole 2024).

The school's functional layout resembles a small school town. One design objective was to ensure uniform natural lighting. Therefore, glazed walls open to the surrounding greenery, and where this was not possible, glass roofs were used. Classrooms adjoin common areas serving as indoor covered courtyards (Fig. 1C). Various activity zones are designed within the clusters. Students can spend time in quiet, isolated spaces to avoid sensory overload. Quiet areas are designed in niches of different sizes (Fig. 1S). The common area features mega-furniture providing partially sheltered

spaces for small group integration (Fig. 1M). Some furniture is mobile. There is limited flexibility in space arrangement and color codes are used to define zones.

Sluseholmen Skole

The school is located between the Sjællandsbroen and Ved Stigbordene districts. It was completed in 2024, designed by JJW ARKITEKTER A/S, with landscape architecture by Thing Brandt Landskab ApS. The school, designed for 840 students, has an area of about 12,500 m². The program includes special classes, KKFO, a recreational club, a sports hall, and a culinary school (JJW ARKITEKTER 2024; Sluseholmen Skole og Fritid 2024).

The building has a terraced layout, with educational spaces blending with the exterior. Educational clusters are arranged around three main atriums, dividing the school into smaller sections. Students can move between indoor educational spaces and school gardens connected to water features. Common areas are divided into activity zones tailored to student age (Fig. 1D). Areas for small group ac-

tivities are designed with various types of tables in open spaces or niches (Fig. 1I, N). Quiet zones are designed in different types of niches, some providing complete isolation (Fig. 1T). Natural materials and corresponding color codes are used. Finishing materials reduce glare and reverb effect.

Lundehusskole

The school is located in the Nørrebro-Bispebjerg district and was built in 1943. It was renovated in 2020 by KANT Arkitekter and Nøhr og Sigsgaard, with landscape designed by GBH. In 2020, artist Malene Back received the Colour Award for her work on the school's color scheme. The school area expanded from 10,230 m² to 17,500 m² after the renovation, with a budget of 180 million DKK. The school has 523 students, with special classes for 6–10 students with autism. Ninety students with autism spectrum and ADHD attend the special classes, with plans to accept more students with special educational needs (Sweco 2021; Lundehusskolen 2024).

A designated area for special classes was created. Common spaces within all clusters follow the same design principles. Activity zones within clusters are clearly separated into quiet and noisy activities. Various free-time areas are designed, such as niches with acoustic panels. Children can use these spaces individually (Fig. 1U) or in small groups (Fig. 1J). A consistent color-coded system aids in navigation and area recognition. Most zones, including educational clusters, have matte floor finishes to minimize light reflection and aid concentration. Walls are covered with materials that reduce echo, improving acoustic comfort and reducing noise.

Results

In the selected schools, a similar approach to shaping common spaces has been observed. The designed activity zones cater to the diverse needs of students during their free time. The schools feature highly escape zones for solitude and calm. Small niches with opaque partitions provide spaces for hiding and calming down (Fig. 1P). There are areas for spending time with a friend and participating in group and school community activities, characterized by higher sensory stimulation. These spaces are constructed in fixed arrangements (Figs. 1F, G, J). In some schools, designated seating areas with various types of tables are set apart from the general movement space (Figs. 1C, H). The design of the spaces indicates a need for many intermediate forms, such as when a child wants to be alone but cannot be completely out of sight for safety reasons. Hence, compartmentalization is introduced through semi-transparent partitions that shield but do not isolate (Fig. 1A). Window niches provide seating areas where one can retreat while still maintaining contact with social situations inside or focus on the view outside (Fig. 1E). Besides classrooms, play zones are designed for use alone or in small groups (Figs. 1D, O).

In educational clusters, spatial sequencing is implemented as a code in common spaces in terms of materials, colours, and furnishings. This characterizes specific activity zones by introducing repetitive physical properties of

the zones or their components. Schools feature recurring elements in activity zones. In Rosenvængets Skole, different colour codes identify areas for small group activities (Fig. 1F) and solitary activities (Fig. 1P). The proportions of space and lighting correlate with the ways of spending free time in Dyvekeskolen (Figs. 1G, L, R). In Sluseholmen Skole and Lundehusskole, spatial sequencing is linked to the design of niches in fixed structures (Figs. 1E, J, T, U). In all selected schools, built-in furniture is designed in common spaces, limiting the possibility of changes (Figs. 1B, I, K, P, U). In Peder Lykke Skolen and Sluseholmen Skole, megafurniture is used, which can be moved (Figs. 1D, M). In common spaces, loud and quiet activity zones alternate. In most cases, there is no clear sensory gradation between them. These zones are part of the common space of educational clusters, with the gaps between them filled with neutral sensory spaces. The congestion of neutral zones, which serve as transitional spaces, decreases proportionally to the number of activity zones introduced.

Attempts have been made to establish clear boundaries for activity areas in the common spaces of the selected schools. Each school implements these boundaries differently. Spatial divisions are not always sharp. In Rosenvængets Skole, clear divisions are marked by built-in furniture, with each zone having a different spatial characteristic. There are table activity zones, isolation zones, step-like arrangements, and rest zones with mattresses shaped to fit. Each has a distinct colour characteristic. The recognition of individual activity areas is not always emphasized by colour but can be highlighted by the spatial layout of the building. In Dyvekeskolen, three corridors with classrooms connect with a transverse one containing loud activity zones. Quiet activity zones are located in skylit areas adjacent to classroom corridors. A similar solution is found in Sluseholmen Skole, where common areas of educational clusters adjoin covered atriums and external terraced gardens. The diverse spatial layout of the building forms the basis for creating characteristic activity zones, complemented by niches in fixed structures and megafurniture. All schools use colours of reduced intensity, following established patterns in the literature. Wall and ceiling finishing materials reduce echo, and matte flooring prevents light reflections. Common spaces in selected schools are evenly lit with natural light, utilizing systems that reduce glare.

Summary

Providing a choice of environments is essential. Every child is unique, and the availability of diverse spaces with varying scales and characteristics (quiet/loud, bright/dim, open/closed, indoors/outdoors) is crucial. Quiet spaces offer opportunities for relaxation, while moderately noisy areas allow children to gradually adapt to external stimuli. Small, enclosed spaces can serve as refuges from sensory overload, whereas open rooms encourage free exploration and interaction.

Natural light, with options for adjustment, supports visual comfort and reduces discomfort caused by light sensitivity. Children with autism often prefer passive participation in group activities, observing peers from a distance.

Designing spaces that enable observation without requiring direct engagement can support their social development and facilitate gradual integration.

Conclusions

The case study analysis of five selected Danish primary schools identifies spatial characteristics that can support the integration of students with autism spectrum disorder in mainstream schools.

The selected designs incorporate principles such as sequencing that considers the physical characteristics of zones and spatial divisions tailored to social activities. Design assumptions for therapeutic environments for individuals on the autism spectrum, identified through literature reviews, are being implemented in contemporary school projects with an inclusive character.

This case study can be considered a pilot study. The results from examining a larger number of buildings may eventually be used to develop specific design guidelines.

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Streszczenie

Identyfikacja cech przestrzeni, które mogą wspomagać integrację uczniów z autyzmem w szkołach podstawowych. Studium przypadków

W szkołach zwiększa się liczba uczniów ze spektrum autyzmu. Uczniowie z autyzmem mogą potrzebować wsparcia terapeutycznego oraz odpowiedniego dostosowania środowiska szkolnego. Celem autorów artykułu była identyfikacja cech przestrzeni, które mogą mieć wpływ na funkcjonowanie uczniów ze spektrum autyzmu w szkole podstawowej.

W trakcie prac, na podstawie badań literatury przedmiotu, określono cechy przestrzeni, które mogą pozytywnie wpływać na uczniów ze spektrum. Do studium przypadków wybrano pięć szkół w duńskim systemie edukacji. Charakteryzuje się on wysokim współczynnikiem włączenia osób z autyzmem do klas specjalnych, nieintegracyjnych w ogólnodostępnych szkołach podstawowych. Kryterium wyboru obiektów zostało określone na podstawie danych międzynarodowego raportu European Agency for Special Needs and Inclusive Education.

Przedstawione studium przypadków pięciu wybranych duńskich szkół podstawowych pozwoliło zidentyfikować cechy przestrzeni, które mogą wspomagać integrację uczniów ze spektrum autyzmu. W wybranych projektach wprowadzono zasady, sekwencjonowanie z uwzględnieniem właściwości fizycznych stref oraz podziały przestrzeni służących różnym rodzajom aktywności społecznej.

Słowa kluczowe: autyzm, architektura, projektowanie

