An aerial photograph of a residential area. The central focus is a two-story yellow building with a red tiled roof. The building has several white-framed windows, a central entrance with a small set of stairs, and a dormer window on the right side. The roof features two white chimneys. To the left, a tall white flagpole stands. The surrounding area includes other buildings with red roofs, green trees, and a paved area with a dark car. The overall scene is bright and sunny.

# Fæstningens Materialgård

Udgivet af Realdania Byg

Fæstningens Materialgård  
The Fortifications Depot

Fæstningens Materialgård  
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# Fæstningens Materialgård

## The Fortifications Depot



Udgivet af Realdania Byg

# Forord

I hjertet af København ligger det fredede anlæg, Fæstningens Materialgård, som en lille oase med en lukket gårdhave med roser og magnolier. Ejendommen ligger på en hjørnegrund mod Frederiksholms Kanal og med Christiansborg, Kongens Bryghus og Det Kongelige Bibliotek som nærmeste naboer. I 2007 købte Realdania Byg Fæstningens Materialgård af Forsvarets Bygnings- & Etablissements-tjeneste. Ejendommen havde på det tidspunkt været i Forsvarets tjeneste i mere end 250 år.

Med overtagelsen ønskede Realdania Byg at give det gamle anlæg nyt liv og formål som et attraktivt erhvervslejemål. Samtidig var der i et samarbejde med Kulturstyrelsen opstået et ønske om at gå nye veje med denne ejendom og bringe den ind i debatten om energi og klima. Fæstningens Materialgård skulle være udgangspunkt for et demonstrationsprojekt, hvis hovedformål var at vise, hvordan man kan tænke energirenovering i fredede bygninger.

Fæstningens Materialgård blev valgt fordi de fire bygningskroppes variation i både stil og konstruktion gav et meget bredspektret perspektiv på udfordringen. Anlæggets karakter gav mulighed for at afprøve og undersøge for-

skellige energioptimerende og restaureringstekniske tiltags indpasning i bygninger fra barokken og klassicismen og i konstruktioner som grundmur og bindingsværk. Ydermere havde forsvaret gennem årene flittigt målt husets forbrug af el, vand og varme. Det datamæssige grundlag for projektet var derfor uforligneligt.

Udgivelsen af denne bog markerer afslutningen på restaureringen af bygningsanlægget. Det markerer samtidig også starten på anden fase af projektet 'Energirenovering af fredede bygninger'. Det næste lange stykke tid vil forbruget i bygningerne blive målt for efterfølgende at blive sammenholdt med husets forbrug før restaureringen. Beregninger viser, at man samlet vil spare over 20% CO<sub>2</sub> pr arbejdsplads i forhold til forbruget anno 1990, som er de tal, man arbejder ud fra.

Det, vi allerede nu kan tage med videre, er de erfaringer og resultater, som er gjort i restaureringsprocessen. En af disse er nødvendigheden af at tænke indretning i nye baner. Dette har bl.a. medført, at man har gentænkt hele kompleksets planløsning flere gange. Resultatet er flere skriveborde end først beregnet og dermed en gevinst for både ejer, lejer, miljø og arkitektur.

Fæstningens Materialgård er et demonstrationsprojekt – ikke en standardløsning. For der findes ikke standardløsninger, når det drejer sig om fredede bygninger. Fæstningens Materialgård står nu som inspiration og eksempel på, at det kan lade sig gøre at tænke energirenovering og fredede bygninger sammen endda med uventede gevinster til følge.

Realdania Byg,  
juni 2012



# Foreword

In the heart of Copenhagen, the Fortifications Depot encloses a little oasis with roses and magnolias. The complex, which has heritage status, stands along Frederiksholms Kanal, with Christiansborg Palace, the King's Brewery, and the Royal Library as its nearest neighbors. In 2007, Realdania Byg bought the Fortifications Depot from the Ministry of Defense, which had used the facility for more than 250 years.

Realdania Byg wanted to give this historical complex new life and a new purpose as an attractive rental property. In collaboration with the National Cultural Heritage Agency, the company also wanted to go new ways and make the Fortifications Depot part of the debate on efficient energy and the climate. It was to be a demonstration project, aimed at showing how energy conservation can be applied to heritage buildings.

The Fortifications Depot was chosen for this purpose because of its distinctive and diverse character, which provided a very broad perspective of the problems involved. The suitability of different measures for optimizing energy consumption and restoration techniques could be studied and tested in both Baroque and clas-

sicist buildings, in both brick and half-timbered structures. Over the years, the Ministry of Defense had moreover kept records of the buildings' energy, water, and heat consumption, providing an incomparable wealth of data for the project.

The publication of this book marks the end of the process of restoring the Fortifications Depot. It also marks the start of the second phase of the project "Energy Conservation in Historical Buildings." For an extended period, energy consumption will be measured and the results will be compared with figures from before restoration, taking 1990 as the baseline. Calculations show that as a whole, the expected CO<sub>2</sub> reduction is 20 percent per workplace.

What we can use today are the experiences gained from the restoration process. One is the necessity of rethinking how interiors are laid out and used, a process that meant reconsidering the entire complex's floor plans several times. The result is more workplaces than first envisioned – an advantage for the owner, the tenant, the environment, and the architecture.

The Fortifications Depot is a demonstration project, not a standard model, for there are no standard models when it comes to buildings like these. It can serve as inspiration and an example of how energy conservation can be applied to heritage buildings and even bring unexpected benefits.

Realdania Byg,  
June 2012







FÆSTNINGENS MATERIALGAARD

# Fæstningen København og dens materialgårde

Chr. IV var kun 21 år, da han gav sig i kast med at omdanne og forstærke hovedstadens svage, utidssvarende befæstning. Fra 1598 til 1606 blev flådehavnen med Tøjhuset og Proviantgården anlagt. Næste etape påbegyndtes i 1607, hvor middelalderbyens gamle grave og mure blev omdannet til et system af bredere og dybere grave og jordvolde med små bastioner. I 1618 blev Christianshavn grundlagt og befæstet på tilsvarende måde.

I 1642 begyndte arbejdet på den nye Østervold fra middelalderbyen uden om Rosenborg og Nyboder til den tidligere anlagte Sankt Annæ Skanse – efter ombygningen navngivet Citadellet Frederikshavn, eller i daglig tale Kastellet. Det skulle være den største omdannelse af byen og dens befæstning, som Chr. IV udtænkte. Volden var ufærdig ved kongens død i 1648.

Frederik III videreførte arbejdet på Østervold. Selvom volden stadig var ufærdig, da Karl X Gustav i 1658 belejrede byen, modstod den det allersidste svenske stormløb mod byen d. 11. februar 1659. Det var hollandske infanterister ankommet med den hollandsk flåde, der her med stor krigserfaring tilføjede svenskerne det sidste sviende nederlag under stormen på København.

Efter enevældens indførelse i 1660 kom der atter gang i forstærkningen af voldene. Det

# Copenhagen's fortifications and their depots

Christian IV was only 21 years of age when he undertook to transform and reinforce the capital's weak, outdated fortifications. The naval harbor, along with its Arsenal and Provision Yard, was laid out between 1598 and 1606. The next phase was begun in 1607, when the medieval city's old moats and walls were transformed into a system of wider, deeper moats and ramparts with little bastions. In 1618, the Christianshavn quarter was founded and fortified in similar fashion.

In 1642, work began on the new Eastern Ramparts, extending from the medieval city beyond Rosenborg Castle and the Nyboder naval housing complex to the Sankt Annæ Entrenchment, which had been laid out earlier. The reinforced entrenchment was named the Frederikshavn Citadel, called simply the Citadel. This was the most extensive transformation of the city and its fortifications envisioned by Christian IV. The ramparts were still incomplete upon the king's death in 1648.

Frederik III continued work on the Eastern Ramparts. Although they had still not been finished when Sweden's Charles X Gustav besieged Copenhagen in 1658, they did withstand the very last Swedish attack on the city on February 11, 1659. A Dutch fleet carrying well-trained and experienced infantrymen came to

Af /By  
Jens Christian  
Varming

*Modsatte side:  
Kongstanken bag restaureringen af Fæstningens Materialgård har været at genskabe og fremhæve anlæggets karakter.*

*Opposite page:  
The principal goal of restoring the Fortifications Depot was to recreate and highlight the complex's distinctive character.*



vældige jordarbejde, hvortil hundredevis af arbejdere og soldater var udkommanderede, krævede et sted, hvor redskaber og materialer kunne opbevares og sikres mod tyveri. Et sådant sted kaldes en *materialgård* og kan være en enkelt bygning eller et indhegnet område med bygninger, f.eks. magasiner, stalde, vognporte m.m. Fæstningens Materialgård lå da ved Nyboder tæt ved Østervold. Den nævnes i 1658 og i grundtaksten fra 1668. I materialgården var der oplagret sten, kalk, tømmer og planker til brug for arbejdet på fæstningen og dens bygninger, desuden talrige redskaber, hakker, spader og skubkarrer, dvs. hjulbøre i mængde. Da Østervold og Kastellet var fuldført omkring 1665 blev opmærksomheden rettet mod den endnu ret svage Vestervold, hvor der blev arbejdet til 1668. Der blev i de følgende år stadig udført mindre forbedringer af fæstningens side mod det omgivende Sjælland. I hele perioden havde den gamle materialgård ved Nyboder været basis for arbejdet.

I 1681 blev Frederiksholms Kanal anlagt og Frederiksholmskvarteret grundlagt. Et stort areal i den nye bydel blev udlagt til en ny materialgård, som her ville ligge mere bekvemt for fremtidens nyanlæg mod Amager. Den store voldlinje, der omkranser Holmen med syv bastioner og foranliggende envelope blev

Denmark's aid and delivered the Swedes the decisive blow during the storming of Copenhagen.

After the introduction of absolutism in 1660, work was resumed on reinforcing the ramparts. Hundreds of laborers and soldiers were commandeered for the enormous project, which required a place where tools and materials could be stored and secured. These depots could consist of a single building or an enclosed area with warehouses, stables, wagon yards, etc. At the time, the Fortifications Depot (Fæstningens Materialgaard) was located at Nyboder, close to the Eastern Ramparts. It is mentioned in 1658 and in the land tax assessments for 1668. The depot stored stone, lime, timber, and planks to be used on the fortifications and their buildings, in addition to quantities of tools, picks, spades, and wheelbarrows. After work on the Eastern Ramparts and the Citadel had been completed in around 1665, attention shifted to the Western Ramparts, which were still quite weak, where work continued until 1668. Minor improvements were made in the ensuing years to the side of the fortifications facing away from the city. Throughout the period, the old depot at Nyboder served as the base for this work.

When the Frederiksholm quarter was laid out, a canal was dug in 1681 separating it from

*Modsatte side:  
John Huusmanns kobberstik  
til Resens 'Atlas Danicus'  
fra 1677, Det Kongelige  
Bibliotek.*

*Opposite page:  
John Huusmann's  
copperplate engraving in  
Resen's Atlas Danicus,  
1677. Royal Library.*

anlagt i 1685-1692. Forud var volden syd for Christianshavn flyttet – i realiteten helt nyanlagt. Det afspejles i materialgårdens indretning ved, at et stort magasinhus i svært bindingsværk blev opført i 1683. Det var foreløbig den eneste betydelige bygning på grunden, men der må også have været både stalde og vognport. Den dag i dag vidner det lille “Foderknægthus”, Frederiksholms Kanal 28, som er fra 1684, om, at der må have været heste at fodre og dermed stalde på området stort set fra den nye materialgårds anlæggelse. De nye voldanlæg krævede som Østervold, Kuppet og Vestervold en arbejdsstyrke på flere hundrede mand. De mange redskaber skulle opbevares sikkert i en stor bygning, og hertil var det store magasinhus velegnet.

Materialgården var både base for arbejdet på fæstningen og for statens civile bygningsvæsen, som med tiden voksede i betydning. Byggearbejder på Slotsholmen fik i Frederik IV's regeringsår større og større omfang, og kulminerede med slottets ombygning i 1720'erne. I 1716 blev materialgårdens grund delt. Civiletatens Materialgård fik rådighed over ca. 70 % af det samlede areal, Fæstningens Materialgård beholdt de resterende 30 %. Det afspejler tydeligt, at fæstningens udbygning nu i alt væsentligt var fuldført. På den tilbageblevne

the island of Slotsholmen. A sizable plot in the quarter was set aside for a new depot that was more convenient when work was begun on fortifying the island of Amager. The extensive line of ramparts surrounding the Holmen naval yard, with seven bastions behind an envelope, was laid out between 1685 and 1692. The ramparts south of the Christianshavn quarter had already been moved – in reality completely rebuilt. This was reflected at the Fortifications Depot in the addition of a sturdy half-timbered warehouse in 1683. It was the only prominent building on the site, but there must also have been stables and a wagon yard. The little “Stable-boy's House” at Frederiksholms Kanal 28, from 1684, shows that there were undoubtedly horses to feed and stable on the site from around the time that the depot was founded. Like the Eastern and Western Ramparts and the Citadel, the new fortifications required a labor force of several hundred. Their many tools and equipment had to be stored securely in a large building; the big warehouse was quite suitable for the purpose.

The Fortifications Depot served as the center of operations for this work and also for the state's public building projects, which became increasingly important. Construction on the island of Slotsholmen expanded considerably during the



grund opførtes i 1740 Materialforvalterboligen, som er anlæggets facade mod Frederiksholms Kanal, og som fra et arkitektonisk synspunkt er det mest værdifulde hus i Fæstningens Materialgård. I 1748 byggedes det lange bindingsværkshus mod volden, indrettet til stald, vognport og magasin.

Det såkaldte Chr. IV's bryghus, bygget ovenpå en muret bastion foran Tøjhuset, brændte i 1767. Bryghusfunktionen blev flyttet til et nyt, stort hus. Det blev placeret sydøst for Fæstningens Materialgård, som måtte afgive en strimmel jord til det nye byggeri og yderligere en strimmel til anlægget af en ny gade, Bryghusgade. På den afgivne jord lå det gamle magasin fra 1683, som blev nedrevet. Det blev erstattet af et nyt grundmuret magasin i to eta-

reign of Frederik IV and culminated in the remodeling of Copenhagen Castle in the 1720s. The Depot's plot was divided up in 1716. The Public Works Depot was given c. 70 percent of the overall area, while the Fortifications Depot retained 30 percent. This clearly reflects the fact that the expansion of the fortifications had essentially been completed. The Superintendent's Residence was built on the remaining space in 1740 to form the complex's facade on the canal. Architecturally, it is the Fortifications Depot's most important building. The long Half-timbered Building was added in 1748 along the ramparts to hold a stable, wagon yard, and magazine.

Christian IV's Brewery, built on a brick bastion in front of the Armory, burned down in 1767. Beer production was moved to a big new

*Facaden på Materialforvalterboligen.  
Sophus Bengtsson, 1937,  
Nationalmuseet.*

*The facade of the  
Superintendent's Residence.  
Sophus Bengtsson, 1937.  
National Museum.*

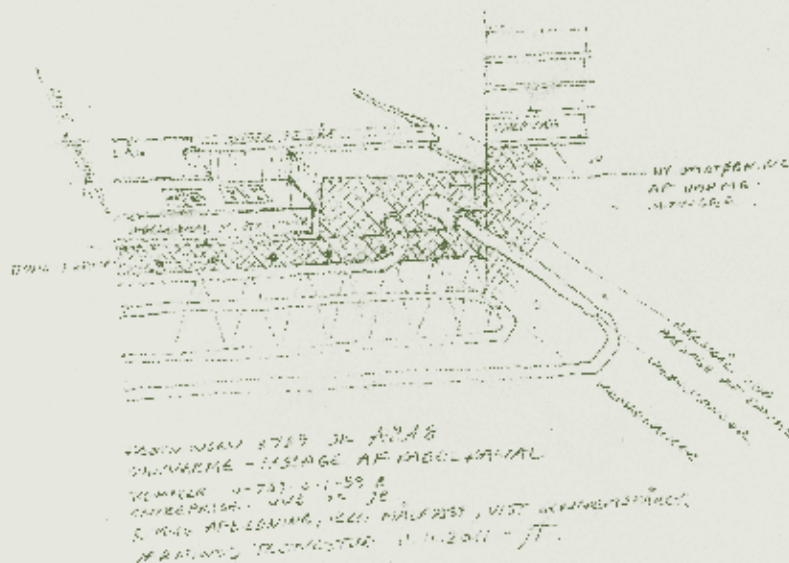


Da vi kom til, lignede bygningerne hinanden for meget – alle steder var der sprossede vinduer – og sådan har de ikke oprindeligt set ud. Vores ide var at differentiere mellem bygningerne og genskabe deres særegne identitet.

Anders Brüel, Realdania Byg

When we arrived, the buildings were too much alike. There were muntined windows all over the place, and this is not how it looked originally. Our intention was to differentiate the buildings and recreate their distinctive identities.

Anders Brüel, Realdania Byg



building southeast of the Fortifications Depot, which had to relinquish a strip of land for the building itself and another strip for a new street, aptly named Bryghusgade (Brewery Street). The old warehouse from 1683 that had stood on the site was demolished and replaced by a two-story brick magazine with more or less the same capacity as the old one. It might have looked quite suitable, but wasn't it a bit too big for needs at the time? After only three years, storerooms and lofts at one end of the building were transformed into an apartment for the buildings clerk and an office with a drafting office and meeting room for the head of the corps of engineers. Storerooms and lofts were transformed into apartments for senior officials and offices in quick succession. By 1815 there were virtually no storerooms left, a clear indication that there was no longer any need for a large depot of fortifications materials or equipment.

After the rim of earthworks around Copenhagen was dismantled in 1856, there was no longer any reason to maintain a fortifications depot. The old complex did, however, live on as a military institution, as the headquarters for military authorities under various designations, most recently as the Danish Defense Construction Service, until it moved and the Fortifications Depot was sold in 2007.

ger med nogenlunde samme kapacitet som det gamle magasinhus. Det kunne se ud til at være meget passende, men det var måske for stort til det aktuelle behov? Allerede efter tre år indtog man pakrum og paklofter i den ene ende og indrettede bolig for bygningskriveren og kontor med tegnestue og møderum for ingeniørkorpsets chef. Herefter gik det slag i slag, og pakrum og lofter inddrog til chefboliger og kontorer. I 1815 var der stort set ingen magasinrum tilbage, et tydeligt udtryk for, at der ikke længere var brug for oplagring i større målestok til fæstningens brug.

Efter fæstningens nedlæggelse i 1856 bortfaldt den oprindelige anledning til at opretholde en "Fæstningens Materialgård". Det gamle anlæg fortsatte dog som militær institution, nu som domicil for den militære bygningstjeneste under forskellige navne, senest som "Forsvarets Bygningstjeneste" indtil fraflytningen og forsvarrets salg af materialgården i 2007.

## Bygningshistoriske iagttagelser i de enkelte bygninger

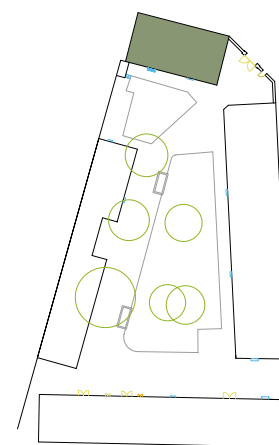
Fæstningens Materialgård består af flere bygninger med hver sin karakter og bygningshistorie. Alligevel fremstår anlægget som et samlet hele, dels på grund af den fælles farve på det gulkalkede

## Observations about the history of the individual buildings

The Fortifications Depot consists of several buildings, each with its own character and history. Nonetheless, the complex forms an entity, on the one hand because of its yellow, limewashed walls, and on the other because the buildings are all arranged around a common courtyard. When Realdania Byg took over the complex, it consisted of six main buildings: the Superintendent's Residence (building 1), the Magazine (building 4), the Half-timbered Building (building 11), and the Shed Building (consisting of buildings 7, 8, and 9). An old out-house stood by the Superintendent's Residence and a narrow shed at the end of the Half-timbered Building; both have been renovated and preserved. A guardhouse from 1995 at the main entrance has been demolished. A concrete bunker with two entrances had been built under the courtyard during World War II, presumably as a shelter. The bunker has been preserved, but will not be discussed in the following.

### The Superintendent's Residence

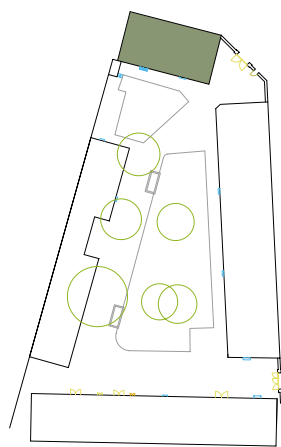
The building was built in 1740. The exterior was well preserved, though the original door on the canal had been in the bay farthest to the





*Modsatte side:  
Fæstningens Materialgård  
består af flere bygninger  
med hver sin karakter og  
bygningshistorie. Alligevel  
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samlet hele.*

*Opposite page:  
The Fortifications Depot  
consists of several buildings,  
each with its own character  
and history. Nonetheless,  
the complex forms an entity.*



murværk, dels fordi alle bygninger ligger som en krans omkring en fælles gård. Ved Realdania Bygs overtagelse bestod anlægget af seks egentlige bygninger: nemlig Materialforvalterboligen (bygning 1), Magasinbygningen (bygning 4), Bindingsværksbygningen (bygning 11) og de sammenbyggede halvtagshuse (bygning 7, 8 og 9). Desuden var der den gamle lokumsbygning ved Materialforvalterboligen samt et smalt halvtagsskur ved gavlen af Bindingsværksbygningen (begge istandsat og bevaret), og endelig en vagtbygning fra 1995 ved hovedporten (nu nedrevet). Under gården blev i krigsårene 1940-45 anlagt en betonbunker med to nedgange, formodentlig som sikringsrum. Bunkeren er bevaret, men den er ikke yderligere omtalt i det følgende.

## Materialforvalterboligen

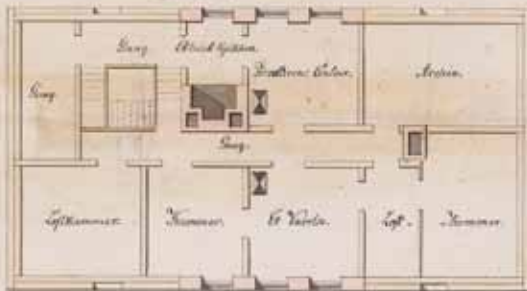
Bygningen er som anført fra 1740. Huset er i det ydre meget velbevaret, dog havde det oprindeligt gadedør mod kanalen i det yderste fag til venstre. Langs gavlen var der en gennemgående gang til en dør mod gården. Fra gangen var der adgang til en treløbs hovedtrappe til mansardetagen (første sal) i to fag mod gården. Herefter var der i to fag et køkken med et stort køkkenildsted. Resten af etagen var af en ret rodet opdeling, som ikke rigtig fulgte

left. There was a continuous corridor along the end wall to a door on the courtyard. The corridor gave access to a three-flight main staircase leading to the mansard (second) story in two bays on the courtyard. This was followed by two bays with a kitchen that had a good-sized fireplace. The rest of the story was divided up haphazardly so that it did not completely harmonize with the clearly segmented long sides, each with a large, three-bay pedimented front gable in the middle. The ground floor, for example, had a spacious room that spanned four bays, three of them under the front gable and the fourth on its right. There was a clear structural weakness on the second story, as a partition wall was missing under the left cheek of the front gable, which consequently rested on a beam that was not even reinforced. Only in a few places did the second story's partitions rest on the ground floor's walls; the remainder rested only on the joists – yet another weakness. Later remodelings made the plan increasingly muddled. This had especially unfortunate results when the corridor was moved between 1815 and 1833 from the outermost bay to the third bay from the left, and the main staircase was moved along with it, but by only one bay and not two. The result was a staircase with an unusually confused structure, with one quarter

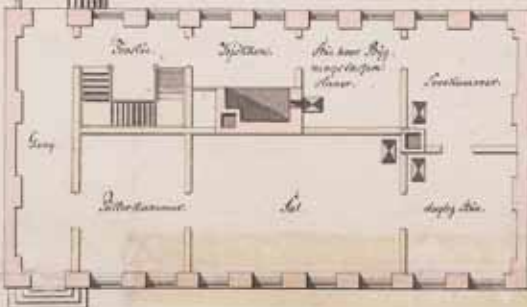


*Grund og Facade. Tegning af Materialforvalterens Tæsnig.*

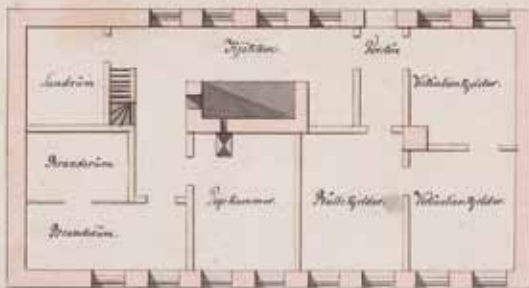
*Grundtegnig af Aftens og Gæststuen.*



*Grundtegnig af Kvæstue.*



*Grundtegnig af Hjælper-Kvæstue.*



*Facade mod Gaden.*



*Facade imod Tæden.*



de klart opdelt langsider med de store trefags kviste i midten. F.eks. var der i stueetagen en sal (benævnt således i 1815) på fire fag, de tre under kvisten og det fjerde til højre side. I mansardetagen var der en klar konstruktiv svaghed, idet der manglede en skillevæg under kvistens venstre flanke, som derved udelukkende hvilede på et spær, som ikke engang var forstærket. Mansardetagens skillevægge hviler kun undtagelsesvis på stueetagens vægge, ellers alene på bjælkelaget, hvilket også er en svaghed. Senere ombygninger har gjort planløsningerne stadig mere uklare. I særlig grad fik det uheldige virkninger, da gennemgangen blev flyttet mellem 1815 og 1833 fra yderfaget til tredje fag fra venstre og hovedtrappen blev flyttet med, dog ikke to fag, men kun ét fag. Resultatet blev en trappe af usædvanlig forvirret opbygning, hvor trappens ene kvartsving og det øverste løb hang over gennemgangen! Køkkenildstedet i stueetagen blev fjernet, atter en konstruktiv uheldig løsning, da der stadig var et tungt, muret køkkenildsted oven på i mansardetagen.

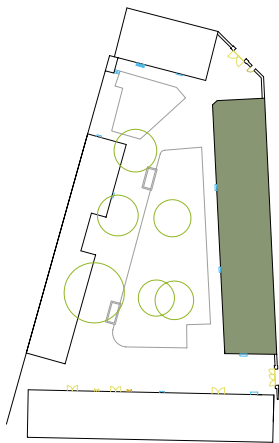
Alligevel har huset, næsten på trods af de amatøragtige planløsninger og de mange ombygninger, haft interiører af høj kvalitet. I forbindelse med restaureringen af anlægget blev Varmings Tegneste bedt om at udføre en gennemgribende bygningsarkæologisk under-

turn of the staircase and the top flight hanging over the corridor! The kitchen fireplace on the ground floor was removed, resulting in yet another unfortunate design, since there was still a heavy brick fireplace in the kitchen on the second story above.

Despite the amateurish floor plans and many remodelings, the building had interiors of a high quality. When the complex was restored, Varmings Tegneste was asked to carry out a thorough building-archeological study in order to clarify the building's historical and architectural values. The study showed that good carpentry from several periods had been preserved, though very little from 1740. There were dados and pier panels, some of them reused and pieced together. Several rooms had traces of old layers of paint and decorations in the form of rocailles and marbling that clearly showed that the interiors had had quite a distinguished look. A single room had marbled panels that were sufficiently well preserved to be uncovered and conserved. As a whole, the interiors in the northeast part of the ground floor had a measure of coherence and quality that was respected in Realdania Byg's remodeling of the building. As there was almost nothing of high quality to take into account in the southwest part of the building, major changes were made

*Modsatte side:  
Materialforvalterboligen er fra 1740. Huset er i det ydre meget velbevaret, dog havde det oprindeligt gadedør mod kanalen i det yderste fag til venstre.*

*Opposite page:  
The Superintendent's Residence was built in 1740. The exterior was well preserved, though the original door on the canal had been in the bay farthest to the left.*



søgelse af huset for at afklare husets historiske og arkitektoniske værdier. Undersøgelsen afslørede, at der var bevaret godt snedkerarbejde fra flere perioder, dog meget lidt fra 1740. Der er brystnings- og pillepaneler, til dels genanvendte og sammenstykkede. I flere rum fandtes spor af gamle farvelag og dekorationer i form af rocailler og marmorering, der tydeligt viste, at interiørene tidligere havde haft et ret fornemt præg. I et enkelt rum var der marmorerede fyldinger, der var tilstrækkelig velbevarede til at blive afdækkede og malerkonserverede. I det hele taget havde interiørene i stueetagens nordøstlige del en vis sammenhæng og kvalitet, som ved Realdania Bygs ombygning er blevet respekteret. I den sydvestlige del var der næsten ingenting af kvalitet at tage hensyn til, og her

there. The main staircase was demolished and a new three-flight staircase was recreated in the original 1740 location. A three-bay room was created along the canal by combining the corner room and the blind part of the corridor where the street door had been bricked up after 1913, probably before the building was given heritage status (listed) in 1918. Now the floor plan corresponds more closely than ever before to the building's facade rhythm of three + three + three bays.

## The Magazine

The building from 1768 was profoundly affected by the transformations that took place from the earliest years after its construction to



er indgrebene blevet store. Hovedtrappen er blevet revet ned, og trappen er blevet genskabt på det oprindelige sted fra 1740, hvor en ny treløbstrappe er blevet opbygget. Mod kanalen er der etableret en stue på tre fag ved sammenlægning af hjørnestuen og den blinde del af gennemgangen, hvor hoveddøren mod kanalen var blændet efter 1913, sandsynligvis før fredningen i 1918. Efter ombygningen er planløsningerne mere end nogensinde i overensstemmelse med husets facadeskema tre+tre+tre fag.

## Magasinbygningen

Bygningen fra 1768 er dybtgående præget af den successive omdannelse til bolig og kontor, som har fundet sted lige fra de tidligste år efter

the time when it was acquired by Realdania Byg: from a warehouse with large open rooms intended for storing heavy materials to apartments and offices. The building was extended on the northeast in two stages: first in 1819 with a building a little over half its depth, flush with the facade on Bryghusgade, and then in 1889, when the extension was made just as deep as the old one. Considering that the building took on its form and appearance as a result of many remodelings and additions over a period of 118 years, its exterior is amazingly regular. Even the doors and windows that were added are almost evenly apportioned on the long sides. This regularity is the result of very evenly spaced recesses in the outer wall that were simply intended to save on bricks.

*Et væsentligt element i restaureringsprojektet har været at bruge den bygningshistoriske analyse som et redskab til at fastlægge karakteren af den enkelte bygning's detaljeringsgrad.*

*An important element in the restoration project was to use the historical analyses as a tool for determining the character of an individual building's level of detailing.*

*I betragtning af, at bygningen har fået sin form over 118 år, er eksteriøret forbausende regulært.*

*Considering that the building took on its form and appearance over a period of 118 years, its exterior is amazingly regular.*



opførelsen og til Realdania Bygs overtagelse – fra magasin med store åbne rum tiltænkt oplagring af grove materialer til bolig og kontor. Bygningen er forlænget mod nordøst i to omgange; først i 1819 med et hus i godt og vel halv bredde, i flugt med facaden mod Bryghusgade; dernæst i 1889, hvor den smalle bygning gøres lige så bred som det gamle hus. Af hensyn til passagen mellem bygningerne 1 og 4, blev hushjørnet afskåret over ca. 2 alen eller 122 cm. I betragtning af, at bygningen har fået sin form og fremtræden ved en lang række om- og tilbygninger over 118 år, er eksteriøret forbausende regulært. Selv de gennembrudte døre og vinduer sidder i næsten jævn takt fordelt over langsiderne. Denne regelmæssighed er et

There are fifteen recesses along Bryghusgade and eight recesses with seven wall openings between them – gateways, doors, and hatches – on the courtyard. Each time a wall was given a window as a section was converted from storeroom into office or living space, this was naturally done in a recess, where the wall was thinnest, and in principle nonbearing.

The interiors no longer reflect the original warehouse function, only the building's later use as offices, a drafting office, and apartments. The first transformation was in 1771, just three years after the warehouse was built. At the southwest end on the courtyard, two hatches were bricked up and two others were changed into windows, supplemented with three windows in the recesses that had been opened up. After this first transformation, the facade on the courtyard looked quite irregular, with its two big windows providing daylight for a drafting office on the second story. On Bryghusgade, eight recesses were transformed into eight large windows, and the end wall was given a main entrance to the new rooms. The door opened on a stairwell with a three-flight staircase. On the ground floor were a kitchen, a living room, and a bedroom for the first building's clerk, as well as a little orderly room. The head of the corps of engineers had

*Interiørerne afspejler ikke længere den oprindelige  
magasinfunktion, men udelukkende den senere  
indretning til kontorlokaler, tegnestue og boligrum.*

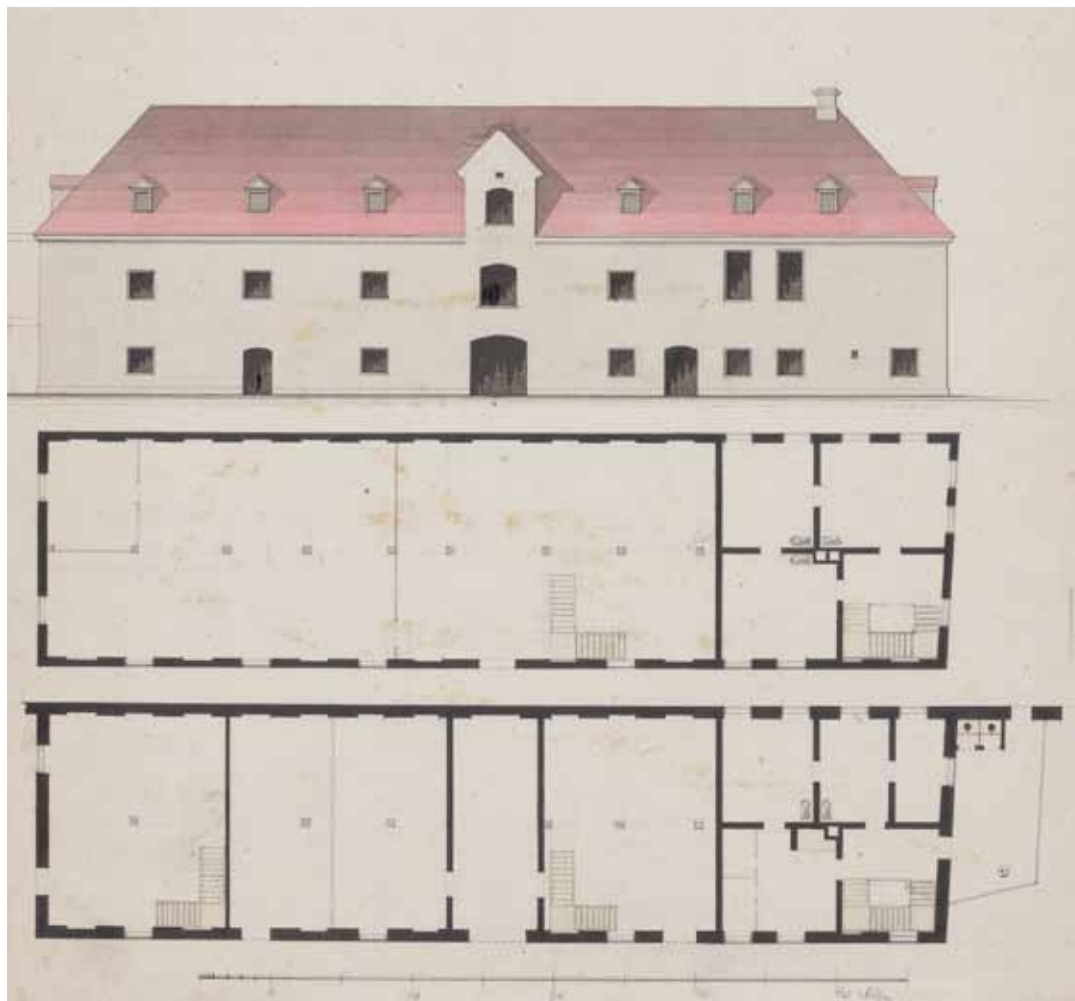
*The interiors no longer reflect the original  
warehouse function, only the building's later  
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*Magasinbygningen fra 1768 er dybtgående præget af den successive omdannelse til bolig og kontor.*

*The Magazine from 1768 was profoundly affected by the transformations.*



resultat af ganske taktfast anbragte sparenicher i magasinets murværk. En spareniche er en indvendig blænding i murværket. Der er femten nicher mod Bryghusgade og otte nicher med mellemfaldende syv muråbninger, port, døre og pakhusluger mod gården. Hver gang murene er blevet gennembrudt for at anbringe et vindue i takt med skiftet fra magasin til opholdsrum, er det selvfølgelig sket i en spareniche, fordi muren her var tyndest og i princippet ikke-bærende.

Interiørerne afspejler ikke længere den oprindelige magasinfunktion, men udelukkende den senere indretning til kontorlokaler, tegnestue og boligrum. Den første omdannelse fandt sted i 1771, kun tre år efter, at huset var bygget. Mod gården i den sydvestre ende blev to pakhusluger tilmuret og to andre luger omdannet til vinduer suppleret med tre vinduer i gennembrudte sparenicher. Gårdsiden blev meget irregulær at se på efter dette første indgreb, hvor to store vinduesåbninger gav dagslys til en tegnestue i salsetagen. Mod Bryghusgade blev otte spareblændinger omdannet til otte store vinduer, og i gavlen blev muren gennembrudt til en hoveddør ind til de nye lokaler. Bag hoveddøren blev der trapperum med en treløbstrappe, desuden var der i stueetagen køkken, stue og kammer til 1.bygningssskriveren samt en lille ordonnansstue. Ovenpå regerede ingeniørkorpsets chef fra

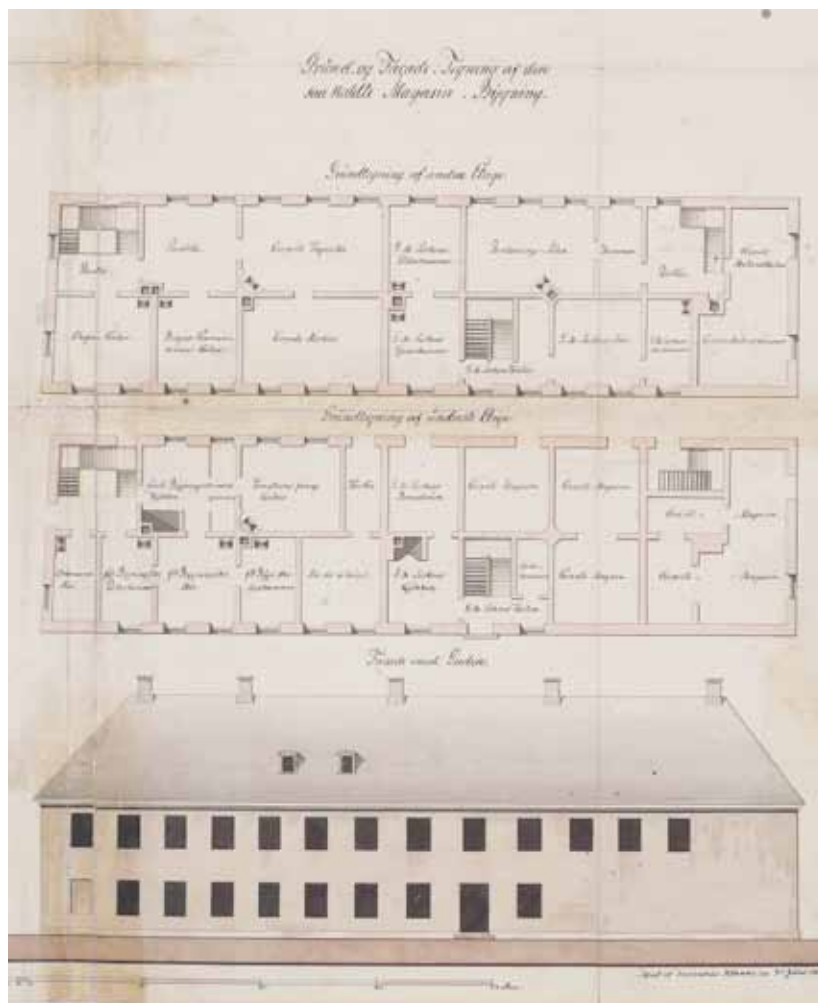
his office and the corps' drafting office on the second story, which had large windows on the courtyard.

When quarters soon became cramped, three more bays in the Magazine were relinquished, possibly as early as 1803. The Superintendent might have complained about losing so much space, and there is some indication that this was considered the limit. A sturdy wall was built through both stories and the attic with a party-wall parapet over the roof. This firewall gave the drafting office, archives, office, and apartment the best protection if a fire should start in the stores. The firewall was moreover a clear signal: this far and no further! An office for the Superintendent and a hall with a door to the courtyard were laid out on the ground floor. The buildings clerk's apartment was expanded with one bay on the street, and the last two bays had a room that could be accessed only from the hall and was not used in 1815. On the second story, the corps of engineers was given a drafting office spanning three bays and spacious archives on Bryghusgade.

The detailed plan from 1815 shows that after a few years, almost all the storage space was relinquished nonetheless. An area was converted into an apartment accessed from

*Den detaljerede plan fra 1815 viser,  
at man efter få år inddrog  
næsten hele magasinet.*

*The detailed plan from 1815  
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Bryghusgade for the new head of the corps of engineers, Lieutenant Colonel Christoph Henrich Suckow, probably in 1809, when he was appointed to the position. The apartment was separated from the building's other rooms in curious fashion. On the ground floor it spanned three bays on the street and one on the courtyard, and on the second story, six bays on the street and one on the courtyard. The apartment had no front door on the courtyard and was completely detached from everything else. Perhaps this is how Suckow protected his solitary private life. The apartment was the first in the building to house a senior official.

When Suckow died 1818, he was succeeded by Lieutenant Colonel Rasmus Krag, who wanted a larger residence, as he had a family, and evidently a big one. On the ground floor, the new residence covered the entire southwest end, seven bays, to the firewall. On the second story, it occupied not only these same seven bays, but also one bay on Bryghusgade and five bays on the courtyard. The residence was occupied for more than 100 years.

As noted above, a curious extension was added to the northeast end of the building after Krag took up occupancy of the entire southwest end in 1818. Just half as deep as the Magazine,

sit kontor over korpsets tegnestue med de store vinduer mod gården.

Pladsen blev hurtigt for kneben og yderligere tre fag af magasinbygningen blev inddraget, muligvis allerede i 1803. Materialforvalteren har muligvis knurret over at skulle afgive så stor plads. Noget tyder på, at man havde tænkt sig at stoppe her. Der bygges en kraftig mur op gennem begge etager og tagrummet med en brandkam over tagfladen. Med denne brandmur var tegnestuen og arkivet samt kontor og boligrum sikret bedst muligt, hvis der skulle opstå brand i magasinerne. Man signalerer med brandmuren: Hertil og ikke længere! I stueetagen indrettedes kontor til forvalteren og en forstue med dør til gården. Bygningsskriverens bolig blev udvidet med et fag mod gaden, og i de sidste to fag var der en stue, som kun havde adgang fra forstuen, og som var ubenyttet i 1815. Ovenpå fik ingeniørkorpset tegnestue på tre fag og mod Bryghusgade et stort arkiv.

Den detaljerede plan fra 1815 viser, at man efter få år alligevel inddrog næsten hele magasinet. Der blev med adgang fra Bryghusgade indrettet en lejlighed til ingeniørkorpsets nye chef oberstløjtnant Christoph Henrich Suckow, antagelig samme år som hans udnævnelse, dvs. 1809. Lejligheden havde en mærkelig afgrænsning fra husets øvrige rum. Den bestod i stueetagen af tre

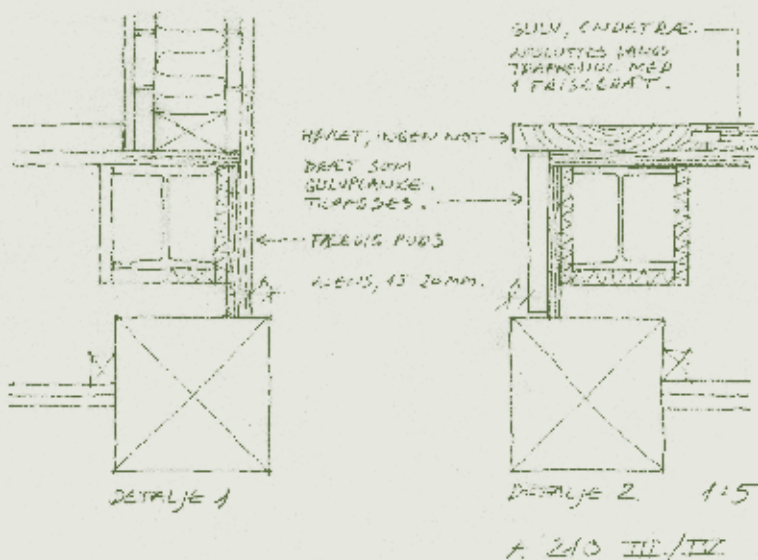


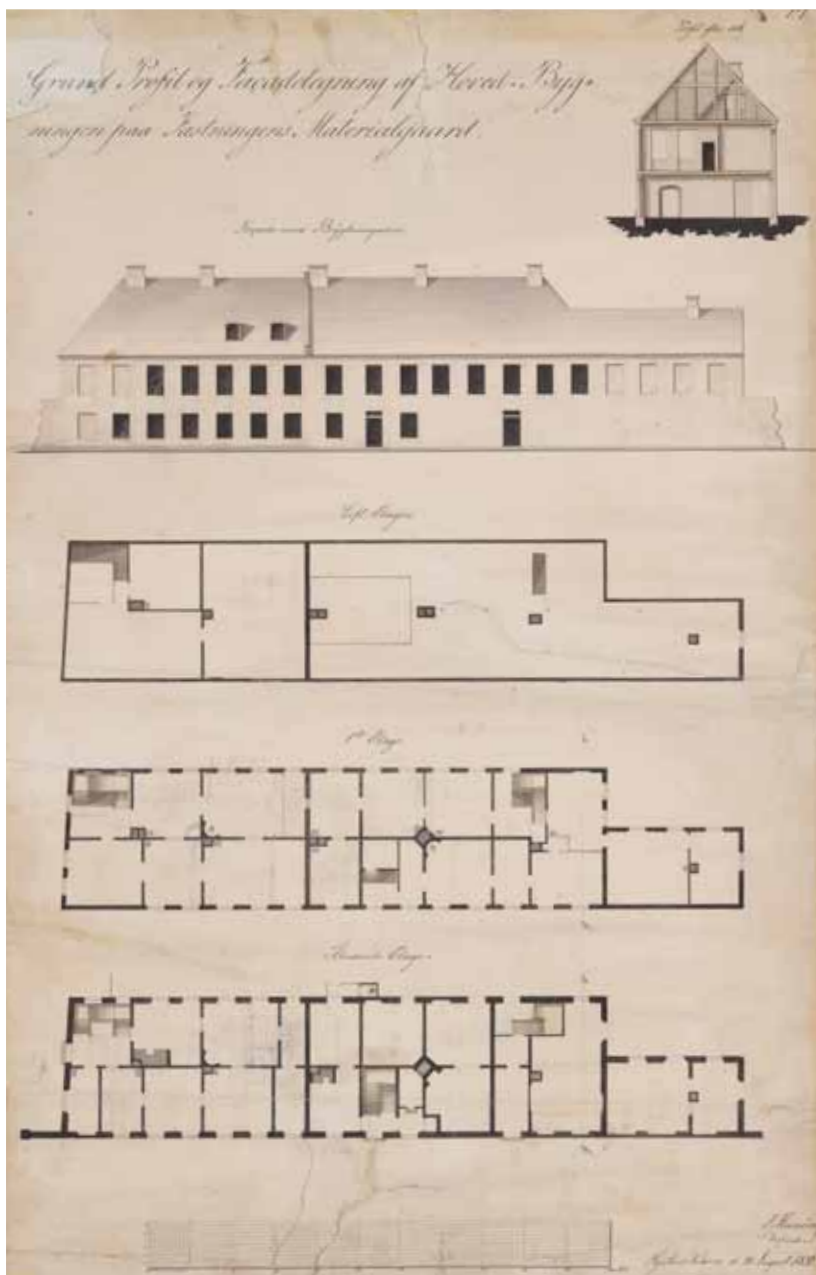
Jeg synes, det er fantastisk spændende at få mulighed for at dykke ned i historien og finde ud af, hvad der virkelig har værdi – husk på, at ikke alt har arkitektonisk værdi, bare fordi det er gammelt.

Anne Lene Jørgensen, Varmings Tegnestue

I think it's fantastically exciting to get the chance to delve down into history and find out what really is valuable. Remember, not everything has architectural value just because it's old.

Anne Lene Jørgensen, Varmings Tegnestue





*En mærkelig tilbygning føjedes til nordøstgavlen i 1818.*

*A curious extension was added to the northeast end of the building in 1818.*

it had a solid facade on Bryghusgade, though there were blank window openings on the second story. All light entered the extension from the courtyard. The old Magazine still had its hipped gables, but the extension was given a straight gable. The second story was used as a library and archives.

A drawing in pencil on a plan from 1870 (perhaps later) shows how the extension could be expanded, as it was in 1889. Its gable on Frederiksholms Kanal was straight, like the extension's, but its corner was canted by 122 cm to make room between the building and the Superintendent's Residence. The drawings from 1870 show that the gable on the southwest had been transformed into a half-hipped gable at a time when a number of garrets were built at this end of the attic. Seven bays to the firewall were fully built out in the attic, and three dormers were added on the street and three on the courtyard. Four of the six dormers provided a large room with daylight from both sides. The dormers were preserved and were later supplemented with 18 others when the entire attic was fully built out.

When the big apartment was vacated, the space was used for offices. This meant building a central corridor on both main stories. It had

fag mod gaden og et fag mod gården, i salsetagen af seks fag mod gaden og et fag mod gården. Løjigheden havde ingen yderdør mod gården og var helt afgrænset fra alt andet. Suckow værnede måske om sit ensomme privatliv på denne måde. Løjigheden var den første chefbolig i huset.

I 1818 tiltrådte oberstløjtnant Rasmus Krag stillingen efter Suckows død. Han ønskede en større chefbolig, da han havde familie, tilsyneladende af en betragtelig størrelse. Den nye chefbolig blev i hvert fald meget stor. Den omfattede i stuen hele den sydvestlige ende på syv fag indtil brandmuren, og i salsetagen foruden de samme syv fag yderligere et fag mod Bryghusgade og fem fag mod gården. Denne bolig var i brug i mere end 100 år.

En mærkelig tilbygning føjedes til nordøstgavlen i forbindelse med Krags indtagelse af hele den sydvestlige ende i 1818. Husdybden var kun godt halvt så stor som magasinbygningens. Facaden mod Bryghusgade var blind og vinduesløs, dog med vinduesblændinger i overetagen. Alt lysindfald var fra gården. Det gamle magasin havde stadig sine valmede gavle i behold, men tilbygningen fik stående gavl. Overetagen blev indrettet til bibliotek og arkiv.

På en plan fra 1870 er der (måske senere) med blyant indtegnet en udbygning af det smalle hus. Denne udbygning blev realiseret

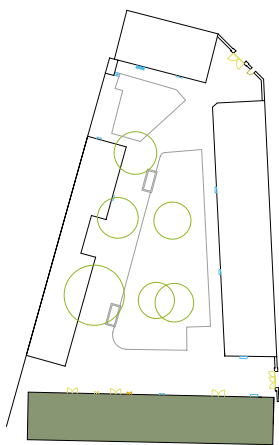


*Magasinbygningen er udvidet tre gange – sidst i 1889.*

*The Magazine was expanded three times – most recently in 1889.*

i 1889. Den fik som nævnt afskåret hjørne mod Materialforvalterboligen. Gavlen mod Frederiksholms Kanal blev en stående gavl i lighed med gavlen på det smalle hus. Man kan af tegningerne fra 1870 se, at gavlen mod syd-vest var ændret til en halvvalm på et tidspunkt, hvor man havde bygget nogle tagkamre i denne ende af tagetagen. Udnyttelsen af tagetagen omfattede de syv fag indtil brandgavlen, og der var indsat tre kviste mod gaden og tre mod gården. Fire af de seks kviste gav dagslys til et stort gennemgående rum. Kvistene er bevaret og er senere i forbindelse med udnyttelsen af hele tagrummet blevet suppleret med 18 kviste.

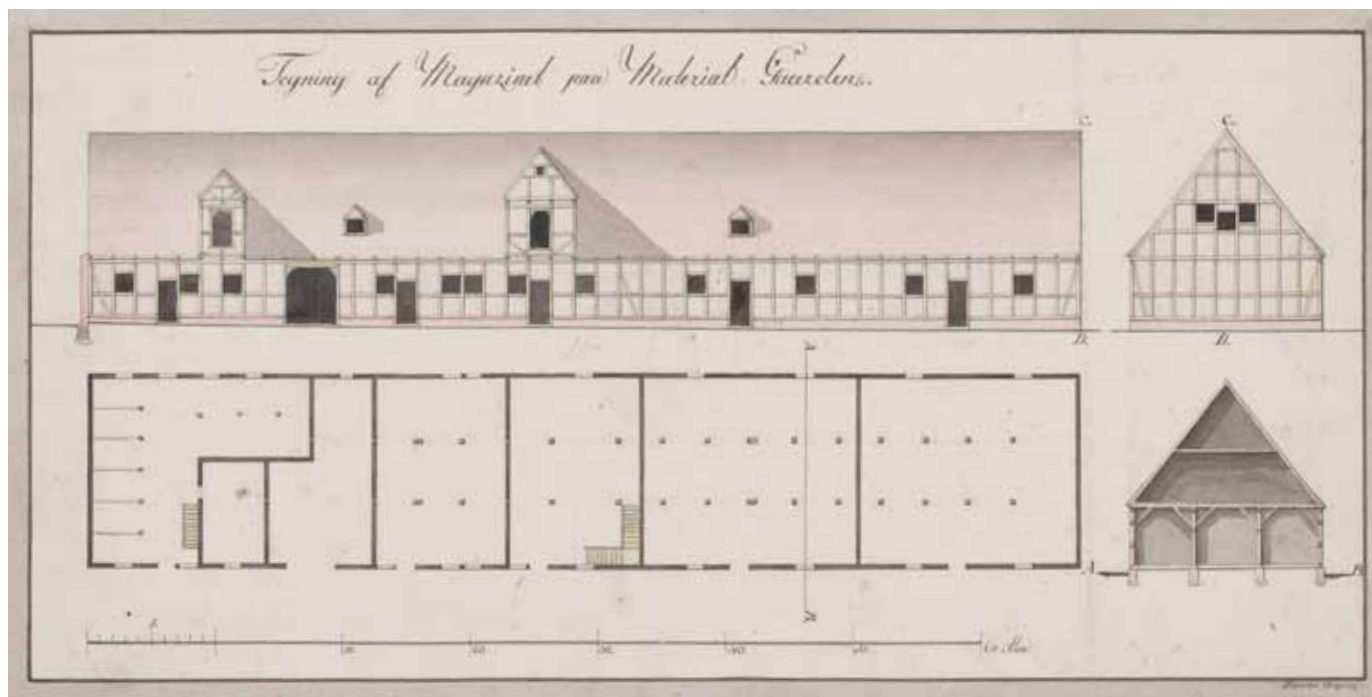
Da den store chefbolig blev nedlagt, benyttede man lokalerne til kontorer. Denne brug medførte, at en midterkorridor blev indbygget i begge hovedetager. Især på første sal var gangens forløb mildt sagt irregulær og kroget, og gangens indbygning havde slået flere gode interiører i stykker. En fjerdedel af rummene var gået fri og blev fra begyndelsen, da Varmings Tegnesteue påbegyndte den bygningsarkæologiske undersøgelse, betegnet som væsentlige og bevaringsværdige. De sønderlemmede rum havde i stor udstrækning så mange fragmenter bevaret af det, der engang havde givet dem kvalitet (paneler, døre, loftsgesimser), at en rekonstruktion kunne komme på tale.



a highly irregular and contorted progress especially on the second story, and building it had fragmented several good interiors. A quarter of the rooms had not been affected, and when Varmings Tegnesteue began its studies, they were considered significant and worthy of preservation. The dismembered rooms as a whole had so many fragments of what had once given them such quality (panels, doors, ceiling cornices) that a reconstruction could be considered.

## The Half-timbered Building

The building from 1748 is a very simple warehouse structure with thin walls. The beams were supported at the third points by longitudinal sleepers borne by sturdy posts at every second bay. The structure was further supported by diagonal struts between the sleepers and the posts, four struts per post. Along the outer walls, every second sleeper was connected with a strut to the post that stood right under the beam. This construction made the joists very solid and gave the entire building good lateral stability. In 1748, 35 bays were used as stores: three large spaces covering ten bays and one smaller space covering five bays. There were five bays for the wagon yard and there was a stable with six stalls at the southeast end. This



## Bindingsværksbygningen

Bygningen fra 1748 er et ret simpelt hus – bindingsværk med tynde vægge. Indvendig var bygningen konstrueret som et pakhus. Bjælkerne var understøttet i trediedelspunkterne af langsgående underslagsbjælker, der blev båret af kraftige stolper for hvert andet fag. Konstruktionerne var yderligere understøttet med skrå kopbånd mellem underslagsbjælkerne og stolperne, fire kopbånd per stolpe. Langs ydervæggene var hver anden bjælke forbundet med et kopbånd til den bindingsværksstolpe, der stod lige under bjælken. Konstruktionen gjorde bjækelaget meget stabilt, og den gav hele bygningen en god

stable housed six of the “king’s supply horses,” which were put out to graze during the summer outside the western city gates – in the meadows where the Swedes had readied their attack on the city’s weakly fortified Western Ramparts in 1659. In 1748, the building also had a big dormer with hatches above the three-centermost bays, and four dormers in the roof on the courtyard.

In around 1800-1810, the three-bay dormer was moved two bays to the southeast, and a two-bay dormer with a hatch was built over the sixth and seventh bays from the southeast. The stable remained unchanged, but was given a fodder barn or perhaps a foal stable that

*Bindingsværksbygningen fra 1748 er et ret simpelt hus. Indvendig var bygningen konstrueret som et pakhus.*

*The Half-timbered Building from 1748 is a very simple warehouse structure.*



sideværts stabilitet. I 1748 var femogtredive fag indrettet til magasinrum, tre store på ti fag og et mindre på fem fag, dernæst fem fag til vognport og i den sydøstre ende en hestestald med seks spiltove. Stalden var indrettet til seks af de såkaldte "Kongens Materialheste", der om sommeren var på græs uden for Vesterport i "den Store Enghave", hvor svenskerne i 1659 havde forberedt hovedstormen på byens svage Vestervold. Bygningen havde i 1748 en stor kvist med luge over de tre midterste fag og fire kviste i taget mod gården.

Omkring år 1800-1810 flyttedes den trefags kvist to fag mod sydøst og en kvist over to fag med luge opførtes over sjette – syvende fag fra sydøst. Hestestalden forblev uændret, dog forøget med en foderlo eller måske en følstald på fem fag mod volden. Mod gården blev der af den nedlagte vognport afsat et kammer på tre fag formodentlig til seletøj, og resten af vognporten, to fag mod gården, blev sammenlagt med tre fag af det mindste magasinrum. Porten blev flyttet til tiende – elvte fag, hvor den stadig findes, og det irregulære rum var sandsynligvis vognport. Herefter fulgte to magasinrum á seks fag og resten var uændret.

Af senere ændringer noteres pakhuskarakterens fuldstændige forsvinden i den sydøstre ende, hvor ethvert spor af den tidligere heste-

spanned five bays along the ramparts. On the courtyard, part of the former wagon yard was converted into a three-bay room, probably for harnesses. The rest of the wagon yard, two bays on the courtyard, was merged with three bays of the smallest storage area. The gate was moved to the tenth and eleventh bay, where it is still found; the irregular room was probably the wagon yard. Then came two stores, each six bays, and the rest remained unchanged.

Later changes resulted in the complete disappearance of any sign of the building's past as a warehouse in the southeast end, where every trace of the stable had also been erased. When Realdania Byg bought the property, the two storage areas in the northwest end were more or less intact. The transverse partition wall between them had been moved at some point about one bay toward the southeast. This location was not changed in the current restoration. The attic was fully built out and received light from 19 large, modern skylights, which had defaced the roof. The offices on the top floor had been constructed with a profusion of gypsum boards for partitions, jamb walls, and sloping walls. Nothing inside showed that it was an old building. The building's original, robust character was apparent in a few places



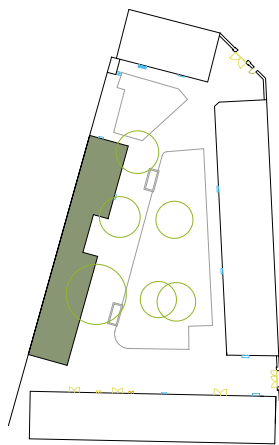
*I Bindingsværkbygningen  
er konstruktionen nu igen  
delvist synlig.*

*The structure of the  
Half-timbered Building  
is again partly visible.*



*I 1748 var bygningen indrettet til magasinrum, vognport og en hestestald.*

*In 1748, the building was used as a magazine, a wagon yard, and a stable.*

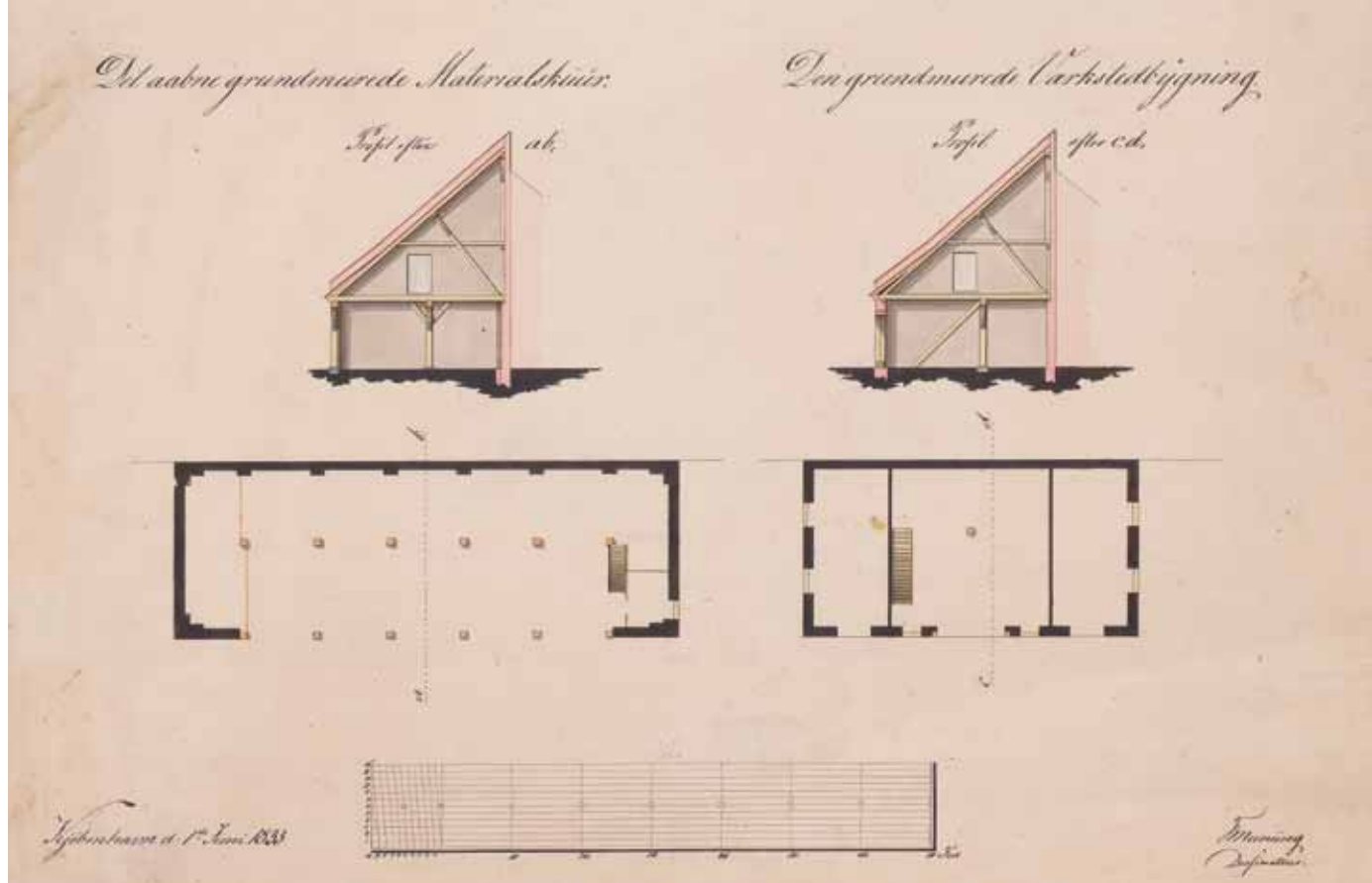


stald også er fjernet. Ved Realdania Bygs overtagelse af ejendommen var de to store magasinrum i den nordvestre ende relativt intakte. Tværskillevæggen mellem dem er på et ukendt tidspunkt flyttet ca. et fag mod sydøst. Denne placering er ikke ændret ved den aktuelle restaurering. Tagetagen var ved overtagelsen fuldt udnyttet og lokalerne belyst med 19 store veluxvinduer, som havde skæmmet taget meget. Kontorlokalerne i tagetagen var opbygget med rigelig anvendelse af gipsplader til skillevægge, skunkvægge og skrævægge. Her var intet, der viste, at man befandt sig i et gammelt hus. I stueetagen trådte husets oprindelige, robuste karakter frem nogle steder, klart i den nordvestre ende, hvor stolper og underslag var bevaret, mindre klart i midten, hvor flere end halvdelen af stolperne var fjernet. I den sydøstlige ende var alle spor af den tidligere indretning og indvendige bærende tømmerkonstruktion fjernet.

on the ground floor, most clearly in the northwest end, where posts and sleepers had been preserved, and less clearly in the center, where more than half of the posts had been removed. All traces of the former floor plan and interior bearing timberwork had been effaced in the southeast end.

### **Three buildings now comprise the Shed Building: the workshop, the connecting building, and the brick shed**

Buildings 7, 8, and 9. In 1819, a fire broke out in the Public Works Depot near the boundary to the Fortifications Depot, where two wooden sheds burned down. The sheds had flanked the pit that had stood at the boundary for some 150 years, filled with slaked lime, which was used both for making mortar and for whitewashing brickwork. The two sheds



## Værkstedbygningen, mellembygningen og det grundmurede materialskur

Bygning 7, 8 og 9. I 1819 udbrod der brand på Civiletatens Materialgård nær skellet til Fæstningens Materialgård, hvor to materialskure af træ antændtes og nedbrændte totalt. Skurene var adskilt af den store kalkkule, som lå ved skellet i omkring 150 år. Kalkkulen rummede læsket kalk, som blev benyttet dels til blanding af mørtel og dels til kalkning af murværk. De to nedbrændte skure opførtes derfor adskilte, men den nye bygning nærmest Materialforvalterboligen blev indrettet til værk-

were consequently rebuilt separately; the new building closest to the Superintendent's Residence became a workshop (though a plan from 1854 calls it a "magazine"), while the other was used for storage. Both were made of brick to minimize the risk of fire and in keeping with new legislation passed after the great fires in Copenhagen in 1795 and 1807. By 1925 the lime pit was gone and a connecting building with a recessed two-story facade was erected. In time, the three buildings' facilities were combined.

The workshop was organized symmetrically with a large room in the center and

*Værkstedbygningen og materialskuret blev bygget i 1819, og i 1925 blev mellembygningen tilføjet.*

*The workshop and brick shed were built in 1819, and the connecting building was added in 1925.*

*Det grundmurede  
materialscur var mod  
gården ganske åbent.*

*The brick shed  
was completely open on  
the courtyard.*



*Alle tre bygninger var ved overtagelsen i 2007 i brug som kontorer med tilhørende arkivrum m.m.*

*When the complex was acquired in 2007, all three buildings were used as offices with archives, etc.*

sted (på en plan fra 1854 dog benævnt "magasin"), den anden blev indrettet til materialskur. Begge bygninger blev opført i grundmur for at mindske brandfaren. Efter de store bybrande i 1795 og 1807 var det i øvrigt et krav at bygge i grundmur. I 1925 var kalkkullen væk og mellembygningen med den tilbagerykkede toetagers facade blev opført. Den har med tiden medført, at de tre huses funktioner er sammensmeltede.

Værkstedbygningen var disponeret symmetrisk med et stort rum i midten med en bred port flankeret af to små vinduer. I begge gavle var der rum med dør mod gården og vinduer i gavlene. Der var ikke døre mellem de tre rum og de to yderste rum må antagelig have været materialerum til værkstedet. Denne struktur var på nær den ene tværskillevæg bevaret, da Realdania Byg købte ejendommen.

Det grundmurede materialskur var mod gården ganske åbent. Mellem to korte murvinger var der en 16,5 m bred åbning, med stolper opdelt i fem dele. Stolperne havde kopbånd sideværts og bar en svær rem. Den er bevaret og er et imponerende stykke tømmer, ca. 17,5 m langt med et tværsnit på 11"x11". De fem åbninger var efter en gammel tegning at dømme uden porte. Omtrent midt i bygningen var der underslag med seks stolper og fire kopbånd pr. stolpe. Tagrummet har man kunnet belaste med



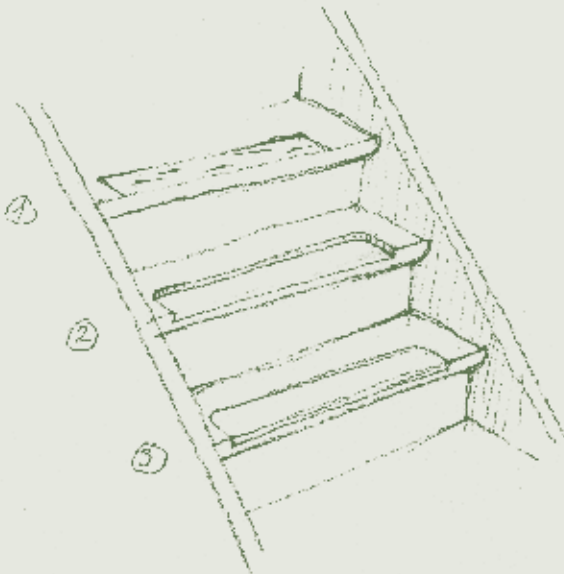


Jeg synes, at den gode historie er, at vi ved at gennemføre et ordentligt forarbejde har erkendt kvaliteterne i bygningerne – og at det er disse kvaliteter, der er arbejdet videre på.

Anne Lene Jørgensen, Varmings Tegnestue

I think our success story is that by carrying out proper preliminary work, we acknowledged the buildings' qualities, and these are the qualities that we worked on further.

Anne Lene Jørgensen, Varmings Tegnestue



FASTNINGEN I RUGERKULSREISE A105 4II  
TRAPPE VED SØRGAUL, REP. VEF TRIN  
VARMINGS TEGNESTUE 2/17-10 JT.

double doors flanked by two small windows. At both ends there were rooms with doors on the courtyard and windows on the end walls. There were no doors connecting the three rooms, so the two outermost must have held materials for the workshop. This structure had been retained, apart from one transverse partition wall, when Realdania Byg bought the property.

The brick shed was completely open on the courtyard. There was a 16.5-meter-wide opening between the two short walls divided into five sections with posts. The posts had transverse struts and supported a thick head. This impressive piece of timber has been preserved: c. 17.5 meters long and with a cross section of 11 x 11 inches. Judging from an old drawing, the five openings had no gates. In about the center of the building, there were sleepers with six posts and four struts per post. The entire building had such a sturdy structure that it was possible to store a great many heavy supplies on the top floor. The very high porch roofs on both of the old buildings were also carefully conceived, high-quality structures with roof trusses under the very long beams. The buildings were designed and intended to be used by officers in the corps of engineers.



mange tunge materialer, da hele bygningen har så kraftig en konstruktion. De meget høje halvtage på begge de gamle huse var ligeledes gennemtænkte, gedigne konstruktioner med tagstole under de meget lange spær. Bygningerne er projekteret af og til brug for ingeniørofficerer.

Alle tre bygninger var ved overtagelsen i 2007 i brug som kontorer med tilhørende arkivrum m.m. og for materialskurets vedkommende har indgrebene været store. Den åbne facade blev lukket, grundmuret med otte vinduer. Et niende vindue blev indsat i den murvinge der vender mod bindingsværksbygningen. Dagslysindtaget til den udnyttede tagetage blev etableret med en taskekvist i næsten hele bygningens længde. I værkstedsbygningens tag var der otte store veluxvinduer. Den uniformering af facaderne på bygningerne 7 og 9, som havde fundet sted, var arkitektonisk temmelig kedelig, og

When the complex was acquired in 2007, all three buildings were used as offices with archives, etc. and major changes had been made to the brick shed. The open facade had become a brick wall with eight windows. A ninth window had been inserted in the short wall facing the Half-timbered Building. A shed dormer had been added almost the entire length of the building to provide daylight for the fully built-out attic. There were eight large, modern skylights in the workshop's roof.

The uniform look that had been given the facades of buildings 7 and 9 was architecturally quite bland, and the restoration project was based on the three buildings' original appearance.

The complex was given heritage status in several stages, not all at once. After heritage

*Anlægget er blevet fredet, ikke på én gang, men i flere omgange. Materialforvalterboligen blev fredet i 1918.*

*The complex was given heritage status in several stages, not all at once. The Superintendent's Residence was listed in 1918.*



*Bræddevæggen er ikke blot et arkitektonisk greb – den skjuler den bagvedliggende installationsvæg.*

*The back wall with lye-treated wooden planks hides all the building's vertical piping.*



istandsættelsesprojektet har taget udgangspunkt i de tre bygningers oprindelige udseende.

Anlægget er blevet fredet, ikke på én gang, men i flere omgange. Efter fredningslovens vedtagelse i 1918 blev Materialforvalterboligen fredet i klasse A. De øvrige bygninger blev ikke fredet. I 1952 blev fredningens omfang udvidet, formentlig kun med randbygningerne mod Bryghusgade og Vester Voldgade. I 1983 omfat-

legislation was passed in 1918, the Superintendent's Residence was listed in class A. More buildings were added in 1952, but probably only the ones along Bryghusgade and Vester Voldgade. In 1983, however, the three shed buildings on the property line between the Fortifications Depot and the Public Works Depot were also included – not only the two from 1819, but also the connect-



*Istandsættelsesprojektet har taget udgangspunkt i de tre bygningers oprindelige udseende.*

*The restoration project was based on the three buildings' original appearance.*

ter fredningen dog også halvtagsbygningerne i skellet mod Civiletatens Materialgård, ikke bare bygningerne fra 1819, men også mellembygningen fra 1925, som det fremgår af teksten i Fredningslisten fra 1983. Desuden omfatter fredningen mure og porte mod Bryghusgade og Frederiksholms Kanal. Over sidstnævnte port står: "Fæstningens Materialgaard". Det bliver der forhåbentligt ved med at stå i mange år.

ing building from 1925, as shown by the official list from 1983. Walls and the portals on Bryghusgade and Frederiksholms Kanal had been added as well. The latter portal is crowned with the words "Fæstningens Materialgaard" – the Fortifications Depot – the name that will hopefully remain there for many years to come.



# Fæstningens Materialgård – Kulturarv og klima

## 1: MÅL OG BARRIERER

### Kulturarven slår dørene op

Langs Frederiksholms Kanal i København ned mod udmundingen til havneløbet ligger en perlerække af gamle gulkalkede længer under store røde tegltage, med hvide småsprossede vinduer og grønne porte. For de fleste københavnere er de en særdeles velkendt del af bybilledet. Bygningerne synes altid at have ligget der men er nok svære at tidsfæste for de fleste – ud over at de ligner noget fra det rigtigt gamle København. Det er nok også de færreste, der har haft mulighed for at komme ind bag murene og fornemme den særlige pittoreske stemning á la Ærøskøbing, som hersker mellem bygningerne og i gårdrummene. Det er nok endnu færre, der har oplevet bygningerne indefra, og det er der en god grund til. De sidste gule bygninger ud mod havneløbet har nemlig frem til 2007 været i Forsvarets eje og dermed i hovedsagen lukket land for offentligheden. Bygningerne husede oprindeligt Fæstningens Materialgård, som blev bygget og udvidet over en periode på mere end 200 år. Fra 1740 til 1995 er bygningerne på godt og ondt løbende blevet ombygget og indrettet i overensstemmelse med tidens fremherskende stil og ejerens konkrete behov.

# The Fortifications Depot – Cultural Heritage and the Climate

Af/By  
Birgitte Kleis

## 1: GOALS AND BARRIERS

### Cultural heritage opens its doors

Along Frederiksholms Kanal in Copenhagen, where the canal runs into the fairway, lies a row of old yellow, limewashed buildings under large red-tile roofs with small-paned, white-framed windows and green gates. For most Copenhageners, they are a very familiar part of the cityscape. They seem to have been there forever, but most people probably have a difficult time dating them – except that they look like something from Copenhagen long ago. Very few have had an opportunity to enter the complex and experience the distinctive, picturesque atmosphere between the buildings and in the courtyards, an atmosphere found in little Danish towns like Ærøskøbing. Still fewer have ever been inside the buildings, and for good reason. The last yellow buildings by the water were the property of the Ministry of Defense until 2007, and consequently off limits to the general public. The buildings originally comprised the Fortifications Depot, a complex that had been erected and expanded over a period of more than 200 years between 1740 and 1995. For better or worse, the buildings had been remodeled and converted to suit the period's prevailing style and the owner's specific needs.

*Modsatte side:  
De gule bygninger har  
frem til 2007 været i  
Forsvarets eje og dermed  
i hovedsagen lukket land  
for offentligheden.*

*Opposite page:  
The yellow buildings  
were the property of the  
Ministry of Defense until  
2007, and consequently off  
limits to the general public.*

I 2007 ønskede Forsvaret imidlertid at afhænde Fæstningens Materialgårds samlede kompleks bestående af fire selvstændige bygninger og et antal mindre skure, der sammen med mure og porte omkranser et fint lille haveanlæg med kastanjer og rosenbuske mod omverdenen.

### **Umistelige kvaliteter og nyt liv**

Straks efter erhvervelsen gik Realdania Byg i gang med at finde ud af, hvad bygningerne fremover skulle bruges til. Selskabet vurderede, at det ville være mest rentabelt at indrette og udleje bygningerne som kontorer med fællesfaciliteter i form af møderum og kantine men på en måde, der i højere grad end tidligere, respekterede og styrkede bygningernes iboende kvaliteter. Samtidig begyndte overvejelserne om, hvad der skulle til for at sikre de værdier, som man håbede at finde. For at blive i stand til at restaurere på et kvalificeret grundlag var det nødvendigt først at gennemføre et opmålingsarbejde og udarbejde en bygningshistorisk undersøgelse, som kunne danne grundlag for formuleringen af et byggeprogram. Man satte sig for at finde ud af, hvad der var tilbage af arkitektoniske og antikvariske værdier – og hvor de var. Fordi bygningerne stod tomme ved overtagelsen, var det muligt at foretage såkaldte

In 2007, the Ministry of Defense wanted to sell the entire complex, consisting of four independent buildings and a number of smaller sheds, which together with walls and gates encircled a fine little garden with chestnut trees and rose bushes.

### **Inalienable qualities and new life**

As soon as Realdania Byg acquired the property, it set about deciding what the buildings would be used for. The company felt it would be most profitable to convert and rent them out as offices with common facilities in the form of meeting rooms and a shared lunchroom, but in a manner that respected and reinforced the buildings' inherent qualities to a greater extent than before. The company also began to consider what it would take to ensure the heritage values that it hoped to find. In order to base restoration on a solid foundation, studies had to be carried out and a technical survey devised so that a building program could be formulated. The goal was to determine what and where architectural and antiquarian values remained. Because the buildings were empty when they were handed over, destructive studies could be used. They included pulling down lowered ceilings in places so that the original ceilings

*destruktive undersøgelser.* Dette betød bl.a., at nedhængte lofter blev revet ned visse steder, så man kunne tage de oprindelige lofter i øjesyn, ligesom gulvbelægningen og flere lag gulve blev fjernet for at konstatere tilstanden af det underliggende trægulv.

Sammenholdt med gamle tegninger og andre arkivalier konkluderede undersøgelsen, at de fire bygninger fra begyndelsen havde haft meget forskellige funktioner, og at dette naturligvis oprindeligt havde præget arkitekturen.

Uagtet at de fire bygninger var opført i hver sin periode og var tiltænkt hver sin funktion, var denne differentiering stort set forsvundet såvel ude som inde. I takt med at pakhusluger og gamle portåbninger blev lukket og erstattet af hvide sprossede vinduer, var der sket en uniformering af anlæggets bygninger. Indretningen af kontorer med brug af de samme materialer og den samme detaljeringsgrad overalt betød, at en del af bygningsanlæggets kvaliteter var forsvundet eller i det mindste var skjult. De oprindelige rumforløb var ændret flere gange, og fine bygningsdetaljer og snedkerarbejder var sløret og gemt bag utallige skillevægge af gipsplader, kilometervis af kabelbakker og under lag af pastikmaling, nålefilt og linoleum – hvis de da ikke helt var fjernet og dermed gået tabt for eftertiden.

could be inspected, and removing the top floor covering and several layers of floors below it to determine the condition of the underlying wooden flooring.

Using this information, along with old drawings and other historical documentation, the survey concluded that the four buildings had originally had very different functions, and that this had naturally influenced their original architecture.

Although the four buildings dated to four different periods and each had been conceived with a specific function in mind, this differentiation had largely disappeared both inside and out. As warehouse hatches and old gateways had been blocked up and replaced by white-framed, muntined windows, the buildings had taken on a uniform look. Converting them into offices, using the same materials and same level of detailing throughout, had meant that some of the complex's qualities had disappeared or at least had been hidden. The original floor plans had been changed several times, and fine building details and carpentry were blurred and hidden behind innumerable gypsum-board partition walls, kilometers of cable trays, and layers of acrylic paint, needle-felt carpeting, and linoleum – unless they had been removed entirely and consequently lost forever.

## Restaurering og CO<sub>2</sub>-reduktion

Intentionen med byggeprogrammet var derfor at gennemføre en klassisk restaurering og genopretning, hvis arkitektoniske kongstanke var at genskabe de fire bygningers oprindelige særpræg og den indbyrdes forskellighed, som bygningerne var født med.

Omtrent samtidig med overtagelsen af Fæstningens Materialgård i 2007, fik København overdraget værtsskabet for det klimatopmøde, som i december 2009 skulle konkretisere og beslutte afløseren for Kyoto-protokollen, og hvis endelige mål var at få en ny aftale i hus om en væsentlig reduktion af verdens CO<sub>2</sub>-udledning. Det lykkedes som bekendt ikke, men topmødet gav anledning til formulering og gennemførelse af mange projekter, der havde ambitionen om CO<sub>2</sub>-reduktion til fælles og dermed egnede sig til at blive præsenteret i forbindelse med topmødet.

Det satte også tanker i gang hos Realdania Byg, som mente, at det ville være oplagt at undersøge og demonstrere, hvor meget man kunne reducere CO<sub>2</sub>-udledningen i en fredet bygning gennem energireovering. Realdania Byg valgte derfor at gennemgå sine fredede ejendomme for at finde en, der egnede sig til formålet. Valget faldt hurtigt på Fæstningens Materialgård af den indlysende årsag, at de fire

## Restoration and CO<sub>2</sub> reduction

The building program consequently aimed at carrying out classical restoration and rehabilitation with the principal architectural goal of recreating the original distinctive appearance of the four buildings and their original mutual diversity.

At about the same time as Realdania Byg took over the Fortifications Depot in 2007, Copenhagen was charged with hosting the climate summit in December 2009 that was to concretize and decide on the successor to the Kyoto Protocol, its final goal being to bring about a new agreement on a significant reduction in the world's CO<sub>2</sub> emissions. Though the summit failed, it did lead to the formulation and implementation of many projects with the common ambition of reducing CO<sub>2</sub> emissions and consequently were suitable for presentation at the summit.

Realdania Byg decided that this would be an obvious opportunity to investigate and demonstrate how much CO<sub>2</sub> emissions could be reduced in a heritage (listed) building through energy conservation. It took a careful look at all its heritage properties to find one that was suitable for the purpose. The choice quickly fell on the Fortifications Depot, for the obvious reason that its four buildings differed with a view to

*Modsatte side:  
Destruktive undersøgelser  
konkluderede, at de fire  
bygninger fra begyndelsen  
havde haft meget forskellige  
funktioner og arkitektur.*

*Opposite page:  
Destructive studies  
concluded that the four  
buildings had originally  
had very different functions  
and architecture.*





bygninger var forskellige i såvel arkitektur og alder som i konstruktion, hvorfor det var muligt at gribe energiproblematikken an på fire forskellige måder.

## Valg og fravalg

Ret hurtigt tegnede konturerne af en række tilsyneladende modsatrettede og helt centrale spørgsmål sig dog: Hvordan behandler man kulturarven og klimaet ligeværdigt, når hensynet til arkitekturen vejer tungest? Hvordan kan man energirenovere uden at antaste de arkitektoniske og fredningsmæssige værdier? Hvordan kan man reducere CO<sub>2</sub>-udledningen og samtidig overholde arbejdsmiljølovens krav til indeklimaet i kontorarbejdspladser?

På den baggrund besluttede Realdania Byg at gøre Fæstningens Materialgård til genstand for demonstrationsprojektet 'Energirenovering i fredede bygninger'. Projektet skulle 1:1 vise, hvor vidtgående det er muligt at energirenovere et fredet bygningskompleks under hensyntagen til de særlige forhold, der gælder, når bygningerne skal bruges til kontorarbejdspladser. Selv om fredede bygninger i Danmark udgør under en halv procent af den samlede bygningsmasse og altså ikke tæller meget i global sammenhæng, når det gælder energibesparelser, valgte byg-

architecture, age, and structure, making it possible to approach energy conservation in four different ways.

## Choosing and rejecting

A number of seemingly conflicting and very central questions soon became obvious. How can the cultural heritage and the climate be given equal consideration when attention to the architecture is paramount? How can energy-conservation measures be carried out without compromising the buildings' architectural and heritage values? How can CO<sub>2</sub> emissions be reduced yet ensure that the Working Environment Act's provisions concerning the indoor air quality in office workplaces are still met?

Realdania Byg decided to make the Fortifications Depot the subject of a demonstration project, "Energy Conservation in Historical Buildings." The project was to demonstrate on a 1:1 scale the extent to which energy-conservation measures can be carried out in a heritage building complex, taking account of the special provisions in force when buildings are going to be used as office workplaces. Although heritage buildings account for less than half a percent of the total building stock

herren at vende argumentet rundt: Hvis man selv i en fredet bygning kan opnå en betydelig CO<sub>2</sub>-reduktion ved at energirenovere, hvor meget vil det så ikke være muligt at reducere CO<sub>2</sub>-udledningen i det almindelige byggeri, som ikke er underlagt skrappe fredningsbestemmelser?

## Tværfaglig dialog

Det blev besluttet at integrere energiprojektet i restaureringen på et tidspunkt, da man var i gang med projekteringen. Bygherren benyttede imidlertid anledningen til at gå et skridt baglæns i processen og give tid til at gennemføre en formaliseret analysefase forud for det konkrete byggeprojekt. Der blev derfor nedsat en tværfaglig arbejdsgruppe med deltagelse af arkitekter, konstruktionsingeniører, vvs-ingeniører, fredningsmyndigheder og bygherre selv. Gruppen skulle fungere som projektets styrende instrument, og dens væsentligste opgave lød på at analysere mulige CO<sub>2</sub>- og energibesparende tiltag og redegøre for, hvilke energimæssige konsekvenser tiltagene ville have i forhold til fredningsværdier, arkitektur, konstruktion, indeklima og økonomi.

Analysedelen mandede ud i en rapport med en indkredsning af, hvilke energitiltag der ville være mulige at gennemføre i projektets anden fase, der omfattede det konkrete byggeprojekt.

in Denmark, and consequently do not account for much in a global context when it comes to saving energy, the client decided to reverse the argument. If a significant CO<sub>2</sub> reduction can be achieved even in a heritage building through energy conservation, how much more could CO<sub>2</sub> emissions be reduced in ordinary buildings that are not subject to strict heritage regulations?

## Interdisciplinary dialogue

Realdania Byg decided to integrate the energy project in the restoration work at a point when planning was already under way. It took a step back in the process and made enough time to carry out a formalized analysis before the building project was begun. An interdisciplinary working group was set up for the purpose comprising architects, structural engineers, HVAC engineers, the heritage authorities, and the client. The group was to serve as the project's governing body, and its most important task was to analyze potential measures to reduce CO<sub>2</sub> emissions and energy consumption and clarify what consequences these measures would have for the complex's heritage values, architecture, structure, indoor climate, and economy.



The analysis phase resulted in a report that identified energy-saving measures that could be carried out in the second phase: the building project itself. The report was also intended to serve as inspiration for similar projects to remodel and convert heritage buildings into offices.

The interdisciplinary working group was given adequate time – nearly a year – so that final choices could be made on the best possible foundation. To do so, it held a number of workshops that were initially spent literally in role-playing, with each participant acting out his or her own professional part. To put it simply, the client, for example, played the role of a landlord who was less concerned about how the work was done as long as the restored buildings could be rented out. The engineer was supposed to ignore how the result looked and concentrate on saving energy. The heritage authorities were supposed to do their utmost to safeguard historical values.

The goal was naturally not to get the different professions to engage in a round of mudslinging, but rather to objectively describe and provide an argument for choosing or rejecting potential measures. This proved both a challenging and an enriching process for all parties, since it was difficult, but also educational,

Tanken var, at rapporten også kunne fungere som inspiration for andre lignende opgaver, hvor fredede bygninger ombygges og indrettes til kontorer.

Processen i den tværfaglige arbejdsgruppe tog det meste af et år, hvilket var helt bevidst, fordi man ønskede at træffe de endelige valg ud fra et så kvalificeret grundlag som muligt.

Gruppen holdt derfor en række møder, hvor man i begyndelsen ganske bogstaveligt spillede et rollespil – hver med sin faglige kasket på. Sat lidt på spidsen betød det, at bygherren eksempelvis indtog rollen som udlejeren, der var mindre optaget af, hvordan det blev konstrueret, når blot de restaurerede bygninger ville kunne lejes ud. Ingeniøren skulle ignorere, hvordan det så ud, og i stedet koncentrere sig om at spare energi, mens fredningsmyndigheden skulle varetage bevaringsværdierne bedst muligt.

Formålet var naturligvis ikke faglig mudderkastning men derimod sagligt at beskrive og argumentere for både valg og fravalg af mulige løsninger. Det viste sig at være en både udfordrende og berigende proces for alle parter, idet det var svært, men samtidig lærerigt, at blive tvunget til at sætte ord på, hvorfor én løsning kunne accepteres, mens en anden ikke kunne. Hvorfor afslår man at montere solceller på en teglbeklædt, fredet bygning? Handler det udelukkende om

to be forced to verbalize why one measure could be accepted while another could not. Why refuse to mount solar panels on a heritage building with a tile roof? Just because of how it would look, or might there be a fundamental and perhaps better reason, and if so, what would it be?

The experiment showed that although the different professions initially stuck to their own accepted positions and reacted as expected, slowing down or actually blocking a dialogue, in time it had the opposite effect. The dialogue provided greater insight into one another's areas of expertise, and greater mutual understanding of and focus on aesthetic and technical characteristics that made it possible to find good solutions as a team. Since everyone had to listen the others' arguments for and against the various proposals, each member of the group stepped out of his role and permitted himself to think in a new way. What was difficult and educational for the individual was to keep to his own role's arguments, for example keep a sharp focus on architecture without thinking of heritage aspects. The most important lesson was that plumbing and wiring had to be taken into account right from the beginning, which meant that engineers already had an important part to play in the sketching process.

*Modsatte side:  
Det blev besluttet at integrere energiprojektet i restaureringen på et tidspunkt, da man var i gang med projekteringen.*

*Opposite page:  
Realdania Byg decided to integrate the energy project in the restoration work at a point when planning was under way.*

udseendet, eller er der en underliggende og måske bedre grund, og hvordan ser den ud?

Eksperimentet viste, at selv om de forskellige faggrupper i begyndelsen nok holdt fast i egne vedtagne holdninger og forventelige reaktioner, som bremsede eller ligefrem forhindrede dialogen, så havde det på længere sigt den modsatte effekt. Dialogen gav nemlig en større indsigt i hinandens fagområder og større gensidig forståelse for og fokus på æstetiske og tekniske egenskaber, som gjorde det muligt at finde gode løsninger i fællesskab. Når alle var nødt til at høre på hinandens argumenter for og imod de enkelte forslag, resulterede det i, at den enkelte trådte ud af den fastlåste rolle og tillod sig at tænke nyt. Det svære og lærerige for den enkelte var at holde sig til sin egen rolles argumenter og eksempelvis være helt skarp på det arkitektoniske uden at tænke fredning. Den vigtigste lære var, at de tekniske installationer skulle tænkes ind i projektet helt fra starten, og at ingeniørerne derfor havde en vigtig rolle at spille allerede i skitseringsprocessen.

### **Grovsortering af bruttoliste**

På baggrund af byggeprogrammets beskrivelse af bygningshistorie og eksisterende forhold samt af analysen af de antikvariske og arkitekto-

### **Shortening the long list**

A long list of all possible – and impossible – energy-saving measures was drawn up on the basis of the building program's description of the complex's history and existing conditions, and of an analysis of its antiquarian and architectural values. The list was deliberately drawn up without taking architecture or heritage values into account, and neither were location, physical conditions, or function considered. This was done in order to provide the broadest possible foundation for the work.

Each of the measures on the long list was accompanied by an evaluation form that the members of the group used to analyze and justify accepting or rejecting measures from their expert point of view. It was the client's task to evaluate the energy-saving measures' affect on whether the premises could be rented out, and on operations and maintenance. The heritage authorities were to view the measures based on their knowledge of building typology. The architect's task consisted of evaluating the form, function, and integration potential of the energy-saving measures and seeing how they harmonized with the goals of the restoration project. The structural engineer was asked to analyze the significance of the energy-saving measures for the buildings' existing structures, especially in

niske værdier blev der udarbejdet en bruttoliste over alle tænkelige – og utænkelige – energibesparende tiltag. Listen blev bevidst udarbejdet uden hensyntagen til arkitektur og fredningsværdier, ligesom forslagene heller ikke tog beliggenhed, bygningsfysiske forhold eller funktion med i betragtning. Dette var for at have det bredest mulige grundlag at arbejde ud fra.

Til alle bruttolistens forslag blev der desuden udarbejdet vurderingsskemaer, hvor gruppens deltagere hver især skulle analysere og begrunde afslag eller accept af forslagene ud fra faglige betragtninger. Det var således bygherrens opgave at vurdere de enkelte energitiltags indvirkning på udlejningsmuligheder og på drifts- og vedligeholdelsesmæssige forhold. Fredningsmyndigheden skulle se på tiltaget ud fra et bevaringsmæssigt synspunkt baseret på deres viden om bygningstypologi. Arkitektens opgave bestod i at vurdere form, funktion og indpansningsmæssige forhold i de enkelte energibesparende forslag og holde dem op mod restaureringsprojektets ideer. Konstruktionsingeniøren blev bedt om at analysere energiforslagenes betydning for de eksisterende konstruktioner, især i forhold til fugtbalance. Endelig spillede vvs-ingeniøren en central rolle, idet han for hver bygning skulle vurdere forslagets betydning for, hvor meget energi, der kunne spares,

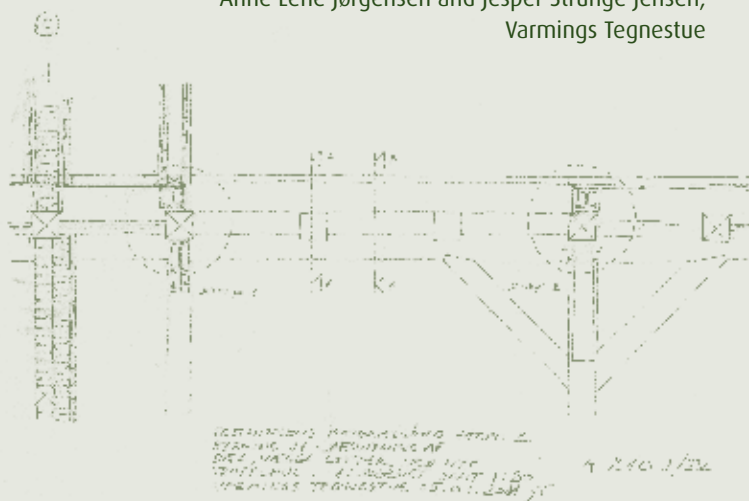


Den store fordel ved at arbejde med fire forskellige bygninger var, at vi kunne tænke i at placere funktionerne rigtigt i forhold til bygningernes egenskaber og formåen. Helt afgørende er at vi i dette projekt fik lov at lave en dybdegående analyse af bygningernes energimæssige opførsel, der viste, hvor de satte energi til, og hvordan indeklimaet var.

Anne Lene Jørgensen og Jesper Strunge Jensen,  
Varmings Tegnestue

The great advantage of working with four different buildings is that we were able to think about locating facilities correctly in relation to the buildings' characteristics and capabilities. What was completely decisive was that we were allowed to make an in-depth analysis of the buildings' energy patterns to show where energy was consumed and the state of the indoor climate.

Anne Lene Jørgensen and Jesper Strunge Jensen,  
Varmings Tegnestue



og om indeklimaet blev acceptabelt, hvad angik rumtemperatur og luftskifte.

Første arbejdsgruppevurdering gik ud på at foretage en grovsortering af bruttolisten ud fra de vurderinger, som fremgik af skemaerne. For hver af de fire bygninger var der til at begynde med lige knap 40 forslag som f. eks. ideen om at udskifte de originale vinduer til nye energivinduer. Dette blev dog forkastet med det samme af bygherre, arkitekter og fredningsmyndigheden, fordi forslaget hverken respekterede arkitekturen eller fredningen.

Heller ikke et forslag om nye vinduer med aktiv indvendig solafskærmning som f. eks. persiener kom længere i processen. Det ville naturligvis minimere varmetabet og reducere kuldebroer, men forslaget blev ved første arbejdsgruppevurdering afslået af fredningsmyndigheden, der ikke kunne acceptere integreret solafskærmning i et historisk vindue. Heller ikke arkitekterne kunne gå ind for forslaget, fordi de mente, at persiener mellem vindue og forsatsvindue ville have uacceptable arkitektoniske konsekvenser for helheden i bygningen. Derimod anbefalede både konstruktionsingeniøren, vvs-ingeniøren og bygherren i første omgang forslaget til videre behandling. Denne skulle blandt andet dokumentere, om manuelt betjente persiener på den ene side kunne af-

relation to the moisture balance. The HVAC engineer played a key role, since he had to evaluate for each building how much energy could be saved by adopting the measures, and whether the resulting indoor climate's room temperature and air circulation were acceptable.

The first workshop was spent shortening the long list based on the evaluation forms. Initially there were nearly 40 proposals for each of the four buildings, for example replacing the original windows with new energy-efficient windows. This was immediately rejected by the client, architects, and heritage authorities, because it respected neither the architecture nor the buildings' heritage status.

The proposal for new windows with active indoor shading devices, for example blinds, got no further either. It would naturally have minimized heat loss and reduced thermal bridges, but at the first workshop it was rejected by the heritage authorities, which could not accept integrated shading in a historical window. The architects were also unable to accept the proposal, since they believed that blinds between the outer and secondary windows would have unacceptable architectural consequences for a building's overall appearance. The structural engineer, HVAC engineer, and client, in contrast, initially approved the proposal. A further study

hjælpe problemer med overtemperaturer om sommeren og på den anden side sikre et varmetilskud om vinteren og dermed, om forslaget ville have nogen målbar effekt på energiforbruget. Når forslaget alligevel ikke gik videre til anden arbejdsgruppevurdering, var det fordi de arkitektoniske og fredningsmæssige værdier vejede tungest i vurderingen og ikke måtte antastes.

## **Blower-door-test og termografering**

Som led i indsamlingen af data om de eksisterende forhold blev der gennemført to undersøgelser, der skulle dokumentere om de gamle bygninger var utætte og i givet fald hvor. Den ene var en såkaldt blower-door-test, der ved at generere trykforskel mellem ude og inde kunne vise, hvor utæthederne var og dermed, hvor energien blev brugt. Bygningstætheden beregnes ud fra, hvor meget luft der skal tilføres for at opretholde trykket. Undersøgelsen viste, at der var mange utætheder i og omkring vinduerne – blot ikke i Materialforvalterboligen, som viste sig at have en tæthed på højde med nyere byggerier. Desuden var der et generelt problem med kolde luftstrømme ved gulvet. Bindingsværksbygningen var faktisk så utæt, at det

was intended to document whether manually operated blinds could alleviate problems with overheating in the summer, on the one hand, and contribute additional heat in the winter, on the other, and thus if the proposal would have any measurable effect on energy consumption. The proposal nonetheless failed to reach the second workshop because architectural and heritage values carried greater weight in the evaluation and could not be challenged.

## **Blower-door testing and thermal infrared photography**

As part of the process of collecting data on existing conditions, two studies were carried out to document the old buildings' airtightness and localize any leakage. One was a blower-door test, which generates a difference in building-to-outside pressure to show where air leakage was found and consequently where energy was used. A building's airtightness is calculated according to how much air must be added in order to maintain pressure. The test showed that there was a great deal of leakage in and around the windows, though not in the Superintendent's Residence, which was found to have airtightness on a par with that of modern buildings. In addition, cold air currents at floor



overhovedet ikke kunne lade sig gøre at opbygge tryk.

Disse forhold blev yderligere underbygget af en termografisk undersøgelse foretaget med et infrarødt kamera, som dokumenterede et stort varmetab omkring vinduer og døre – selv omkring forholdsvis nye ovenlysvinduer – samt ved skunkvægge og lofter med gennembyrninger til rør og kabler.

## Energianalyse

Frem mod andet arbejdsgruppemøde blev der udarbejdet en computermodel ved hjælp af simuleringssprogrammet BSim, der beregner energi- og indeklimateforhold. Først blev et omfattende datamateriale over bygningernes temperaturforhold, vand- og varmekonsumtion, som forsvaret hver dag gennem mange år havde registreret, indarbejdet i modellen.

Dernæst blev også alle eksisterende bygningsdeles konstruktioner, areal og orientering lagt ind i computermodellen og suppleret af tal for personbelastning og belysning. Dette gjorde det muligt at beregne det eksisterende energiforbrug fordelt på de enkelte bygningsdele og samtidig få et indtryk af det eksisterende termiske indeklima i et udvalg af rum fordelt på forskellige etager i de fire bygninger. Endelig

level proved a general problem. Leakage in the Half-timbered Building was actually so great that it was impossible to generate any pressure.

These conditions were further confirmed by thermal infrared photography, which documented considerable heat loss around windows and doors – even around the fairly new skylights – and at jamb walls and attics where holes had been made for pipes and cables.

## Energy analyses

Before the group's second workshop, a computer simulation model was created using BSim, which calculates energy consumption and indoor climate. A large amount of data on the buildings' temperature conditions and water and heat consumption was incorporated into the model using daily statistics that the Ministry of Defense had compiled over a period of many years.

Then data on all of the structures, spaces, and orientation of the existing buildings were fed into the computer model and supplemented with figures for person load and lighting. This made it possible to calculate the existing energy consumption for the individual building sections, and at the same time get an impression of the existing thermal indoor climate in

*Modsatte side:  
Hele restaureringen  
og nyindretningen af  
Fæstningens Materialgård  
vil give plads til 40 flere  
arbejdspladser.*

*Opposite page:  
Restoring and converting  
the Fortifications Depot  
would make room for  
40 more workplaces.*



blev de energiforslag, der var anbefalet til videre behandling, beregnet i forhold til potentialet for energibesparelse, simpel tilbagebetalingstid og CO<sub>2</sub>-besparelse. Det udgjorde grundlaget for andet vurderingsmøde, som resulterede i indkredsningen af en nettoliste med beskrivelser af, hvordan det enkelte energibesparende tiltag kunne udføres, og hvilken effekt det ville have i forhold til besparende effekt i energimængde, indeklimamæssig effekt, netto CO<sub>2</sub>-besparelse og simpel tilbagebetalingstid, ud fra nuværende energipriser.

Formålet med den tredje vurdering var at foretage en kvalitativ udvælgelse blandt de af nettolistens energibesparende forslag, som samlet ville kunne understøtte hinanden i stedet for at gå i hver sin retning og dermed muligvis modarbejde hinanden. Forslagene skulle desuden være fornuftige i forhold til de overordnede retningslinjer i restaureringsprojektet og bygherrens indretningsønsker, og de skulle kunne realiseres under hensyntagen til fredningsværdierne.

Den fjerde og sidste vurderingsrunde blev brugt til at gennemgå og korrigere det samlede energirenovationsprojekt, i de tilfælde hvor eventuelle delprojekter ikke levede op til forventningerne til CO<sub>2</sub>-besparelse, energibesparelse og til kvaliteten af indeklimaet.

a selection of rooms on different stories in the four buildings. And finally, the energy measures that had been recommended for further consideration were calculated in relation to their potential energy reduction, simple payback time, and CO<sub>2</sub> reduction. This comprised the basis for the second workshop, which resulted in a short list with descriptions of how each energy-saving measure could be carried out, and what effect it would have on energy reduction, indoor climate, net CO<sub>2</sub> reduction, and simple payback time based on current energy prices.

The goal of the third workshop was to make a qualitative choice among the short list's energy-saving proposals, which in combination would be mutually reinforcing instead of taking different directions and possibly counteracting one another. The proposals would also have to harmonize with the restoration project's overall guidelines and the client's wishes for how the buildings were to be converted, and moreover be achievable considering the buildings' heritage values.

The fourth and last workshop was spent reviewing and amending the energy-conservation project as a whole where parts of it might not live up to expectations for CO<sub>2</sub> and energy reduction and for indoor-climate quality.

## Energiberegninger og faktiske besparelser

Resultatet af de grundige energiberegninger viste, at det ville være muligt at opnå CO<sub>2</sub>-besparelser på næsten 20 procent ved at gennemføre energibesparende indgreb, der ikke væsentligt antastede bygningernes fredningsværdier. Det tal udgør imidlertid kun halvdelen af regnskabets. Den faktiske CO<sub>2</sub>-besparelse ligger mellem 4 og 8 procent, idet konsekvensen af at tætte bygningerne og dermed reducere varmetabet er, at rumtemperaturen samtidig øges. For at kunne leve op til Arbejdstilsynets krav til indeklima og komfort i kontorarbejdspladser, som tilsiger, at der ikke må være mere end 20-22° og, at temperaturen om sommeren ikke må overstige 25°, skal der altså bruges energi på at køle.

Et eksempel på dette er det energitiltag, som arbejdsgruppen efter sidste vurdering havde besluttet at gennemføre som et af de væsentligste nemlig at udskifte glasset i forsatsvinduer med energiglas. Det ville reducere varmeforbruget med 26,08 procent men på grund af glassets bedre isoleringsevne samtidig øge rumtemperaturen. Det betød, at behovet for at køle bygningen i varme perioder også ville stige og samlet medføre en øget CO<sub>2</sub>-udledning på 21,88 procent. Da energiglas samtidig har en ringere

## Energy calculations and actual reductions

The result of the detailed energy calculations showed that it would be possible to achieve CO<sub>2</sub> reductions of nearly 20 percent by implementing energy-saving measures that did not significantly impact the buildings' heritage values. This figure accounts for only half of the balance, however. The actual CO<sub>2</sub> reduction is 4-8 percent, since when airtightness is improved, reducing heat loss, room temperatures simultaneously rise. In order to meet the Danish Working Environment Authority's standards for indoor climate and comfort in office workplaces – specifying that the temperature may not exceed 20-22° C. (25° C. in summer) – energy must be used for cooling.

One example is the measure that the working group considered most important and had decided to carry out after its last evaluation: replacing the glass in the secondary windows with low-emissivity (low-E) glass. This would reduce heating by 26.08 percent, but also increase the room temperature because of the glass's better insulation properties. This meant that the need for cooling the building in hot spells would also rise, resulting in increased CO<sub>2</sub> emissions of 21.88 percent. Since low-E glass has poorer light penetration than



*Resultatet af de grundige energiberegninger viste, at det ville være muligt at opnå CO<sub>2</sub>-besparelser på næsten 20 procent.*

*The result of the detailed energy calculations showed that it would be possible to achieve CO<sub>2</sub> reductions of nearly 20 percent.*

lysgennemtrængning end almindeligt vinduesglas, viste beregningerne, at elforbruget ville øges med 3,75 procent, fordi der skulle bruges mere kunstig belysning. Alt i alt ville den forventede netto-CO<sub>2</sub>-besparelse blive 4,29 procent

Med til billedet hører dog også det faktum, at hele restaureringen og nyindretningen af Fæstningens Materialgård ville give plads til flere arbejdspladser – faktisk 40 flere arbejdspladser – end bygningerne hidtil havde huset. Takket være energirenoeringen ville hver medarbejder dog belaste energiregnskabet mindre og dermed udlede mindre CO<sub>2</sub>. Med andre ord: En mere intensiv udnyttelse af en energirenoveret bygning betyder et bedre CO<sub>2</sub>-regnskab pr. arbejdsplads.

ordinary window glass, calculations showed that electricity consumption would rise by 3.75 percent because more artificial light would be required. All in all, the expected net CO<sub>2</sub> reduction would be 4.29 percent.

Another matter had to be taken into consideration. Restoring and converting the Fortifications Depot would make room for more workplaces – an extra 40, in fact – than the buildings had previously accommodated. Thanks to energy conservation, however, each worker would have a smaller impact on the energy balance and consequently emit less CO<sub>2</sub>. In other words: more intensive use of an energy-conserved building means a better energy balance per workplace.

## 2: RESTAURERING OG ENERGIRENOVERING

### Hierarki og helhed

Kongstanken bag restaureringen af Fæstningens Materialgård har som nævnt været at genskabe og fremhæve den kvalitet, at anlæggets bygninger oprindeligt var af ganske forskellig karakter og underlagt et indbyrdes hierarki, som tilsammen dannede en helhed. Materialforvalterboligen skal efter restaureringen således atter indtage sin naturlige plads øverst i hierarkiet som den fornemme og repræsentative bygning. Magasinbygningen er blevet befriet for årtiers kontorindretning af svingende kvalitet, så de oprindelige fine rumforløb kommer til deres ret igen, og Halvtags-husenes oprindelige udseende er genopstået i en nyfortolket udgave. Endelig har Bindingsværksbygningen igen fået karakter af pakhus.

Et væsentligt element i restaureringsprojektet har været at bruge den bygningshistoriske analyse som et redskab til at fastlægge karakteren af den enkelte bygning detaljeringsgrad, således at den passer til bygningens arkitektur, funktion og stemning.

### Materialforvalterboligen

Materialforvalterboligen er opført ud mod Frederiksholms Kanal som en grundmurret bygning i ni fag med gulkalkede facader

## 2: RESTORATION AND ENERGY CONSERVATION

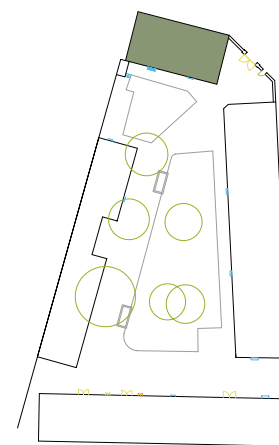
### A hierarchy and the whole

The principal goal of restoring the Fortifications Depot was to recreate and highlight the complex's distinctive character: buildings that had originally been quite diverse and were part of a hierarchy that formed a whole. After restoration, the Superintendent's Residence was once again to assume its natural place in this hierarchy as a distinguished building. The Magazine has been unburdened of decades of office interiors of disparate quality, so that the original fine sequences of rooms have come into their own again. The Shed Building's original appearance has been reinterpreted. The Half-timbered Building now looks like what it was to begin with: a warehouse.

An important element in the restoration project was to use the historical analyses as a tool for determining the character of an individual building's level of detailing, so that it suits the building's architecture, function, and atmosphere.

### The Superintendent's Residence

The Superintendent's Residence was built along Frederiksholms Kanal (the name of both the canal and the street) as a brick structure



under et rødt tegltag. Bygningen rejser sig i en etage over en høj kælder og med en høj mansardetage i taget, der prydes af en trefags gavlkvist mod gade og gård. Den høje sokkel hæver bygningen over gadens niveau og lægger afstand til de øvrige bygninger i anlægget, hvorved bygningens særlige betydning i Fæstningens Materialgård understreges. Bygningen var fra begyndelsen bolig for materialforvalteren men havde også udadvendte repræsentative funktioner. Dette afspejler sig i et tydeligt hierarki mellem etagerne med stueetagens rigt udstyrede sale og kabinetter mod gaden og kanalen. Første sal har dannet ramme om den private sfære, og kælderen har haft praktiske funktioner.

Den bygningshistoriske analyse fastslog, at de bærende fredningsværdier i Materialforvalterboligen først og fremmest er bygningens repræsentative karakter og placering i anlæggets helhed og det indbyrdes forhold og hierarkiet mellem etagerne. Også bygningens stilhistoriske sammensatte rum og interiører har stor betydning, ligesom de mange snedkerdetaljer, som oprindelige vinduesrammer og døre, brystnings- og lysningspaneler, skodder i vinduesnicherne, samt gerichter og fodpaneler udgør en væsentlig del af fredningsværdierne. Huset indeholder elementer fra både barok, empire og

nine bays long, with yellow, limewashed facades under a red-tile roof. The building has one story above a high basement as well as a high mansard story in the roof, embellished with three-bay, pedimented front gables on the street and the courtyard. The high plinth raises the building above street level and differentiates it from the other buildings in the Fortifications Depot, emphasizing its special significance in the complex. It originally housed the Superintendent, but was also used for official functions, something that is reflected in the different stories' clear hierarchy. The ground floor's richly decorated rooms, large and small, faced the street and canal. The second story formed the private sphere, and the basement served practical needs.

The historical analysis showed that the primary heritage values in the Superintendent's Residence are its distinguished character and location in the complex as a whole, and the mutual relationship and hierarchy of its different stories. The building's stylistically composite rooms and interiors are also highly significant, as are the many carpentry details. The original window frames and doors, dados and reveals, shutters in the window niches, architraves and baseboards account for much of its heritage value. The building features Baroque, Empire, and



*Materialforvalterboligen er opført ud mod Frederiksholms Kanal som en grundmuret bygning med gulkalkede facader og et rødt tag.*

*The Superintendent's Residence was built along Frederiksholms Kanal as a brick structure with yellow, limewashed facades under a red-tile roof.*



klassicisme, som lever fint side om side, hvori- mod senere tilføjelser ikke på samme måde bi- drager positivt til helheden.

### **Restaurering med mange lag**

Restaureringen lægger ikke ét enkelt tidsmæssigt snit i huset men søger i stedet både at bevare vis- se elementer, som de er, og foretage en delvis til- bageføring af husets hoveddisponering. Endelig tilføjer restaureringen også et nyt lag til husets historie, som tager udgangspunkt i de tilstede- værende stilarter men gendigter dem i en nutidig fortolkning som et bud på, hvordan et hus fra midten af 1700-tallet kan tage sig ud i 2012. Den overordnede rumlige idé har været at bevare hierarkiet mellem bygningens etager, etablere en klar og sammenhængende rumstruktur, frem- drage og styrke de rigt udstyrede interiører og endelig at udforme en trappeforbindelse og som passer til bygningens repræsentative karakter, i den østlige del af bygningen, som har færrest ar- kitektoniske og antikvariske værdier.

### **Trappen**

Bygningens eksisterende trappe fungerede ikke optimalt, da man fra stueetagen var nødt til at gå en halv etage op ad én trappe og derpå

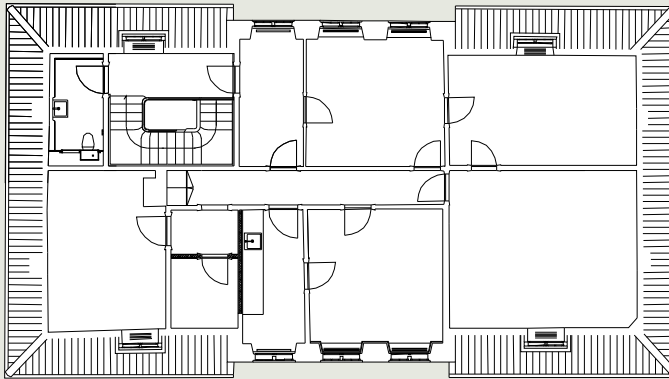
and classicist elements that coexist nicely, while later additions make no real positive contribu- tion to the whole.

### **Restoration with many layers**

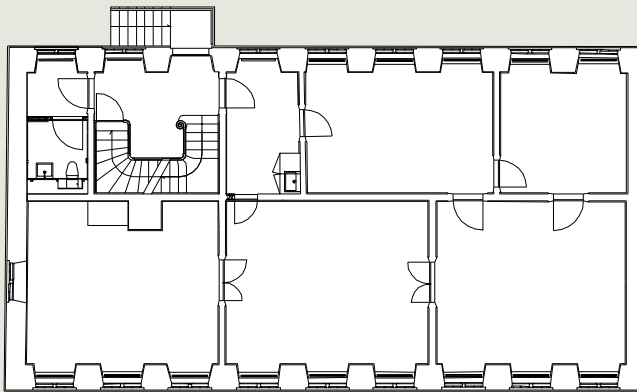
Instead of keeping to one specific period in the building, restoration endeavored both to pre- serve certain elements as they are and to par- tially recreate the building's main plan. Resto- ration also added a new layer to the building's history, based on the styles that are present, but giving them a modern reinterpretation to show how a structure from the mid-18th century can look in 2012. The overall spatial concept was to preserve the stories' hierarchy, establish a clear and cohesive room structure, highlight and reinforce the richly appointed interiors, and design a suitably distinguished stairwell for the eastern part of the building, which has the fewest architectural and anti- quarian values.

### **The staircase**

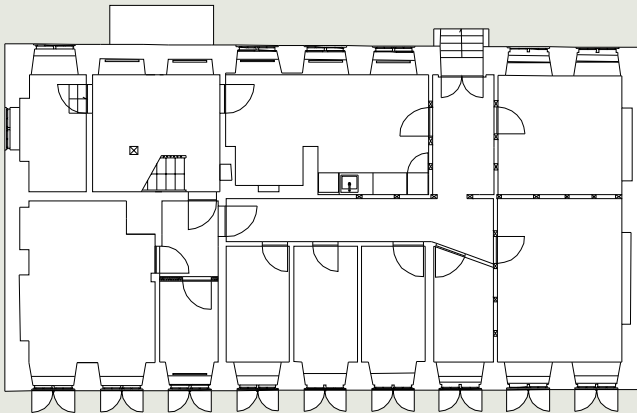
The building's staircase did not function opti- mally, since a person on the ground floor had to walk up half a story on one staircase and then enter another room to continue up the stairs



*1. sal / 2nd story*



*Stuen / Ground floor*



*Kælderen / Basement*

*Den overordnede rumlige idé har været at bevare hierarkiet mellem bygningens etager, etablere en klar og sammenhængende rumstruktur, fremdrage og styrke de rigt udstyrede interierer og endelig at udforme en trappeforbindelse.*

*The overall spatial concept was to preserve the stories' hierarchy, establish a clear and cohesive room structure, highlight and reinforce the richly appointed interiors, and design a stairwell.*

*Den tidligere trappe  
blev revet ned og erstattet  
af en ny. Den nye trappe  
giver bedre cirkulation  
rundt på etagerne.*

*The old staircase was  
demolished and replaced  
by a new one. This one  
gives better circulation  
on the stories.*



gå ind i et andet rum for at komme videre ad trappen til første sal. Endelig var der øverst et halvt trappeløb, som ganske mærkværdigt endte blindt. Trappens placering i andet og tredje fag fra østgavlen betød desuden, at det ikke var muligt at bevæge sig rundt gennem alle rum på etagen. Derfor blev den tidligere trappe revet ned og erstattet af en ny – uagtet at den var gammel og nok rummede, om ikke antikvarisk værdi, så dog en kulturhistorisk værdi, men i det samlede billede vejede den arkitektoniske og funktionelle vurdering tungest.

Først blev det undersøgt, om det ville være muligt at flytte trappen et fag længere mod vest, men den løsning viste sig at hænge dårligt sammen med konstruktionen i etagedækket. Endvidere ville det betyde, at der skulle indføres en ny stålkonstruktion i etageadskillelsen, som ikke harmonerede med husets materialer, og med andre ord, ville gøre vold på bygningens egen vilje. Den nye trappe spænder derfor fortsat ud mellem andet og tredje fag men er vendt i forhold til den eksisterende trappe således, at den giver bedre cirkulation rundt på etagerne. For at overkomme den halve etage fra indgangsdøren til stueetagen er der desuden etableret en ny udvendig trappe, der fører til den nye hoveddør. Den udvendige trappe er belagt med granittrin og svarer i udtryk og materialer således



*Den nye trappe respekterer husets ånd og er derfor opført som en trætrappe med fine snedkerdetaljer og profileringer*

*The new staircase respects the building's spirit, and was therefore conceived as a wooden staircase with fine carpentry details and molding.*

to the second story. At the very top was a half staircase, which ended curiously in a blank wall. The staircase's location in the second and third bays from the east end wall moreover made it impossible to make a round of all the rooms on the story. This is why the staircase was demolished and replaced by a new one, although the old one had some cultural-historical value, if not antiquarian. In the overall picture, architectural and functional assessments outweighed it.

First the possibility of moving the staircase one bay farther to the west was considered, but the arrangement proved incompatible with the floor slab's structure. It would also have meant inserting a new steel structure in the subflooring that would not have harmonized with the building's other materials, and in other words would have infringed on the building's integrity. The new staircase consequently still takes up the

til både bygningens facader og til det brostensbelagte gårdrum.

Også den indvendige trappe respekterer husets ånd og er derfor opført som en trætrappe med fine snedkerdetaljer og profileringer, der nok har hentet inspiration i barokken men alligevel har en umiskendeligt nutidig udformning – ikke som en ny trappe i et nybygget hus – men én der passer præcis til Materialforvalterboligen. Intentionen er nemlig ikke at kopiere den oprindelige trappe eller forsøge at bilde nogen ind, at den kan have set ud som den nye trappe men derimod at styrke og bevare arkitektoniske værdier og tilføje nye elementer i traditionelle materialer. Dermed føjer trappen et lag til de mange forskellige perioders snedkerarbejder og fortæller en historie om arkitektonisk ophav, og om bygningens fortsatte udvikling.

### **Bevaringsværdige rumstrukturer**

I den øvrige del af Materialforvalterboligen hersker en fin og bevaringsværdig sammenhæng mellem stueetagens fire stuer, omend mange af kvalitetene var godt gemt bag årtiers lag af plastikmaling i farver, der ikke passede til huset og under misforstået brede plankegulve samt skæmmet af kabelbakker på tværs

second and third bays, but was turned in relation to the former staircase to give better circulation on the stories. Steps were built at the new front door, leading directly from the courtyard to the ground floor. Their granite corresponds in expression and material to both the building's facades and the cobblestoned courtyard.

The staircase inside the building also respects its spirit, and was therefore conceived in wood with fine carpentry details and molding. Although it displays inspiration from the Baroque, it nonetheless has an unmistakably modern design – not as a new staircase in a brand-new building, but one that perfectly suits the Superintendent's Residence. The intention was namely not to copy the original staircase or try to convince anyone that this is what the old one may have looked like, but rather to reinforce and preserve architectural values and add new elements in traditional materials. As a result, the staircase adds a layer to the carpentry of the building's many different periods, and tells a story about its architectural past and its continued development.

### **Room structures worth preserving**

There is a fine cohesion worth preserving in the rest of the Superintendent's Residence,



af vinduesnicher. Mod gaden lå oprindeligt bygningens fornemste rum – en sal i fire fag, der var omgivet af to kabinetter og et gennemgangsfag langs gavlen. Indretningen stemte altså ikke overens med facadens opdeling i tre gange tre fag, og da bygningsanalysen dokumenterede hvilke skillevægge, der var flyttet flere gange og hvilke, der var ældst og derfor vigtigst at bevare, gav det god mening at indrette tre mere ligeværdige rum en-suite mod gaden. Dermed har man i konstruktionen af et nyt hjørneværelse inddraget et tidligere toilet og et forrum i forbindelse med trappens oprindelige placering. Værelset får lys fra to sider og har fin udsigt til Kongens Bryghus og havnen. Fredningsmyndighederne har stået fast på vigtigheden af at bevare en gammel skorsten, som nu på grund af flytningen af skillevæggen står som en fremtrædende murpille i rummets bagvæg. Skorstenen har fået en anden farve end

comprising the four rooms on the second floor, though many of their qualities were well hidden behind decades of acrylic paint in colors that did not suit the building, under misplaced wide floor planks and cable trays spanning window niches. What had originally been the building's finest room lay on the street side, taking up four bays and flanked by two smaller rooms and a corridor along the end wall. The arrangement did not correspond to the facade's division into three + three + three bays, and when the building analysis documented which partition walls had been moved several times and which were oldest, and consequently should be preserved, it made sense to create three more equal, connecting rooms on the street. A former lavatory and vestibule next to the original staircase were incorporated into the new corner room. It receives light from two sides and commands a fine view of the King's

*I Materialforvalterboligen hersker en fin og bevaringsværdig sammenhæng mellem stueetagens fire stuer, omend mange af kvaliteterne var godt gemt.*

*There is a fine cohesion worth preserving in the Superintendent's Residence, comprising the four rooms on the second floor, though many of their qualities were well hidden.*

væggene, fordi den til forskel fra de øvrige vægge naturligvis ikke er lærredsbespændt. Skorstenen har aldrig været bespændt med lærred, da det jo ville have medført brandfare, dengang skorstenen endnu var i brug. Denne historiske detalje respekteres og understreges af ændringen i farvevalget.

Også på første sal er flere oprindelige rumforløb bevaret, og her rummer særligt de to kvadratiske stuer, med vinduer ud mod hver sin frontkvist, arkitektoniske og antikvariske værdier i form af intakte paneler og oprindelige døre med fint låsetøj. Her lå boligens opholdsrum med overdådige barokke vægdekorationer og rødt træværk, og restaureringen har derfor søgt at bevare og styrke rummenes barokstemning blandt andet gennem en nyfortolkning af de oprindelige farver.

Til sammenligning har de rum, der flankerer de fire stuer i mansardetagen en ganske anden og mere ydmyg stemning; det var loftrum uden dagslys, som sikkert har huset tyendet. De kviste, der i dag giver rummene dagslys, er først kommet til senere. Den ydmyge atmosfære er helt bevidst fastholdt og understreget i restaureringen ved hjælp af enkle bygningsdetaljer og neutrale farver på væggene, og det er især tagkonstruktionens frilagte skråbånd og bjælker, der giver rummene karakter.

Brewery and the harbor. The heritage authorities maintained the importance of preserving an old chimney, which because a partition wall was moved takes the form of a prominent pier on the room's back wall. The chimney was never covered with fabric, since it would have posed a fire hazard when the chimney was still in use. This historical detail was respected and emphasized by painting the walls and chimney different colors.

Several of the original room layouts were preserved on the second story as well, where the two square rooms, in particular, each with windows in the pedimented front gable, have architectural and antiquarian values in the form of intact panels and original doors with fine fittings. This was the residence's living room, with sumptuous Baroque wall decorations and woodwork painted red. Restoration endeavored to preserve and reinforce the rooms' Baroque atmosphere among other things by reinterpreting the original colors.

The areas that flank the four rooms on the mansard story, by comparison, have quite a different and more humble atmosphere. They comprised an attic without daylight, undoubtedly the servants' quarters. The dormers that now provide daylight are a later addition. A deliberate effort was made to maintain and un-

## Materialer, farver og dekorationer

Gulvene i stueetagen er sammensat af gamle gulvbrædder fra Magasinbygningen og Materialforvalterboligen, som er slebet men i øvrigt får lov at ligge i vekslende længder og bredder komplet med huller fra borebiller. Træværk og snedkerarbejder i Materialforvalterboligen, dvs. både trappen, døre, paneler, vinduesrammer og lysningspaneler, er malet i samme varme grå nuance, uanset om de stammer fra barokken, empiren eller er nye. At den ser ud til at variere i tone fra rum til rum skyldes dels vejrets skiften og dels væggenes skiftende farvetoner.

Alle rum har således hver sin farvetone, og paletten er tydeligt inspireret af barokkens farveglæde suppleret af empiretidens lettere tone i en nutidig arkitekts fortolkning; her er både okseblod, søgrøn, violet og babyrosa, dæmpet blågrå og grønjord. I stueetagen er farverne i form af mat silikatmaling strøget på opspændte lærredspartier med kost, mens de på første sal er strøget direkte på de pudsede vægge, hvilket begge steder resulterer i overflader med et raffineret lysspil.

Såkaldte farvetrapper, som en konservator har fremdraget af vægge og paneler, fører bevis for, at bygningen faktisk har indeholdt alle farverne på et eller andet tidspunkt i sit lange

derline the humble atmosphere during restoration with the aid of simple building details and neutral wall colors; the bare braces and beams, in particular, are what give the rooms character.

## Materials, colors, and decorations

The floors on the ground floor were assembled from floorboards from the Magazine and the Superintendent's Residence. They were sanded, but otherwise were laid in different lengths and widths, making no effort to disguise holes made by deathwatch beetles. The woodwork and carpentry in the Superintendent's Residence – staircase, doors, panels, window frames, and reveals – were painted in the same warm shade of gray, regardless of whether they date to the Baroque or Empire or are new. The fact that the color seems to vary in tone from room to room is due partly to changes in light with the weather and partly to the different colors used on the walls.

Each room has its own tone, the palette clearly inspired by the Baroque's love of color and the Empire's lighter hues as interpreted by a contemporary architect: oxblood, sea green, violet, baby pink, subdued bluish gray, and green earth. On the ground floor, the matte silicate paint was applied to sections of stretched





liv. Et sted fandt man således tre lag dekorationsmaling i form af kvader- og flise-imitationer, og et andet sted udspandt sig jagt- og landskabsscener. Ingen af dekorationerne var dog i en sådan stand, at de kunne bevares, og de blev i stedet registreret og pudset over med en let puds, så de nu ligger beskyttede for eftertiden. I den fine stue på første sal ud mod Frederiksholms Kanal var der malet lyserøde rocailler (slyngede plantemotiver) rundt om døre og på alle vægflader, ligesom træværket på et tidspunkt også havde haft en fantastisk rød farve, der altså har været den direkte inspirationskilde til rummets nuværende dybrøde vægfarve.

Også i stueetagen knytter interessante fund fortid og nutid sammen. Bag en gipspladevæg fandt man en fin lille oprindelig dør, som nu i befriet og restaureret tilstand forbinder to rum. Og ved et tilfælde kom en håndværker til at skrabe maling af et profileret brystningspanel, da han skulle forbi med en lægte og derved afslørede panelets fint marmorerede, malede felter. Bygningshistoriske undersøgelser kunne sandsynliggøre, at panelerne, der sidder på gavlvæggen i det sidste af de tre rum, som ligger en-suite mod kanalen, var blevet flyttet fra den fire fag store sal til sin nuværende placering i begyndelsen af 1800-tallet. Man valgte

when he walked by with a lath, and revealed the dado's finely marbled, painted panels. Historical surveys demonstrated the probability that the panels on the end wall in the last of the three connected rooms facing the canal had been moved at the beginning of the 19th century from the four-bay room to their current location. A decision was made to clean and retouch the dado and recreate its painted Baroque decorations from around 1740, when it was found in the large room. The intention was naturally to give the impression of the period's love of color, but this means that the Baroque dado is now in a room whose other furnishings, for example wall fabric, date to later periods, while the colors on the walls are completely new and have no Baroque decorations. The client gladly admits and defends playing around with historical effects in this way, but the room seems convincingly true, fanciful as it is.

### Common sense –

It should be obvious that it was an enormous challenge to find energy-saving measures suitable for use in a building like the Superintendent's Residence. Out of respect for the building's primary heritage values, members of the working group rejected proposals for modern

at rense og retouchere brystningspanelet og genskabe den barokke bemaling, som panelet havde haft omkring 1740, da det sad i den store sal. Intentionen var naturligvis at give et indtryk af barokkens farveglæde, og det betyder, at barokpanelet i dag sidder i et rum, hvis øvrige udstyr, som eksempelvis væglærreder, stammer fra senere perioder, mens vægfarverne er helt nye og uden barokkens vægdekorationer. Der er med andre ord tale om en leg med de historiske virkemidler, som bygherren glad og gerne står ved, men rummet virker overbevisende helstøbt – selv om det er digtet.

### **Sund fornuft -**

Det siger næsten sig selv, at der har ligget en kæmpe udfordring i at finde energitiltag, der egner sig til at indgå i en bygning som Materialforvalterboligen. Respekten for bygningens bærende bevaringsværdier har således betydet, at forslag om energibesparende vinduer, udvendig og indvendig solafskærmning og udvendig og indvendig efterisolering alle er afvist af arbejdsgruppens deltagere – allerede ved første vurderingsmøde.

Derimod har gruppen vurderet, at det giver god mening i forhold til at reducere CO<sub>2</sub>-udledningen at øge tætheden af bygningen, udskifte glasset i forsatsvinduerne til energiglas,

energy-efficient windows, external and internal shading devices, and external and internal insulation – all at their very first workshop.

The group did find, however, that in efforts to reduce CO<sub>2</sub> emissions it would be sensible to increase the building's airtightness, replace the glass in secondary windows with low-E glass, install a combined heating and cooling system, control the use of artificial lighting according to daylight, use energy-efficient lighting fixtures, and as part of this process install the central control of all IT systems and water, heating, and electricity consumption. The final choice of energy-saving measures was based on the realization that old buildings are capable of doing a lot on their own, and that it might be a good idea to let common sense prevail. The project's point of departure was consequently to work with the building's own climatic characteristics, not against them. An example was the shutters inside the building that naturally had a practical function in addition to a purely aesthetical one; people in the 18th century also used common sense and closed the shutters at night to keep rooms warm when it was cold outside. The shutters were quite effective, suggesting that perhaps removing all the panels in the reveals and behind radiators to insulate them and then



etablere et kombineret varme- og kølesystem, styre kunstlysforbruget – der styres af dagslysendfaldet, bruge energibesparende lyskilder og i den forbindelse etablere en central styring af alle it-systemer og af vand-, varme- og elforbrug. Til grund for det endelige valg af energiløsninger ligger en erkendelse af, at gamle bygninger kan meget selv, og at det er en god idé at lade den sunde fornuft råde. Energiprojektet tager således udgangspunkt i at arbejde med bygningens egne klimatiske egenskaber – ikke imod dem. En sådan var bygningens indvendige skodder, der selvfølgelig havde haft en funktion ud over den rent æstetiske – for

replacing the panels might not have much effect – though it is a tried and true method in creating an airtight building and reducing heat loss as a result. The blower-door test namely showed that all the window frames and panels – and the plastered walls as well – were perfectly airtight because they had been correctly constructed and so well maintained over the years that there were not even any cracks in the painted surfaces. It would therefore be a complete waste of money to insulate behind the panels. This experience was a good reminder that it pays to carry out specific measurements in a building as the point of departure for eco-

*Man valgte at rense og retouchere brystningspanelet og genskabe den barokke bemaling, som panelet havde haft omkring 1740.*

*A decision was made to clean and retouch the dado and recreate its painted Baroque decorations from around 1740.*

også i 1700-tallet tænkte man sig om og lukkede skodderne for at holde på varmen, når det var koldt om natten. De fungerede ganske effektivt og gav et hint om, at ideen om at fjerne alle lysningspaneler omkring vinduer og bag radiatorer for at efterisolere bag dem og derpå sætte panelerne op igen måske ikke ville have den helt store effekt. Selv om det jo er en gængs og afprøvet metode, som beviseligt har stor effekt, når det gælder om at skabe en tæt bygning og dermed reducere varmetabet. Blower-door-testen viste nemlig, at alle vinduesrammer og paneler – og i øvrigt også de pudsede vægge – var fuldkommen tætte, fordi de var rigtigt konstruerede og i øvrigt så godt vedligeholdt gennem alle årene, at der end ikke var sprækker i de maledede overflader. Det ville altså være fuldkomment spild af penge at efterisolere bag panelerne. Oplevelsen er en god påmindelse om, at det betaler sig at foretage konkrete målinger i bygningen som udgangspunkt for en økonomisk baseret energioptimering og ikke kun forlade sig på, hvad normalt er praktisk.

### **– og teknologisk nybrud**

I et andet tilfælde var der omvendt brug for et højteknologisk nybrud. Arbejdsgruppens be-

nomically based energy optimization, and not just rely on what is usually practical.

### **– and technological innovations**

In another case, in contrast, high-technology innovation was needed. The working group's calculations showed that it would be necessary to install a cooling system in order to meet the authorities' standards for the indoor climate in office workplaces, something that very few converted offices in heritage buildings actually do. The ambition was at a minimum to live up to the Working Environment Act's lowest category, C, corresponding to what is called an "acceptable thermal indoor climate."

Because of the arrangement of the rooms in the Superintendent's Residence, they cannot be defined as an open office and are not required to have mechanical ventilation, since the rooms can be supplied with fresh air simply by opening windows. In order to avoid high temperatures, however, it is necessary to provide cooling, but not in the form of mechanical ventilation systems, as their over-dimensioned ducting and quite shoddy materials would be completely incompatible with the Superintendent's Residence's fine interiors. This was the start of a challenging and far from easy search for a combined heating/cooling

regninger viste nemlig, at det ville være nødvendigt at etablere køling i rummene for at leve op til arbejdstilsynets krav til indeklimaet i kontorarbejdspladser, hvilket kun ganske få kontorer indrettet i fredede bygninger rent faktisk gør. Ambitionen var som minimum at leve op til arbejdsmiljølovens laveste kategori C svarende til det, der kaldes et 'acceptabelt termisk indeklima'.

Materialforvalterboligens rumdisponering gør, at rummene ikke defineres som et storrums kontor og ikke er underlagt krav om mekanisk ventilation, man kan derfor få frisk i luft i rummene blot ved at åbne vinduerne. For at undgå overtemperaturer måtte der dog køling til men altså ikke i form af mekanisk ventilationsanlæg, hvis voldsomt dimensionerede kanalføringer i ret tarvelige materialer på ingen måde kunne forenes med Materialforvalterboligens fine interiører. Det blev startskuddet på en udfordrende og ikke helt let jagt på en kombineret varme/køleunit, som dels kunne skabe et acceptabelt indeklima ved at dække rummets varmebehov om vinteren og dets kølebehov om sommeren; dels skulle have dimensioner svarende til en traditionel plan radiator, således at den kunne gemmes bag en radiatorskjuler og dermed ikke genere rummets proportioner.

unit that on the one hand would be able to create an acceptable indoor climate by meeting the rooms' heating requirements in winter and their cooling requirements in summer, and on the other have dimensions corresponding to those of a traditional flat radiator that could be hidden behind a radiator screen and consequently not mar the rooms' proportions.

It quickly proved obvious that a unit with these qualities and dimensions was simply not available on the market, and also that manufacturers that made larger, clumsier models were not interested in using their product-development resources for such a small project. It was finally possible to find a fan-coil unit that was not too deep and could consequently be built into window niches and hidden behind beautifully molded wooden panels designed specifically to mimic the Superintendent's Residence's other carpentry details.

## Plumbing

The advantage – and disadvantage – of the system is the plumbing. The advantage is that the dimension of an individual pipe is only double that of an ordinary water pipe. The disadvantage is that four sets of pipes are needed for every unit, because it has to both heat and cool,

Det viste sig hurtigt, at det var svært at finde en unit med de egenskaber og dimensioner og desuden, at de producenter, som står bag større modeller, ikke var interesserede i at produktudvikle deres sortiment til en så relativt lille opgave.

Til sidst lykkedes det dog at finde en vandbåren varme/køle-unit, en såkaldt 'fan coil', der ikke var så dyb og derfor kunne indbygges i vinduesnicjerne og gemmes bag smukt profilerede træpaneler tegnet specifikt, så de mimer Materialforvalterboligens øvrige snedkerdetaljer.

## Rørføringer

Systemets fordel – og dets ulempe – er rørføringen. Til fordelene hører, at det enkelte rørs dimension kun er det dobbelte af et almindeligt vandrør. Ulempen er, at der skal fire sæt rør til hver unit, fordi den både skal køle og varme, og der kan opstå behov for at køle ét sted og varme et andet sted – på samme tid.

Diskussionen om føringen af de vandbærende rør begyndte med et forslag om, at lade stålrør føres synligt i rummene, men det blev hurtigt klart for arbejdsgruppen, at det ikke kunne gå i en fredet bygning af Materialforvalterboligens karakter. En rørføring under

and there might be a need to cool the air in one place and heat it in another – simultaneously.

The discussion about how to install the necessary water pipes began with a proposal to let steel pipes remain exposed in the rooms, but it quickly became obvious to the working group that this would simply not do in a heritage building of this character. Installing plumbing under the wooden floors, perpendicular to the joists – which would have to be cut through countless times – was initially unpalatable for the client, architects, and heritage authorities alike. They were concerned on the one hand about whether it was aesthetically reasonable to hide a technologically complex unit in a fine old building that was not intended for it. On the other, they were concerned about having to integrate water pipes that presumably have a shorter lifetime in a wooden floor structure that should preferably remain untouched for many years, without the risk of water damage. The group eventually chose nonetheless to have the plumbing laid under the floors because it could be placed over the joists. The system was given the additional safety feature of using a tube-in-tube arrangement, in which the water pipe is incased in a second pipe and is consequently not exposed. Plumbing along the length of the building can be serviced by lifting a removable

*Det lykkedes at finde en vandbåren varme/køle-unit, 'fan coil', der kunne indbygges bag træpaneler.*

*It was possible to find a fan-coil unit that could be built into the window niches.*

trægulvene på tværs af de bærende bjælker, som skulle gennemskæres et utal af gange, var i første omgang heller ikke spiselig for hverken bygherren, arkitekterne, eller fredningsmyndighederne. De gjorde sig dels overvejelser om det æstetisk rimelige i at skjule et teknologisk komplekst element i en fin gammel bygning, der ikke er beregnet til det. Desuden var de bekymrede over at skulle integrere vandførende installationer med formodet kortere levetid i en gulvkonstruktion af træ, der helst skal ligge urørt i mange år uden risiko for, at der opstår vandskader. Når gruppen i sidste ende alligevel valgte at lade rørføringen løbe i gulvet, hængte det sammen med, at rørføringen kunne placeres over bjælkelaget, og at man sikrede systemet med en rør-i-rør-løsning, hvor selve det vandførende rør ligger inden i et andet rør, og derfor ikke er risikabelt at bruge. Rørføringen på langs af bygningen kan serviceres ved at løfte et demonterbart gulvbræt langs facdevæggen. Eksemplet er en fin illustration af, at det handler om at værdisætte de ting, man vil værne om, og de ting man bedre kan ofre for at nå det ønskede resultat; nemlig at få krav om CO<sub>2</sub>-reduktion, fredningsværdier og indeklima til at mødes. Først som sidst har det handlet om at prioritere og træffe de valg, der gør mindst ondt.





*Glasset i den yderste vinduesramme har et særligt spil af ujævnheder, der har stor arkitektonisk og fredningsmæssig værdi.*

*The glass in the outer window frames has a distinctive play of light that has great architectural and heritage value.*



*Modsatte side:  
Til grund for det endelige valg af energiløsninger ligger en erkendelse af, at gamle bygninger kan meget selv, og at det er en god idé at lade den sunde fornuft råde.*

*Opposite page:  
The final choice of energy-saving measures was based on the realization that old buildings are capable of doing a lot on their own and that it might be a good idea to let common sense prevail.*

## Energiglas

Det andet helt centrale energitiltag i Materialforvalterboligen er udskiftningen af glasset i forsatsvinduerne med energiglas. Når man ikke også kunne skifte glasset i den yderste vinduesramme, var det fordi, der er et særligt spil af ujævnheder i det gamle glas, der har stor arkitektonisk og fredningsmæssig værdi for bygningen som helhed. Den kvalitet kan man ikke genskabe i en ny termo- eller energirude, og derfor valgte gruppen at koncentrere indsatsen om forsatsruderne. Her var en af udfordringerne at finde et glas, der højst var 3 mm tykt af hensyn til de eksisterende rammers dimensioner. Desuden blev der brugt mange kræfter på at finde et glas med lavt jernindhold, så det ikke syner grønt i tonen. Det valgte glas har en coating med en svag grå toning,

floorboard along the facade wall. This example provides an excellent illustration of the importance of appreciating the features that one wants to preserve, and being willing to sacrifice others in order to achieve the desired result. In this case it was a matter of reconciling CO<sub>2</sub> reductions, heritage values, and indoor climate. Above all, it meant prioritizing and making the decisions that are least painful.

## Low-emissivity glass

The second major energy-saving measure in the Superintendent's Residence was replacing the panes in the secondary windows with low-E glass. It was unfeasible to replace the glass in the outer window frames because the imperfections in the old glass give a distinctive play of light that has great architectural and heritage value for the building as a whole. Since this quality cannot be recreated in insulating or low-E glass, the group chose to concentrate its efforts on the secondary windows. One of the challenges was to find glass with a maximum thickness of 3 mm to fit the dimensions of the frames. A great deal of effort was also spent finding glass with low iron content so that it did not have a green tint. The glass that was chosen has a slightly grayish coating inside

der ligger inde i selve glasset, hvilket er vigtigt, når glasset skal kunne pudsес på begge sider; her duer det ikke, hvis coatningen er monteret som en film på den ene side af glasset. Coatningen reducerer varmepåvirkningen fra solen og burde – hvis den skulle fungere optimalt – sidde i det yderste lag, men det er som nævnt ikke muligt. Energiglas i forsatsvinduerne er dog langt bedre end blot at have en indvendig solafskærmning i form af et gardin, som nok skærmer for solen men ikke reducerer varmetilskuddet til rummet i nævneværdig grad. Energiglas i forsatsvinduerne er et godt eksempel på, at en perspektiveret beslutning, der tager hensyn til mange aspekter, resulterer i det bedst tænkelige kompromis.

### Forventet CO<sub>2</sub>-reduktion

Når bygningen tages i brug forventes det, at energiglasset vil give en CO<sub>2</sub>-reduktion på 4,29 procent, mens den øgede tæthed af klimaskærmen vil resultere i en reduktion på 6,11 procent. Centralstyring af strømforbruget vil medføre en CO<sub>2</sub>-reduktion på 7,50 procent, men behovet for køling vil samtidig indvirke negativt med 0,47 procent på CO<sub>2</sub>-besparelsen. Samlet forventes bygningen at nå en relativ CO<sub>2</sub>-reduktion på 6 procent i forhold til CO<sub>2</sub>-udledningen fra Materialforvalterboligen inden energirenoveringen.



*Samlet forventes bygningen at nå en relativ CO<sub>2</sub>-reduktion på 6 procent.*

*As a whole, the Superintendent's Residence is expected to achieve a relative CO<sub>2</sub> reduction of 6 percent.*



the pane itself, something that is important, as it should be possible to wash the windows on both sides. The coating reduces the sun's effect and should – if it is to work optimally – be applied to the outermost layer, which as noted was not possible here. Using low-E glass in the secondary windows, however, was far better than just having a device inside in the form of a sunshade, which would indeed keep out sunlight, but would only reduce the sun's warming effect to a negligible extent. Using low-E glass in secondary windows is a good example of how decisions based on many aspects result in the best possible compromise.

### **Expected CO<sub>2</sub> reduction**

When the building is ready for occupancy, low-E glass is expected to provide a CO<sub>2</sub> reduction of 4.29 percent, while the climate shield's increased airtightness will result in a reduction of 6.11 percent. Central control of electricity consumption will reduce CO<sub>2</sub> by 7.50 percent, but the need for cooling will have a negative effect of 0.47 percent on this CO<sub>2</sub> reduction. As a whole, the Superintendent's Residence is expected to achieve a relative CO<sub>2</sub> reduction of 6 percent in comparison with its CO<sub>2</sub> emissions before energy conservation.

## Magasinbygningen

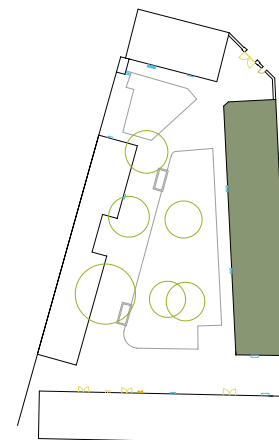
Den første del af Magasinbygningen mod Bryghusgade blev opført i 1768. Bygningen er siden udvidet to gange i længden og desuden ombygget indvendigt flere gange. Bygningen består i dag af 18 fag, som står med gulkalkede facader i to etager under et rødt tegltag med høj rejsning. Taget brydes op af en brandkam, der markerer en af ombygningerne, og af et ujævnt mønster af kviste og tagvinduer både mod gaden og gården. Et af bygningens særlige karakteristika er dens ganske lave sokkel, som skyldes, at den oprindeligt blev anvendt som magasin for materialer. Dette betød, at der skulle være direkte og omtrent niveaufri adgang til magasinerne. De mange udvidelser og ombygninger betyder, at Magasinbygningen i dag er et rumligt og sammensat kompleks men også, at der findes både rumstrukturelle værdier og fine detaljer fra flere perioder, som er vigtige at fremdrage og understrege.

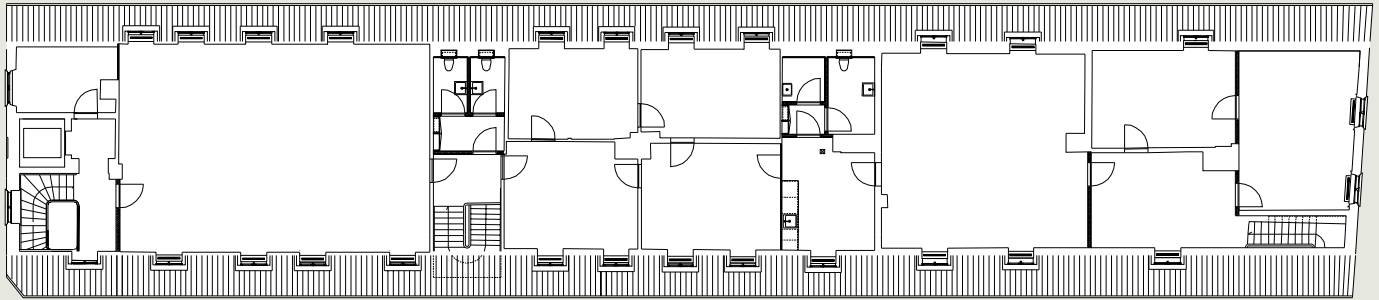
Hovedstrukturen i bygningen er angivet af tre trappeforløb – én i hver ende og én placeret omtrent i tredjedelspunktet fra nord – der opdeler bygningen i tre sektioner på tværs af bygningens længde; mens en muret længdeskillevæg, der løber hele vejen gennem bygningen, definerer bygningens klare opdeling på langs. Længdeskillevæggen er således en af de

## The Magazine

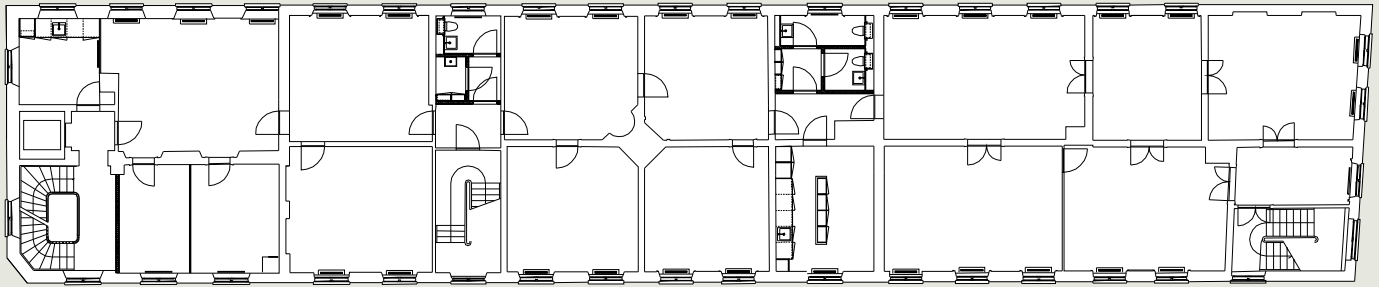
The oldest part of the Magazine on Bryghusgade dates to 1768. Since then, it has been lengthened twice and its interior has been remodeled several times. Today it consists of 18 bays, with yellow, limewashed facades under a high-pitched red-tile roof. The roof surface is broken by a party-wall parapet, which denotes one of the remodeling stages, and by an irregular pattern of dormers and skylights on both the street and the courtyard. One of the building's distinctive characteristics is its very low plinth, a detail that shows it was originally used as a warehouse that needed direct and more or less horizontal access to the stores. Because of the many extensions and remodelings, the Magazine is a spacious and complex structure, but also one with rooms of spatial and structural values and fine details from several periods that it is important to uncover and highlight.

The building is structured by three stairwells, one at each end and one placed at a point about one third of the distance from the north. They divide the building into three sections perpendicular to its length, while a brick partition wall runs the length of the building. As it clearly divides the Magazine longitudinally, this wall is one of the building's most important primary

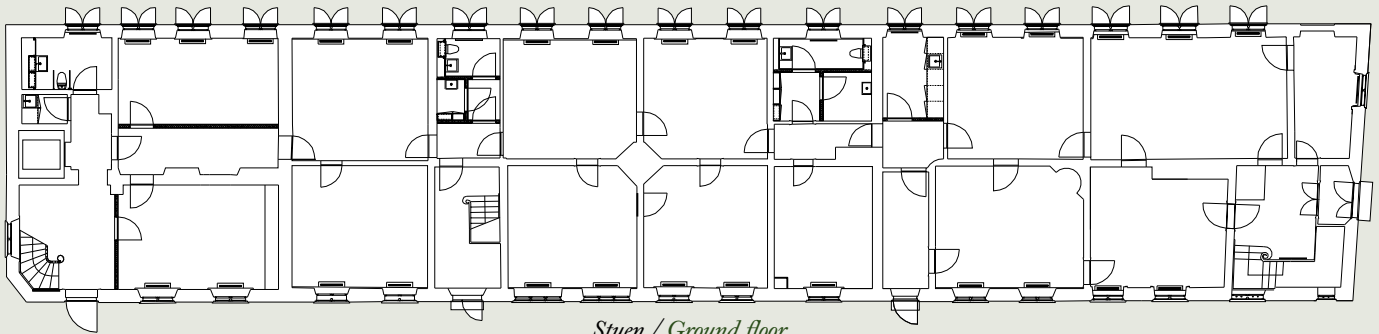




*2. sal / 3rd floor*



*1. sal / 2nd floor*



*Stuen / Ground floor*

væsentligste bærende bevaringsværdier i Magasinbygningen, som også omfatter de hierarkiske forskelle i rumligheder og udstyr mellem den sydlige rigt udstyrede del, hvor boligen lå, og så de nordlige tilbyggede dele som rummede kontorer. Forskellene opleves desuden tydeligt etagerne imellem; med stueetagen og første salen som de fineste etager, prydet af stuk og snedkerdetaljer – særligt i boligen, mens anden sal i højere grad bærer præg af pragmatisk kontorindretning. Generelt er der flest bevaringsværdier mod syd, men også i midten ses sammenhængende rumlige helheder, mens der bliver længere mellem værdierne mod nord i bygningen, hvor de fleste ændringer i forbindelse med restaureringen således er foretaget.

De bevaringsmæssige værdier er imidlertid først kommet for en dag efter en grundig undersøgelse, som har vist, at der er bevaret langt flere interiørdetaljer end først antaget.

Da Realdania Byg overtog bygningskomplekset var alle oprindelige flader beklædt af materialer uden materialemæssige eller arkitektoniske kvaliteter. Bygningen var således pakket ind i gipspladevægge fra kælder til kvist med glatte døre uden profileringer på anden sal, og var også her præget af kabelbakker der ikke tog hensyn til vinduesnicher og brystningspaneler og kun nogenlunde gik fri af vinduerne.

heritage values. Others are the hierarchical differences in spatiality and details between the richly appointed southern section, which held an apartment, and the northern extensions, which held offices. There are also clear differences from one story to the next. The ground floor and second story are the most refined, graced with stucco and carpentry details, especially in the apartment, while the third story more clearly reflects its pragmatic use as office space. As a whole, most of the heritage values are found on the south, but the center of the building also has cohesive spatial entities. Heritage values are few and far between on the north, where most of the changes were consequently made during restoration.

These heritage values were not uncovered, though, until a thorough survey had shown that many more interior details had been preserved than had initially been assumed.

When Realdania Byg acquired the complex, all of the building's original surfaces were covered with materials of no high material or architectural quality. The Magazine was wrapped up in gypsum boards from top to bottom. The doors had no molding on the third story, which was moreover defaced with plastic cable trays that took no account of window niches or dados, and only just failed to block part of the windows.

*Modsatte side:*

*Den første del af Magasinbygningen mod Bryghusgade blev opført i 1768. Bygningen er siden udvidet to gange i længden og desuden ombygget indvendigt flere gang.*

*Opposite page:*

*The first part of the Magazine on Bryghusgade dates to 1768. Since then, it has been lengthened twice and its interior has been remodeled several times.*

På gulvene lå vinyl, nålefilt eller parket og nedhængte lofter var placeret lige akkurat over vinduernes overkant.

### **Stram rumlig struktur**

Bygningen var indrettet med en lang gang uden dagslys, som lå parallelt med længdeskillevæggen. Den gav nok direkte adgang til alle cellekontorer men underdelte også rummene mod Bryghusgade i mindre, forkert proportionerede rum og resulterede i en fragmenteret bygning uden struktur.

Hovedintentionen med restaureringen har derfor været at rydde op i rumstrukturen og fremhæve de bevaringsværdige rum fra forskellige perioder. Det er gjort ved at fjerne den mørke gang og nedrive alle nye skillevægge og nedhængte lofter i stueetagen og på første sal. Derigennem har man genskabt en klar struktur med velbelyste, velproportionerede rum på hver side af længdeskillevæggen.

Også den lodrette sammenhæng i bygningen er styrket og gjort tydeligere gennem en opstramning af plandisposition. Denne inddeler bygningen i mindre vertikale enheder, der grupperer sig omkring hver sin trappe og dermed overflødiggør de gangforløb, som ellers vil sløre rumstrukturen. I tilknytning til trapperne

The floors were covered with vinyl, needle-felt carpeting, or parquet, and ceilings had been lowered to just over the top of the windows.

### **A terse spatial structure**

The building had been given a long corridor without daylight parallel with the brick partition wall. It did provide direct access to all the cell offices, but also subdivided the rooms along Bryghusgade into smaller, poorly proportioned spaces, resulting in a fragmented, unstructured building.

The main goal of the restoration was to organize the spatial structure and highlight the rooms from different periods that had heritage value. This was done by removing the dark corridor and demolishing all new partition walls and suspended ceilings on the ground floor and second story. This recreated a clear structure, with well-lit, well-proportioned rooms on each side of the brick partition wall.

The building's vertical cohesion was also reinforced and clarified by making the plan terser. It divides the building into smaller vertical units, each grouped around its staircase, eliminating the need for corridors that would otherwise blur the spatial structure. Adjoining the staircases are lavatories, a kitchenette, and a



*I det oprindelige portfag mod nord er trappen flyttet fra midten af bygningskroppen til det nordøstlige hjørne og opført som en ny halvsvingstrappe.*

*In the original entrance bay on the north, the staircase was moved from the center of the building volume to the northeast corner, and given the form of a new half-turn staircase.*





*Hele bagvæggen i receptionen udgøres af en skabsvæg, der lidt muntert kaldes 'julekalenderen'.*

*The entire back wall in the reception room was fitted with cabinets, and has jokingly been called "the Advent calendar."*

ligger toiletter, tekøkken og kopirum og i det oprindelige portfag mod nord er trappen flyttet fra midten af bygningskroppen til det nordøstlige hjørne og opført som en ny halvsvings-trappe lige til venstre for hovedindgangsdøren. Flytningen af trappen har givet plads til en nødvendig elevator og samtidig forbedret flugtvejsforholdene og fordelingen i bygningen.

Anden sal ligger under taget med skrå vægge og lavt til loftet, og her har ambitionen ligeledes været at rydde ud i de oprindelige cellekontorer og skabe flest mulige gennemlyste storrums-

copy room. In the original entrance bay on the north, the staircase was moved from the center of the building volume to the northeast corner, and given the form of a new half-turn staircase just left of the main entrance. Moving the staircase made space for an elevator, a necessary addition, and simultaneously improved escape routes and circulation in the building.

The third story, under the roof, has sloping walls and low ceilings. The ambition here, too, was to eliminate the original cell offices and create the largest number of open offices with

kontorer i vekselvirkning med mindre kontorer til to eller tre medarbejdere.

Resultatet er, at Magasinbygningens særlige sammensatte karakteristika er blevet understreget således, at de mange bevarede bygningsdetaljer nu tydeligt hører til i bestemte veldefinerede områder, der hver især forholder sig til længdeskillevæggen og de tre trappeforbindelser. Konsekvensen af plandispositionen er på den anden side, at alle rum i princippet bliver gennemgangsrum, nu da den mørke fordelingsgang er forsvundet. De velproportionerede rum kan dog sagtens bære det; der er både fysisk og mental plads til at kunne arbejde i fred og ro med døren lukket ind til næste kontor og mulighed for at lade dørene stå åbne og drage fordel af samværet med flere kolleger. Man kan kalde det storrumskontorer på 'den fede måde'.

## Materialer og detaljering

Også i Magasinbygningen er der gjort en stor indsats for at sikre, at de eksisterende snedkerarbejder bevares for eftertiden, så man kan opleve bygningsdetaljernes udviklingshistorie, når man færdes gennem den lange bygning. For at skabe harmoni mellem nyt og gammelt og for at videreføre den fortsatte fortælling følger det nye lag af bygningsdetaljer, som restaureringen

light from both sides in interaction with smaller offices for two or three employees.

As a result, the Magazine's distinctive composite character has been underlined, so that the many building details that have been preserved now clearly belong to specific, well-defined areas created by the brick partition wall and the three staircases. On the other hand, the plan means that all of the rooms have through access now that the dark corridor has disappeared. The well-proportioned rooms can nonetheless hold their own. There is both physical and mental space to work in peace and quiet with the door to the next office closed, or kept open to reap the advantages of having more colleagues close by. We could call it open offices in the best of all worlds.

## Materials and details

A major effort was made in the Magazine, as it was in the Superintendent's Residence, to ensure that its carpentry was preserved for later generations, so that visitors will see how its details evolved as they walk through the long building. In order to create harmony between old and new, and to carry on the narrative, the new layer of details that restoration brought with it was harmonized with old layers through

har medført, sig ind i den materialemæssige helhed. Dette er sket ved, at alt nyt er udført som snedkerværk i træ – ikke usynligt og forløjet ved at kopiere historiske stilarter – men ved at oversætte historien til en moderne udgave.

Et eksempel er den nye halvsvingstrappe af træ, hvis overordnede udtryk er traditionelt, men knap så elaboreret som trappen i Materialforvalterboligen; her er balustre og håndlister helt enkle.

Rummet lige over for trappen er indrettet så det kan fungere som fælles reception for hele bygningen, der, takket være de tre trapper, kan deles op i flere lejemål. Hele bagvæggen i rummet udgøres af en skabsvæg, der lidt muntert kaldes 'julekalenderen' på grund af de mange skabslågers varierende størrelse. Her er valgt en anden strategi, idet detaljeringen er bevidst og umiskendeligt moderne og gerne vedstår sig sin egen tid.

Endelig ligger der en omstændelig formgivningsproces bag udtrykket i de træpaneler, som man har valgt at bruge til at skjule de såkaldte 'fan coils', der også her sørger for varme og køling. Overvejelserne har gået på, om det er æstetisk og historisk i orden at iklæde et højteknologisk element en kappe med et formsprog, som var det af en anden tid, og bygge det ind bag panelerne, som om det er en del af selve bygningen. Eller om det er mere ærligt at be-

the materials that were used. All new details are made of wood, not so that they cannot be identified as being new or by copying historical styles, but giving them a modern interpretation. An example is the new wooden half-turn staircase, which as a whole has a traditional look, but is not as elaborate as the staircase in the Superintendent's Residence, since its balusters and handrail are quite simple.

The room opposite the staircase was designed to serve as a common reception room for the entire building, which can be divided up into several rental entities thanks to the three staircases. The entire back wall was fitted with cabinets, and has jokingly been called "the Advent calendar" because of its many doors of different sizes. A different strategy was chosen here, because the detailing is deliberately and unmistakably modern and gladly acknowledges its own time.

The wooden panels that were chosen to conceal the fan-coil units for heating and cooling in this building, too, were the subject of a lengthy design process. Would it be aesthetically and historically acceptable to give a high-tech piece of equipment a covering that makes it look as if it came from another era by installing it behind panels as if it were part of the building itself? Or would it be more hon-

klæde det, men dog lade det være tydeligt, at unit'en er et fremmedelement med en formodet begrænset levetid i forhold til resten af bygningen. Valget er i sidste ende faldet på et panel udformet med en enkel profilering, og unit'en er placeret i vinduesnicherne, så den ikke antaster fodpanelerne – en løsning der fungerer bedst i de rum, hvor nicherne er så dybe, at den ikke stikker ud som en boks i rummet.

I tagetagen (anden sal) skifter udtrykket karakter fra de højloftede og højstemt fornemme rum til store pragmatiske rum med mange anvendelsesmuligheder og helt enkle snedkerdetaljer; såvel gulve, vægge som paneler danner på den måde en neutral baggrund for det liv, der måtte komme til at udspille sig i dem.

## Farver

I modsætning til Materialforvalterboligen har man ikke fundet farvemæssige inspirationskilder at gå ud fra i valget af farvepaletten til væggene i Magasinbygningen. I stedet har arkitekterne valgt en palet med 12 nuancer af kølige og varme farver, som blev prøvemalet på store ark pap og placeret i rummene, så de kunne vurderes på stedet. Farverne veksler mellem grå, blågrønne, gyldne og babyrosa nuancer. De kraftigste farver er i fordelings- og gennemgangsrum

est to cover it, but let it be clear that the unit is a foreign body with what is presumably a shorter lifetime than the rest of the building? The choice finally fell upon a panel designed with simple molding. The units are placed in window niches so that they do not intrude on the baseboards – a design that works best in rooms where the niches are so deep that the units do not protrude like boxes.

On the third story, the building changes character, from high-ceilinged, distinguished rooms to large, pragmatic ones with many potential uses and very simple carpentry details. Floors, walls, and panels provide a neutral background for the activities to come.

## Colors

In contrast to the Superintendent's Residence, no sources of inspiration were found here for the colors that could be used on the Magazine's walls. Instead, the architects chose a palette of 12 nuances of cool and warm tones that were test-painted on large sheets of cardboard and placed in the rooms so they could be evaluated on the site. The colors range from gray, bluish-green, and golden to baby-pink nuances. The strongest colors are used in rooms with circulation and through traffic, with more subdued

*Hovedintentionen med restaureringen har været at rydde op i rumstrukturen og fremhæve de bevaringsværdige rum fra forskellige perioder.*

*The main goal of the restoration was to organize the spatial structure and highlight the rooms from different periods with heritage value.*



og mere afdæmpede farver i hjørneværelser og rum, hvor man opholder sig i længere perioder ad gangen. Den enkelte farve er afstemt under hensyntagen til verdenshjørner og lystemperatur med de varmeste nuancer i rum, der vender mod sydøst og kølige nuancer mod nordvest; men nok så meget under hensyntagen til farven på træværket der blev håndtonet som den første farve og dermed i høj grad har været styrende for valget af farver til væggene. Alle vægge er malet med silikatmaling strøget på med kost, som giver en fin stofflighed i overfladen.

Der knytter sig i øvrigt en sjov og lærerig historie til bemalingen af lofterne, der på traditionel vis er strøget over med limfarve af kogt mos, som normalt giver en helt mat overflade. Det blev også resultatet i stueetagen og på første sal,

tones in corner rooms and those occupied for longer periods. Each color was matched according to the points of the compass and light temperature, the warmest nuances in rooms facing southeast and cooler nuances on the northwest, but at least as much in keeping with the woodwork, which was the first color chosen and was toned by hand, and consequently was highly important for the choice of wall colors. All of the walls were given silicate paint applied with a whitewash brush, giving the surface a fine texture.

There is an amusing and instructive story about how the ceilings were painted, in traditional fashion with distemper made from boiled moss that normally gives a completely matt surface. This was in fact the result on the



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*No sources of inspiration were found here for the colors. Instead, the architects chose a palette of 12 nuances of cool and warm tones.*

hvor der er næsten 3,5 meter til loftet, men sådan gik det ikke i tagetagen. Her er der nemlig skråvægge og lav rumhøjde. Og i et stort gennemlyst rum, der får dagslys fra kviste til begge sider, så det pludselig ud som om limfarven skinnede så meget, at den spejlede omgivelserne. I første omgang bredte mystikken sig, og ingen kunne greje, hvad årsagen var. Maleren blev sat til at male prøvelfelter med farveblandinger med mindre og mindre lim i, men lige meget hjalp det – loftet skinnede stadig. Årsagen til problemet viste sig at være malemetoden; når limfarve stryges på med kost, flyder den så jævnt sammen, at den, set under en skarp vinkel i et lavloftet rum, altså ser ud som den rent optisk har en skinnende overflade. Løsningen blev at male lofterne på anden sal med silikatmaling.

ground floor and on the second story, where the rooms are nearly 3.5 meters high, but not on the third story, which has sloping walls and low ceilings. In a large room with light from dormers on both sides, the distemper seemed to shine so much that it reflected its surroundings. At first nobody could understand the reason for the mystery. The painter was put to work painting test panels using mixtures with varying amounts of size, but to no avail: the ceiling still shone. The problem proved to be the painting method. When distemper is applied with a whitewash brush, it flows together so evenly that seen under a sharp angle in a low-ceilinged room, it looks as if it has a shiny surface. The solution was to give the ceiling on the third story a coat of silicate paint.

## Køling og kabler

Flere af energitiltagene i Magasinbygningen er de samme som i Materialforvalterboligen, nemlig energiglas i forsatsvinduerne og fan coils, der sørger for opvarmning og køling. Dog er der den særlige forskel, at de her ikke tager frisk luft ind udefra til køling men derimod recirkulerer luften i rummet dvs. suger luften ind fra gulvniveau og blæser den via kølesystemet op langs vinduerne og ud i rummet igen. Det kan lade sig gøre, fordi der er så højt til loftet. Rummenes store luftvolumen og det faktum, at der kun skal være to eller tre arbejdspladser i hvert rum og, at der ikke er fælles møderum eller kantine, er også årsagen til, at arbejdsmiljøloven ikke stiller krav om mekanisk ventilation. Er der behov for frisk luft i rummene, foregår det ganske simpelt ved at åbne vinduerne, præcis som man vil gøre derhjemme.

Det, der fremfor alt påkalder sig opmærksomhed i energiprojektet i Magasinbygningen, er imidlertid alt det, man ikke kan se. Bag det sobre ydre, de fine vægge med smukke farver og fyrretræsgulvene af høj kvalitet, gemmer der sig nemlig uendelige mængder moderne teknologi og kilometervis af kabler, der styrer hele bygningens it- og el-system centralt. Et eksempel er bevægelsesmålere, der registrerer, om der er nogen, som bevæger sig i rummet, og

## Cooling and cables

Several of the energy-saving measures used in the Magazine were the same as those used in the Superintendent's Residence: low-E glass in secondary windows and fan-coil units that provided heating and cooling. The difference here, however, is that instead of bringing in fresh air from the outside for cooling, the units extract air at floor level and expel it via the cooling system along the windows and out into the room again. This recirculation is possible because the ceilings are so high. Because of the rooms' large air volume, the fact that there will only be two or three workplaces in each room, and the absence of common meeting rooms and a shared lunchroom, the Working Environment Act does not require mechanical ventilation. If the rooms need fresh air, then windows can simply be opened, just as people would do at home.

What is most noteworthy about the Magazine's energy-saving project is everything that is not visible. Behind the sober exterior, the fine walls with their lovely colors, and the high-quality pine flooring lie an infinite quantity of modern technological equipment and kilometers of cables that provide central control for the entire building's IT and electrical systems. An example are the motion sensors, which register if anyone is moving around in a room; if

*Bag det sobre ydre gemmer der sig uendelige mængder moderne teknologi og kilometervis af kabler.*

*Behind the sober exterior lie an infinite quantity of modern technological equipment and kilometers of cables.*





*Bygningen består i dag af  
18 fag, som står med  
gulvaskede facader i to  
etager under et rødt tegltag  
med høj rejsning.*

*Today the building consists  
of 18 bays, with yellow,  
limewashed facades under  
a high-pitched red-tile roof.*



hvis der ikke registreres bevægelse i en periode, slukker lyset.

Andre målere registrerer mængden af dagslys, og hvis der er nok, kan man ikke tænde skrivebordslampen – og så dog alligevel. Der er selvfølgelig mulighed for, at den enkelte medarbejder selv kan tænde og slukke for lyset eller skrue op og ned for varmen, men de skal vælge at gøre det aktivt. Hver nat nulstiller den computer, der kører den intelligente styring af bygningen, og går tilbage til den energimæssigt korrekte indstilling. Det handler med andre ord om at guide folks adfærd, for når de glemmer at slukke lyset, kaffemaskinen eller computeren tæller det dobbelt i regnskabet. Dels i form af et øget strømforbrug og dels fordi de tændte maskiner afgiver varme til bygningen, som der så skal bruges energi på at køle. Og da det koster 2,5 gange mere energi at køle ned end at varme op, kan det godt betale sig at styre bygningen centralt, og derfor er der brugt mange kræfter – og meget strøm – på, at de kommende medarbejdere ikke skal bruge for meget strøm.

Kablerne, der forbinder al det teknologiske isenkram, er såkaldte 'state-of-the-art' signalkabler, som formodes at have lang levetid, selv om de nok ikke har lige så lang levetid som det fyrretræsgulv, de løber under i tykke bundter. Det har selv sagt givet anledning til mange – og

there is no movement for a period of time, the lights turn off.

Other sensors register the amount of daylight, and if there is enough, desk lamps cannot be turned on – at least in principle. Employees can naturally turn lights on and off or turn the heat up or down, but this is a deliberate choice. Each night the computer with the building's intelligent control system is reset and reverts to the correct energy-saving settings. In other words, it is a question of helping people change their habits. When they forget to turn off the light, the coffee maker, or the computer, energy consumption doubles, on the one hand in the form of higher electricity consumption, and on the other because machines that are turned on give off heat, requiring energy to cool the building. And since it costs 2.5 times as much energy to cool than to heat, it certainly pays to have central control for the building. This is why a great deal of effort – and a lot of electricity – was expended so that future employees do not use too much of it.

The cables that link all this technological hardware are state-of-the-art signal cables that presumably have a long life, though not as long as the pine floors above these thick bunches of wiring. This naturally gave rise to many lengthy deliberations about whether it



*I forhold til bygningens oprindelige tilstand er den forventede CO<sub>2</sub>-reduktion på 20 procent, samtidig med at det er muligt at opnå et termisk indeklimaniveau svarende til klasse C.*

*The expected CO<sub>2</sub> reduction in comparison with the building's original state is 20 percent, while it is possible to achieve a thermal indoor climate level corresponding to class C.*



lange – principielle overvejelser om, hvorvidt det er rigtigt at fylde gamle fredede bygninger med højteknologiske komponenter, der kræver både lodrette og vandrette føringsveje, som der dybest set ikke er plads til i konstruktionen. Komponenter som skal være skjult, fungere upåklageligt i årevis og alligevel tilgængelige for service, hvis de ikke gør. Den udfordring er løst ved at lægge flest mulige kabelsamlinger under

was right to fill old heritage buildings with high-tech components that require both vertical and horizontal cable-tray systems for which there actually is no room in the building's structure. The components have to be hidden, work impeccably for years, and yet still be accessible for service if they do not. This challenge was met by laying the greatest number of cables under the floorboards, which

gulvbrædder, der kan skrues af og i små gulv-bokse, med et lille låg af fyrretræ, der er lige til at løfte op.

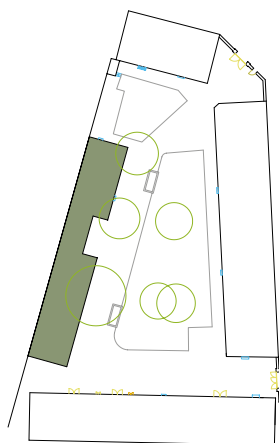
## Forventet CO<sub>2</sub>-reduktion

Set i et større perspektiv har ambitionen om at reducere CO<sub>2</sub>-udledningen mest muligt vejet så tungt, at det har formået at få alle projektets parter til at prioritere og tænke ud af boksen. Det betyder, at man regner med, at energiglas-set vil give en CO<sub>2</sub>-reduktion på 4,44 procent, mens den øgede tæthed af klimaskærmen vil resultere i en reduktion på 6,11 procent. Centralstyring af strømforbruget vil medføre en CO<sub>2</sub>-reduktion på hele 10,75 procent. Den høje besparelse skyldes bygningens relativt mange arbejdsstationer, som omvendt betyder, at behovet for køling samtidig indvirker negativt med 2,67 procent på CO<sub>2</sub>-besparelsen. Det samlede resultat forventes at give et reduceret transmissionstab på knap 19,6 procent og en samlet relativ CO<sub>2</sub>-reduktion på knap 24 procent. I forhold til bygningens oprindelige tilstand er den forventede CO<sub>2</sub>-reduktion på 20 procent, samtidig med at det er muligt at opnå et termisk indeklimaniveau svarende til klasse C, hvilket er ganske imponerende, når antallet af arbejdspladser samtidig øges fra 90 til 140.

are attached with screws to permit removal, and in little boxes under the floor with a pine lid that can simply be lifted.

## Expected CO<sub>2</sub> reduction

Seen in a wider perspective, the ambition to reduce CO<sub>2</sub> emissions as much as possible was considered so important that it spurred all parties to consider their priorities and think innovatively. As a result, low-E glass is expected to give a CO<sub>2</sub> reduction of 4.44 percent, while the climate shield's increased air tightness will result in a reduction of 6.11 percent. The central control of electricity consumption will result in a CO<sub>2</sub> reduction of a full 10.75 percent. This high figure is due to the building's fairly large number of workstations, which in turn means that the need for cooling has a negative effect of 2.67 percent on CO<sub>2</sub> savings. The overall result is expected to give a reduced transmission loss of nearly 19.6 percent and an overall relative CO<sub>2</sub> reduction of nearly 24 percent. The expected CO<sub>2</sub> reduction in comparison with the building's original state is 20 percent, while it is possible to achieve a thermal indoor climate level corresponding to class C. This is quite impressive, considering that the number of workplaces will have increased from 90 to 140.



## Halvtagshusene

De såkaldte Halvtagshuse blev bygget i 1819 op ad bagvanten ind mod Civiletatens Materialgård med ensidig taghældning og kun lysindtag fra øst og i gavlene. De to bygninger blev i 1925 forbundet af en mellembgning. Den sydligste del af Halvtagshusene var oprindeligt et åbent materialskur. I taget blev der omkring 1970 tilføjet en taskekvist i næsten hele tagets udtrækning. Remmen, der bærer taget, var stadig synlig ved restaureringens begyndelse, selv om åbningerne for længst var muret til og erstattet af otte sprossede vinduer. Værkstedbygningen mod nord havde i begyndelsen en port i facadens midte, to døre og to mindre vinduer.

## Skuret genskabt

I lighed med bygningsanlæggets øvrige bygninger har også Halvtagshusenes indre ændret karakter og brug gennem årene – fra store og åbne arealer, hvor man oplagrede materialer og maskiner, til små cellekontorer forbundet af en mørk gang længst inde i bygningen op mod bagvanten. I øvrigt var det også her et sandt gipspladevæggenes paradis meget langt i udtryk fra de oprindeligt enkle og ganske rå bygninger. Det kan til en vis grad undre, at de overhovedet

## The Shed Building

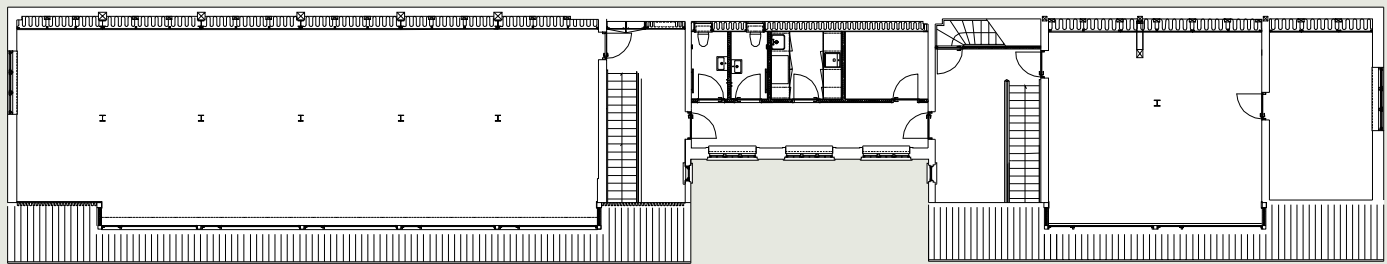
Two of the three structures that make up today's Shed Building were erected in 1819 on the property line with Public Works Depot. They have a shed roof and light intake only from the east and at the end walls. The two were linked by a connecting building in 1925. The southern structure was originally an open store. A shed dormer extending almost the entire length of the roof was added in around 1970. The head that supports the roof was still visible when restoration began, although openings had long since been bricked up and replaced by eight muntined windows. The workshop on the north initially had a gate in the middle, two doors, and two small windows.

## Recreating the shed

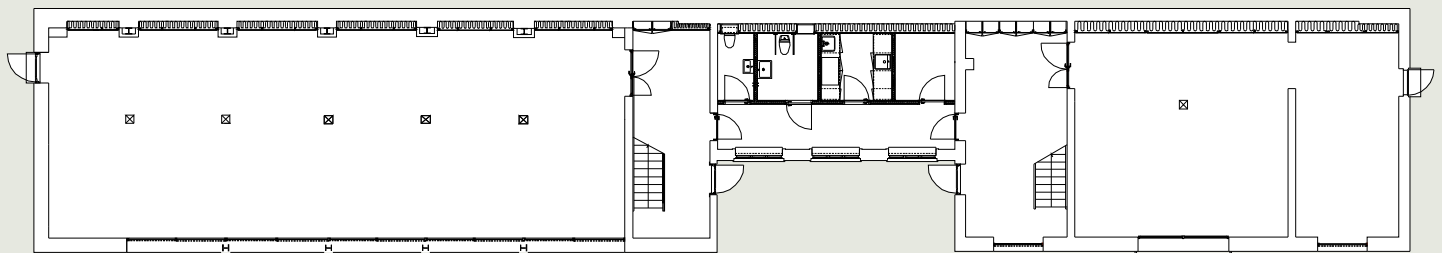
Like the other buildings in the complex, this one had also changed character and use over the years: from large, open spaces for storing materials and machines to little cell offices linked by a dark corridor deep inside the building at the back wall. This building was yet another treasure trove of gypsum-board walls – very different indeed from the original simple, rather coarse structures. It is curious that it was considered to have heritage value, but the

*De såkaldte Halvtagshuse blev bygget i 1819.  
De to bygninger blev i 1925 forbundet af  
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*Two of the three structures that make up today's  
Shed Building were erected in 1819. The two  
were linked by a connecting building in 1925.*



*1. sal / 2nd story*



*Stuen / Ground floor*



reason is naturally that it is part of a historical whole.

At the south end, the ground floor had been converted into special fireproof archives behind 60-cm-thick concrete walls resting on a concrete deck. Destructive surveys showed that some of the original bearing timberwork (apart from a single post) was still enclosed in the longitudinal partition wall. The thick, sturdy joists were also intact. The timberwork comprises one of the Shed Building's primary heritage values, while the others are its design, namely the division into three clear building volumes and light intake from only one side.

### **Reconstruction or something completely new**

All these heritage values pointed directly to the intention behind restoration: to recreate the three original buildings' characteristics as more or less open sheds, with their heavy bearing structures clearly visible in the large open rooms, which with the aid of large expanses of glass have close visual and physical contact with the courtyard.

The relatively few heritage values that have been preserved paved the way for giving all changes made to the Shed Building an un-

er fredet, men årsagen er naturligvis, at de indgår som en del af en historisk helhed.

Længst mod syd var der i stueetagen indrettet et særligt brandsikkert arkiv bag 60 cm tykke betonmure og et betondæk. Under de destruktive undersøgelser viste det sig, at en del af den oprindelige bærende tømmerkonstruktion (på nær én stolpe) stadig fandtes indmuret i længdeskillevæggen; ligeledes viste det sig, at bjælkelaget med dets kraftige dimensioner var intakt. Tømmerkonstruktionerne udgør en af de bærende bevaringsværdier i Halvtagshusene, mens de øvrige værdier knytter sig til selve bygningens udformning nemlig opdelingen i tre tydelige bygningsvolumener og det ensidige lysindtag.

## Tilbageføring eller helt nyt

Alle peger de direkte på hensigten bag restaureringen; at genskabe bygningernes karakteristika som mere eller mindre åbne skure, med de kraftige bærende konstruktioner stående frit synlige i store åbne rum, der ved hjælp af store glaspartier står i nær visuel og fysisk kontakt med gårdrummet.

De forholdsvis få bevarede fredningsværdier har åbnet mulighed for, på den ene side at lade alle ændringer i Halvtagshusene få et entydigt

equivocally contemporary idiom, and integrating modern additions in rooms whose proportions endeavor to reinterpret those of the old sheds.

This strategy did, however, give rise to a number of discussions of a principle nature among the client, architects, and heritage authorities about whether there are really enough original elements left to justify the building being restored to something that could be considered original. Should the building be left as it is, and if so, what value would this have? Or should one accept the fact that the three structures that make up the Shed Building had been remodeled so radically that they could just as well be transformed into something completely new?

More concretely, the discussion centered on whether it was admissible to give the ground floor its original appearance if only very few physical traces remained of it, without being consistent and doing the same with the second story. If consistency were the choice, then the shed dormer – which has heritage status – would have to be removed, since it had been added quite late in the building's life. This, in turn, would mean that the entire roof structure that had been demolished when the dormer was added would

*Modsatte side:  
Tømmerkonstruktionerne udgør en af de bærende bevaringsværdier i Halvtagshusene, mens de øvrige værdier knytter sig til selve bygningens udformning.*

*Opposite page:  
The timberwork comprises one of the Shed Building's primary heritage values, while the others are its design.*





*Materialerne i Halvtags-husene er generelt enkle og prunkløse; her er ingen stuklofter eller forfinede snedkerdetaljer.*

*The materials used in the Shed Building as a whole are simple and unostentatious. There are no stuccoed ceilings or refined carpentry.*

nutidigt formsprog, og på den anden side integrere de moderne tilføjelser i rum, hvis proportioner søger at gendigte de gamle skures.

Den strategi har imidlertid givet anledning til en række principielle diskussioner mellem bygherre, arkitekter og fredningsmyndigheder om, hvorvidt der reelt er nok oprindelige elementer tilbage til at begrunde en tilbageførsel til noget oprindeligt? Skal man i stedet lade bygningerne være, som de er – og hvad vil værdien være af at gøre det? Eller skal man erkende, at Halvtags-husene er så voldsomt ombyggede, at man lige så godt kan bygge dem om til noget helt nyt?

Mere konkret har diskussionen gået på, hvorvidt man kan tillade en meget voldsom tilbageføring af stueetagen til en oprindelighed, som der altså kun er sparsomme fysiske spor tilbage af, uden at tage konsekvensen og dermed gøre det samme på første sal. Hvis man skulle være konsekvent, ville det betyde, at taskekvisten – som jo er fredet – burde fjernes, idet den først er tilføjet ganske sent i forhold til bygningsens alder. Det ville igen medføre, at hele den oprindelige tagkonstruktion, som blev ødelagt, da kvisten kom til, skulle retableres. Resultatet af en konsekvent gennemført strategi ville også betyde, at arealet på første sal ikke kunne anvendes til arbejdspladser, fordi der ikke ville være dagslys nok.

have to be rebuilt. The result of a consistently implemented strategy would also mean that the space on the second story could not be used for workplaces because there would not be enough daylight.

## Simple and contemporary

The discussion ended in a commonsensical solution that accommodates the largest possible number of heritage, architectural, and practical interests. The system of posts was preserved, the rooms take on new architectural life through contemporary furnishings and modern windows, and the second story can be used because the shed dormer was preserved, though in a modified version, so that now its length corresponds to that of the series of large full-length windows on the ground floor.

The plan is simple and clear. The entire ground floor of the original building on the south is a single open office, while the original building on the north has one large room and a meeting room at the end wall. The smaller connecting building, which has few heritage values, holds secondary service facilities such as lavatories, a kitchenette, and a copy room, and also serves as connecting space between

## Enkel og nutidig

Enden på diskussionen er snusfornuftig og tilgodeser flest mulige interesser såvel fredningsmæssige, arkitektoniske som anvendelsesmæssige. Stolpeværket er bevaret, rummene får nyt arkitektonisk liv gennem nutidig indretning og nye glaspartier, og første sal kan udnyttes, fordi kvisten er bevaret omend i en tillempet udgave, så dens udtrækning svarer til det store glasparti i stueetagen.

Plandispositionen er enkel og overskuelig; hele stueetagen i den sydlige bygning er udlagt som ét storrumskontor, mens den nordlige bygning er indrettet med et stort rum og et møderum ud mod gavlen. Den mindre bygning i midten, som ikke rummer fredningsværdier, er indrettet med sekundære servicefunktioner som toiletter, tekøkken og kopirum, ligesom den også agerer fordelingsrum mellem de to trapper, der fører til første sal, hvor planløsningen er gentaget.

Hvor porten sad i den nordlige bygning, sidder nu en ny port i form af to vældige glasskydedøre, som kan skydes helt til side langs den indvendige side af ydermuren. Dermed forstyrres den hverken brugen af rummet eller kommer i karambolage med det udvendige solgardin, som styres automatisk af, hvor meget sol og dermed hvor meget varme der kommer ind i rummet.

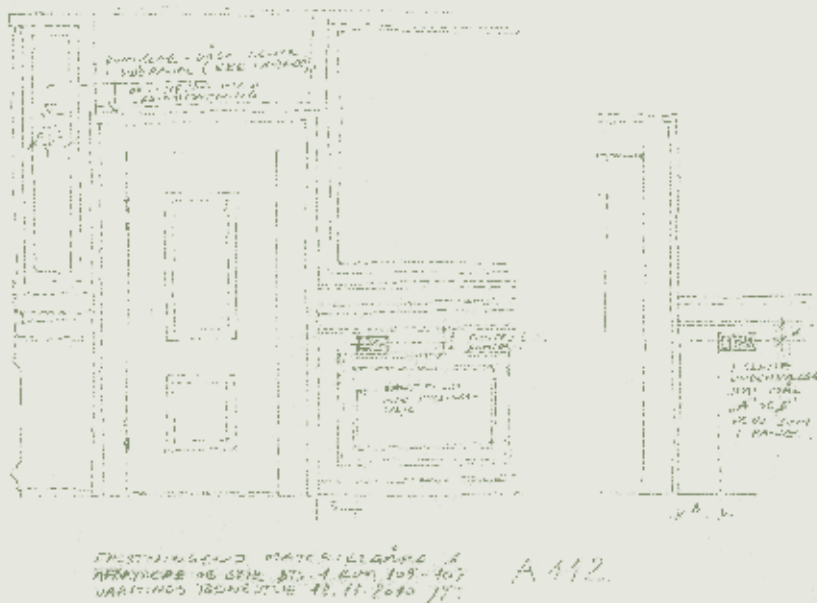


Det er vores kæphest, at man skal lade bygningen vise, hvad den kan, før man griber til moderne tekniske løsninger, for traditionel byggeteknik og materialer kan virkelig noget.

Birte Skov, Kulturstyrelsen

Our golden rule is to let a building show what it can do before we resort to modern technical measures, since traditional building techniques and materials do work.

Birte Skov, Danish Agency of Culture



*I forhold til den oprindelige bygning er den forventede CO<sub>2</sub>-reduktion 20 procent og samtidig opnås et termisk indeklimaniveau svarende til klasse C.*

*The expected CO<sub>2</sub> reduction is 20 percent in comparison with the building as it was, and at the same time results in a thermal indoor climate corresponding to class C.*



I den sydlige bygning optager glaspartiet hele fem stolpefag, og her består hvert fag af et fast parti og en skydedør adskilt af solide I-jern af stål. Glasset er korsopdelt med en lodret deling på midten og en vandret deling højt oppe, og også her sørger udvendige solgardiner for at reducere overophedningen om sommeren. Glasvæggen står ned på nye groft tilhuggede granittrin i hele fagets bredde, og ingen er i tvivl om, at dette er et nutidigt arkitektonisk greb.

## Materialer og overflader

Materialerne i Halvtagshusene er generelt enkle og prunkløse; her er ingen stuklofter eller forfinede snedkerdetaljer, og intet pussenusset har fået lov at overleve. Gulvene i stueetagen er således glittede betongulve, som udstøbes på stedet og slibes, så betonens tilslag af en særlig

the two staircases that lead to the second story, where the floor plan is repeated.

The gate in the building on the north was replaced by two large sliding glass doors mounted on the inside of the wall. This means that they neither interfere with the use of the room itself nor block the sunshade on the facade that is controlled automatically by the amount of sunlight – and consequently heat – that the room receives. In the building on the south, the glass-enclosed section has five posts, each bay consisting of a fixed window and a sliding door separated by sturdy steel I-beams. The glass is divided into four, vertically in the center and horizontally higher up, and sunshades on the facade help reduce overheating in the summer here as well. The windows and doors rest on new, coarsely dressed granite steps the entire width of the bay, and there is no doubt that this is a contemporary architectural touch.

## Materials and surfaces

The materials used in the Shed Building as a whole are simple and unostentatious. There are no stuccoed ceilings or refined carpentry, and no cute little details have been allowed to survive. The ground floor has glazed concrete floors cast in situ and polished so that the special

*Modsatte side:  
I lighed med bygningsanlæggets øvrige bygninger har også Halvtagshusenes indre ændret karakter og brug gennem årene.*

*Opposite page:  
Like the other buildings in the complex, this one had also changed character and use over the years.*



*Hensigten bag restaureringen: At genskabe bygningernes karakteristika som mere eller mindre åbne skure.*

*The intention behind restoration: to recreate the three original buildings' characteristics as more or less open sheds.*



slags sand træder frem, mens der ligger træplanker på gulvene på første sal. Alle vægge er ganske enkelt malet hvide på nær bagvæggen, der får lov at stå som en rå, ludbehandlet brædevæg med en lille afstand mellem de enkelte brædder. Det er ikke bare et arkitektonisk greb, for væggen skjuler en bagvedliggende installationsvæg, som klarer hele den lodrette rørføring i bygningen og, som ved hjælp af kantstillede brædder foroven og forneden sørger for ventilationen af rummene.

## Turbo på energibesparelser

Det er lykkedes at få gennemført mange af de energitiltag, som oprindeligt blev foreslået på bruttolisten, og det har selvsagt kunnet lade sig gøre fordi, der netop kun er relativt få bærende bevaringsværdier at tage hensyn til. Alle eksisterende og nye vinduespartier er således forsynet med nye superlavenergiglas, mens der er sat energiglas i forsatsrammerne på den lille mellembygning. Det har også været muligt at efterisolere indvendigt på hele den høje bagmur, ligesom terrændækket er efterisolert og forsynet med gulvvarme. Som i de øvrige bygninger er der naturligvis udelukkende energibesparende lyskilder, som sammen med alle øvrige el- og it-installationer styres centralt.

sand used in the aggregate is clearly discernible, while wooden planks were used on the second story. The walls were simply painted white, the only exception being the back wall, where lye-treated wooden planks were mounted, leaving little spaces between them. This is not just an architectural touch; the wall hides all the building's vertical plumbing. Boards set at an angle at the top and bottom ensure ventilation for the rooms.

## Speeding up energy savings

Because there were relatively few primary heritage values to take into account, it proved possible to carry out many of the energy-saving measures that had originally been proposed on the long list. All existing and new windows were given new low-E glass with argon fill, while the secondary windows in the little connecting building were fitted with low-E glass. It was also possible to provide the entire tall back wall with internal insulation, and insulate the deck on the ground floor and then install floor heating. Like the other buildings, the Shed Building naturally only uses low-energy lighting fixtures that are centrally controlled, like the rest of the electrical and IT equipment.

## Forenklet ventilation

Det er imidlertid særligt to ting, som påkalder sig opmærksomhed og adskiller sig fra forholdene i Materialforvalterboligen og Magasinbygningen. Fordi Halvtagshusene indrettes som storrums-kontorer, hvor mange mennesker skal opholde sig, fordrer arbejdsmiljøloven, at der etableres mekanisk ventilation. Her havde man egentligt valgt et såkaldt decentralt ventilationsanlæg med mekanisk genvinden og køling, som håndterer kølingen af rummene om sommeren og flytter varmen fra udsugningsluft over til indblæsningsluften om vinteren. For at sikre en korrekt varmestyring i de forskellige lejemål, omfattede løsningen flere anlæg og en masse kanalføringer på spidsloftet, således at der ikke var mulighed for at bruge bygnings spidsloft som depot.

Der var med andre ord brug for en time-out til at gentænke ventilationsanlægget. Med hjælp fra en ekstern energiingeniør fandt man frem til en såre fornuftig løsning, der udnytter, at der under gården ligger en gammel bunker fra krigens tid, hvor der er naturligt koldt året rundt. Den er et optimalt sted at placere selve køleanlægget, der skal forsyne Halvtagshusene og Bindingsværksbygningen med frisk luft. Som en sidegevinst giver den mulighed for at afvikle hovedparten af den komplicerede rørføring med store dimensioner under jorden langs med Halvtagshusene.

## Simplified ventilation

Two features, in particular, are noteworthy and not found in the Superintendent's Residence or Magazine. Because the Shed Building was converted into open offices that must accommodate a large number of employees, the Working Environment Act requires mechanical ventilation. Actually a decentralized ventilation system with mechanical recycling and cooling had been chosen. It would have cooled the rooms in the summer and shifted the heat from the exhaust air to the intake air in the winter. In order to ensure correct heat control in the different rental entities, the system would have consisted of several units and a great deal of ducting under the roof peak, making it impossible to use this area as storage space.

In other words, the ventilation system had to be reconsidered. With the aid of an external energy engineer, a very simple solution was found that takes advantage of an old World War II bunker that is naturally cool the year round. The bunker is the perfect place to put the cooling system that will provide the Shed Building and the Half-timbered Building with fresh air. An added bonus is that most of the complicated plumbing with large-dimensioned pipes can be laid underground along the Shed Building. Many pipes, but smaller ones, run into



Dermed er det mange, men mindre rør, der løber ind i bygningen – støbt ind i betongulvet – og frem til installationsrummet bag bræddevæggen.

## Fjernkøling

Omtrent samtidig kom en henvendelse fra Københavns Energi, der spurgte, om man ville være interesseret i at koble sig på deres nye fjernkøling, som er en langt mere CO<sub>2</sub>-venlig måde at producere køling på, end hvis den skulle have været produceret lokalt i Fæstningens Materialgård. Også det krævede overvejelser, idet tilbudet nok var fristende, fordi man ad den vej kunne komme langt ned i CO<sub>2</sub>-udledning men også var et opgør med et af hele projektets kongstanker, som jo handler om at se på, hvor meget man kan reducere CO<sub>2</sub>-udledningen ved at optimere selve bygningen – ikke ved at skifte forsyningskilder. Hvis det havde været en ambition, kunne

the building, cast in the cement floor and up behind the plank wall.

## District cooling

At about this time, the local power company, Københavns Energi, contacted Realdania Byg and asked if it would be interested in linking up the Fortifications Depot to its new district-cooling system, which is a much more CO<sub>2</sub> friendly way of producing cooling than doing so locally. This needed careful consideration, since though the offer was tempting, as it would mean reducing CO<sub>2</sub> emissions considerably, it also conflicted with one of the project's principal goals: seeing how much CO<sub>2</sub> emissions could be reduced by optimizing the buildings themselves, not by changing supply sources. If this had been an ambition, Realdania Byg could just as well have installed a wind

*Rummene får nyt arkitektonisk liv gennem nutidig indretning og nye glaspartier, og første sal kan udnyttes, fordi kvisten er bevaret.*

*The rooms take on new architectural life through contemporary furnishings and new glass enclosures, and the second story can be used because the shed dormer was preserved.*



man nemlig lige så godt have stillet en vindmølle op i gården eller have lavet vertikale jordboringer, som ville have resulteret i et energibehov på næsten nul. Når man alligevel har besluttet at koble sig på fjernkølingen, handler det om, at det er indlysende fornuftigt set i et større samfundsmæssigt perspektiv – også selv om der er tale om en foræring til CO<sub>2</sub>-regnskabet.

### Forventet CO<sub>2</sub>-reduktion

Man regner med, at den udvendige solafskærmning vil give 7,25 procent forventet CO<sub>2</sub>-reduktion, mens superlavenergivinduerne medfører en CO<sub>2</sub>-reduktion på 8,13 procent. Ved at efterisolere hele bagvæggen opnås ifølge beregningerne en CO<sub>2</sub>-reduktion på hele 13,49 procent, og ved at skabe øget bygningstæthed nås en reduktion på 6,77 procent. Endelig vil centralstyringen af strøm medføre en forventet CO<sub>2</sub>-reduktion på 3,72 procent. Modsat vil den nødvendige køling og ventilation påvirke den forventede CO<sub>2</sub>-besparelse negativt med 10,5 procent. Samlet set er det muligt at opnå et reduceret transmissions-tab på 39 procent og en samlet forventet relativ CO<sub>2</sub>-reduktion på knap 17 procent. I forhold til den oprindelige bygning er den forventede CO<sub>2</sub>-reduktion 20 procent og samtidig opnås et termisk indeklimaniveau svarende til klasse C.

turbine in the courtyard or used vertical earth drilling, resulting in an energy requirement of almost nothing at all. The decision to link up to the district-cooling system was made nonetheless because it so clearly makes sense in a wider social perspective, although it is a gift to the CO<sub>2</sub> balance.

### The expected CO<sub>2</sub> reduction

External sunshades are expected to give a CO<sub>2</sub> reduction of 7.25 percent, while low-E glass with argon fill will give a CO<sub>2</sub> reduction of 8.13 percent. Insulating the entire back wall will reduce CO<sub>2</sub> emissions by a full 13.49 percent, and increasing the air tightness will give a reduction of 6.77 percent. There is an expected CO<sub>2</sub> reduction of 3.72 percent if a centrally controlled electrical system is installed. In contrast, the necessary cooling and ventilation will have a negative effect on expected CO<sub>2</sub> reductions of 10.5 percent. As a whole, it is possible to achieve a reduced transmission loss of 39 percent and a total expected relative CO<sub>2</sub> reduction of nearly 17 percent. The expected CO<sub>2</sub> reduction is 20 percent in comparison with the building as it was, and at the same time results in a thermal indoor climate corresponding to class C.

## Bindingsværksbygningen

I 1748 blev en lang bindingsværksbygning opført langs Vester Vold, der lå hvor Vester Voldgade løber i dag. Bindingsværksbygningen er 45 fag lang og ni fag dyb, men hvert fag er ganske smalle, kun lidt over en meter. Bygningen orienterer sig entydigt mod gården med to hejsekviste, der bryder den store teglhængte tagflade med høj rejsning.

Bygningen skulle bruges som materialbygning, men der blev også plads til en mindre hestestald i den østlige ende af bygningen. Derfor var hovedparten af bygningen opdelt i fire store rum, med en åben rumstruktur, uden mange bærende skillevægge, hvilket var muligt takket være bygningens kraftige tømmerkonstruktion, med to parallelle rækker tæt placerede stolper, der bar et langsgående dragerværk.

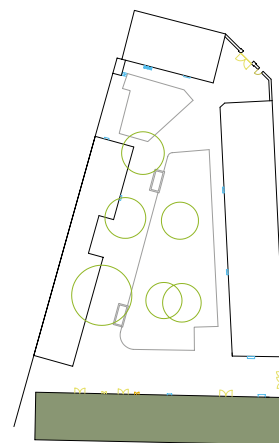
Siden 1800-tallet har bygningen undergået store forandringer, blandt andet flytning af den ene frontkvist, og flytning af døre, som betyder, at kun få døre sidder, som da huset blev opført. Nogle af de oprindelige luger er desuden erstattet af vinduer, og der er tilføjet nye sprossevinduer. Værst er det dog indvendigt, hvor halvdelen af de oprindelige stolper var fjernet, og i 2007 da Realdania Byg overtog det samlede bygningskompleks, var den engang enkle rumstruktur og detaljeringsgrad, som har

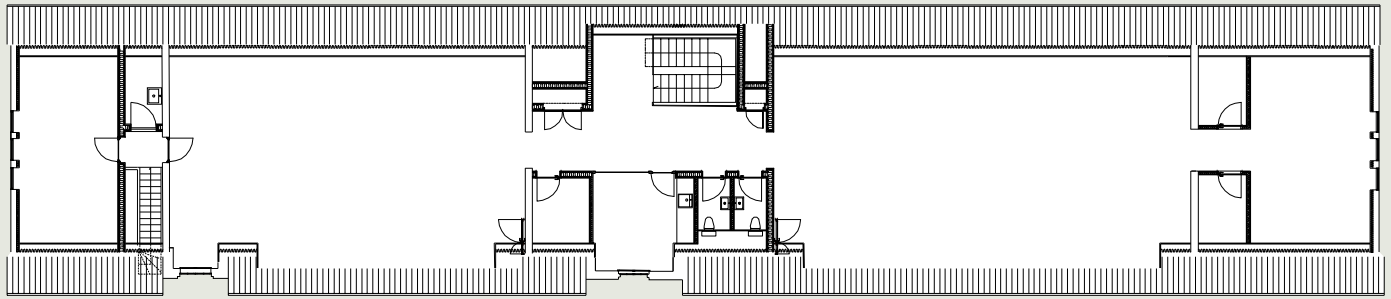
## The Half-timbered Building

In 1748, a long Half-timbered Building was erected along the Western Ramparts, where a street that bears their name runs today: Vester Voldgade. The Half-timbered Building is 45 bays long and nine bays deep, but each bay is quite narrow, just over a meter. It is oriented entirely toward the courtyard, with two front gables that originally held hoists in the large, high-pitched tile roof.

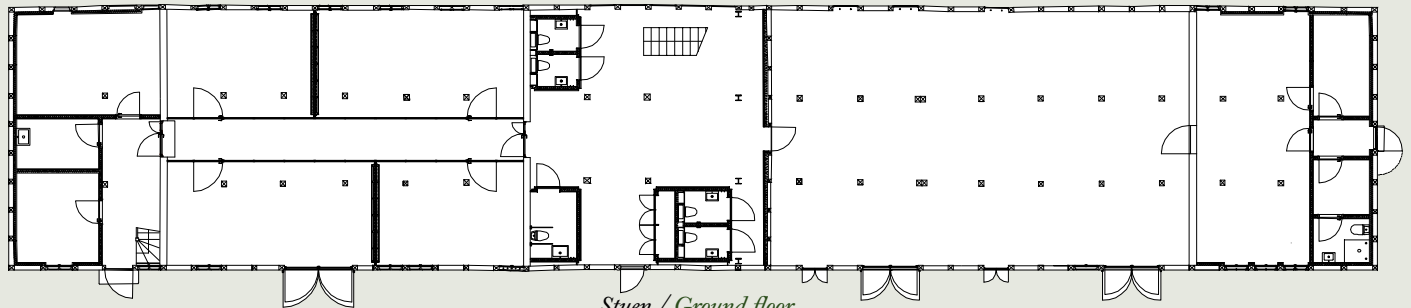
The building was used as a warehouse, but there was also room for a small stable at the east end. Most of the building was divided into four large spaces with an open plan and without many bearing partition walls, a construction made possible by the building's sturdy timberwork, with two dense, parallel rows of posts supporting beams the length of the building.

The building has undergone major changes since the beginning in the 19th century. One of the front gables as well as doors were moved, as a result of which only a few doors now remain in their original places. Some of the original hatches were moreover replaced by windows, and new muntined windows were added. The most damaging changes, however, were made inside, where half of the original posts were removed. In 2007, when Realdania Byg took





*1. sal / 2nd story*



*Stuen / Ground floor*

passet godt til de oprindelige funktioner, erstattet af en rumstruktur, der virkede fragmenteret. Tilføjede detaljer af nyere dato, som eksempelvis snedkerværk og glasdøre med alu-rammer, bidrog ikke positivt til det arkitektoniske helhedsbillede. I den institutionsagtige kontorindretning på første sal var det svært at få øje på arkitektoniske kvaliteter

## Nyt – og rigtig gammelt

Bindingsværksbygningens bærende værdier er således få og har af den årsag været væsentlige at fremdrage og styrke. De omfatter frem for alt pakhuskarakteren, hvis enkle konstruktioner og uforfinede detaljer er blevet styrket, og de to langsgående dragerværk og stolpekonstruktionen, som er blevet retableret, hvor stolper og kopbånd var fjernet. Også to oprindelige tværgående bindingsværksvægge og de to hejsekviste i facaden er blevet vurderet bevaringsværdige. Ambitionen har været at gøre konstruktionen til bygningens særlige kendetegn, og her er man gået så konsekvent til værks, at bygningen nu kun indeholder bygningsdele, der stammer fra opførelsen og nye tilføjelser anno 2012.

Denne angrebsvinkel blev genstand for interessante betragtninger om forholdet mellem nyt og gammelt. Arkitekterne foreslog nemlig,

over the entire building complex, the once simple room structure and level of detailing that had suited the building's original functions had been replaced by a confused, fragmented floor plan. Recent details, such as carpentry and glass doors with aluminum frames, made no positive contribution to the architectural whole. It was nearly impossible to catch sight of any architectural qualities in the institution-like offices on the second story.

## New – and really old

Since the Half-timbered Building's primary heritage values are few in number, it was important to uncover and underline them: the building's warehouse character, with simple structures and rustic details. The two parallel rows of posts supporting beams the length of the building were recreated in places where posts and braces had been removed. Two original transverse half-timbered walls and the two front gables had been judged worthy of preservation. The ambition was to make the building's structure its distinctive feature, and the work was carried out with such consistency that the building now contains only what it had when it was erected as well as new additions made in 2012.

*Modsatte side:  
Bindingsværksbygningen  
er 45 fag lang og ni fag  
dyb, men hvert fag er  
ganske smalle, kun lidt  
over en meter.*

*Opposite page:  
The Half-timbered Building  
is 45 bays long and nine  
bays deep, but each bay  
is quite narrow, just over  
a meter.*

*Ambitionen har været at gøre konstruktionen til bygningens særlige kendetegn.*

*The ambition was to make the building's structure its distinctive feature.*



at de nye stolper, der skulle opføres som erstatning for de gamle tømmerstolper, kunne være af stål, så de nye indgreb blev forståelige, og der opstod et kontrastfyldt møde mellem nyt og gammelt. At man samtidig kunne indstøbe stålsøjlerne og dermed skabe den tværstabilitet, som den gamle, lidt leddeløse bygning havde brug for, talte til fordel for forslaget.

Fredningsmyndighederne mente dog, at i og med stolpekonstruktionen netop var udpeget som en af de bærende fredningsværdier, måtte man være tro mod det oprindelige konstruktionsprincip og retablere de manglende træstolper. Deres synspunkt fik i sidste ende opbakning, da det blev åbenbart, at kantinerummet, som stålsøjlerne i givet fald skulle opføres i, ville ende med at have fem stålsøjler og ni træstolper, så her vejede hensynet til helhedsindtrykket tungest.

Til gengæld vandt arkitekterne gehør for deres forslag om, at give det centrale trapperum midt i den lange bygning et umiskendeligt

This approach led to interesting deliberations about the relationship between old and new. The architects namely proposed that the new posts that were to take the place of the ones that had been removed could be made of steel, so that the changes were understandable and a contrast was created between old and new. The fact that the steel columns could be imbedded in the ground, and thus create the transverse stability that the rather loose-jointed building needed, spoke in favor of this proposal.

The heritage authorities, however, believed that because the building's structure had been highlighted as one of its primary heritage values, it was necessary to remain true to the original structural principle and recreate the missing wooden posts. Their viewpoint gained support in the end when it became obvious that the lunchroom that was to hold the steel columns would end up with five steel columns and nine wooden posts. The overall impression was most important here.

The architects, in contrast, found support for their proposal that the central stairwell in the middle of the long building be given an unmistakably modern look. This is where traffic moves to the shared lunchroom and pantry at one end, and a number of meeting rooms at the other, while a steel staircase leads to the

*En af genistregene i projektet er at samle fælles servicefunktioner under ét tag.*

*One of the strokes of genius in the project was the decision to bring together common service facilities under one roof.*



moderne udtryk. Her fordeles trafikken til den fælles kantine og anretterkøkken i den ene ende og til en række møderum i den anden, mens en ståltrappe fører op til storrumskontorer på første sal. Trapperummet optages i øvrigt af tre bokse, der står som møbler – en i hvert sit hjørne af det næsten kvadratiske rum. Boksene indeholder garderobe og toiletter og er beklædt med genbrugte gamle gulvbrædder – men altså bearbejdet i et nutidigt formsprog. Møderummene skærmes af lette glasvægge ud mod en central gang og opdeles af lette skillevægge således, at der er to møderum på hver side af gangen. På den måde kan de to rækker af træstolper nemlig stadig opfattes i deres helhed.

## Usynlige kviste

Projektets måske dristigste indslag findes på første sal i Bindingsværksbygningen – men er omtrent usynligt i hvert fald udefra. For at skaffe lys til de utallige celekontorer og en lang gang langs den sydvendte tagflade var det fine gamle tegtag efterhånden blevet gennemhullet som en schweizerost af tagvinduer. Der var bred enighed om, at de måtte væk, men der var jo stadig behov for at få dagslys ind i tagetagen, hvis den skulle kunne udnyttes – og hvordan gør man det, hvis man samtidig vil have en rolig tagflade?

open offices on the second story. The stairwell also holds three large boxes, rather like pieces of furniture, each in its own corner of the almost square space. The boxes hold cloakrooms and lavatories and are faced with old recycled floorboards, but reused in a contemporary idiom. The meeting rooms are closed off by light glass walls on the central corridor, and divided by light partitions to form two meeting rooms on each side of the corridor. This still makes it possible to view the two rows of wooden posts as a whole.

## Invisible dormers

Perhaps the project's boldest contribution is found on the Half-timbered Building's second story, but it is more or less invisible, at least from the outside. In order to provide light for innumerable cell offices and a long corridor along the roof on the south, the fine old tile roof had been riddled with skylights like a Swiss cheese. There was broad agreement that they had to go, but it was still necessary to get daylight into the second story if it was to be used, and how could that be done if the goal was a calm roof surface?

The final solution to the problem was found indirectly, but it was clear from an early stage

Den endelige løsning blev fundet ad nogle omveje, men det stod ret tidligt fast, at et nyt lysindtag måtte udformes som et langt, smalt og vandret felt, hvis intentionen om at opretholde en rolig tagflade med de to hejsekviste som det dominerende træk skulle indfris. Mod syd fandt man hurtigt en model, som alle kunne tilslutte sig – nemlig et langt rytterlys langs tagryggen som den primære dagslyskilde, men da der er krav om, at man fra arbejdspladser også skal kunne se ud, måtte man tænke ud over de gængse løsninger.

I første omgang arbejdede man med et forslag om at montere tegllameller hen over almindelige tagvinduer i vandrette bånd med mellemrum (ligesom ved tagryggen), så der stadig ville være delvist udsyn. Men med den løsning ville det ikke være muligt at holde vinduerne rene medmindre man kunne finde et indadgående tagvindue. Og et sådan findes simpelthen ikke på markedet, fordi de ikke er tætte! Andre forslag involverede teknisk komplicerede løsninger med mekaniske og bevægelige dele, der skulle sikre, at tegllamellerne kunne løftes, når vinduerne skulle rengøres, men de viste sig at være for komplekse.

Til sidst fandt man i samarbejde med en ekstern arkitektrådgiver frem til en ganske simpel løsning. To lange partier af lodrette indadgående

that a new light intake had to be designed as a long, narrow, horizontal panel if the goal of maintaining a calm roof surface with the two front gables as the dominant feature was to be met. A model was quickly found on the south that all could accept: a long skylight along the ridge turret as the primary source of daylight. But since employees must to be able to look out a window, customary solutions were not enough.

Work started with a proposal to mount tile slats over ordinary skylights in horizontal bands at specific intervals (just as on the ridge turret) so there would still be some visibility. This design, however, would make it impossible to keep the windows clean unless a skylight that opened inward could be found. And there is simply nothing like this on the market: it would not be tight! Other proposals involved technically complicated solutions with mechanical and movable parts to ensure that the slats could be lifted when the windows had to be washed, but they proved too complex.

Finally, a very simple solution was found in collaboration with an external architectural consultant. Two long sections of vertical windows that open inwards mounted on top of high jamb walls are hidden by horizontal tile slats that match the tiles on the rest of the roof.





vinduer, der er monteret ovenpå høje skunkvægge, skjules af vandrette lameller af teglsten, som svarer til tagets øvrige teglbeklædning. Mellemrummet mellem lamellerne sikrer udsynet til gårdrummet, og de indadgående vinduer kan nemt rengøres. Omkostningen er en indadgående kvist, hvor efterårets løvfald, vinterens sne og forårets fugleunger givetvis vil søge hen.

Dette forslag rækker naturligvis langt ud over, hvad der normalt er muligt indenfor en fredning, men alle parter var enige om værdien af at lave et eksperiment med en vinduesløsning, der aldrig før er set og er tilpasset netop dette konkrete sted.

## Fælles servicefunktioner

En af genistregene i hele projektet i Fæstningens Materialgård er beslutningen om at samle fælles servicefunktioner som kantine og møderum under ét tag i stedet for at fordele dem ud på de enkelte bygninger. Dels giver det liv i gårdrummet i løbet af dagen, når mennesker går til og fra møder og frokost; dels – og vigtigst – tæller det at samle funktioner, der kræver et kortvarigt men højt ventilationsbehov, positivt i CO<sub>2</sub>-regnskabet på to måder: For det første undgår man at skulle etablere mekanisk ventilation i de bygninger, hvor der ikke er

The spaces between the slats ensure a view of the courtyard, and the windows are easy to wash, as they open inwards. The disadvantage is a recessed space that will naturally attract leaves in autumn, snow in winter, and nestlings in spring.

This proposal naturally goes much farther than what is normally possible in a heritage building, but all parties agreed on the value of making an experiment with a window design that had never been seen before and was adapted especially for this specific place.

## Common service facilities

One of the strokes of genius in the entire Fortifications Depot project was the decision to bring together common service facilities, such as the lunchroom and meeting rooms, under one roof instead of apportioning them among the individual buildings. This brings life to the courtyard in the course of the day, when people walk to and from meetings and lunch. Most importantly, combining facilities that require ventilation for short periods but with high efficiency has a positive effect on the CO<sub>2</sub> balance in two ways. First of all, mechanical ventilation does not have to be installed in the buildings with no open offices or common meeting rooms.



*Modsatte side:  
Bindingsværksbygningens  
bærende værdier omfatter  
frem for alt pakhuskarak-  
teren.*

*Opposite page:  
The Half-timbered  
Building's primary  
heritage value is the  
building's warehouse  
character.*

storrumskontorer og ingen fælles møderum. For det andet behøver man ikke at efterisolere indvendigt i store dele af Bindingsværksbygningens stueetage, fordi der ikke skal være arbejdspladser. Eksemplet dokumenterer, at der er meget at vinde på energikontoen blot ved at tænke sig om og finde de rigtige funktioner til de rigtige bygninger.

## Forventet CO<sub>2</sub>-reduktion

Mange af de energitiltag som er gennemført i Halvtagshusene går igen i Bindingsværksbygningen herunder energiglas i de eksisterende forsatsrammer og superlavenergiruder i alle nye vinduer. I møderummene og kantinen i stueetagen foregår ventilationen ved hjælp af såkaldte konvektorgrave i gulvet, hvorfra der blæses frisk luft ind i rummene, mens man på første sal bruger skunkvæggene til at føre ventilationsinstallationerne. Via træpaneler langs gulvet blæses luften ind i de to storrumskontorer på hver side af trapperummet. Der er foretaget indvendig efterisolering i køkkenet og i birum, men derudover har det ikke været muligt at efterisolere, fordi hensynet til de eksisterende bindingsværksvægge naturligvis er prioriteret højest. Derfor har man blot helt traditionelt tætnet fugerne mellem bindingsværk og tavl

Secondly, it is not necessary to install internal insulation in large parts of the Half-timbered Building's ground floor because there are not going to be any workplaces there. The example documents that a great deal can be gained on the energy balance simply by thinking things through and finding the right facilities for the right buildings.

## Expected CO<sub>2</sub> reduction

Many of the energy-saving measures that were carried out in the Shed Building were repeated in the Half-timbered Building, including installing low-E glass in the secondary frames and low-E glass with argon fill in all new windows. In the meeting rooms and lunchroom on the ground floor, trench convectors in the floor blow fresh air into the rooms. On the second story, the roof space holds the equipment that provides ventilation for the two open offices on each side of the stairwell. The kitchen and auxiliary areas were insulated inside, but it was impossible to insulate elsewhere, because the original half-timbered walls were naturally given highest priority. This is why the joints between the timbers and the compartments were simply filled out in the traditional way, with surprisingly good results: the increased

*Modsatte side:  
Samlet giver energitiltagene  
et reduceret transmissions-  
tab på 57 procent og en  
samlet forventet relativ  
CO<sub>2</sub>-reduktion på  
17 procent.*

*Opposite page:  
In all, the energy-saving  
measures give a reduction  
in the transmission loss  
of 57 percent and a total  
expected relative CO<sub>2</sub>  
reduction of 17 percent.*

med overraskende god virkning til følge, idet man regner med, at den øgede tæthed medfører en forventet CO<sub>2</sub>-reduktion på 7,27 procent.

Centralstyring af strømmen giver ifølge beregningerne en forventet CO<sub>2</sub>-reduktion på 7,59 procent, mens køling og ventilation ventes at indvirke negativt med 7,7 procent på den forventede CO<sub>2</sub>-besparelse. Samlet giver energitiltagene et reduceret transmissionstab på 57 procent og en samlet forventet relativ CO<sub>2</sub>-reduktion på 17 procent. Men bygningens funktionsændring betyder, at der vil være et øget CO<sub>2</sub>-forbrug på 20 procent i forhold til den oprindelige bygning. Dog er det muligt at opnå et indeklimaniveau svarende til klasse C.

### 3: ERFARINGER OG OPFØLGNING

#### International bevågenhed

Fæstningens Materialgård er på grund af sin åbne og transparente proces ganske særegen i Europa, og derfor har det vakt opmærksomhed, når projektet er blevet præsenteret i internationale sammenhænge. I foråret 2011 var Fæstningens Materialgård således et af indlæggene på en UNDP-konference i Dubrovnik om kulturarv og klima. Her var der en positiv modtagelse af budskabet om at huske den sunde fornuft i iveren



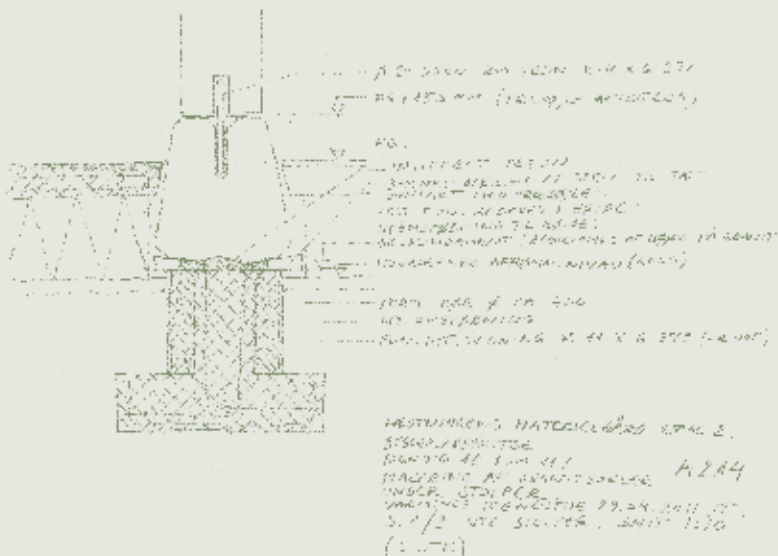


Det kræver køling og koster nogle føringsveje under gulvet at få CO<sub>2</sub>-reduktion, fredningsværdier og arbejdsmiljø til at mødes. Det er et simpelt spørgsmål om 'give and take'.

Martin Funch, Strunge Jensen Rådgivende Ingeniører

Getting CO<sub>2</sub> reductions, heritage values, and the working environment to harmonize requires cooling, and this means that some plumbing has to be hidden under the floor. It is simply a question of give and take.

Martin Funch, Strunge Jensen Rådgivende Ingeniører



airtightness is expected to give a CO<sub>2</sub> reduction of 7.27 percent.

The centrally controlled electrical system is expected to give a CO<sub>2</sub> reduction of 7.59 percent, while cooling and ventilation are expected to have a negative effect of 7.7 percent on the expected CO<sub>2</sub> reduction. In all, the energy-saving measures give a reduction in the transmission loss of 57 percent and a total expected relative CO<sub>2</sub> reduction of 17 percent. While the building's new function will result in an increase in CO<sub>2</sub> emissions of 20 percent in comparison with the original building, it will still be possible to achieve a thermal indoor climate level corresponding to class C.

### 3: EXPERIENCES AND FOLLOW UP

#### International interest

Because of the open and transparent process of restoring the Fortifications Depot, the project is quite distinctive in Europe and consequently attracted some attention when it was presented in international forums. In the spring of 2011, the Fortifications Depot was one of the topics at a UNDP conference on cultural heritage and climate held in Dubrovnik. The project's message – remember to use common sense in zeal-

efter at spare energi, for ofte glemmer man at bruge de helt banale – men gode – løsninger.

Fæstningens Materialgård er imidlertid også genstand for et stort anlagt og EU-finansieret forskningsprojekt, der handler om at bygge bro mellem bevarelse af historiske bygninger og beskyttelse af klima gennem energieffektivitet. Hovedformålet er at udvikle metoder til at renovere fredede bygninger i Europa ved at formulere et sæt vurderingskriterier, der kan bruges før og efter indgrebet.

Projektet bærer overskriften 'Efficient Energy for EU Cultural Heritage – '3ENCULT' – og løber fra oktober 2010 til marts 2014. Det omfatter otte cases, som analyseres af et antal arbejdsgrupper, der har hvert sit formål. En gruppe har til opgave at finde redskaber, der kan bruges til at identificere de bygningsmæssige kvaliteter i en fredet eller bevaringsværdig bygning, en anden gruppe opsamler de mulige energimæssige tiltag, og en tredje ser på, hvilke produkter der kan indgå i energirenoveringer. Helt centralt er selvfølgelig også den gruppes arbejde, der handler om at lave energiberegninger, og endelig er der grupper, som sørger for at følge fremdriften i de otte cases og formidle resultaterne af dem.

Fra Danmark deltager Kunstakademiets Arkitektskoles Institut for Teknologi, som er inviteret med i projektet på grund af sine erfaringer

ous efforts to save energy – was given a positive reception, since often quite banal, but good, measures are often forgotten.

The Fortifications Depot is also the subject of a large-scale, EU-financed research project to build a bridge between the work of preserving historical buildings and efforts to protect the climate through energy efficiency. The main goal is to develop methods of renovating heritage buildings in Europe by formulating a set of evaluation criteria that can be used before and after the work is carried out.

Efficient Energy for EU Cultural Heritage – 3ENCULT – runs from October 2010 to March 2014. It comprises eight case studies carried out by a number of working groups, each with its specific purpose. One group finds tools that can be used to identify the architectural qualities of a building that has been given heritage status or is worthy of preservation. Another compiles a list of potential energy-saving measures, while yet another looks at the products that could be used in energy-conservation projects. The work of the group that makes energy calculations is naturally of key importance. Other groups follow the progress of the eight case studies and publish their results.

The Danish participant is the Royal Danish Academy of Fine Arts, School of Architecture's

med bevaringsprogrammerne SAVE, der handler om kortlægning og registrering af bevaringsværdier i byer og bygninger og SUII, der drejer sig om bæredygtig udvikling i historiske bykvarterer.

Her satte man sig for at finde et dansk projekt, der kunne egne sig som case, og som ikke var længere fremme end, at EU-projektet 3ENCULT kunne nå at øve indflydelse på dets udvikling. Det viste sig ikke at være muligt, men så rettede man opmærksomheden mod Fæstningens Materialgård, der ganske vist ved 3ENCULTs begyndelse allerede var ved at blive realiseret og derfor ikke umiddelbart kunne nå at få glæde af EU-projektet.

Omvendt kunne 3ENCULT udnytte erfaringerne i Fæstningens Materialgård, og her har det vist sig, at det danske projekt på sin vis har foregrebet den centrale arbejdsmetode i 3ENCULT, som nemlig også opererer med en liste over mulige energirenovringstiltag i den ene vægtskål og bygningsværdier i den anden vægtskål. Mens energitiltagene let kan omsættes i sammenlignelige tal, forholder det sig anderledes med bygningsværdierne, hvor man hidtil har manglet et anvendeligt redskab til værdisætning af dem.

Den store åbenhed og transparens i det danske projektets tværfaglige udvælgelsesproces og

Institute of Technology, which was invited because of its experience with SAVE (Survey of Architectural Values in the Environment) and SUII (Sustainable development of Urban historical areas through an active Integration within Towns).

The institute went about finding a Danish project that could be used as a case study but was still at a stage where 3ENCULT would have time to influence it. When this proved impossible, attention was turned to the Fortifications Depot, though by the time 3ENCULT began, it was already in progress and could consequently not benefit from the EU project.

3ENCULT, in contrast, would be able to make use of experiences gained in the Fortifications Depot project, which in a way had anticipated the key work method used in 3ENCULT. It namely operates with a list of possible energy-conservation measures and heritage values that must be weighed against one another. While energy-saving measures can easily be transformed into comparable figures, it is a different matter with heritage values, for which no useful tool has been found yet for assessing their worth.

The great openness and transparency of the Danish project's interdisciplinary selection



*Projektets måske dristigste indslag findes på første sal i Bindingsværksbygningen – vinduet.*

*Perhaps the project's boldest contribution is found on the Half-timbered Building's second story – the window.*

den rapport, som er resultatet af processen, har derfor vakt behørig opmærksomhed i EU-projektet. Dette skyldes, at den netop tegner omridset af det nødvendige redskab, som skal til for at kunne identificere og værdisætte de bygnings- og bevaringsmæssige værdier og dermed for at kunne kvalificere afvejningen.

## Evaluering

Mens der allerede på nuværende tidspunkt er stor ros til transparensen og procesbeskrivelsen af realiseringen af Fæstningens Materialgård fra

processen og den rapport, som er resultatet af processen, har derfor vakt behørig opmærksomhed i EU-projektet. Dette skyldes, at den netop tegner omridset af det nødvendige redskab, som skal til for at kunne identificere og værdisætte de bygnings- og bevaringsmæssige værdier og dermed for at kunne kvalificere afvejningen.

## Evaluations

While the Fortifications Depot project's transparency and the description of how the process was carried out have received considerable praise, 3ENCULT has also expressed



*En vigtig lære er, at det er nødvendigt at finde løsninger, som passer præcis til den pågældende fredede bygning, og at standardløsninger ofte ikke duer.*

*An important lesson is that it is necessary to find measures that are suited specifically to the heritage building in question, and that standard solutions often do not work.*



3ENCULT, er der på et konceptuelt plan også kritikpunkter. De handler om, hvorvidt Fæstningens Materialgård forholder sig til – og forløser – helt centrale begreber indenfor restaurering: nemlig originalitet, autenticitet, identitet og narrativitet – eller fortælleverdi. Her er det holdningen, at Fæstningens Materialgård er fikseret i et for homogent udtryk, der i det ydre ikke evner at fortælle hele historien om bygningsanlæggets oprindelse, dets lange udvikling og særlige funktion. Man savner med andre ord et spor af tjærelugt og et glimt af hejseværk i de fint renoverede bygninger, der nu ellers overbevisende lever videre som rammer om moderne arbejdspladser med godt indeklima og godt energiregnskab.

some criticism on a conceptual level. They center on whether the Fortifications Depot takes a stand on, and lives up to, essential concepts in restoration: originality, authenticity, identity, and narrativity. 3ENCULT finds that the Fortifications Depot has been frozen in a far too homogeneous overall look; its exteriors are unable to tell the entire history of the complex's origins, long development, and special function. In other words, the odor of tar and a glimpse of the hoists are missing in the finely renovated buildings, though they otherwise live on quite convincingly as a framework for modern workplaces with a good indoor climate and good energy balance.

## Målinger

På længere sigt skal 3ENCULT i samarbejde med projektets danske ingeniører forestå målinger af de klimatiske parametre i Fæstningens Materialgård. Det er planen at måle på bygningernes drift i tre sæsoner og sammenholde tallene med de beregnede data. Resultaterne vil indgå i en rapport som forventes offentliggjort om fire til fem år.

Selv om det ikke er en ønskesituation set fra en udlejers synsvinkel, leger bygherren med ideen om at lade et lejemål stå tomt i en periode, og lade det centrale computersystem styre det, som om det bliver brugt optimalt i energimæssig henseende. De tal, der kommer ud af det, kan derpå sammenlignes med et nablejemål, hvor medarbejderne skruer op og ned for varmen og glemmer at slukke for lyset, når de går hjem. Dermed kan man få et dækkende billede af, hvad den menneskelige faktor betyder for energiregnskabet.

## Den gode historie

I 2007 gik deltagerne ind i projektet med hver deres faglige forudsætninger og ekspertise, og nu omtrent fem år senere er alle et sæt værdifulde erfaringer rigere. Den vigtigste er, at selv om det tværfaglige samarbejde har været en

## Measurements

In the long term, 3ENCULT will carry out measurements of the Fortifications Depot's climatic parameters in collaboration with the project's Danish engineers. The plan is to follow the buildings' operations for three seasons and compare the figures with data estimates. The results will be included in a report that is expected to be published in four or five years' time.

Although this is not an ideal situation for a landlord, the client is toying with the idea of letting one rental entity remain empty for a period and having the central computer system control it as if it were being used optimally with regard to energy consumption. The resulting figures could then be compared with those of an adjacent rental entity where employees turn the heat up and down and forget to turn off the lights before they go home. This would give a comprehensive picture of what the human factor means for the energy balance.

## A good story

In 2007, each of the participants began work on the project with his or her professional background and expertise, and now – some five years later – all are a number of valuable

omstændelig, tidskrævende og dyr proces har den alligevel kunnet betale sig, fordi den har resulteret i et projekt, der er realiseret på et højt kvalificeret grundlag.

En anden vigtig lære er, at det er nødvendigt at finde løsninger, som passer præcis til den pågældende fredede bygning, og at standardløsninger ofte ikke duer, fordi hver bygnings fysik og 'stofsifte' er særegent og skal behandles som sådan. Og lige i forlængelse heraf står erfaringen, at meget er vundet ved at udnytte bygningens egne klimatiske egenskaber – lytte til det den selv kan – og så arbejde med det ikke imod det.

Det helt oplagte spørgsmål er selvfølgelig, om alt dette kan betale sig set i et samfundsøkonomisk perspektiv. Det korte svar er, at det kan det ikke, som dagens energipriser ser ud. Dertil er varme-køleunits, avancerede kabler og central computerstyring for kostbare at anskaffe og drive. Men graver man lidt dybere, bliver billedet mere nuanceret, for det koster ikke noget at tænke sig om, når man skal fastlægge hvilke funktioner, der egner sig til at være i en given bygning, og når man beslutter, hvilke energitiltag bygningen kan bære og drage nytte af.

Der ligger halvdelen af CO<sub>2</sub>-besparelserne. Og det er en god historie at give videre.

experiences richer. Most importantly, although interdisciplinary cooperation was a laborious, time-consuming, and expensive process, it still paid off because it resulted in a project based on the best possible foundation.

Another important lesson is that it is necessary to find measures that are suited specifically to the heritage building in question, and that standard solutions often do not work because every building's physical condition and "metabolism" are distinctive and must be treated as such. Similarly, a great deal was gained by exploiting a building's own climatic characteristics: listening to what it can do itself and then working with it, not against it.

An obvious question is naturally whether all this can pay off in a socioeconomic perspective. The short answer is that it cannot, considering today's energy prices. It is too expensive to install and operate heating and cooling units, advanced cable systems, and central computer control. But if we go a bit deeper, we see a more nuanced picture, since it does not cost anything to do some careful thinking when decisions are made on what facilities are suitable for a given building and what energy-saving measures the building can accommodate and benefit from.

This is where half of the CO<sub>2</sub> reduction lies. And that is a good story to tell others.



*Fæstningens Materialgård  
er ganske særegen i Europa,  
og derfor har det vakt  
opmærksomhed.*

*The project is quite  
distinctive in Europe.*





Bygninger er en del af vores kulturarv. Et håndgribeligt levn, som vores forfædre har givet videre, og som vi er forpligtet til at værne om.

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