Henning Larsen —

Design with in pact Looking at the healthy buildings of the future

Jakob Strøm ann-Andersen Partner, Head of Sustainability Engineering



7 offices 300 colleagues 32 nationalities 20 countries





From ideas



Know ledge-based design and design that gives know ledge

By 2050,68% of the world's population will live in cities.

To keep up, we must build a new city for 1.5 million people each week.

A Time of Complex Challenges

AK2

AK2 1. question topics should correlate directly to HLA projects shown later; 2. image and questions can be swapped out for a lecture with different focus - eg. community space vs. sustainable design from an energy/resource/climate perspective Andrea Kahn; 6.12.2018

We can't allow our future to look like this!

W hat is the future relevance of architects?

The Architect as the M aster Sketcher

Henning

arset

Ludw ig M ies van der Rohe

(1886 - 19

The Architect as the Conductor

Elbphiham onie, Ham burg, Germ any by Herzog & de Meuron

icked Problem s

Ν

© Henning Larsen

W orkshop, Copenhagen Perform ing Arts CenterW orld Trade Center Architecture is fundam entally about staging hum an interaction. Munich,Germany

Siem ens GlobalHQ



Identity Historic link to Munich

V isibility Sustainable frontrunner in an urban context

Urbanity M odem and attractive w ork place



W oven into the urban fabric



The site



Inviting the public in



Structural optim ization



A series of green court yards



3 different façade strategies

1:D iscreet tow ards the protected Ludw ig Ferdinand Palais



3 different façade strategies

2:Elegant and adaptable tow ards neighbour buildings



3 different façade strategies

3:Significant and modern tow ards the heavy traffic



Sustainable by design Tilted innerfaced for inflow of daylight



A social contribution to the city



© Henning Larsen



 \Box

1 🔳

•••

Henning Larsen —

IN PUT <u>The questions w e ask</u> D ream s V isions G oals

> Data M easurem ents

ARCHITECTURE

OUTPUT The effectw e create

Effecton the individual Effecton the culture/city Effecton the environm ent

Research

Inverge and Publishings 42 (2011) 2011-2020



The urban canyon and building energy use: Urban density versus daylight and passive solar gains

J. Strømann-Andersen 4*, P.A. Sattrup^b

* Department of Cost Begineering, Technical University of Denmark, Browy Building 118, 2000 Ego: Longly, Denmark * Institute of Building Technology, Royal Density Academy of Ten-Arts 20 Inni of Architecture, Philip de Langes Ald 12, 1425 Copenhages K, Denmark

ABTICLE INFO ABSTRACT

Article Natury Encatived #September 2010 Encatived in reviewd/herm 20 March 2011 Accepted 10 April 2011 Reports Urban density Energy use Daylight Solar taskation Integrated design

The table between when density and building emerginant is a complex belace between danasts factors and the openal, moreal and are partered of when spaces and the building that coverage between their adjust user the coverage of the when cargos to invertigate be wayed to the energy performance of low-energy buildings in a staff any penet strategy and detailed by their covera. Thus any given is comprehenses near of danase build penets thermal and dappet annulations to nor primary factors in the passive energy properties of buildings are

the geometry of urban cameras has an impact on total energy A their the generativy of values compares has an imagent in total energy consemptions in the energy can buildings. It was demonstrated how the reflectivity of when compares in energy can buildings. The set demonstrated how the reflectivity of when compares plays as energy can buildings. The set demonstrated how the reflectivity of when compares plays as energy can buildings. The set of the set of the table is not concord when set designs play the set of the set of the set of the table as and building decays requires a detailed of the complex complex playment the trapped and grand playments at decay plays. ive and quartitative considerations. © 2011 Elsevier B.V. All rights reserved.

winter heat losses are reduced with better insulation, glazing and ar rightness. Ubban desuffication is one strategy for nurstainable development, focusing on energy savings through efficient transport systems, shared influentertures and minimizing hear gains and losses that dominate energy budgets. It has been established that desuffica-tion is a balanchig at between these opportunities on the one hand, and ensuring solar access for low-energy budding and others

1. Introduction

testin of research. In presmetric terms, the utilian canyon is described at the length/statist ratio of the rapset between adjustest buildings. Here length length is produced by the second se One of the struct basis and fundamental questions in when ma-ter planning and building regulations is how to secret common accent to run, higher and bend at the time for the owners of addeddad properties. It is often a question of participation of what do avail-able. There is portable for protecting resulting conditions for had at a walk. There is portable also regulations and the right to light some pable and provide solvered. India accent and the right to light some in the structure of the solution pable and provide solvered in the accent and the right to light some interview. pro-sens in most industrialized codeficies, but the impact of fits code fits no obstations are energy one multiple over the years – more than disk on the industrial set of the same challenges to arrive the rest of the set of the same challenges of the industrial performance of our buildings and other, we need to improve our end the same characteristic set on the improve the rest of the set of the same challenges of the same characteristic set on the dynamic integration of the same characteristic set of the end of the same properties of the same characteristic set of the end of the same properties of the same characteristic set of the same have end multiplication between the same characteristic set of the same characteristic set of the same characteristic set of the same have end multiplication between the same characteristic set of the same characteristic set of the same characteristic set of the same have end multiplication between the same characteristic set of the same have end multiplication between the same characteristic set of the same have end multiplication between the same characteristic set of the same have end multiplication between the same characteristic set of the same have end multiplication between the same characteristic set of the s

and plasmas. The analysis of the second part of the second second

* Conceptuding archist. 761. +45 4525 1869; fair. +45 4525 1700; mebble. +45 4529 701.6. 8-twill of drive just allrage tracks (). Promiano-Andrews).

0376-7788(\$ - are front numer 0-2011 Raester BH All rightstreatives. doi:10.1016j.esbval.02011.04.007

146 | DESIGN WITH KNOWLEDGE | RESEARCH ARTICLES



air tightness.

DESIGN WITH KNOWLEDGE

New research in sustainable building Published by Henning Larsen Architects

Design m ethods



Projects

W hy dowe do research?

© Henning Larsen

Because we seek solutions that validate our architecture and create the best possible conditions for the users in our buildings and cities.

It's not about how buildings and cities look, but w hat they can do.

In-house Industrial PhDs Program s



Im ke W ies van M ils PhD.Stud.ArtificialLighting



Pelle M unch-Petersen PhD.Stud.Facade Design, Architects



KristerJens PhD.Stud.BigData



Drew Thilm any Phd.Stud.Ethnology,MA Applied CulturalAnalysis



FinnurPind Phd.Stud.Acoustics,MSc. CivilEngineer



© Henning Larsen



Uppsala, Sweden

Uppsala City Hall






⁹ Henning Larsen



Uppsala C ity Hall

Research virtual acoustics



Uppsala C ity Hall

Research virtual acoustics



[©] Henning Larsen

Uppsala City Hall Combining technologies







[©] Henning Larsen

41

Uppsala City Hall

Virtualsoundscapes and immersive audio

- new technologies to engage the user

Henning Larsen

Uppsala City Hall Atrium Virtual Acoustics

	Curick Launch (C	(Ini+Q) P _ 0 ×	<u>R</u> ⊨ = € +	/ A 7 📑 🖬	Au	todesk Revit 2018 - A-40-V-200_LV	ER - Floor Plan: AAB - Plan 2, Botte	nvåning, Entré - working Type a key
Window Help		Sign in 🔒	File Architecture Structure Insert	Annotate Analyze Massing & Site	e Collaborate View	Manage Add-Ins Enscape™	Quantification Henning Larsen	ToolKit Extensions Modify 📼 -
tart - 🏓 🖕 🔚 📭 🖼 🚆 📜 भी भी भी 🖕			Views of "A-40-V-200 LVIER":	\$	a		82.2	
IInncala <mark>®®®</mark> ***	<u>⊀∕</u> ∐]] ·	Solution Explorer 🔹 🖣 🗙	Pause Enscape - EPIN	Enable Render Image	Export Create View Asse	t Library Camera Video Editor R	nder Video Render Panorama	Manage Uploads Place Sound Source Ena
· · · · · · · · · · · · · · · · · · ·	-Y II A II - M HL_Tools.Command - @ GetRoomInfo(UIDocument uidoc, Docum -	° ⊂ ⊂ ∰ - To - ≒ "	Live Updates		•	Path (on/off)	•	(on selected face) * So
+ 66	public XYZ GetWallInfo(UIDocument uidoc, Document doc)	Search Solution Explorer (Ctrl 🔑 -	Control Active Document	VR Headset	Tools	Video	Panorama	Uploads Sound
or the add-in associated with 91	- menoreBrou	Solution 'HL_Tools' (1 project)						CONTRACTOR OF A CONTRACTOR OF
	#region ROOM INFO	HL_Tools	Properties	X Project Browser - A-40-V-200_LVIER	×			BALL THE ALL AND
93	<pre>// having the room coordinates, it is possible to find which grid poin</pre>	Properties References	Floor Plan	O Project Information	neet)			
94	public void GetRoomInfo(UIDocument uidoc, Document doc)	C* App.cs	1 Floor Plan (working)	 1 AAB - Working Views 		A .		all all
appid, new Guid(a/1/c042-a6(95	Reference roomReference = uidoc.Selection.PickObject(ObjectType.Fl	Bitmap16.bmp	a second and the second second	1 Floor Plan (working)	an 1 Kallar			
	Room roomElement = doc.GetElement(roomReference) as Room;	Bitmap32.bmp	Hoor Plan: AAB - Plan 2, Botter ~ Di Edit Typ	Floor Plan: AAB - H	Plan 2, Bott			The store is
	<pre>Element RoomPoint = doc.GetElement(roomReference);</pre>	CameraPosition.cs	View Scale 1 : 100	Floor Plan: AAB - Pl	an 2.1, Bot	And Same Provide State		1 to a part
99		C* CameraUpdater.cs	Scale Value 1: 100	Floor Plan: AAB - Pl Floor Plan: AAB - Pl	an 3, Vānin an 4, Vānin		1 1 EPJ-	A Start A Start
ta) <u>100</u> 101	<pre>//ElementCollector sc = new ElementCollector(); //// calling collector for enscape camera</pre>	C Command.cs C ElementCollector.cs	Display Model Normal	Floor Plan: AAB - Pl	an 5, Vânin 💮			Total And And And
t(); 102	<pre>//Element roomFilter = sc.GetCameraByNameLambda(doc, "Room1");</pre>	HL_Tools.addin	Parts Visibility Show Original	Floor Plan: AAB - P	an 6, Vânin	P +		· Ash a stars
	//Room roomElement = roomFilter as Room;		Visibility/Graphics	Floor Plan: AAB - P	an 7, Vanin an 8, Vânin			VIETERS TRACK
h camera 104			Graphic Display O Edit	Floor Plan: AAB - Pl	an 9, Takpla			+ 10 # 5/ A 5/ 6 13 15 18 18 18
on 105 entfollector(): 185	////get the coom position		Orientation Project North	3D View	en ann teach an ta	• — — PB		The las All
100	//LocationPoint roomLocation = RoomPoint.Location as LocationPoint		Wall Join Display Clean all wall joins	⊞ 1 AVN - Working Views		0		HAS THE . STATE
	<pre>//XYZ roomPoint = roomLocation.Point;</pre>	Solution Team Ex Property	Show Hidden Lines By Discipline	1 AWES - Working Views		• P		Shirt Shirt
eCamera_Class = sc.GetEnscap(109	<pre>//Debug.WriteLine("Room Coordinates" + roomPoint.X + "," + roomPoi</pre>	Properties - 🖣 🗙	Color Scheme Loc Background	1 AZAK - Working Views 1 CB - Working Views		0	(O)	The states
GetCameraByNameLINQ(doc, "EI 110	SpatialFlementRoundaryOntions ontions - new SpatialFlementRoundary		Color Scheme <none></none>	- 1 CGR - Working Views		• [al		
	options.SpatialElementBoundaryLocation = SpatialElementBoundaryLoc.		Visible In Option all	1 CSCH - Working Views	~	A -+ 0		
	<pre>string roomElementInfo = "";</pre>		Ignore Scale	3D Enscape View		e		la de da
			Sun Path	- 3D View: Enscape -	FPIN	D	1 Lipping	A A A A A A A A A A A A A A A A A A A
era Element tound was " + Car 115	foreach (IList <boundarysegment> boundSegList in roomElement.GetBoundsegList in roomElement</boundarysegment>		Properties help Apply	3D View: Enscape -	FPIN - worl v 3 1 : 100	MAGGARDOOA		
	foreach (BoundarySegment boundSeg in boundSegList)		Click to select, TAB for alternates, CTRL adds, SH	HIFT unselects.		A Workset	Not Editable) ~ 2 10	Ten III Main Model
CameraElement as FamilyInstar 118			Engrand 2.4.1 Views 'Engrand EDIN'			0.0	0	
	<pre>ElementId eID = boundSeg.ElementId;</pre>		Enscape 2.4.1 - View: Enscape - PPIN					
	Element e = doc.GetElement(eID);		945.5. 34 546	1. 2.				1 3 M 1 1 1
	LocationCurve locationCurve = wall.Location as LocationCurve			1 1 2				State of the second
Position(); 123	Curve curve = locationCurve.Curve;		- Part - Parts - Read -	A ANT				A ALAS
			Martin Carlo A	A State of the second s				and the second second
for enscape camera, using G 125 hod "lambda" 126	Parameter wallParameter = wall.get_Parameter(BuiltInParame		1 State State				-	Party and a series
cationDataXYZ(CameraElement) 127	double lengthOfWall = wallParameter.AsDouble() * feet2Meter					and the second se	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
			THE CARE WAR	Carles Provide			A LA LOT A LA L	Alter A
nData.X; 129	<pre>roomElementInfo += e.Name + " " + curve.Length + "\n";</pre>		The second second second second			and the second s		
nData.Y; 130				1992 - C		- COLORADOR - CARDIN	Contraction of the second	
132				No.		1-1-1	a second second	A DAMAGE AND A DAM
ameraX + "\n"+"Y data: " + c; 133	TaskDialog.Show("Boundary Segment Elements", roomElementInfo);		Transie and the second	- Balling			2/	49
			A REAL PROPERTY OF THE REAL			and the second s	1	
	//return roomPoint;		STATESTIC AND A STATESTICS	and the state			200	
	#endregion		ALL AND ALL AND ALL AND ALL AND ALL A	The second se				The second s
				per t				Star NY IS
* 139	#region INTERPOLATION GRID CALCULATION			a state of				
		• 1 v		States - Barris		No. of Concession, name	The second value of the se	10 1 15 10
5 5 2 m			and the second s			and the second se		
				No.				
				STATE OF STATE	100	STREAM		
						AL PROPERTY AND IN COLUMN		
code -1 (0xfffffff).				Contraction of the local division of the loc				÷
			- Alter	-			Votes Chilar	► + + Silt
© Henning Larsen								
	Ln 103 Col 48 Ch 48 INS	Add to Source Control -			Move	: By Up / Down By / Walk	HIGH HIGH HIGH HIGH HIGH	ook Around Orbit Time of Day











⁸ Henning Larsen

Uppsala C ity Hall

Outcomeon KPIsand awards

New window DFD and acoustic absorptions integrated

Higherperform ance, less materials and reduced construction cost

New software in virtual acoustics simulation



© Henning Larsen

Aarhus, Denmark

Frederiksbjerg School



[©] Henning Larsen



Frederiksbjerg School

A new way of learning about...





© Henning Larsen







Sources: Flynn (1973, 1977, 1980), Collins et al (1975), Löfberg et al (1975), Weinstein et al (1979), Smith & Rea (1980), Dunn et al (1985), Küller & Lindsten (1992), Hathaway (1995), Knez et al (1995, 1998, 2001), Rusak et al (1997), Kuller (1998), Heschong Mahone Group (1999), Veitch & McColl, (2001), Goven et al (2001), Boyce (2003, 2014), Winterbottom (2001), Van Bommel et al (2004), Wessolowski (2010), Goven et al (2011), Barkmann et al (2011, 2014), Sleegers et al (2012), Mott et al. (2014)

Henning

Larsen

Frederiksbjerg School Legislation / BR18



Det skal eftervises, at det elektriske belysningsanlæg opfylder bygningsreglementets krav for belysningsstyrke, jf. DS/EN 12464-1, *Lys og Belysning - Belysning ved arbejdspladser – Del 1: Indendørs arbejdspladser.* For nogle arbejdspladser er kravene til belysningsstyrke yderligere specificeret i det nationale anneks DS/EN 12464-1 DK NA. Eksempler på krav til middelbelysningsstyrke og regelmæssighed er givet i tabel 3. Regelmæssigheden af belysningen, U0, defineres som minimums belysningsstyrken, E_{min}, i forhold til middelbelysningsstyrken, E_{mid}.

De tekniske krav til belysningen skal kunne opfyldes i hele anlæggets levetid.

Tabel 3. Eksempler på krav til belysningsstyrke ved udvalgte arbejdspladser, jf. DS/EN 12464-1 og DS/EN 12464-1 DK NA.

Sted	Middelbelysningsstyrke på ar-bejdsplanet, E _{mid}	Regelmæssighed, U _o		
Gange og trapper	100 lux	0,40		
Kontorarbejde - Opgaveområde (på synsobjektet) - I nærområdet (over ½ m fra synsobjektet)	500 lux 300 lux	0,60 0,40		
Børnehaver og vuggestuer	300 lux	0,40 0,60 (koncentrationsleg)		
Undervisningslokaler	300 lux	0,6		









⁹ Henning Larsen

Combining the audio and visualhum an experience

New Research in Light, Acoustics and Learning



[©] Henning Larsen



Experimenting withmood lighting

Nom al

AmbientLighting

Experiment Focused lighting



© Henning Larsen



Default, traditional ceiling lighting (video snapshot)





Pendant lighting activated (video snapshot)





Findings:

Ourdata shows an average reduction of 2-8 dB

- 1dB:Noticeable with special equipment in a soundproof room
- 2-3 dB:Noticeable in an average environm ent' (though perhaps only when asked)
- 4-6 dB: Very noticeable in an average environm ent (students will hear the difference)
- 7-8 dB:Significant, a notew orthy reduction
- 10 dB:50 percent reduction, extrem ely audible

64 dB

58 dB



⁹ Henning Larsen

64 dB

58 dB



⁹ Henning Larsen

End results:

- Calm forstudents
- More com fortable
- Low ered electricity use (35% reduction)
- Less noise, on average 8 dB (A)

Aarhus, Denmark

Outcomeon KPIsandawards

Calm forstudents

M ore com fortable

Low ered electricity use (35% reduction)

Less noise, on average -8 dB(A)



[©] Henning Larsen

CarlH. Lindner College of Business

Location Cincinnati, Ohio, USA

Gross floorarea 22,500 sqm

Status Underopførelse





Young adults are the loneliest generation in America.

Lonely millennials twice as likely to experience depression oranxiety

29.3% of UC students felt so depressed that it was difficult to function. (2016)



⁹ Henning Larsen





"You don't know w hat inclusivity m eans to us."

David Szym anski Dean, LindnerCollege of Business University of Cincinnati
"How can we ensure new kinds of environm ents don't become empty, unused spaces?"

Drew Thilm any, Henning Larsen Ph.d.stud., Anthropology



Inclusivity has a scale



Anonym ity (DK)

Recognition (US)



Design developm ent

[©] Henning Larsen





How can we docum ent the effect?

Circulation spaces

Before

Transforming the circulation spaces into social interaction spaces



Future



C IRCULATION SPACES OLD VERSUS NEW

OLD BUILD ING

18% OFENTRE BULDING

> OFWHICH 60% ARE PUBLICLY ACCESSIBLE

NEW BUILDING

25% OFENTRE BUILDING OFWHICH 73% ARE PUBLICLY ACCESSIBLE











[©] Henning Larsen



W here do w e m easure ?



Building Typologies

• Functions and intended designs

PhysicalEnvironm ent

- Layout and ratios
- Design elem ents

Flows&Occupancy

• Behvioralpattems

IndoorC lim ate

- Noise and Light
- Tem perature

Usage & Activities

• Optionalvs.necessary

W here do w e m easure?





W ALLAND W ORK SEAT-UTLIZATION IN TIME







OCCUPANCY DURATION

RETENTION CAPABILITIES BY BUILDING / FURNITURE TYPE





ROUNDTABLE

W ALL AND W ORK

X M NUTES (to be confirmed)192 M NUTESDom inantGroupsize:Dom inantGroupsize:M ediumSm all

Duration:???? Activity:Concentration Group Types:Pair and Group (3) Occupancy type:???

Duration:LONGDuration:MEDIDMActivity:ConcentrationActivity Type:Recreation/WG roup Types:Individualand PairG roup Types:G roup βA,5)O ccupancy type:SteadyO ccupancy type:Rythm ic



20.3 M NUTES Dom inantGroupsize: Medium to Large



8.7 M INUTES Dom inant Groupsize: Sm allto M edium

Duration:M ED IUMDuration:SHORTActivity Type:Recreation/W ork Activity Type:W altingG roup Types:G roup (3,4,5)G roup types: Individual and PairO ccupancy type:Rythm icO ccupancy type:Rythm ic

UPNEXT:

- Deeperuse and activity analysis of the functions
- Behavior and W ellbeing; stress levels
- Correlations to PhysicalDesign and
 Circulation Flow s
- Starbucks Sales Data
- Crime and Traffic
- Dropout rates
- Value propositions; open and enclosed spaces







"W e shape our buildings and afterw ards our buildings shape us."

W inston Churchill

Thank you

Henning Larsen —

JSTR@henninglarsen.com www.henninglarsen.com



⁹ Henning Larsen