Expanding Space

Redefining Persian Cultural Hubs in Toronto through Interactive Architecture

by

Negar Behzad Jazi

A thesis
presented to the University of Waterloo
In fulfillment of the
Thesis requirement for the degree of
Master of Architecture

Waterloo, Ontario, Canada, 2018 © Negar Behzad Jazi 2018

AUTHOR'S DECLARATON

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

ersian communities in Toronto use certain public spaces as a group. One of the less obvious, but interesting, spaces that serve as cultural hubs for these communities are strip malls. These cultural-commercial spaces sometimes act as spaces for political protest or cultural gatherings. This observed use of space was the basis of this thesis and formed the initial thesis question: "how can we start thinking of the strip mall as a public gathering space?" In seeking the answer to this question, there were challenges to face. The nature of strip malls is that they sometimes act as a public space and sometimes as a parking space. In order to expand the public uses of these kinds of hubs, space needs to be shared between cars and people. This thesis therefore seeks to explore a dynamic (interactive) architecture that can be expanded based on the different conditions of the site (strip mall).

This thesis aims to study and employ three different elements to create prototypes that have the capacity to expand limited space in this context: the strip mall's spatial qualities, deployable techniques for creating a dynamic space, and Persian culture. Among several models produced using deployable techniques, two prototypes have been developed as the most appropriate models for expanding the public space in a Persian context. These are the "Market Shell" and "Gathering Shell." When there is a cultural or social occasion after business hours, these shells activate the strip mall through the functional space that they provide. However, during opening hours, these shells are deactivated to permit the stores and parking area of the strip mall to function.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my supervisor Maya Przybylski for the useful comments, remarks and engagement through the learning process of this master thesis. Furthermore I would like to thank my committee member David Correa for inspiring comments as well for the support on the way. Also, I like to thank Magdalena Miłosz, who patiently edited my thesis in a stylish way. I would like to thank my loved ones, who have supported me throughout entire process, both by encouraging me and helping me putting pieces together. I will be grateful forever for your love.

Thank you,

To my loving family, thank you for your endless encouragement and support, without you this success would not have been possible.

To my best friends from whom I have learned a lot throughout the process, I will always appreciate all you have done.

TABI	TABLE OF CONTENTS P	
0.0	PREFACE	
	Author's Declaration	ii
	Abstract	iii
	Acknowledgements	iv
	Dedication	V
	List of Figures	viii
	Introduction	xxiv
1.0	CHAPTER 1. STRIP MALLS AS PERSIAN CULTURAL HUBS	1
	Persian Neighborhoods in the GTA	2
	Persian Public Spaces	2
	Exploring the Strip Malls	7
	Redefining the Strip Malls as Public Gathering Spaces	9
2.0	CHAPTER 2. INTERACTIVE ARCHITECTURE	11
	The Dual Nature of the Strip Malls and Interactive Architecture	13
	Definition of Interactive Architecture	13
	High-tech and Low-tech Design	14
	High-tech Interactive Design Precedents	17
	Low-tech Interactive Design Precedents	21
	Deployable Design	25

3.0	CHAPTER 3. PERSIAN CULTURAL FEATURES	29
	Culture as an Inspirational Resource	31
	Architecture	31
	The Bazaar	31
	The Parametric Language of Patterns in Persian Architecture	32
	Gathering Events	40
	Persian Dance	40
	Festival of Fire	41
4.0		
4.0	CHAPTER 4. DESIGN	49
	Overview of Site, Interactivity and Culture	50
	Exploring the Site (Persian Plaza)	50
	Dynamic Qualities of the Site	57
	Design Process	57
	Early Conceptual Ideas	57
	Experimenting with Deployable Design	67
	Critique of Rolling Space as a Deployable Module	79
	Deployable Prototypes Inspired by Persian Culture	81
	Market Shell	84
	Gathering Shell	87
	Furniture	90
	Different States of Expanding and Shrinking of Shells on the Site	95
	Conclusion	119
	Bibliography	125

LIST	OF FIGURES	PG#
Fig.1	Physical model of the deployable shells in the site (Persian plaza) Image by author	xxv
Fig.2	West view of Iranian plaza, North York, Toronto Image by author	1
Fig.3	Persian neighborhoods in GTA Data adapted from: Faryadi, Shahrzad. "Urban Representation of Multiculturalism in a Global City: Toronto's Iranian Community." Tehran: Globalization and Autonomy Online Compendium, August, 2008. 15	3
Fig.4	Persian public spaces in North York, Toronto Data adapted from: Faryadi, Shahrzad. "Urban Representation of Multiculturalism in a Global City: Toronto's Iranian Community." Tehran: Globalization and Autonomy Online Compendium, August, 2008. 15,17	4
Fig.5	Persian people celebrating Nature day in Sunnybrook Park located in North York, Toronto "13 Bedar ۱۳۹۶". سیز ده بدر "YouTube video, 6:08. Posted by "Persian Mirror", Apr 2, 2017. https://youtu.be/I5xEXoAJgxM	5
Fig.6	Persian people celebrating Nature day in Sunnybrook Park located in North York, Toronto "13 Bedar ۱۳۹۶ سیز ده بدر" YouTube video, 6:08. Posted by "Persian Mirror", Apr 2, 2017. https://youtu.be/I5xEXoAJgxM	5
Fig.7	Persian people celebrating Nature day in Sunnybrook Park located in North York, Toronto "13 Bedar ۱۳۹۶ سیز ده بدر" YouTube video, 6:08. Posted by "Persian Mirror", Apr 2, 2017. https://youtu.be/l5xEXoAJgxM	5
Fig.8	Persian people celebrating Nature day in Sunnybrook Park located in North York, Toronto "13 Bedar ۱۳۹۶"." YouTube video, 6:08. Posted by "Persian Mirror", Apr 2, 2017. https://youtu.be/l5xEXoAJgxM	5

Fig.9	Mel Lastman Square located in North York, Toronto "Posts about North York Arts on Neighbourhood Arts." Neighbourhood Arts,	6
	neighbourhoodarts.wordpress.com/tag/north-york-arts/.	
Fig.10	The annual Persian Family Day Festival in Mel Lastman Square located in North York, Toronto	6
	"The annual Persian Family Day Festival." BlogTO. Accessed December 22, 2017. https://www.blogto.com/events/the-annual-persian-family-day-festival/.	
Fig.11	Persian people celebrating Persian family day in Mel Lastman square located in North York, Toronto	6
	"Mc Master Iranian Dance Association (Bahar Dance) in Persian Family Day 2014 Part 1." YouTube video, 8:41. Posted by "radioroya", September 21, 2014. Accessed December 22, 2017. https://youtu.be/MhZ62h_abRE.	
Fig.12	Persian gathering for social and political events in Mel Lastman square located in North York, Toronto	6
	Image by Pourya Ali."Candlelight Vigil for Victims of Tehran Attacks at Mel Lastman Square, Toronto." Salam Toronto Weekly Newspaper (Farsi) Bringing you the latest Iranian-Canadian News from Toronto in Persian. Accessed December 22, 2017. http://salamtoronto.ca/2017/%DA%AF%D8%B2%D8%A7%D8%B1%D8%B4-%DA%A9%D8%A7%D9%85%D9%84-%D9%85%D8%B1%D8%A7%D8%B3%D9%85-%D8%AA%D9%86%D8%A7%D8%B3%D9%85-%D8%AA%D9%88-%D8%A7-%D9%87%D9%85%D8%AF%D8%B1%D8%AF%D8%AF%DB%8C-%D8%A8%D8%A7-%D9%85%D8%B1/Candlelight-vigil-for-victims-of-tehran-attacks-at-mel-lastman-square-toronto-13/.	
Fig.13	Persian plaza (Persian strip mall) located on Yonge Street, North York, Toronto Image by author	7
Fig.14	A strip mall consists of Persian and Korean stores located in Persian neighborhood on Yonge Street, North York, Toronto Image by author	7
Fig.15	A strip mall consists of Persian and Korean stores located in Persian neighborhood on Yonge Street, North York, Toronto Image by author	7
Fig.16	A strip mall consists of Persian and Korean stores located in Persian neighborhood on Yonge Street, North York, Toronto Image by author	7

Fig.17	A strip mall consists of Persian and Korean stores located in Persian neighborhood on Yonge Street, North York, Toronto Image by author	8
Fig.18	A strip mall consists of Persian stores and restaurants located in Persian neighborhood on Steeles Street, Markham, Toronto	8
	Image by author	
Fig.19	A Persian hair saloon located in a strip mall in Persian neighborhood on Steeles Street, Markham, Toronto Image by author	8
Fig.20	Front view of a strip mall consists of Persian and Korean stores located in Persian neighborhood on Yonge Street, North York, Toronto Image by author	8
Fig.21	A strip mall consists of a Persian supermarket and restaurant located in Persian neighborhood on Yonge Street, North York, Toronto Image by author	8
Fig.22	Persian plaza (Persian strip mall) located on Yonge Street, North York, Toronto Image by author	8
Fig.23	Political gathering of Persian people in the side walk of Persian plaza (strip mall) located on Yonge Street, North York, Toronto	9
	"Ghadeghan Iranian Plaza." YouTube video, 2:14. Posted by "Babak Yazdi", July 29, 2013. Accessed December 22, 2017. https://www.youtube.com/watch?v=dN9_OcVHiSo&t=11s.	
Fig.24	Political gathering of Persian people in the side walk of Persian plaza (strip mall) located On Yonge Street, North York, Toronto	9
	"Ghadeghan Iranian Plaza." YouTube video, 2:14. Posted by "Babak Yazdi", July 29, 2013. Accessed December 22, 2017. https://www.youtube.com/watch?v=dN9_OcVHiSo&t=11s.	
Fig.25	Political gathering of Persian people in the side walk of Persian plaza (strip mall)	9
	located on Yonge Street, North York, Toronto	
	"Iranian Plaza DemoSep24 2017." YouTube video, 1:01:06. Posted by "Babak Yazdi", September 24, 2017. Accessed December 22, 2017. https://www.youtube.com/watch?v=TIVdvuOSG5w.	

Fig.26	Political gathering of Persian people in the side walk of Persian plaza (strip mall)	9
	located on Yonge Street, North York, Toronto	
	"Mohammad Ashrafi F Ashoora2017 Toronto." You Tube video, 2:14. Posted by "Babak Yazdi", Oct 1, 2017. Accessed December 22, 2017. "https://www.youtube.com/watch?v=vVb3M5tGnQA	
Fig.27	Persian people celebrating winning of Iran's team in one of the soccer games in	9
	world cup –Persian plaza (strip mall) located on Yonge Street, North York, Toronto	
	"Toronto Iranians." You Tube video, 3:48. Posted by "Matin naderi", June 18, 2014. Accessed December 22, 2017. https://youtu.be/oYZTAxBqEqU.	
Fig.28	Persian people celebrating winning of Iran's team in one of the soccer games in	9
	world cup – Persian plaza (strip mall) located on Yonge Street, North York, Toronto	
	"Toronto Iranians." You Tube video, 3:48. Posted by "Matin naderi", June 18, 2014. Accessed December 22, 2017. https://youtu.be/oYZTAxBqEqU.	
Fig.29	Persian people celebrating winning of Iran's team in one of the soccer games in	9
	world cup – Persian plaza (strip mall) located on Yonge Street, North York, Toronto	
	"Toronto Iranians." You Tube video, 3:48. Posted by "Matin naderi", June 18, 2014. Accessed December 22, 2017. https://youtu.be/oYZTAxBqEqU.	
Fig.30	Persian people celebrating winning of Iran's team in one of the soccer games in	9
	world cup-Persian plaza (strip mall) located on Yonge Street, North York, Toronto	
	"Toronto Iranians." You Tube video, 3:48. Posted by "Matin naderi", June 18, 2014. Accessed December 22, 2017. https://youtu.be/oYZTAxBqEqU.	
Fig.31	Redefining the strip malls in Persian neighborhoods of Toronto as Public Space	10
	Image by author	
Fig.32	Op space, a modular space that was designed and built as an elective design/build	11
	studio at California College of the Arts.	
	"OP Space." Architecture Design. Accessed December 22, 2017. http://www.otaplus.com/project/op-space/.	
Fig.33	Interactive Architecture as a design solution to expand the space OP	12
-	Image by author	
Fig.34	DIY City 0.01, designed and built by Haque Design + Research	17
J	"DIY City 0.01a," Haque Design + Research, accessed December 5, 2017, http://www.haque.co.uk/diycity.php.	

Fig.35	DIY City 0.01, designed and built by Haque Design + Research, people are	17
	connecting to their phone to project their virtual space on the buildings	
	"DIY City 0.01a," Haque Design + Research, accessed December 5, 2017, http://www.haque.co.uk/diycity.php.	
Fig.36	DIY City 0.01, designed and built by Haque Design + Research, people are	17
	connecting to their phone to project their virtual space on the buildings	
	"DIY City 0.01a," Haque Design + Research, accessed December 5, 2017, http://www.haque.co.uk/diycity.php.	
Fig.37	Different components of the project "DIY City 0.01"	18
	Image by author	
Fig.38	TRANSFORM Furniture Designed by MIT Media Lab	19
	"TRANSFORM." Tangible Media Group. Accessed December 23, 2017. http://	
	tangible.media.mit.edu/project/transform/	
Fig.39	TRANSFORM furniture as Dynamic and Adaptive Furniture Designed by MIT Media	19
	Lab	
	"TRANSFORM." Tangible Media Group. Accessed December 23, 2017. http://tangible.media.mit.edu/project/transform/.	
Fig.40		20
	Image by author Data adapted from: "TRANSFORM." Tangible Media Group. Accessed Decem-	
	ber 23, 2017. http://tangible.media.mit.edu/project/transform/.	
Fig.41	Polymorphic Installation – A Kinetic Double-Sided Bench designed and built by	21
	restriction: students from Columbia University "Polymorphic / Columbia University GSAPP." ArchDaily. September 12, 2011.	
	Accessed December 23, 2017. https://www.archdaily.com/168258/polymorphic-columbia-university-gsapp.	
Fig.42	Different sections of the project "Polymorphic Installation"	21
	"Polymorphic / Columbia University GSAPP." ArchDaily. September 12, 2011. Accessed December 23, 2017. https://www.archdaily.com/168258/polymorphic-columbia-university-gsapp.	

Fig.43	Polymorphic Installation, Flowing form of the bench	21
	"Polymorphic / Columbia University GSAPP." ArchDaily. September 12, 2011. Accessed December 23, 2017. https://www.archdaily.com/168258/polymorphic-columbia-university-gsapp.	
Fig.44	The diagram demonstrates a kind of direct interaction between users and the bench	22
	Image by author	
	Data adapted from: "SlinkyVids-Part I." Vimeo. December 23, 2017. Accessed December 23, 2017. https://vimeo.com/24031078.	
	"Polymorphic / Columbia University GSAPP." ArchDaily. September 12, 2011. Accessed December 23, 2017. https://www.archdaily.com/168258/polymorphic-columbia-university-gsapp.	
Fig.45	OP space, a modular space designed and built by students at California College of	23
	the Arts	
	"OP Space." Architecture Design. Accessed December 23, 2017. http://www.otaplus.com/project/op-space/.	
Fig.46	Two different views of the project "OP space"	23
	"OP Space." Architecture Design. Accessed December 23, 2017. http://www.otaplus.com/project/op-space/.	
Fig.47	Different formal states of the project "OP space"	23
	"OP Space." Architecture Design. Accessed December 23, 2017. http://www.otaplus.com/project/op-space/.	
Fig.48	The diagram demonstrates different formal and functional states of the project "OP	24
	space" Image by author	
	Data adapted from: "OP Space." Architecture Design. Accessed December	
	23, 2017. http://www.otaplus.com/project/op-space/.	
Fig.49	Responsive façade of Al Bahar Towers in Abu Dhabi, designed by Aedas	26
	Architects Ltd	
	"Abu Dhabi Investment Council Headquarters." Engineering Abu Dhabi Investment Council's New Headquarters. Accessed December 23, 2017. https://www.arup.com/projects/abu-dhabi-investment-council-headquarters.	

Fig.50	Responsive façade of Al Bahar Towers in Abu Dhabi, designed by Aedas	26
	Architects Ltd	
	"These Towers Have Shape-Shifting Sunshades That React To Sunlight." Bored Panda. Accessed December 23, 2017. https://www.boredpanda.com/geometric-sun-shades-al-bahar-towers-abu-dhabi/.	
Fig.51	The diagram demonstrates the operation of responsive façade of the project "Al Bahar Towers"	26
	"Al Bahar Towers Responsive Facade / Aedas." ArchDaily. September 05, 2012. Accessed December 23, 2017. https://www.archdaily.com/270592/al-bahar-towers-responsive-facade-aedas.	
Fig.52	a solar array prototype designed by Brigham Young University (BYU) engineers in	27
	Collaboration with NASA's Jet Propulsion Laboratory	
	"Deployable Solar Array." Deployable Solar Array Compliant Mechanisms. Accessed December 23, 2017. https://compliantmechanisms.byu.edu/node/892.	
Fig.53	a solar array prototype designed by Brigham Young University (BYU) engineers in	27
	Collaboration with NASA's Jet Propulsion Laboratory "Deployable Solar Array." Deployable Solar Array Compliant Mechanisms. Accessed December 23, 2017. https://compliantmechanisms.byu.edu/node/892.	
Fig.54	Different formal states of a solar array	27
	"KurzweilAI Accelerating Intelligence." KurzweilAI Origami solves a space problem Comments. Accessed December 23, 2017. http://www.kurzweilai.net/origami-solves-a-space-problem#!prettyPhoto.	2,
Fig.55	An interior view of Tehran bazaar located in Tehran, Iran	29
	Image by Golnaz Jamshidi	
Fig.56	The diagram demonstrates why the strip malls located in Persian neighborhoods of Toronto Need to be "Persian" Image by author	30
Fig.57	An interior view of Esfahan Bazaar located in Esfahan, Iran Image by Muyasser Mohammad	33

Fig.58	An interior view of Esfahan Bazaar located in Esfahan, Iran Image by Christian Kohler	34
Fig.59	Light and shadow, Esfahan bazaar Image by Nick Potter	34
Fig.60	An interior view of Esfahan bazaar located in Esfahan, Iran Image by Golnaz Jamshidi	34
Fig.61	An interior view of Zanjan bazaar located in Zanjan, Iran Image by Golnaz Jamshidi	35
Fig.62	An interior view of Zanjan bazaar located in Zanjan, Iran Image by Golnaz Jamshidi	36
Fig.63	An interior view of Zanjan bazaar located in Zanjan, Iran Image by Golnaz Jamshidi	36
Fig.64	An interior view of Zanjan bazaar located in Zanjan, Iran	36
	Image by Golnaz Jamshidi	
Fig.65	Entrance of Zanjan bazaar Image by Golnaz Jamshidi	36
Fig.66	The diagram demonstrates spatial components of Persian bazaars Image by author	37
Fig.67	Ceiling of Naragh bazar located in Naragh, Iran	38
	Image by author	
Fig.68	Parametric language of patterns in Persian architecture	39
	Ahad Nejad Ebrahimi, Minou Gharehbaglou, and Morteza Aliabadi, "Parametric Design pattern Language and Geometric Patterns in Historical Domes in Persian Architecture," (January 2014), 246.	
Fig.69	Parametric language of patterns in Persian architecture	39
	Mansour Mohammadian and Sina Faramarzi. "Goone shenasi va Tadvine sakhtare hendesie karbandi dar Iran," (winter 2011), 106.	
Fig.70	Persian dance, Qalamoo in frontal plane with side hinge	42
S	DanceUS_org. "A Glimps into Persian Dance Technique." DanceUs.org. Accessed December 23, 2017. https://www.danceus.org/persian-dance/a-glimps-into-persian-dance-technique/.	

Fig.71	Different stages of Persian dance, Qalamoo in frontal plane with side hinge	42
	DanceUS_org. "A Glimps into Persian Dance Technique." DanceUs.org. Accessed December 23, 2017. https://www.danceus.org/persian-dance/a-glimps-into-persian-dance-technique/.	
Fig.72	Abshar movement in Persian dance	42
	DanceUS_org. "A Glimps into Persian Dance Technique." DanceUs.org. Accessed December 23, 2017. https://www.danceus.org/persian-dance/a-glimps-into-persian-dance-technique/.	
Fig.73	Nomad Dancers performs Shabe Eshgh - Persian dance	43
	"Shabe Eshgh by Nomad Dancers - Persian dance." YouTube video, 4:12. Posted by "pghodsi", September 23, 2012. Accessed December 23, 2017. https://www.youtube.com/watch?v=3YKd9GAmN2I.	
Fig.74	The diagram demonstrates the circular pattern extracted from the body gestures of	44
	the dancers	
	Image by author	
Fig.75	Yaghoot jam Dancers performs a kind of folk dance – Persian dance	45
	"حتن")." YouTube video, 5:56. Posted by "Omid Safaei", NJune 01, 2015. Accessed December 23, 2017. https://www.youtube.com/watch?v=vgHJtL-mmdE.	
Fig.76	The diagram demonstrates the circular pattern extracted from the body gestures of	46
	dancers	
	Image by author	
Fig.77	Persian Fire festival (Chaharshanbe Soori)	47
	"FESTIVALS – EasyGoIRAN." EasyGoIRAN. Accessed December 23, 2017.	
	https://easygoiran.com/need-to-know/festivals/.	
Fig.78	Circular gathering of Persian people in celebration of Fire festival	47
	Image by Behnam safarzadeh	
F:~ 70	Donale immeries on five to calchyste Develop Eiro feetival	47
Fig.79	People jumping on fire to celebrate Persian Fire festival "Iranian Fire Jumping Festival, Chaharshanbe Soori." Travel to Iran Iran	47
	Travel agency Iran Tour Operator Irandoostan. March 07, 2017. Accessed	
	December 23, 2017. http://irandoostan.com/iranian-fire-jumping-festival-chaharshanbe-soori/.	

Fig.80	The diagram demonstrates the circular pattern extracted from gathering of people in Persian fire festival Image by author	48
Fig.81	Physical model of the deployable shells in the site (Persian plaza) Image by author	49
Fig.82	West view of Persian plaza (strip mall) located in North York, Toronto Image by author	51
Fig.83	Persian plaza top view located on Yonge Street, North York Toronto Image by author Data adapted from Google map	52
Fig.84	A zoomed in top view of Persian plaza, located on Yonge Street, North York Toronto Image by author Data adapted from Google map	53
Fig.85	West view of Persian plaza on Yonge Street Image by author	54
Fig.86	Axonometric view of Persian plaza located in North York, Toronto Image by author	55
Fig.87	A view from vacant parking lot of Persian plaza located in North York, Toronto Image by author	56
Fig.88	A view from crowded parking lot of Persian plaza located in North York, Toronto Image by author	56
Fig.89	A view to the porch in front of the stores in Persian plaza located in North York, Toronto Image by author	56
Fig.90	The diagram demonstrates Use of Parking area (Persian plaza) in different times zones Image by author	58
Fig.91	Components of Design, Applying a responsive layer to the strip mall (Persian plaza) Image by author	59

Fig.92	Possible external forces for creating an interactive architecture Image by author	60
Fig.93	Dynamic playground and parking, moving in XY coordinate, 24 hours Active Image by author	61
Fig.94	Different scenarios for "Dynamic playground and parking" Image by author	62
Fig.95	Foldable playground and parking, moving in Z axis, 24 hours Active Image by author	63
Fig.96	Different scenarios for "Foldable playground and parking" Image by author	64
Fig.97	Virtual space, moving in XY coordinates, Active after 9 pm Image by author	65
Fig.98	Different scenarios for "Virtual space" Image by author	66
Fig.99	Experimenting with Deployable Design Image by author	68
Fig.100	Different stages of the formation of a single triple roll, mostly Active after 8 pm Image by author	69
Fig.101	Different options for the formation of the furniture Image by author	70
Fig.102	Canopy and furniture, 24 hours Active Image by author	71
Fig.103	Canopy and furniture, 24 hours Active Image by author	72
Fig.104	Canopy and furniture for special events, Active 8pm-8am Image by author	73

_	Spreading the roll all over the parking area, Persian plaza located in North York Toronto, Condition of activation: not active parking is full	74
Fig.106	Image by author Spreading the roll all over the parking area, Persian plaza located in North York Toronto, Condition of activation: partially active parking is not completely full Image by author	75
	Spreading the roll all over the parking area, Persian plaza located in North York Toronto, Condition of activation: completely active parking is not full Image by author	76
-	Two interior views to the rolls-market and gallery Image by author	77
_	Two interior views to the rolls-gathering spot and furniture Image by author	78
_	Physical model of Rolling space Image by author	79
_	Deployable Prototypes Inspired by Persian Culture Image by author	82
_	Tabriz bazaar as an architectural inspirational resource Image by Behzad Kalantari	82
_	Tehran bazaar as an architectural inspirational resource	82
Fig.114	Image by Golnaz Jamshidi Zanjan Bazaar as an architectural inspirational resource Image by Golnaz Jamshidi	82
Fig.115	Deployable Prototypes Inspired by Persian Culture Image by author	83
Ū	Market shell and its parametric triangular patterns Image by author	84
Fig.117	Persian bazaar architecture as the main concept for designing the "Market shell" Image by author	85

Fig.118 Different formal states of the "Market shell" Image by author	86
Fig.119 Gathering shell and its parametric triangular patterns Image by author	87
Fig.120 Circular Persian gathering events as the main concept for designing the "Gathering shell" Image by author	88
Fig.121 Different formal states of the "Gathering shell" Image by author	89
Fig.122 Rigid triangular furniture for the "Market shell" Image by author	90
Fig.123 Physical Model of Market shells in the site (Persian plaza) Image by author	91
Fig.124 Rigid trapezium and parallelogram furniture for the "Gathering shell" Image by author	90
Fig.125 Physical Model of Gathering shells in the site (Persian plaza) Image by author	93
Fig.126 Market and gathering shells are off, The strip mall is active and the parking lot is not vacant, site location: Iranian plaza in North York Toronto Image by author	96
Fig.127 Market shells are on, the strip mall is not active and the parking lot is vacant, site location: Iranian plaza in North York Toronto Image by author	97
Fig.128 Gathering shells are on, the strip mall is not active and the parking lot is vacant, Site location: Iranian plaza in North York Toronto Image by author	98
Fig.129 A zoomed in axonometric view of off version of Market and Gathering shells Image by author	99

Fig.130 A zoomed in axonometric view of off version of Gathering shells and on version of Market shells Image by author	100
Fig.131 A zoomed in axonometric view of off version of Market shells and on version of Gathering shells Image by author	101
Fig.132 Top view, shells are off Image by author	103
Fig.133 Top view, Market shells are on Image by author	104
Fig.134 Top view, Gathering shells are on Image by author	105
Fig.135 A zoomed in top view, shells are off Image by author	107
Fig.136 A zoomed in top view, Market shells are on Image by author	108
Fig.137 A zoomed in top view, Gathering shells are on Image by author	109
Fig.138 A Detailed Top view of different states of shells on the site (Persian plaza) Image by author	110
Fig.139 Strip mall (Persian plaza) west elevation Image by author	111
Fig.140 Strip mall (Persian plaza) latitude section Image by author	112
Fig.141 A Detailed sectional view of side walk demonstrating the off version of shells lmage by author	113
Fig.142 An exterior view of the Market shells in the site (Persian plaza) Image by author	115

-	An interior view of the Market shells in the site (Persian plaza) Image by author	115
-	Top View of one individual Market shell in the site (Persian plaza) Image by author	116
-	An exterior view of the Gathering shells in the site (Persian plaza) Image by author	117
-	An interior view of the Gathering shells in the site (Persian plaza) Image by author	117
Fig.147	Top View of Gathering shells in the site (Persian plaza)	118
	Image by author	
	Physical Model of the Market shells and the Gathering shells in the site (Persian plaza) Image by author	119
	The first idea for building the deployable Shells, rigid triangular sheets that are connected to each other by kind of revolute joint Image by author	121
	A zoomed in view to the Gathering shell, rigid triangular sheets that are connected to each other by kind of revolute joint Image by author	121
J	A Detailed view to the joint of the thesis project: "Structural Folding: A parametric 13design method for origami architecture" Camilla Samuelsson and Björn Vestlund, "Structural Folding: A parametric design method for origami architecture," (2015), 139.	121
Fig.152	Assembling and folding of full scale structure of the thesis project: "Structural	121
	Folding: A parametric design method for origami architecture"	
	Camilla Samuelsson and Björn Vestlund, "Structural Folding: A parametric design method for origami architecture," (2015), 137.	

Fig.153 The second idea for building the deployable Shells, Deployable steel frame and rigid triangular sheets that are connected the frame Image by author	122
Fig.154 A zoomed in view to the Gathering shell, Deployable steel frame and rigid triangular sheets that are connected the frame Image by author	122
Fig.155 "02/20: UNDULATING SPACE FRAME" designed by Adam Achrati "02/20: Undulating Space Frame." Adam achrati. September 20, 2016. Accessed December 24, 2017. https://adamachrati.wordpress.com/2014/02/20/0220-undulating-space-frame/.	122
Fig.156 Physical Model of the Deployable shells in the site (Persian plaza) Image by author	123
Fig.157 Front view of DE active shells Image by author	128

INTRODUCTION

The Persian community in Toronto tends to gather in the city's traditional forms of public space, such as parks, squares, shops, and restaurants. By studying this community, I became interested in the strip mall as one of the less obvious kinds of space that serves as a cultural hub. Despite criticism from an urban/architectural perspective¹, these Persian strip malls sometimes act as gathering space. For example, during political protests or soccer games, these strip malls become attractors drawing people together.

The first question of this thesis thus comes to mind: "how can we start thinking of the strip mall as a public space?" Different challenges arise in answering this question. The strip mall is a public space but, at the same time, it is not. Sometimes these strip malls are fully activated as parking space while at other times they are activated as public space. The space needs to be shared between people and cars. The tension between these two uses suggests a need for an architecture that is flexible enough to create a public space in the strip mall whenever space becomes limited, such as interactive architecture. There are different techniques to create interactive space, but, in this thesis, I chose deployable design as a method.

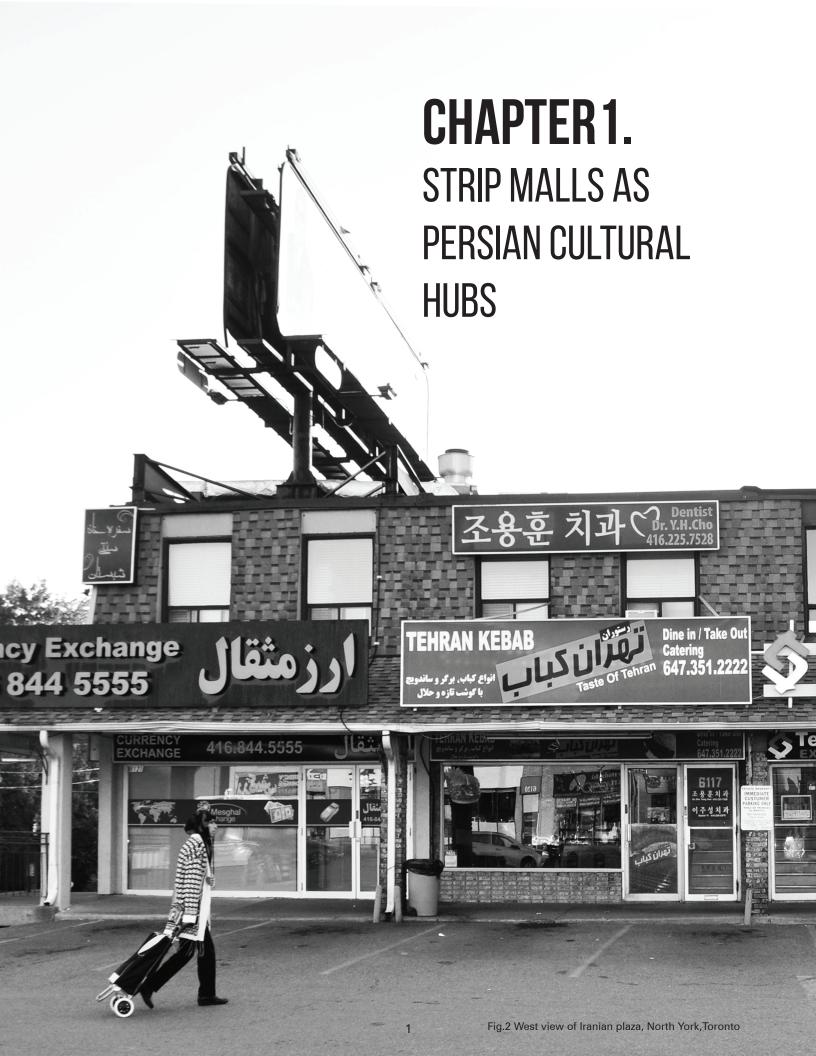
Finally, I chose a specific strip mall in North York, a suburban district of Toronto, as the site of the project. Known as Iranian Plaza, the strip mall is located on Yonge Street between Finch and Steeles Avenues. The mall contains fifteen stores and a large parking lot. With consideration of site limitations, Persian culture, and interactive architecture, I started my investigation by creating different kinds of dynamic space through building deployable models. Following various design experiments, I came up with two prototypes called "Market Shell" and "Gathering Shell." Each shell is made out of triangular patterns, which makes the folding of the shells possible. There are different formal states for the shells that provide opportunities for people to experience different spatial qualities during a specific time period.

This thesis aims to address the three parts of Persian public space, interactive architecture, and Persian culture through analyzing a set of precedents in each part and eventually leading to the final stage of the design proposal. The design comprises an investigation of different physical models made using deployable techniques.

Moreover, specific programs and activities need to be defined to feed into an interactive architecture. Since the context (Persian strip malls) is within the Persian neighborhoods of Toronto, applying aspects of Persian culture to the space seems logical. Therefore, I studied different aspects of culture and illustrated them in order to pull out a visual language that can be developed in further design experiments.

¹ Orly Linovski, "Beyond Aesthetics: Assessing the Value of Strip Mall Retail in Toronto," *Journal of Urban Design* 17, no. 1 (2012), 90-92.





PERSIAN NEIGHBORHOODS IN THE GTA

Iranians are one of the largest groups by ethnic origin in the Toronto Census Metropolitan and there are different Persian communities in the GTA. The analysis proved that the majority of Iranians are living in the northern part of Toronto, especially in the North York area. They are most concentrated in the neighborhood of Don Valley, York Region and Richmond Hill (Figure3).²

PERSIAN PUBLIC SPACES

In the neighborhoods where the Persian community lives in Toronto, there are many public spaces that people use to gather. On different cultural, political, and everyday occasions, Iranians gather at these kinds of spaces to fulfill their specific needs. In North York, there are outdoor public places, such as Leslie Park and Sunnybrook Park, which are used for outdoor public recreation, and Mel Lastman Square, which is used for Iranian social gatherings. Additionally, there are a considerable number of Persian grocery stores, restaurants and bakeries located on Yonge Street where people meet their everyday needs for their Persian lifestyle (Figure 4).³

² Shahrzad Faryadi, "Urban Representation of Multiculturalism in a Global City: Toronto's Iranian Community," Globalization Working Papers, Institute on Globalization & the Human Condition, McMaster University, 8, no. 4 (August 2008), https://globalization.mcmaster.ca/research/ publications/working-papers/2008/ighc-wps_08-4_faryadi.pdf, 13-14.

³ Faryadi, "Urban Representation of Multiculturalism in a Global City," 16-18.

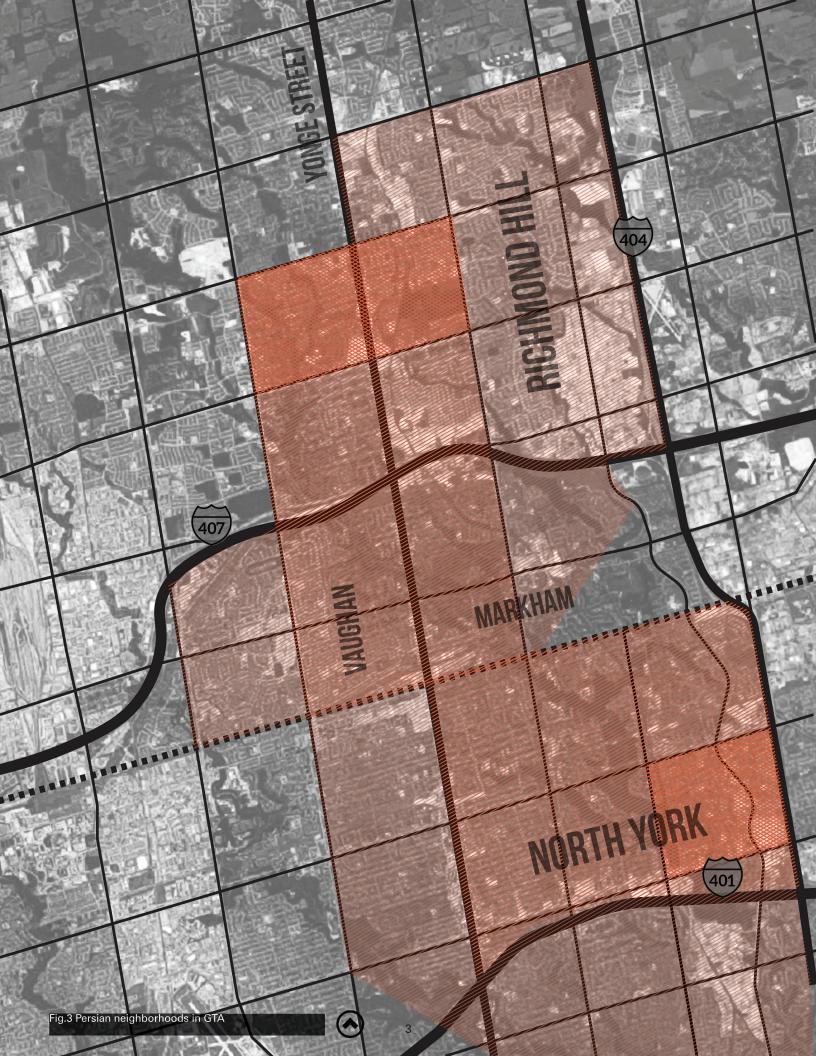






Fig.6 Persian people celebrating Nature day in Sunnybrook

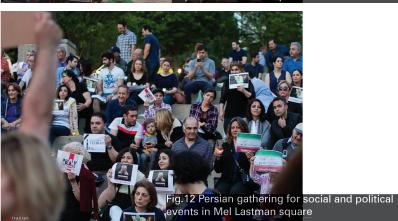






Fig. 10 The annual Persian Family Day Festival in Mel Lastman Square





EXPLORING THE STRIP MALLS

By studying the Persian community's public spaces in Toronto, I became interested in the strip mall as a less obvious kind of cultural hub. To better understand the spatial quality of the strip malls, some of the criticism regarding these spaces needs to be considered (Figure 13).

- In each of these strip malls, there are many unrelated, scattered Persian stores such as restaurants, supermarkets, bakeries, medical offices, hair salons, accountants, immigration offices, and travel agencies, which are distributed all over the site. In fact, there is no architectural and functional homogeneity within these scattered stores. The other thing is that sometimes there are stores related to other nationalities, such as Korean businesses, beside Persian stores, which create lack of architectural cohesion for these various businesses (See Figures 14-15).4
- Based on my experience visiting these strip malls, there are two reasons why they are referred to as "Persian." Firstly, the signs and billboards are all written in Farsi. Secondly, the stores sell Iranian products and the staff is Iranian as well. However, there is no spatial quality representing Persian culture, which makes me experience a sort of dizziness and chaos whenever I enter these strip malls (See Figures 16-20).⁵
- Most of the strip malls comprise a series of stores located around a parking lot. Often, the parking lots are full of cars, which block views of the stores. Although the strip malls act as cultural hubs to attract people, it seems that the presence of cars is stronger than that of people. For instance, there is no open space for people to chill and sit for few minutes, nor is there pedestrian access to the stores (See Figures 21-22). ⁶

Fig.13 Persian plaza (Persian strip mall) located on Yonge Street, North York, Toronto







⁴ Orly Linovski, "Beyond Aesthetics: Assessing the Value of Strip Mall Retail in Toronto," Journal of Urban Design 17, no. 1 (2012), 90-92.

Ibid.
 Ibid.



Fig.17 A strip mall consists of Persian and Korean stores located in Persian neighborhood on Yonge Street, North York, Toronto



Fig.20 Front view of a strip mall consists of Persian and Korean stores located in Persian neighborhood on Yonge Street, North York, Toronto



Fig.18 A strip mall consists of Persian stores and restaurants located in Persian neighborhood on Steeles Street, Markham, Toronto



Fig.21 A strip mall consists of a Persian supermarket and restaurant located in Persian neighborhood on Yonge Street, North York, Toronto



Fig.19 A Persian hair saloon located in a strip mall in Persian neighborhood on Steeles Street, Markham, Toronto



Fig.22 Persian plaza (Persian strip mall) located on Yonge Street, North York, Toronto

REDEFINING THE STRIP MALLS AS PUBLIC GATHERING SPACE

In addition to the above criticism of strip malls, I want to propose a different view of them. There is some evidence showing that these strip malls sometimes play the role of public gathering spaces. For instance, during a political protest or soccer game, the strip mall acts as an attractor for Persian people to gather (see Figures 23-28).⁷ This evidence prompted the formation of the thesis question, "How can we start thinking of the strip mall as a public space?" Furthermore, as a public pace, what are its challenges?

⁷ For example, see "Toronto Iranians," YouTube video, 3:48, posted by "matin naderi," June 18, 2014, https://youtu.be/oYZTAxBqEqU; "Ghadeghan Iranian Plaza," YouTube video, 2:14, posted by "Babak Yazdi," July 29, 2013, https://youtu.be/dN9_OcVHi-So; "Iranian Plaza," YouTube video, 1:45, posted by "Babak Yazdi," July 29, 2014, https://youtu.be/7vwwW1df4jA; "Demo in Iranian Plaza Toronto against recent Executions in Iran," YouTube video, 48:01, posted by "Babak Yazdi," October 27, 2013, https://youtu.be/BKjPiskwOV0.





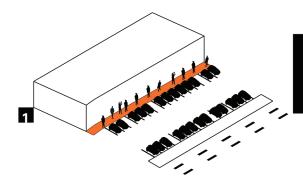




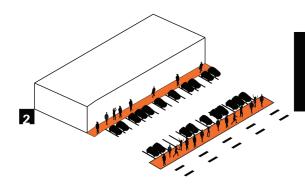




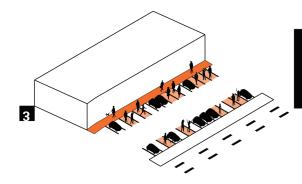
Yonge Street, North York, Toronto



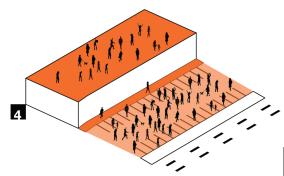
STRIP MALL IS SOMETIMES ACTIVATED FULLY AS A **PARKING SPACE**



STRIP MALL IS SOMETIMES
ACTIVATED AS A
PUBLIC SPACE



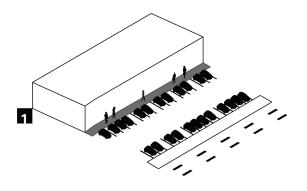
SPACE NEEDS TO BE **SHARED**BETWEEN PEOPLE AND CAR



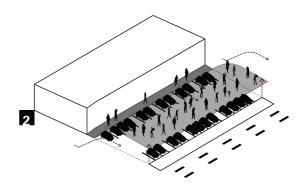
SPACE NEEDS TO BE **EXPANDED AS PUBLIC SPACE**

Fig.31 Redefining the strip malls in Persian neighborhoods of Toronto as Public Space

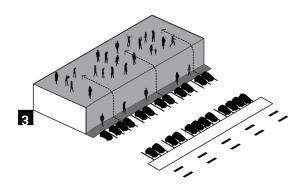
CHAPTER2. INTERACTIVE ARCHITECTURE Fig.32 Op space, a modular space that was designed and built as an elective design/build studio at California College of the Arts. 11

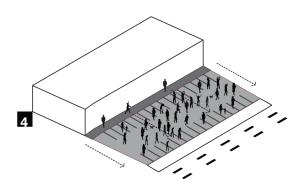


STRIP MALL AS PUBLIC SPACE NEEDS TO BE SHARED BETWEEN CARS AND PEOPLE



A **DYNAMIC** SPACE NEEDS TO BE DEFINED TO BE ON, OFF OR HIDDEN





INTERACTIVE ARCHITECTURE

Fig.33 Interactive Architecture as a design solution to expand the space

DUAL NATURE OF THE STRIP MALLS AND INTERACTIVE ARCHITECTURE

If we think about strip malls as public gathering spaces, then there will be a lot of challenges that need to be focused on. One of the basic challenges is that the strip mall is a public space but also it is not. In other words, these commercial-cultural hubs are sometimes activated as a public space and sometimes activated fully as a parking space. In order to design a public space in the context of the strip mall, the space needs to be shared between cars and people. So, what I am trying to do in this thesis is to think about how I can navigate the tension between these two uses. To address this tension, I propose interactive architecture as an option that is flexible enough to change its spatial qualities based on the different conditions of the strip mall context and different needs of its users. So, it is necessary to propose a dynamic space having the capacity to be on, off or hidden physically or virtually based on availability of the space in the strip malls where most of the times are occupied by cars. It seems that interactive architecture is one of the design approaches that can be addressed for designing a kind of expandable space.

DEFINITION OF INTERACTIVE ARCHI-TECTURE

Interactive architecture is a broad field in the design world, usually associated with architectural ideas such as "intelligent environments," "smart architecture," "soft space," and "kinetic architecture."8 In the notion of

Michael Fox and Miles Kemp, Interactive Architecture (New York: Princeton Architectural Press, 2009), 13.

interactivity, the environment is a kind of stimulation of the internal organization of a living system. So, the inhabitants of this environment need to have continuous interaction with one another and with the environment they live in to survive. 9 In other words, as Michael Fox and Miles Kemp explain, "[a] truly interactive system is a multiple-loop system in which one enters into a conversation."10 There is an input to this system which can be analyzed through the core of the system, the result of which will come out as an output. People play an important role in the formation of this kind of architecture. Therefore, they should not be thought of as "users" but instead as "participants."11

Based on different resources, another terminology that needs to be considered in this field is "kinetic architecture." According to Fox and Kemp, "[k]inetics are defined generally as either transformable objects that dynamically occupy predefined physical space, or moving physical objects that can share a common physical space to create adaptable spatial configurations."12 William Zuk states in his classic book, Kinetic Architecture, that "our present task is to unfreeze architecture, to make it a fluid, vibrating, changeable backdrop for the varied and constantly changing modes of life."13

Luciana Parisi, Contagious Architecture: Computation, Aesthetics, and Space (Cambridge, MA: MIT Press, 2013), 204.

¹⁰

Fox and Kemp, Interactive Architecture, 13.

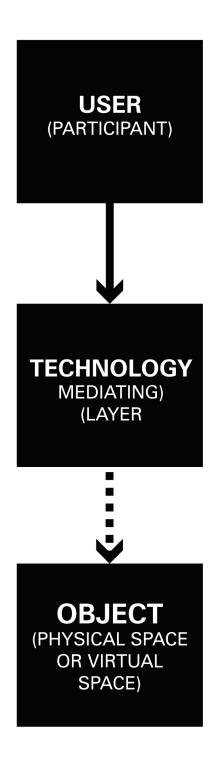
¹¹

¹² Fox and Kemp, Interactive Architecture, 27,

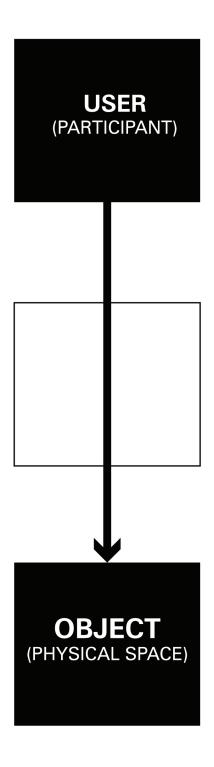
HIGH-TECH AND LOW-TECH DESIGN

Referring to the above definition of interactive architecture, it is a kind of architecture that has the capacity to change based on the different needs of users or the different conditions of its environment. When these changes happen indirectly, through a mediating layer, I call it "high-tech interactive design." When these changes are made directly by the user, we call this "low-tech interactive design." In a high-tech interactive design, users can influence the space indirectly through technological mediation. However, in a low-tech interactive design, users can manipulate the space directly without any mediating layer, which reduces the costs associated with the design. Although the economic benefits of low-tech projects makes them more appropriate precedents for this thesis, I analyze the qualities and components of both high-tech and low-tech projects for inspiration.

HIGH TECH INTERACTIVE DESIGN



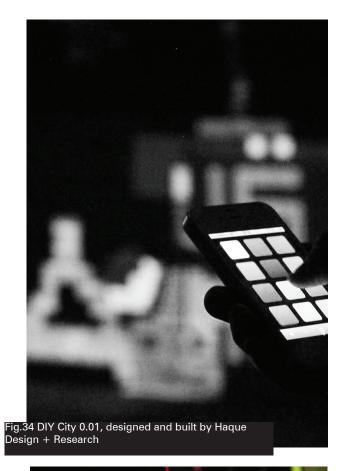
LOW TECH INTERACTIVE DESIGN



HIGH-TECH INTERACTIVE DESIGN PRECEDENTS

DIY City 0.01A

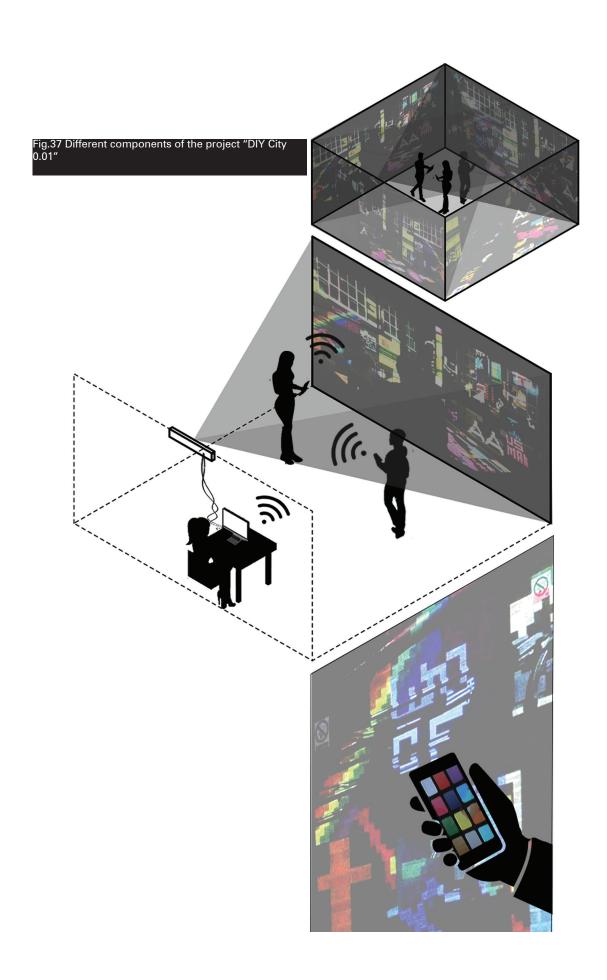
DIY City 0.01a is a virtual project designed and built by Haque Design + Research. It is an initial prototype for a future, mass-participation performance developed in a two-week collaboration with Special Moves. This project is basically a real-time interaction between humans and their urban environment, mediated through a specific cellphone application, to project different graphics on the streets and buildings of the city. This project thus provides a unique opportunity for people to reimagine and redesign the spaces of their city in real time, just by using their cellphones (See Figures 34-37).14 By studying this project, I understood that redefining the qualities of a space can be done not only physically, but also virtually. Hence, I used this project as inspiration for further design experiments to expand space virtually when it is physically limited. To realize this project, I illustrated different technological components, such as a cellphone application, projector, and computer that were used to make this project happened (Figure 37).







^{14 &}quot;DIY City 0.01a," Haque Design + Research, accessed December 5, 2017, http://www.haque.co.uk/diycity.php.



HIGH-TECH INTERACTIVE DESIGN PRECEDENTS

TRANSFORM as Dynamic and Adaptive Furniture

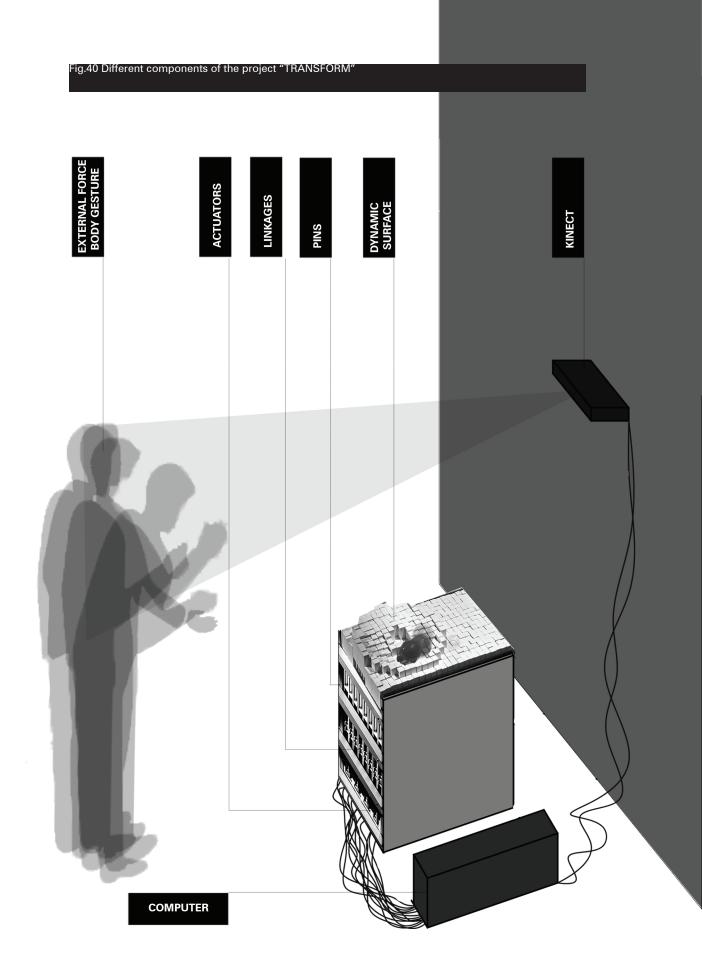
Designed by MIT Media Lab, TRANSFORM is an investigation of a kind of responsive furniture that can change its shape based on the everyday needs of its human user. This dynamic and adaptive furniture can change different aspects of itself, such as functionality, geometry and aesthetics. To clarify the adaptation of TRANSFORM to its environment, I should mention that, for example, this furniture can change the position of objects like fruits, game tokens, and tablets. It can also play the role of an interactive sculpture to convey messages and audio through creating different shapes (See Figures 38-39).¹⁵

This project is somehow inspiring for the design proposal in this thesis because it provides a malleable surface that can be transformed into different shapes, based on the processing of input that can consist of a human's body gestures. This processing is done by different mediating layers, such as Kinect for capturing patterns of human gestures, a computer that is the core of this interactive system, and actuators that create different movements of the surface which is made out of hundreds of pins to create a malleable surface (Figure 40).

Fig.38 TRANSFORM Furniture Designed by MIT Media Lab



¹⁵ Luke Vink, Viirj Kan, Ken Nakagaki, Daniel Leithinger, Sean Follmer, Philipp Schoessler, Amit Zoran, and Hiroshi Ishii, "TRANSFORM as Dynamic and Adaptive Furniture," MIT Media Lab, Tangible Media Group, accessed December 5, 2017, http://tangible.media.mit.edu/project/transform-as-dynamic-and-adaptive-furniture/.



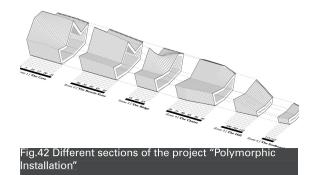
LOW-TECH INTERACTIVE DESIGN PREC-EDENTS

Polymorphic Installation – A Kinetic Double-Sided Bench

Ten architecture students from Columbia University designed and built "Polymorphic," a kinetic installation that is basically a dynamic bench inspired by the kinetic action of the reverberating motion of a slinky (Figure 41).¹⁶ The installation is a double-sided bench, consisting of a series of leveled wooden sections, which can be changed to a flowing form through interaction with its users. This formal transformation is based on the amount of pressure sensed from the people who touch it in different conditions. Occupants can find the most comfortable state to sit or lie down, due to the kinetic qualities of the sections, which make different kinetic actions of the bench possible. 17 The system developed for the bench also has the capacity to grow larger and wider, depending on the availability of the material and the space in which the bench is going to be installed. This developing quality of the bench allows it to be adjusted to different conditions of the environment. 18 I used two basic qualities of the Polymorphic installation for inspiration in this thesis: the reverberating motion and growing quality of the sections, because they create direct interaction between user and object (bench), with no mediating layer to process this interaction. So, people can change their space based on their needs and this quality is what I am looking for in my thesis, which involves expanding space when necessary (See Figures 42-44).



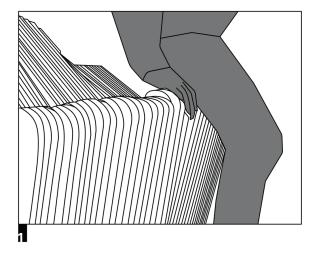


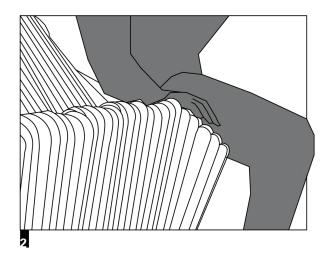


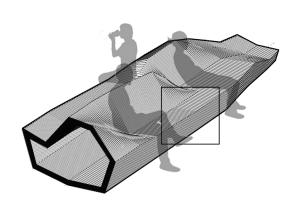
Megan Jett, "Polymorphic / Columbia University GSAPP," ArchDaily, September 13, 2011, https://www.archdaily.com/168258/polymorphic-columbia-university-gsapp.
17
Ibid

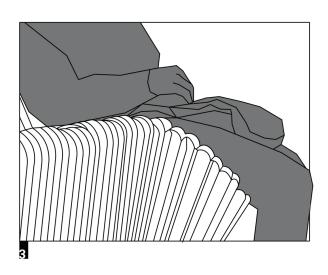
¹⁷ Ibid.

Fig.44 The diagram demonstrates a kind of direct interaction between users and the bench









LOW-TECH INTERACTIVE DESIGN PRECE-DENTS

OP space (FILL THE VOID)

OP space was an experimental project conducted as an elective design/build studio at California College of the Arts. This built project is a kind of modular space that can be transformed into different forms based on different conditions. OP space is a flexible, transportable, and reconfigurable architecture, with different defined functions. This interactive architecture was designed to help reactivate the empty storefronts that break up the urban fabric of downtown San Jose, 19 Technically, OP space comprises five different modules. Each module is defined by three sections. When these sections are open, their surface orientation changes so that, for example, a wall becomes a table or a chair becomes a shelf. To create this flexibility within the space and its functional performance, various structural details and ioints needed to be studied and designed. Thus, hundreds of unique components were exported directly from the digital model to a CNC milling machine. The digital model was unfolded, labeled and milled, allowing for quick and efficient assembly (See Figures 45-47).²⁰ The interactivity of this project is amplified by three important aspects. First, different functions can be accommodated in the space, such as lectures, fashion shows, exhibitions, tastings, and a bike kitchen. Second, the hexagonal and modular form of this space transforms into different forms whenever necessary, based on the required function. Finally, this project is portable enough that people can easily move it to different sites.²¹ These aspects of interactivity prompted me to consider OP space as a low-tech, interactive project that can be changed based on different functions that people look for (Figure 48).

^{19 &}quot;OP Space," OTA+, accessed December 5, 2017, http://www.otaplus.com/project/ op-space/.





Fig.45 OP space, a modular space designed and built by students at California College of the Arts





Fig.47 Different formal states of the project "OP space"

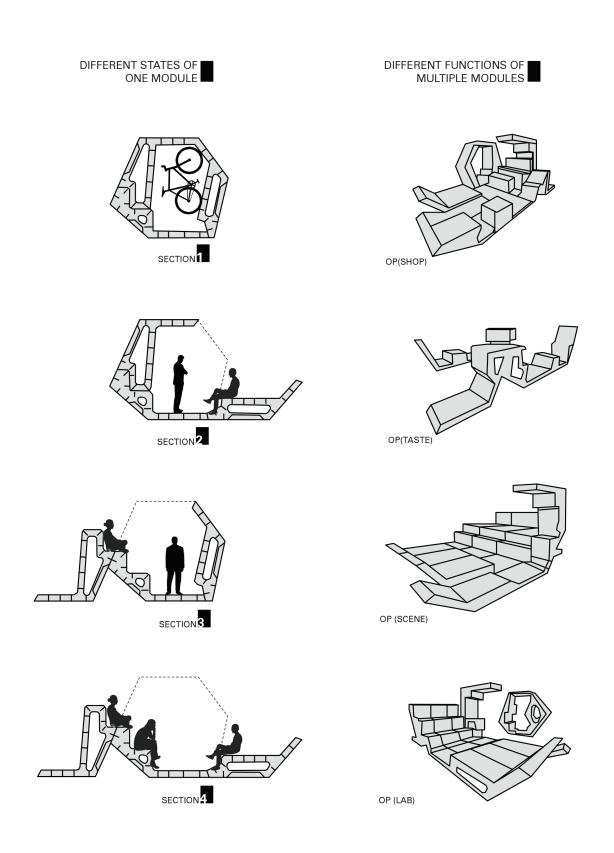


Fig.48 The diagram demonstrates different formal and functional states of the project "OP space"

DEPLOYABLE DESIGN

Based on different analysis that has been done earlier, there are many different techniques for creating interactive (dynamic) architecture. One of the techniques that I found most useful in terms of producing interactive prototypes as fast as possible, directly and without any mediation, is the deployable techniques to create dynamic spaces and one of these deployable techniques is called Folding.

Historically speaking, folding techniques come from the art of origami, which is the art of folding uncut sheets of paper into decorative objects. The word for this ancient Japanese art comes from *ori-*, meaning "folded" and *–kami*, meaning "paper." ²² It should be mentioned that origami can be applied to almost any field, from making spacecraft to architecture ²³. Despite the limitations of using an uncut sheet, origami models come in all kind of scales and with various complexities.²⁴

As Paul Jackson explains, "folding by hand is as low-tech as any making activity can be. You are making something directly with your body (your hands) without the intervention of a third-party tool such as a pencil, mouse or needle. It is an almost unique making experience and perhaps unfamiliarly primal. This very basic, hands-on activity—especially in today's high-tech design studio environments—can be a very powerful experience fordesigners."²⁵

To clarify this technique of deploying, I took a look at two different examples of folding techniques in architecture and NASA space projects. The first project which I was interested in is the responsive façade of Al Bahar Towers (located in Abu Dhabi, UAE) designed by Aedas Architects Ltd. Although the project is high tech in its structural design, I was inspired by the foldable geometry of its façade. As it is obvious, giant triangular wooden sheets are following a foldable geometry allowing them to be used as a device to control the amount of light that is coming inside the building. This intelligent façade is also acting as a device for achieving privacy (See Figures 49-51). 26

The next project that is really interesting is not related to architecture but aerospace. Brigham Young University (BYU) engineers in collaboration with NASA's Jet Propulsion Laboratory have designed a solar array prototype to solve one of space exploration's major problems and that is lack of space. This deployable prototype has the potential to be compacted for launch and then deployed in space to generate power for space stations or satellites. Thus, this deployable solar array has been proved that deployable technique is indeed one of the logical design solutions to expand the space whenever there is limitation of it (See Figures 52-54).²⁷

²² Robert J. Lang, *The Complete Book of Origami: Step-by-Step Instructions in Over 1000 Diagrams* (New York: Dover Publications, 1988), 1. 23 Ibid.

²⁴ Ibid.

²⁵ Paul Jackson, Folding Techniques for Designers: From Sheet to Form (London: Laurence King Publishing, 2011), 10.

²⁶ Adrian Welch, "Al Bahar Towers: Abu Dhabi Buildings." E-architect. March 27, 2017. Accessed December 21, 2017. https://www.e-architect.co.uk/dubai/al-bahar-towers-abu-dhabi.

^{27 &}quot;KurzweilAI | Accelerating Intelligence." KurzweilAl Origami solves a space problem Comments. Accessed December 21, 2017. http://www.kurzweilai.net/origami-solves-a-space-problem#!prettyPhoto.

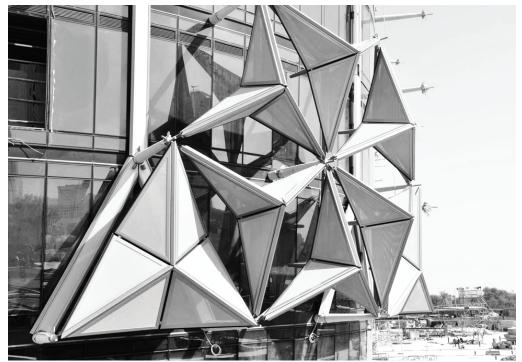


Fig.49 Responsive façade of Al Bahar Towers in Abu Dhabi, designed by Aedas Architects Ltd



Fig.50 Responsive façade of Al Bahar Towers in Abu Dhabi, designed by Aedas Architects Ltd

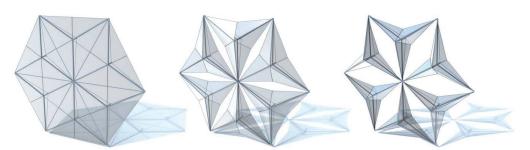


Fig.51The diagram demonstrates the operation of responsive façade of the project "Al Bahar Towers"

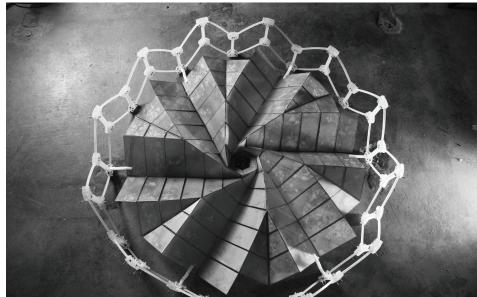


Fig.52 A solar array prototype designed by Brigham Young University (BYU) engineers in Collaboration with NASA's Jet Propulsion Laboratory

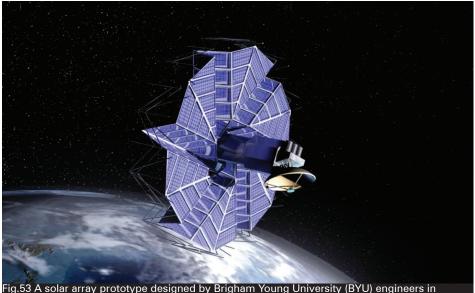
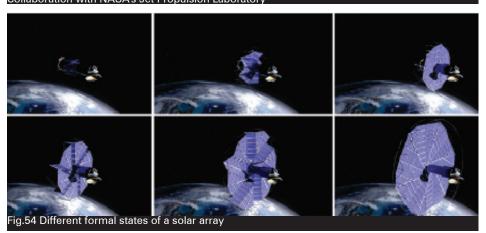
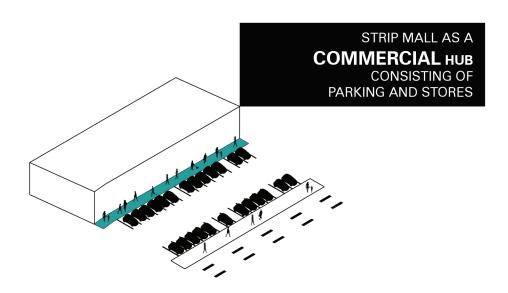
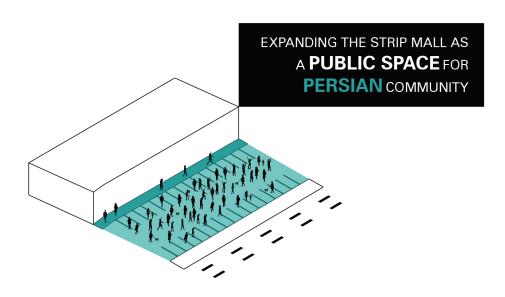


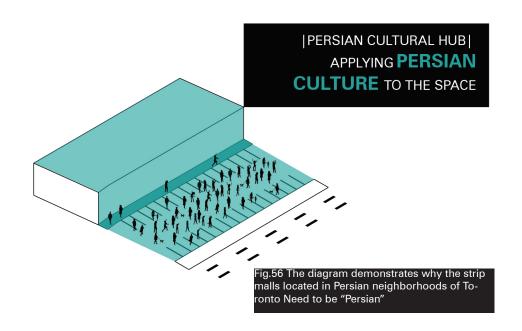
Fig.53 A solar array prototype designed by Brigham Young University (BYU) engineers in Collaboration with NASA's Jet Propulsion Laboratory











CULTURE AS AN INSPIRATIONAL RE-SOURCE

Following the different studies of interactive architecture in the preceding chapter, I now define the specific activities and events that will be accommodated through an interactive design solution. Given the program of expanding public space in a Persian strip mall located in a Persian neighborhood of Toronto, I highlight two features of Persian culture, "architecture" and "gathering events." The scope of this chapter is to define a formal language of the culture and to illustrate it in a tangible way to be applied to the architectural proposal in the next chapter.

ARCHITECTURE

Bazaar

Understood as a commercial hub, this project's strip mall context lends itself to comparison with the bazaar typology as a commercial, architectural and cultural precedent. Urban sociologists, planners, and designers generally consider the bazaar as the heart of the Iranian city. Although the famous bazaars contain mainly retail uses, they are not entirely dedicated to this function. The Iranian bazaar is a unified, self-contained building complex consisting of shops, passageways, and caravanserais, interspersed with a square (meydan), religious buildings, bathhouses (hammam), and other public institutions. Hence, the bazaar is representative of a center where economic, social, cultural and religious activities all take place.²⁸

28 Mir Saeed Moosavi, "Bazaar and its role in the development of Iranian traditional cities", Tabriz Azad University, Faculty of Art & Architecture, Iran, 1, 4, 5

Although the architectural and spatial nature of the historic bazaar was highly dependent on climate, culture, and the economic power of the city, the general space syntax of most Iranian bazaars consists of a main, covered street, which acts as the spine of the bazaar, surrounded by shops on two sides. Moreover, there are several secondary alleys or branches that are connected to the main spine.²⁹

Bazaars were covered to provide protection against unpleasant climate conditions. In a hot climate, the roof provided shade and in a cold climate, it protected the building from precipitation. Natural light penetrated to interior spaces through skylights, which could also provide natural ventilation. The height of the interior space was therefore another feature that differed due to climatic conditions. Bazaars in hot climates were taller to provide better ventilation (See Figures 57-60), while those in cold climates were shorter to keep the warm weather inside (Figure 61-65).30 Given the above, I found the bazaar's linear organization and its spatial qualities could act as a powerful vehicle for the design experiments of this thesis (see Figure 66).

²⁹ Mir Saeed Moosavi,. "Bazaar and its role in the development of Iranian traditional cities." 1,4,5

³⁰ Ibid. 4,5.

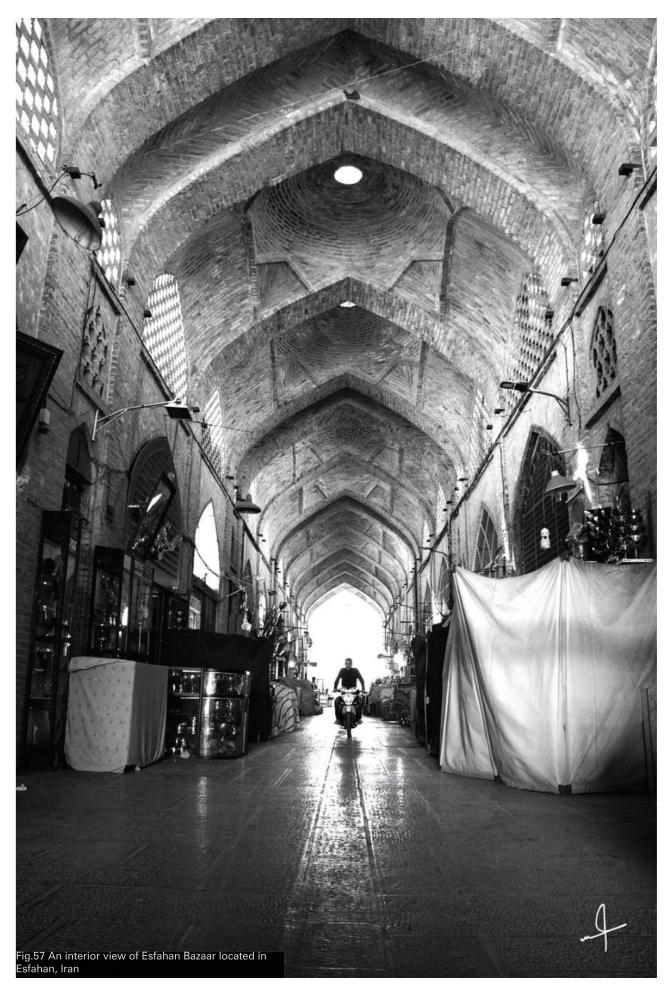
Patterns in Persian Architecture

One of the mesmerizing features of Iranian architecture is the Islamic patterns found on domes and ceilings. By identifying the parametric aspect of these patterns, designers can manipulate and transform them to suit a new context. In Iranian-Islamic arts, Decoration is generally divided into herbal, geometric, and inscriptional categories. Iranian geometric decorations can be found in nodulation. Geometry is the most prominent decorative form in Islamic art, outweighing other patterns and decorative forms. Islamic artists have taken various forms of geometry as their inspiration, achieving a wide variety of complex innovations. Most parts of Iranian-Islamic geometric patterns are drawn through exact symmetries of mathematically determined coordinates. Generally, most geometric patterns and designs in Islamic architecture are, in fact, built based on frequency of a motif (module). This motif is selected in a way that can be repeated; hence, all frequencies are fastened together. The most important characteristic of such patterns is the existence and governance of a pattern or simple geometry which is developed and repeated through various patterns of symmetry (Figure 67).31

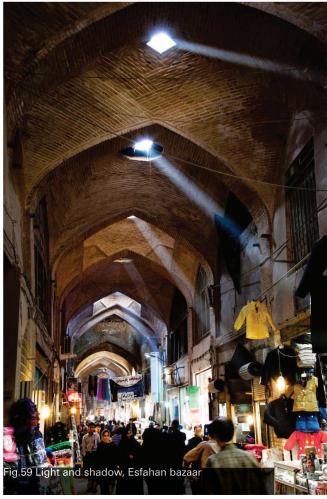
Here, I would like to highlight one of the traditional geometric techniques for ceiling coverage, known as Rasmi-Bandi. This domestic art form represents Iranian architects' mastery of geometry. Unlike the other architectural geometric ornaments such as Yazdi-Bandi, Muqarnas, or kaseh-sazi, Rasmi-bandi follows a precise geometric pattern, which highlights the aesthetic and structural aspects of this technique.32 Based on available visual documents, there are different nets of triangular modules which have been used to cover vaults and domes in Persian architecture in order to create a covered, concave ceiling. Figures 68-69 illustrate the use of a triangular, parametric pattern in Rasmi-bandi at different scales and dimensions.

³¹ Ahad Nejad Ebrahimi, Minou Gharehbaglou, and Morteza Aliabadi, "Parametric Design pattern Language and Geometric Patterns in Historical Domes in Persian Architecture," *Ciência e Técnica Vitivinicola* 29, no. 7 (January 2014), 244-246.

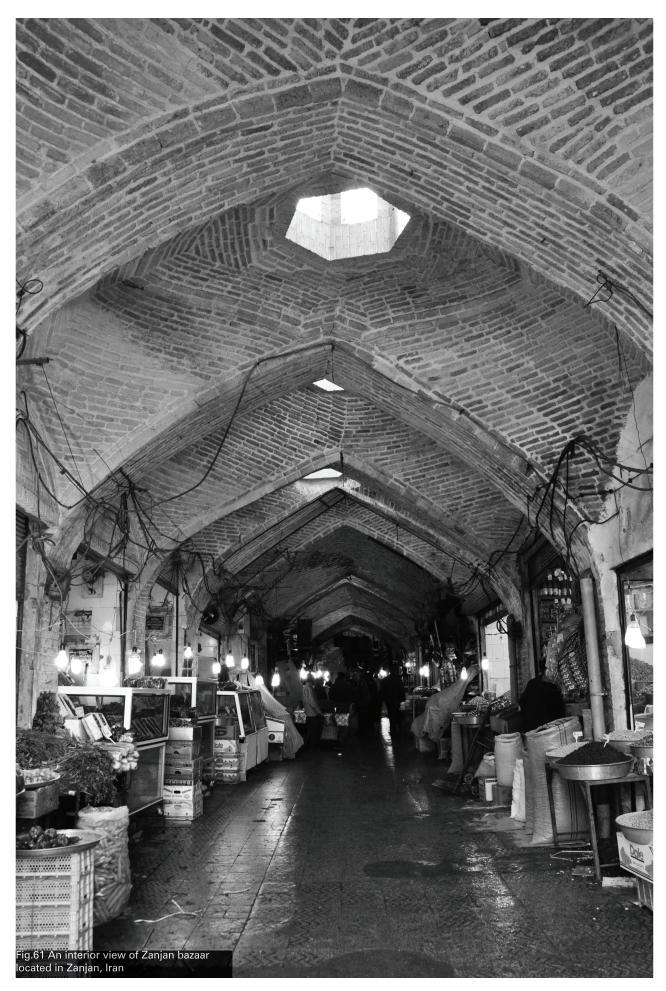
³² Hamidreza Farshchi, Ahmad Danaie Nia, and Ahmad Ashrafi, "The Geometric System of Single Impost Rasmi-bandi, Derived from Peripheral Circle," Maremat & Me'mari-e Iran Magazine (Fall & Winter 2016-2017), 10.





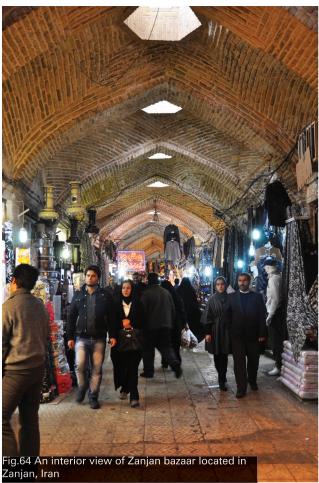




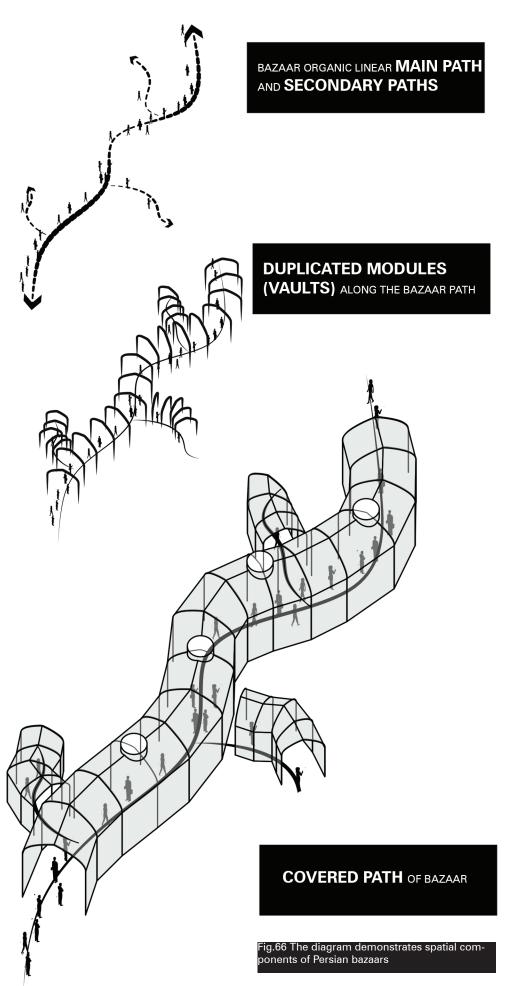














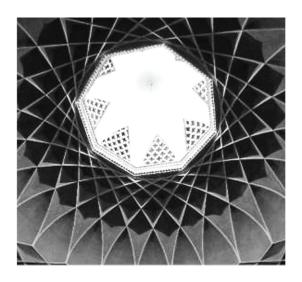


Fig.68 Parametric language of patterns in Persian architecture

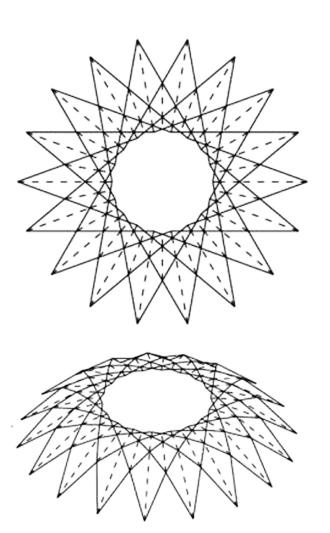
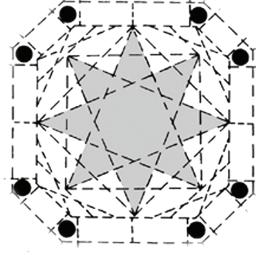




Fig.69 Parametric language of patterns in Persian architecture





GATHERING EVENTS

There are different national and informal gathering events that are part of the culture of Iran. Among various cultural practices that are presented at these events, the two features of "dance" and "fire" are analyzed in this thesis.

Persian Dance

Persian dance is an iconic and common feature at most Iranian gathering. In fact, whether it is at a small, private gathering for fun or a national public event, dance is an inseparable part of Iranian culture.

Persian dance is a spiritual, circular and slow body movement which makes it a dance that is unique to Iran amongst all other dances performed in Middle East. "Persian dance is almost entirely performed to 6\8 time signatures and is the only dance that is performed and known by all Iranians regardless of ethnicity, the dance itself is highly individualistic and also heavily relies on solo improvisation performances."³³

Most of Iranian dances such as regional folk dances are performed in group settings by men and women. Usually in Persian dance the main emphasis is on the motion of upper body and hands which is followed by facial expression to attract audience's attention to the dancers.³⁴

In a more precise point of view I should mention that in Persian dance there should be a "generous amount of energy flowing through the wrists, hands, and fingers and extending out the fingertips. Hand and wrist movements are fluid but can also be rhythmic in response to music. The face, head, and upper body respond to hand and arm movement in a poetic dialogue."³⁵ (See Figures 70-72).

The common version of Persian dance is often performed at relatively informal gatherings, such as family meetings. Everyone will sit in a circle (especially on rugs) and a couple will dance in the middle; sometimes, other people will start accompanying the ones who are already dancing.³⁶

To get the patterns of the dancers' movements, I documented the body gestures of two groups of professional dancers during a performance, traced their gestures, and then overlapped the drawings in top and front views. The final result is a series of drawings demonstrating the circular patterns of dancers' movements (Figures 73-76). This documentation became an interesting inspirational resource to be considered in further design experiments.

^{33 &}quot;Folk Dance." Tallinn University. Tallinn, Estonia. (2011). 10,11

^{34 &}quot;Folk Dance." Tallinn University. 10,11

³⁵ Shahrzad Khorsandi, "A Glimpse into Persian Dance Technique," DanceUs.org, accessed December 5, 2017, https://www.danceus.org/persian-dance/a-glimps-into-persian-dance-technique/.

³⁶ Ibio

Festival of Fire (Chaharshanbe Soori)

On the eve of the last Wednesday of the year, bonfires sprout up in public spaces throughout the cities of Iran and anywhere else Iranian people live. Their light and fire represents the happiness and enlightenment of the people for the coming New Year. People gather around one big bonfire or several small bonfires in a circular shape and leap over the fire while they shout "Oh, Chaharshanbe Soori; Give me your red color (red face color is the symbol of healthiness) and take back sickly pallor," which is a purification ritual.37 l found "Chaharshanbe Soori" pretty interesting to point out since the formal behaviour of people is recognizable as a cultural feature. Figures 77-80 demonstrate this ancient gathering culture.

³⁷ Massoume Price, "Culture of Iran: Festival of Fire," December 2001, accessed December 6, 2017, http://www.iranchamber.com/culture/articles/festival_of_fire.php; HI Tehran Hostel, "Chaharshanbe suri: Persian Festival of Fire I Rituals and routines," March 13, 2017, accessed December 6, 2017, https://www.hitehranhostel.com/chaharshanbe-suri/#.Wcg3CLKGP60.

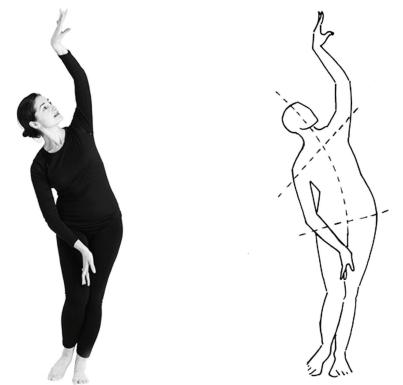


Fig.70 Persian dance, Qalamoo in frontal plane with side hinge

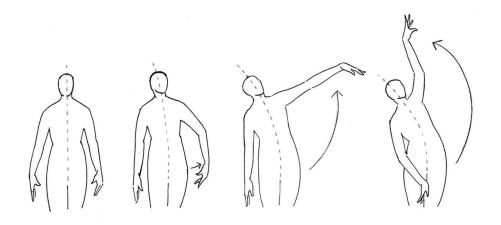


Fig.71 Different stages of Persian dance, Qalamoo in frontal plane with side hinge



Fig.72 Abshar movement in Persian dance



Fig.73 Nomad Dancers performs Shabe Eshgh - Persian dance



Fig.74 The diagram demonstrates the circular pattern extracted from the body gestures of the dancers

















Fig.75 Yaghoot jam Dancers performs a kind of folk dance – Persian dance

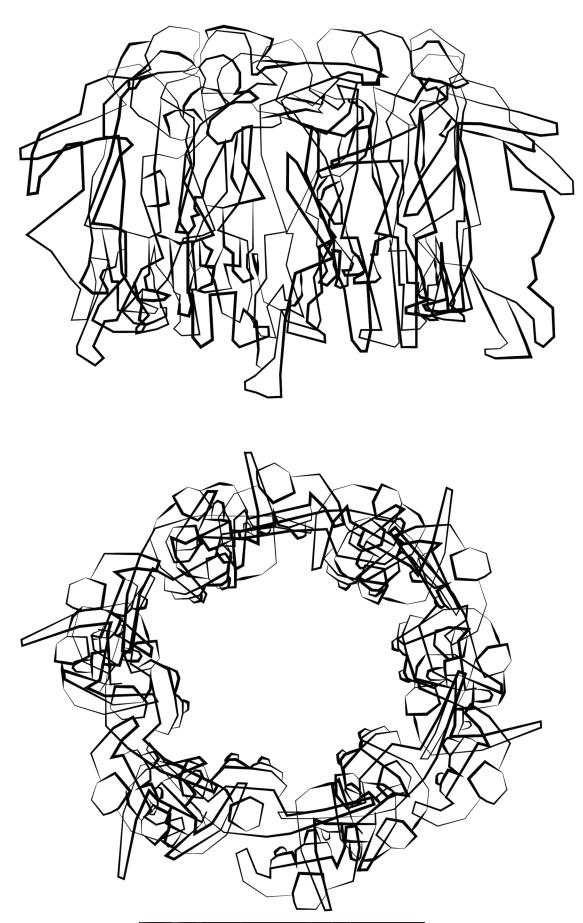
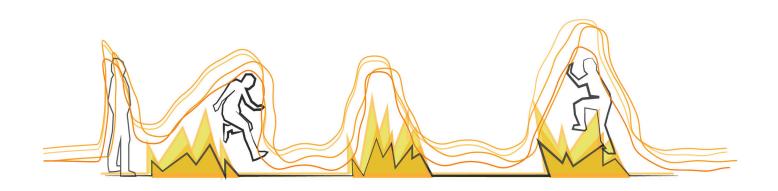


Fig.76 The diagram demonstrates the circular pattern extracted from the body gestures of dancers









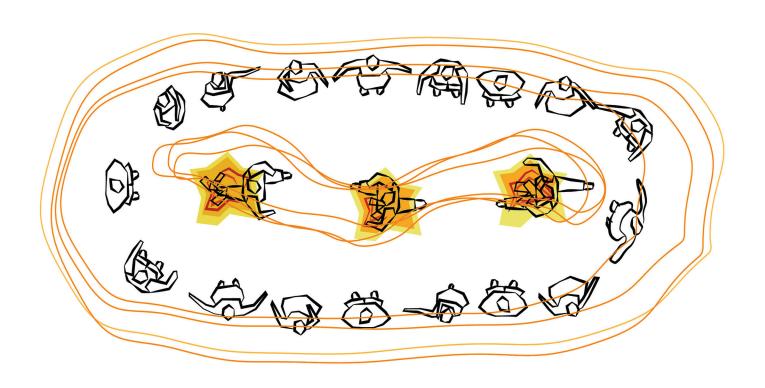


Fig.80 The diagram demonstrates the circular pattern extracted from gathering of people in Persian fire festival

CHAPTER4. DESIGN

OVERVIEW OF THE SITE, INTERAC-TIVE ARCHITECTURE, AND CULTURE

The design proposal will redefine the strip mall as a public gathering space. This temporary public space is proposed as a kind of interactive architecture that is influenced by Persian culture. The design investigation will be prefaced by an exploration of the context (site).

EXPLORING THE SITE (PERSIAN PLAZA)

Amongst the different strip malls in the GTA, I focus on a specific Persian strip mall called Persian Plaza. I introduce this context as the site for the project since it is representative as a commercial-cultural hub for the Persian community of Toronto. As previously discussed, this strip mall has several problems concerning architectural and urban quality. Nevertheless, it acts as a strong attractor for newcomers and long-time Toronto residents alike (Figure 82).

The Persian Plaza is located on Yonge Street in North York, just south of Steeles Avenue. It was originally a multi-ethnic strip mall but, in the mid-1990s, it morphed into a shopping center for members of the Persian community who wanted to make use of supermarkets, tailors, video shops, travel agencies and money transfer services run by their compatriots (See Figures 83-85).³⁸

Orly Linovski describes the strip mall thus:

This particular strip mall is distinguished by a deep colonnade that offers pedestrian protection for the internal sidewalk. The space for surface parking is also deeper on this site, with two rows of perpendicular parking and a double-width access row. This strip has 15 units on the ground floor. One of the most distinctive elements of this strip mall is the amount of signage. Toronto's staid sign by-laws seem to have had little impact on this stretch of Yonge Street (See Figures 86-89).³⁹

The plaza access for both cars and pedestrians is from the northern and southern edges of the parking lot and there is no separate access for pedestrians. Regarding the operation of the strip mall, at most times of the day the parking lot is occupied by cars (9:30 am-8pm). However, at other times of the day, the plaza is not very crowded.

Fig.82 West view of Persian plaza (strip mall) located in North York, Toronto

^{38 &}quot;Store Directory", Toronto Iranian Plaza - پلازای ایرانیان در نورنتو http:// www.torontoiranianplaza.com/.

³⁹ Linovski, "Beyond Aesthetics," 90-92.



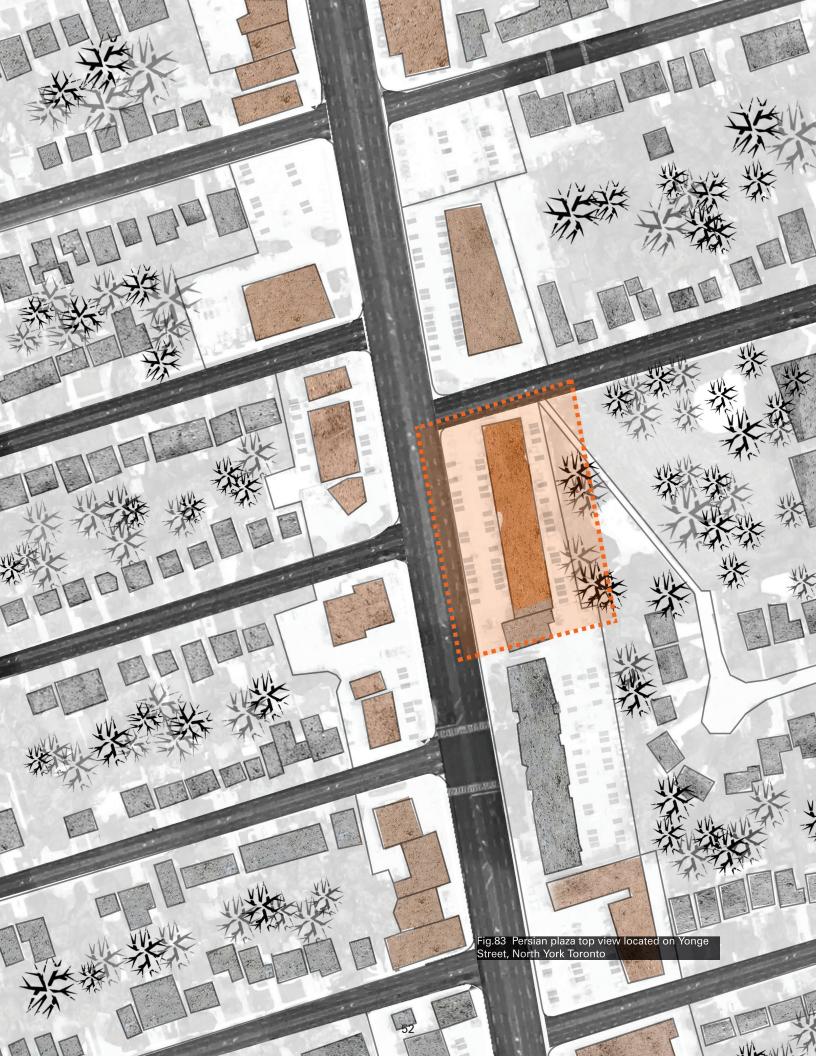
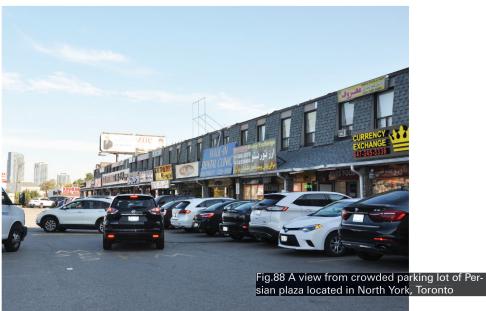






Fig.86 Axonometric view of Persian plaza located in North York, Toronto CANOPY PARKING YONGE STREET STORES SIDE WALK







DYNAMIC QUALITIES OF THE SITE

Since the scope of this thesis is the design of an interactive (dynamic) architecture to create a temporary public space, it is necessary to analyze the dynamic qualities of the site, which I have identified as "parking use at different times" and "unplanned gatherings of Persian people."

As the following diagrams show, the site is occupied by cars from 9 am to 8 pm. Although the supermarket is open 24 hours, during the night and early in the morning, the plaza is vacant of people and cars (Figure 90).

Based on different sources available on social media like YouTube, unpredictable social or political gatherings sometimes happen at this cultural hub. These events are important to consider as a factor for redefining the strip mall as a public gathering space (see Figures 23-30).

DESIGN PROCESS

The design process of this thesis consists of a series of interactive design experiments based on different criteria such as the dynamic qualities of the site and Persian culture. I started the process by illustrating some early conceptual diagrams to propose interactive ideas. Then I continued by making physical models to investigate the possibilities of deployable design to create interactive space. Finally, I developed this notion of interactivity by creating further iterations of deployable prototypes inspired by Persian culture.

EARLY CONCEPTUAL IDEAS

I start this part with this question: "how can the interactivity and responsiveness of architecture make more space virtually and physically whenever there is a limitation on space?"

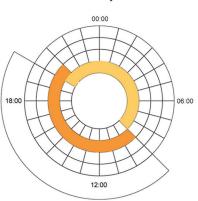
For proposing these conceptual ideas, I first demonstrated the possible components for creating an interactive space within the strip mall (Figure 91). Then, I illustrated possible external forces that create interactivity (Figure 92). Finally, there are three conceptual designs highlighting my attempt toward creating more space when it is limited. The main focus of this part is the negotiation between cars and people through creating a dynamic space that could be physical or virtual (Figures 93-98).

Fig.90 The diagram demonstrates Use of Parking area (Persian plaza) in different times

Use of parking area

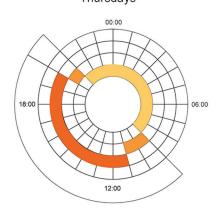
Maximum use of parking average use of parking Minimum use of parking Zero use of parking

Sundays



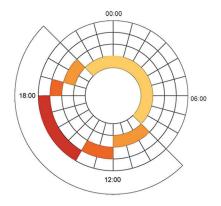


Mondays Tuesdays Thursdays

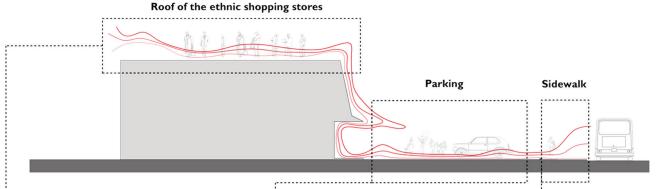




Fridays Saturdays Wednesdays







User

Young people Old people

Activity

Art gallery Musical performance Dance performance

Kind of responsive design

Mobile architecture Kinetic architecture Visual architecture

Kind of engagement

Directly without any application through pysical contact Indirectly through application through virtual contact physical presence is necessary

Sensitive to

People movement
People weight
People touch
People visual contact

Output

Physical output (sitting area, panels) Visual output

Time period

Specific times of the year

Geometry material

User

Young people Old people Car

Activity

Unplanned Social gathering events Musical performance Dance performance

Kind of responsive design

Mobile architecture Kinetic architecture Visual architecture

Kind of engagement

Directly without any application through pysical contact Indirectly through application through virtual contact physical presence is necessary

Sensitive to

Car movement
People movement
People weight
People touch
Density of people

Output

Physical output (playground, sitting area) Visual output

Time period

Specific times of the year Every day

Geometry

material

User

Young people
Old people

Activity

Sitting (furniture for sitting) Getting visual information

Kind of responsive design

Mobile architecture Kinetic architecture Visual architecture

Kind of engagement

Directly without any application through pysical contact Indirectly through application through virtual contact physical presence is necessary

Sensitive to

Bus movement
People movement
People weight
People touch
Distance between people

Output

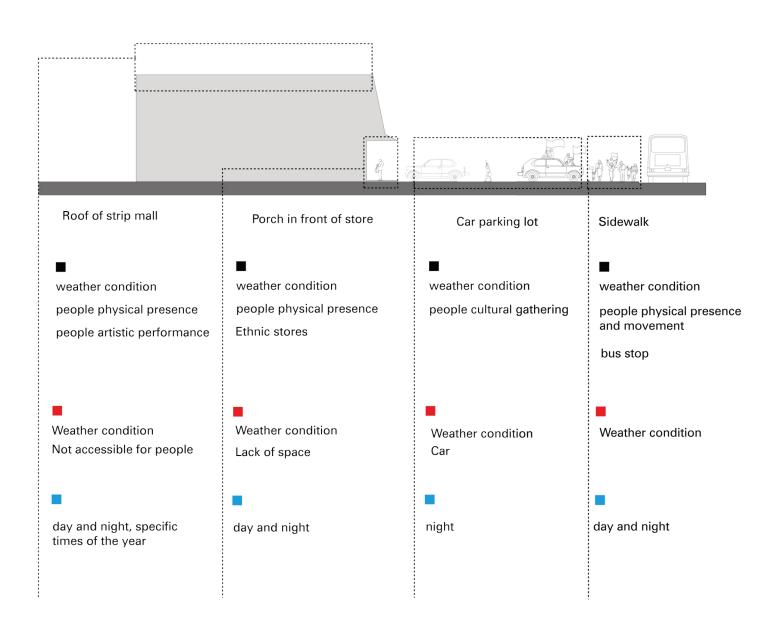
Physical output (sitting area, canopy) Visual output

Time period

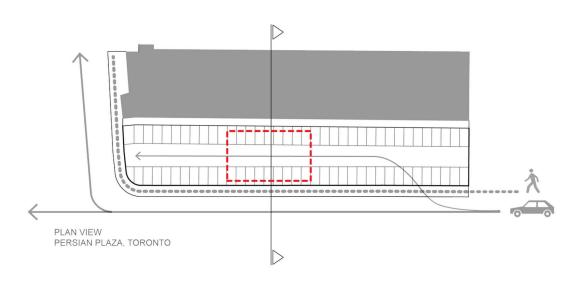
Every day

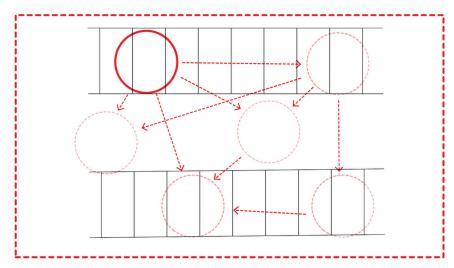
Geometry

material

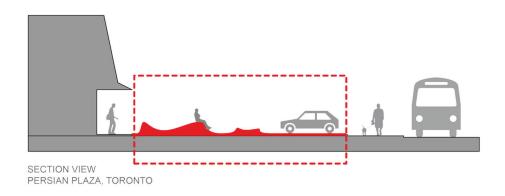


- Forces provideing use of space as a public realm
- Forces limiting use of space as a public realm
- Estimated time when space can be more active





PLAN, ZOOM IN VIEW, MOVING PLAYGROUND PERSIAN PLAZA PARKING, TORONTO



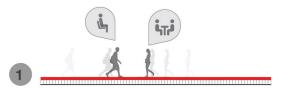
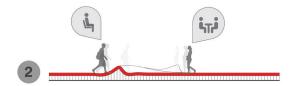


Fig.94 Different scenarios for "Dynamic playground and parking"

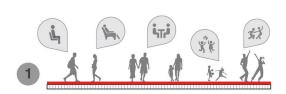


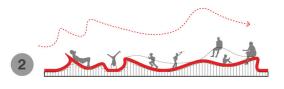




SEQUENTIAL SECTIONS of ground transformation Dynamic furniture, malleable furniture Object: people

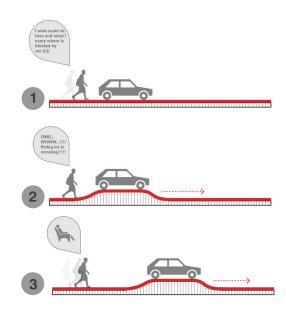
External force: car/people Time of operation: 9am-9pm

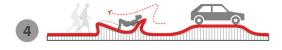




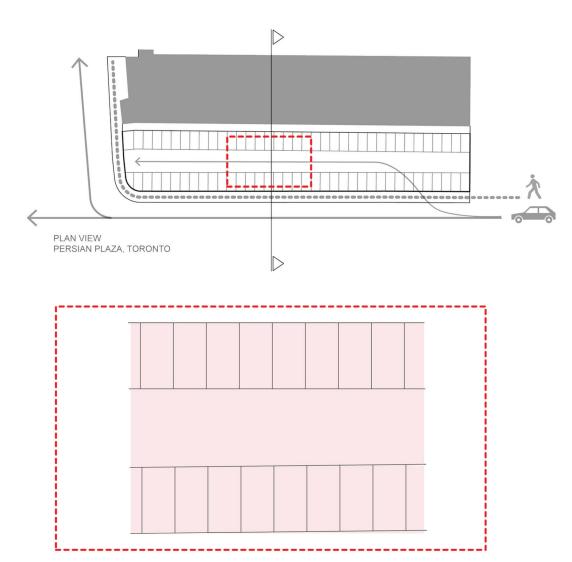


SEQUENTIAL SECTIONS of ground transformation Dynamic furniture/playground Object: people External force: people Time of operation: 9pm-9am

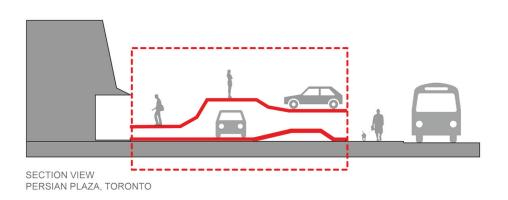


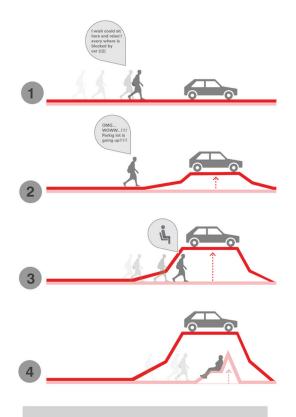


SEQUENTIAL SECTIONS of ground transformation Dynamic furniture vs dynamic parking lot Object: car/people External force: people Time of operation: 9am-9pm

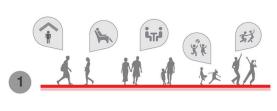


PLAN, ZOOM IN VIEW, FOLDABLE SURFACE COVERING THE PARKING PERSIAN PLAZA PARKING, TORONTO





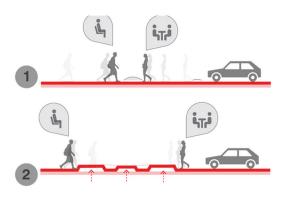
SEQUENTIAL SECTIONS of foldable surface Dynamic furniture/parking/canopy Object: car/people External force: people Time of operation: 9am-9pm

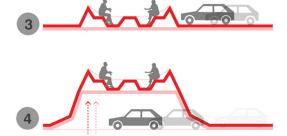




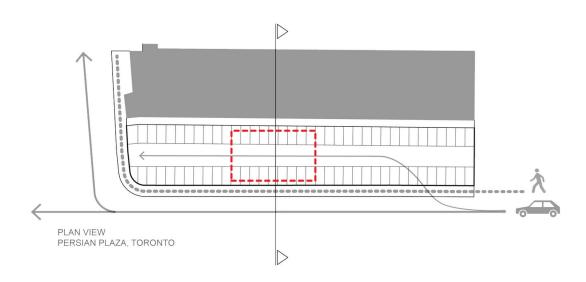
SEQUENTIAL SECTIONS of foldable surface Dynamic furniture/canopy Object: people External force: people Time of operation: 9pm-9am

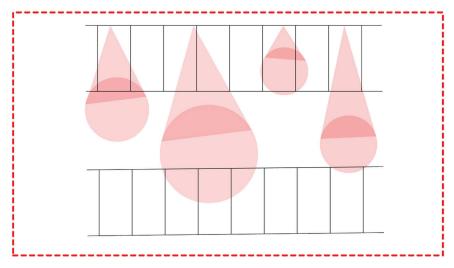
Fig.96 Different scenarios for "Foldable playground and parking"





SEQUENTIAL SECTIONS of foldable surface Dynamic furniture/canopy Object: people External force: people/car Time of operation: 9am-9pm





PLAN, ZOOM IN VIEW, VIRTUAL CONE PERSIAN PLAZA PARKING, TORONTO

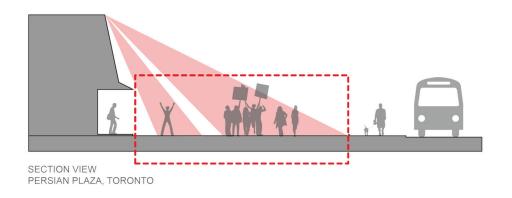
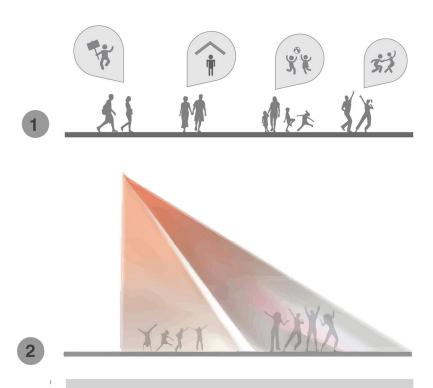
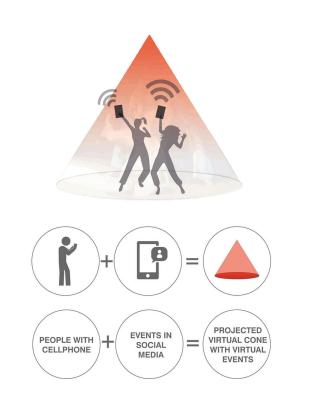


Fig.98 Different scenarios for "Virtual space"



SECTION of virtual cone Dynamic virtual cone External force: people Time of operation: 9pm-9am

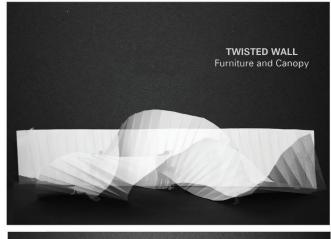


EXPERIMENTING WITH DEPLOYABLE DESIGN

I open this part by proposing this question: "how can we apply a low-technology, interactive strategy to create more open public space rhythmically by either growing the space or by doubling up on space?"

By making a series of physical, deployable prototypes, I aimed to investigate deployable techniques in order to experiment with different possibilities for creating a dynamic space. I did this by producing four foldable prototypes made out of paper (Figure 99). For a further investigation of folding techniques, I developed one of the prototypes, called "Rolling Space." These rolling modules comprise three different layers, each of which is folded on a series of parallel lines, allowing each layer to be rolled and unrolled based on the availability of space in the parking area of the Persian Plaza site. There are different states in which these foldable layers provide stable furniture on which people can sit or arrange their goods. During exploration of this rolling space, I illustrated different scenarios in which I can clarify the limitations and possibilities of this particular deployable module (See Figures 100-109).

Fig.99 Experimenting with Deployable Design

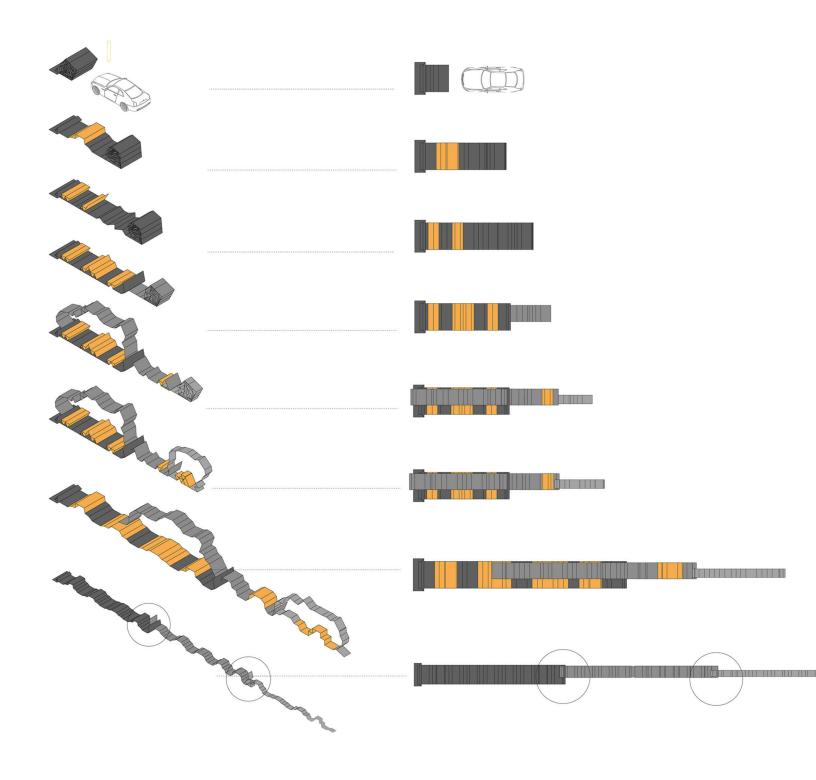


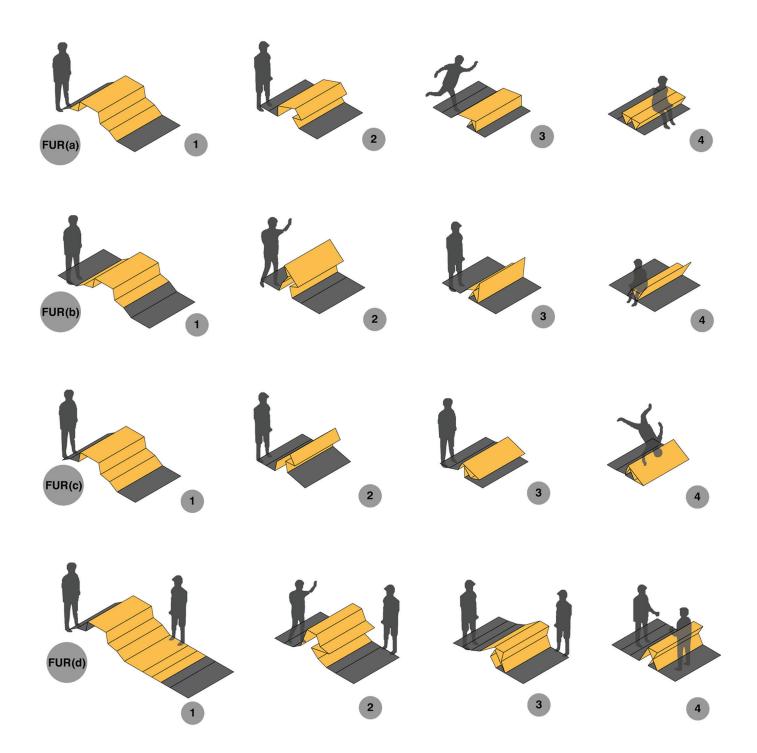


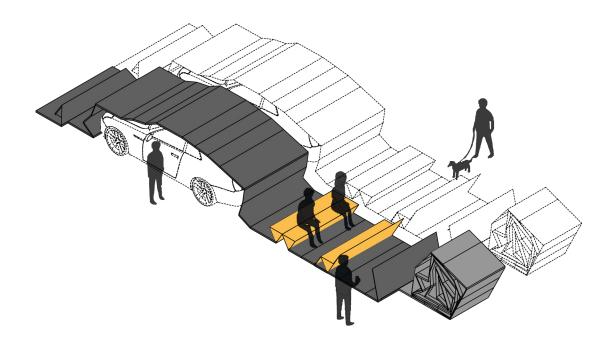


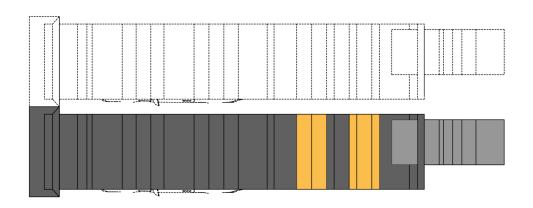


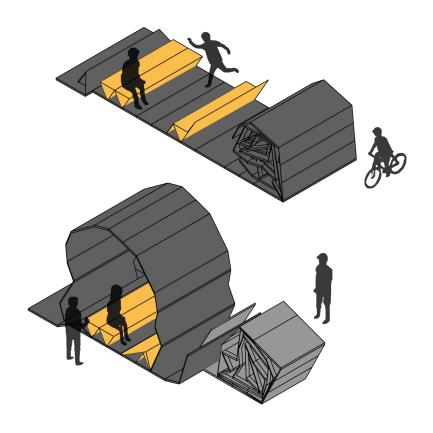


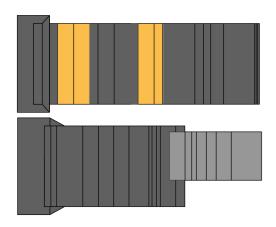


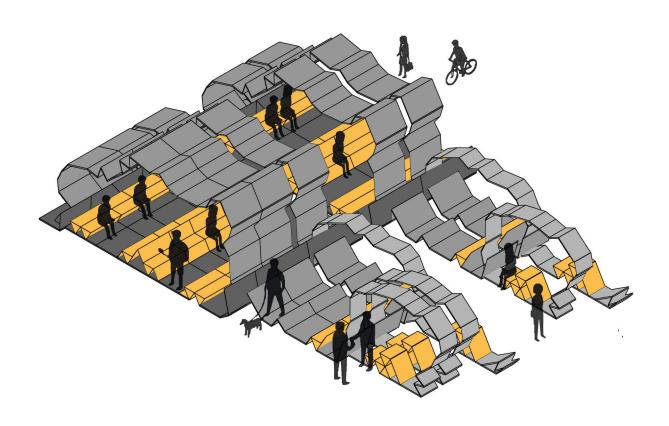












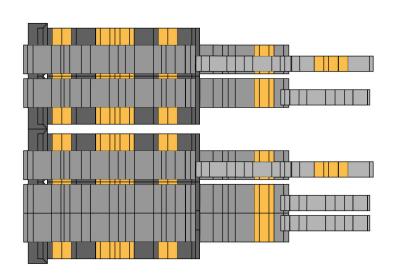
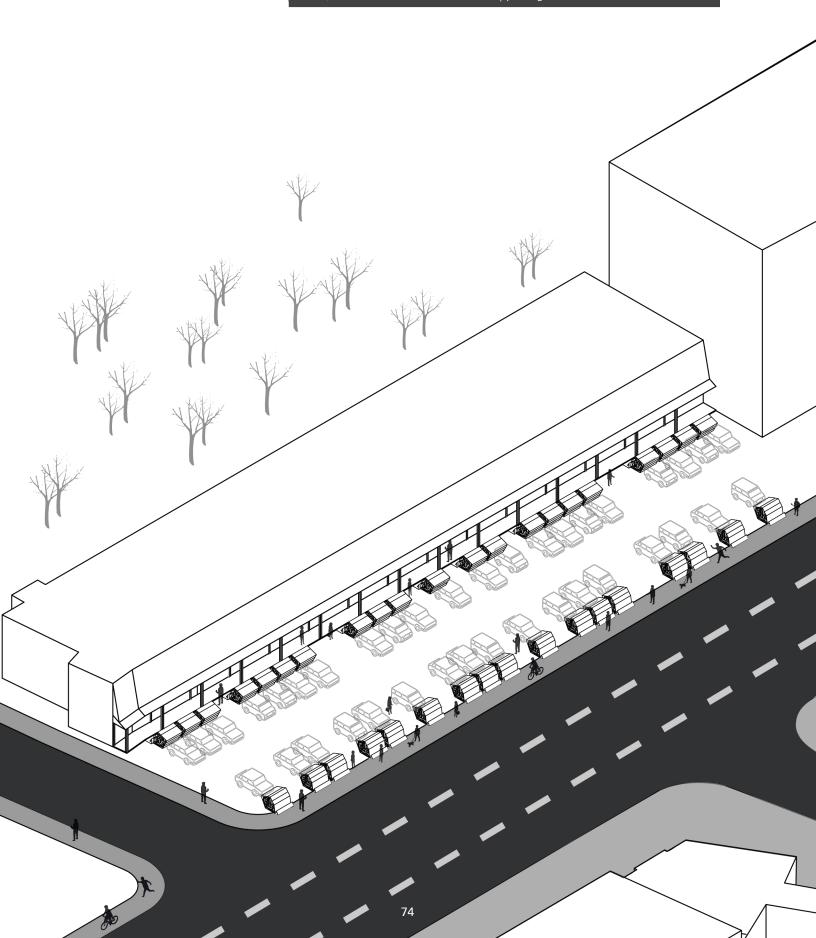
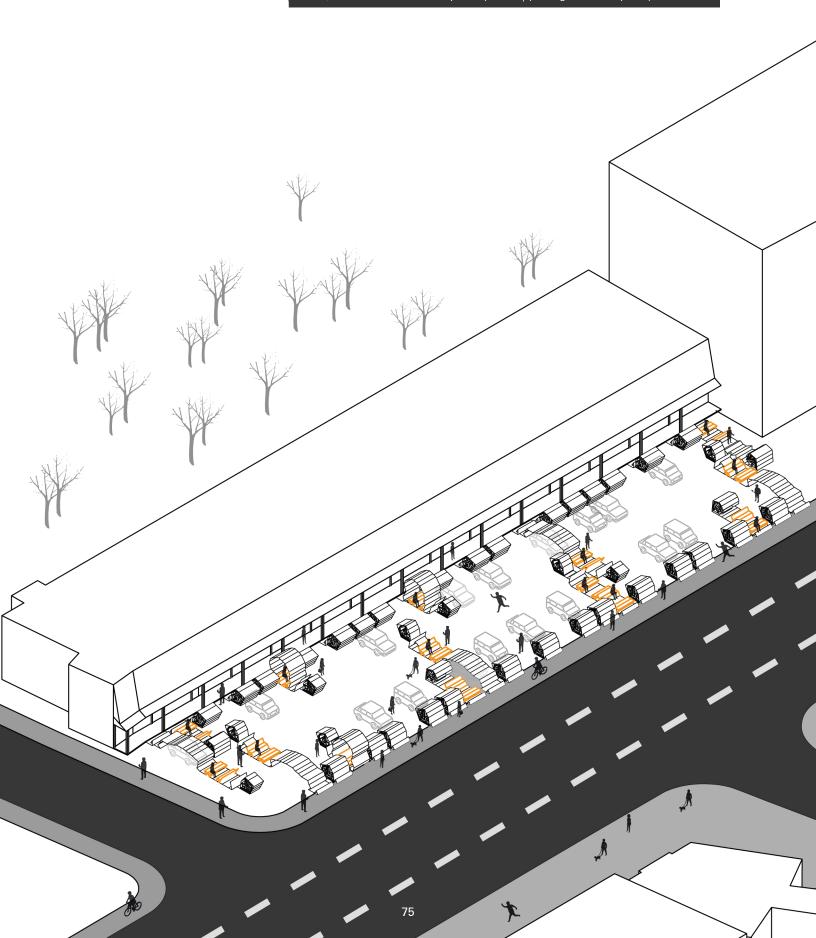


Fig.105 Spreading the roll all over the parking area, Persian plaza located in North York Toronto, Condition of activation: not active parking is full





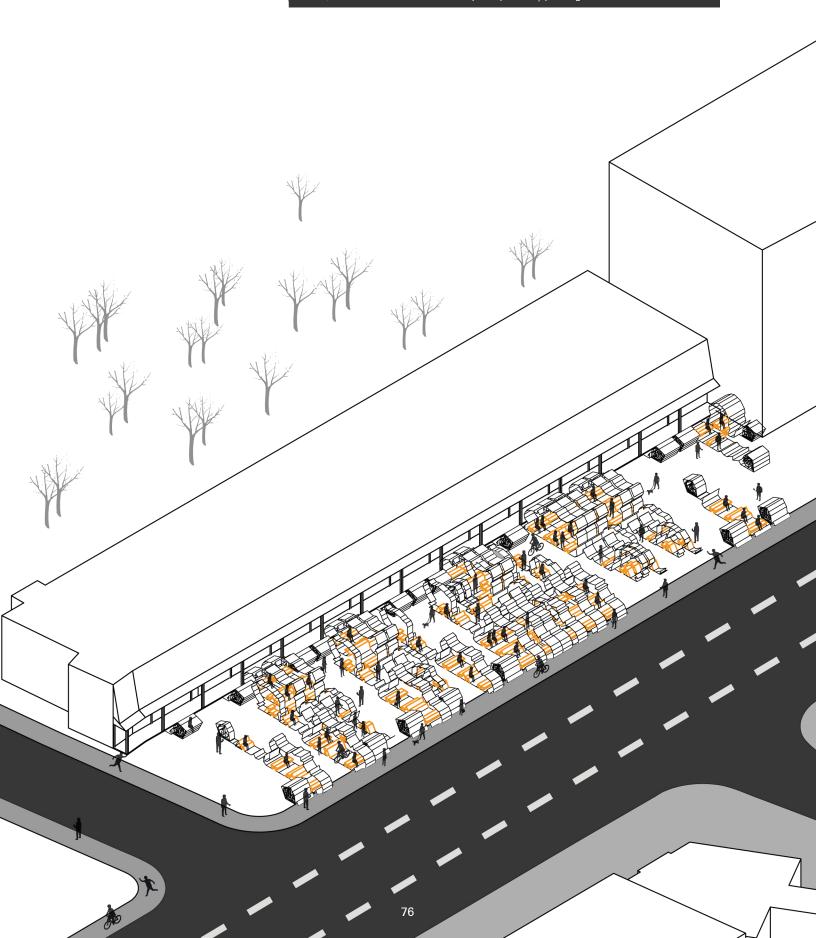


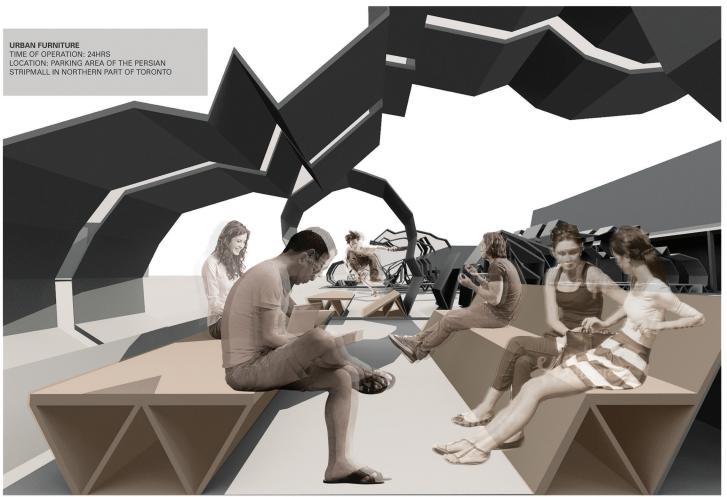


Fig.108 Two interior views to the rolls-gathering spot and furniture



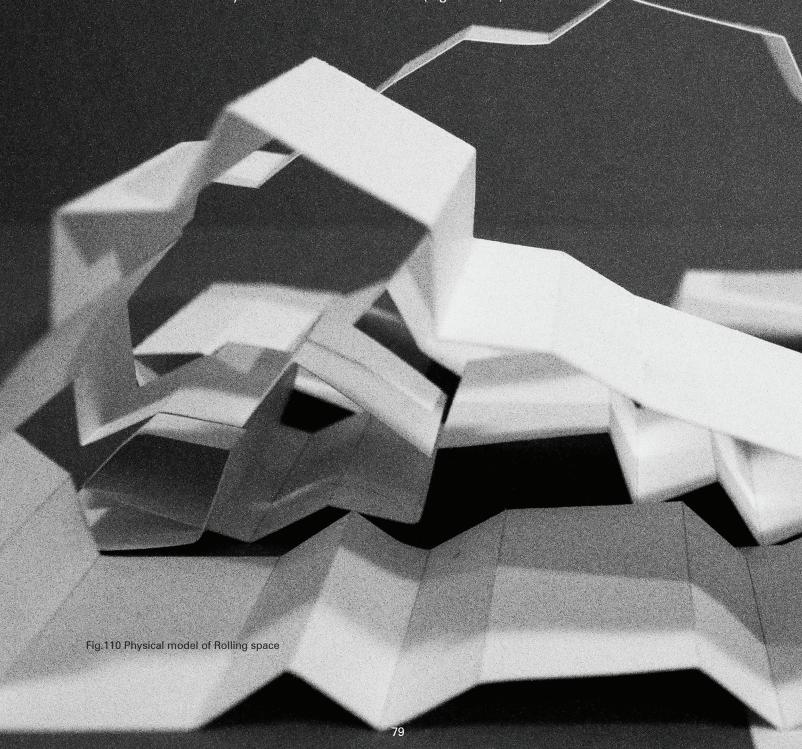


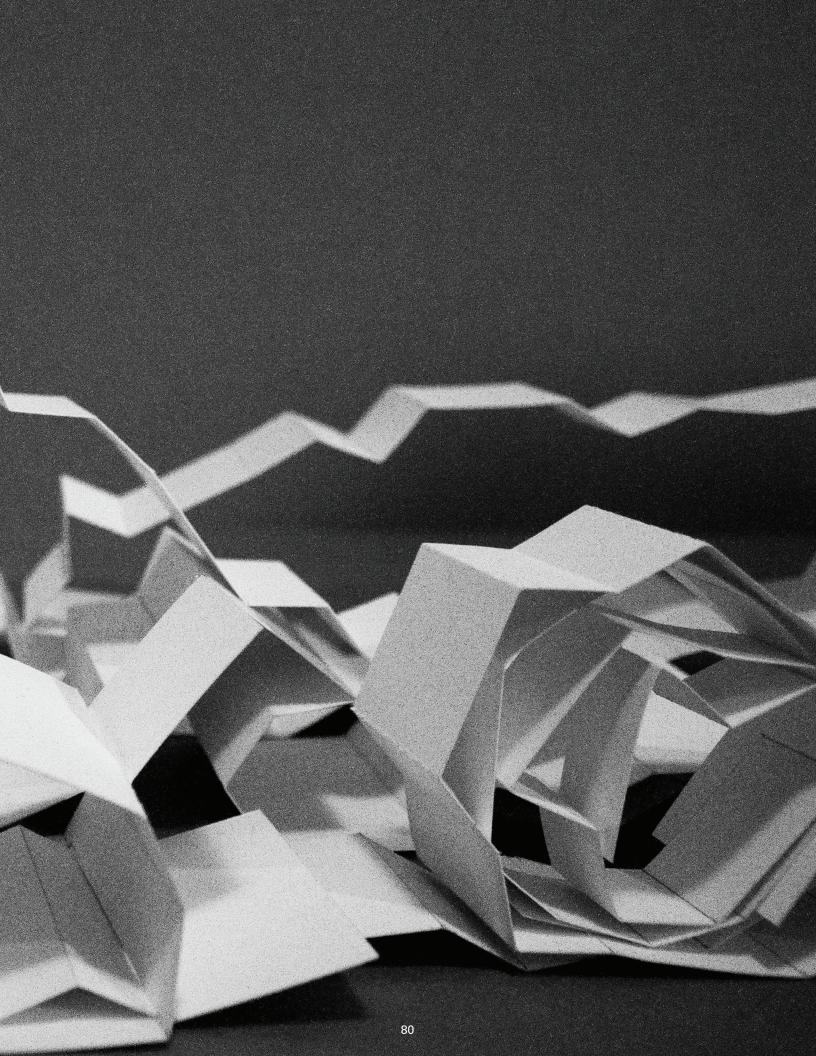
Fig.109 Two interior views to the rolls-gathering spot and furniture



CRITIQUE OF ROLLING SPACE AS A DEPLOYABLE PROTOTYPE

The dynamic qualities of these rolling modules have convinced me that the deployable (folding) technique is one of the interactive design solutions to provide a kind of expandable potential for the space to be applied to the strip mall context. However, there are some challenges regarding this rolling space. For instance, each folded roll is too long and heavy to be controlled and installed by a human user, without mechanical aid. In terms of stability, it seems complex to design and build these rolls in reality. Finally, the most important weakness of this prototype, which motivated me to go further and produce further iteration, is that it is disconnected from my interest in Persian culture (Figure 110).





DEPLOYABLE PROTOTYPES INSPIRED BY PERSIAN CULTURE

Referring to earlier iterations of deployable prototypes and their loose connection with Persian culture, I did another iteration that was driven by the formal language of culture. At this point, a series of deployable shells inspired by Persian culture were produced (See Figures 111-115). Among these flexible shell prototypes, I chose the "market shell" and "gathering shell" for further developments because they have the spatial and functional quality to be applied to the strip mall context (Iranian plaza).

Market Shell

Generally, the idea behind the form and function of this shell comes from the Persian Bazaars. Referring to earlier studies of the space syntax of bazaars, most Persian bazaars comprise a main, covered path and some secondary paths connected to the main one. What I did in this new, deployable prototype is that I adapted this idea of main and secondary paths to the shell by applying a set of parallel, folded lines to the shell (Figures 116-117). These parallel lines create a series of identically sized, parametric, triangular patterns, allowing the shell to be twisted in different states based on availability of space in parking area of the site. Moreover, taking into account the interior space of bazaars, which consists of a series of duplicated vaults along the paths, I created multiples of this deployable module with different states of folding along the path (Figure 118).

Gathering Shell

Based on earlier studies of Persian gathering events, I realized that there are some circular patterns coming out of those gatherings (Persian dance and fire festival celebration). I was inspired by these events and applied this idea of circular gathering to these new shells. I created arch-shaped shells consisting of triangular patterns, allowing the shell to be concave and circular. In other words, these shells are made out of divergent lines creating a series of differently sized, triangular patterns. This allows the shells to be deformed to an arch-shaped module, which is inspired by the parametric, triangular patterns of Persian architecture (See Figures 119-121).

Furniture

Since these shells are designed for people to use as market and gathering zones, a different layer of furniture needs to be defined for people to sit or arrange their goods. The formal language of the shells consists of a series of triangular boxes, parallelogram boxes, and trapezoid boxes have been designed to be applied to the shells as furniture. The geometry of these rigid boxes follows the triangular patterns of the shells, so every component of the space is coordinated with all others. Compared to the shells, which are flexible enough to create different states of space, these boxes are rigid enough to help the stability of the shells. When the shells are off and not activated, these boxes are stacked together (See Figures 122-125).

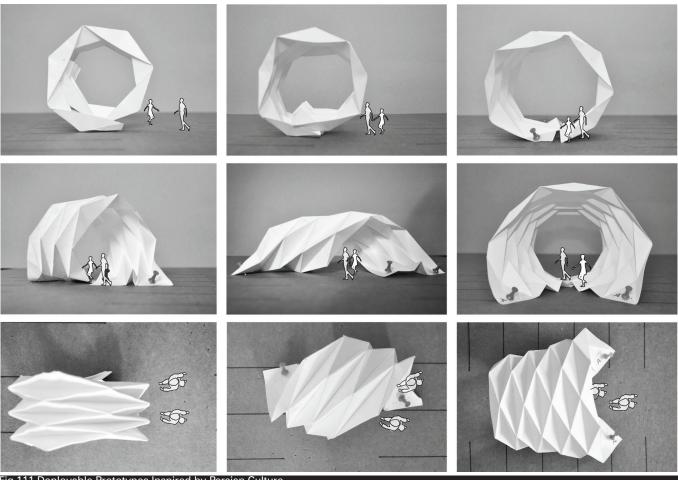


Fig.111 Deployable Prototypes Inspired by Persian Culture



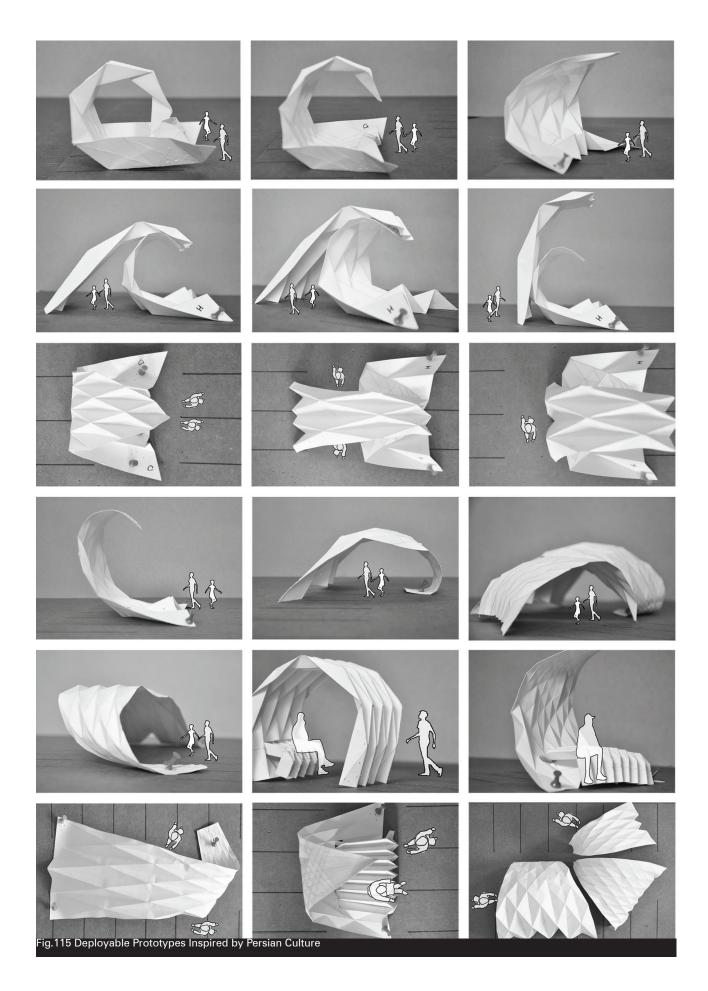
Fig.112 Tabriz bazaar as an architectural inspirational resource



Fig.113 Tehran bazaar as an architectural inspirational resource



Fig.114 Zanjan Bazaar as an architectural inspirational resource



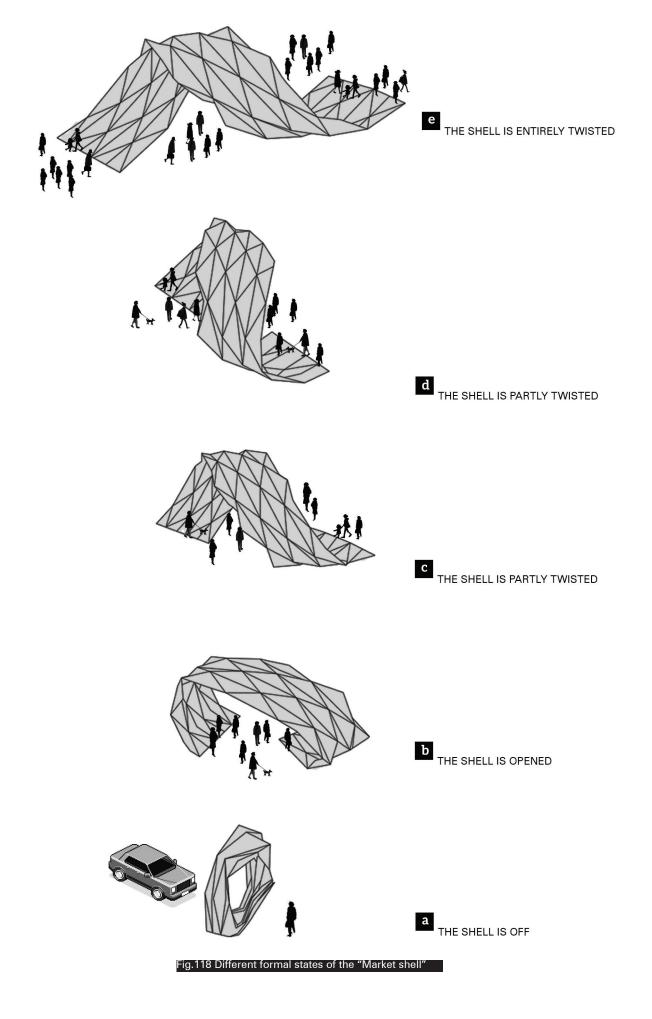


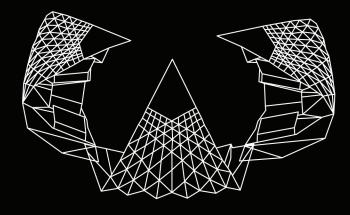
MARKET



Fig.116 Market shell and its parametric triangular patterns







GATHERING SHELL

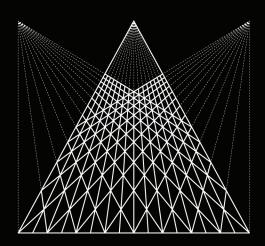
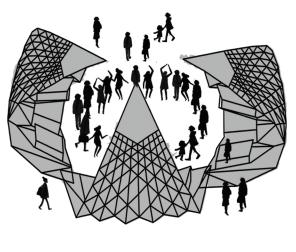


Fig.119 Gathering shell and its parametric triangular patterns



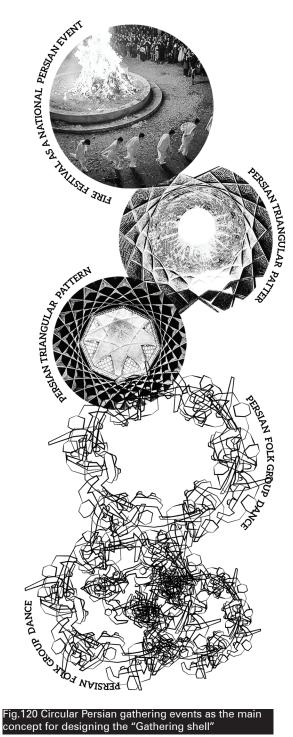
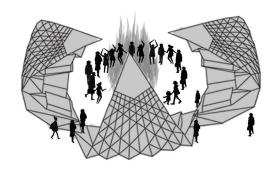
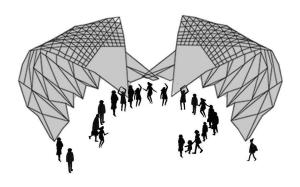


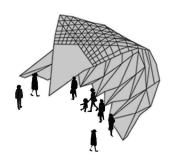
Fig.120 Circular Persian gathering events as the main concept for designing the "Gathering shell"



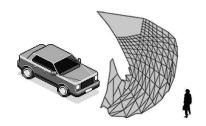
d THREE SHELLS ARE CONNECTED



TWO SHELLS ARE CONNECTED

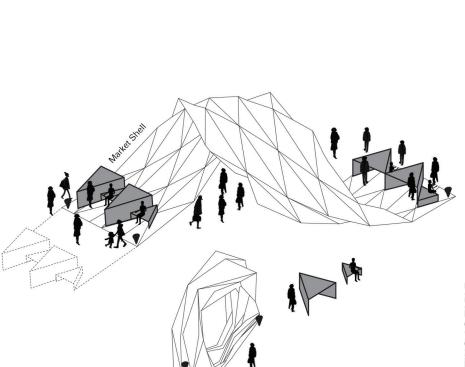


b THE SHELL IS OPENED



a THE SHELL IS OFF

Fig.121 Different formal states of the "Gathering shell"





RIANGULAR BOXES ARE STACKED IN ONE SPOT LOCATED IN NORTHERN SIDE OF PARKING

TING FURNITURE Fig.122 Rigid triangular furniture for the "Market shell"

TRIANGULAR BOXES ARE STACKED IN TWO SPOTS ALONG THE SIDE WALK

Gathering Shell

SITTING FURNITURE

32 PARALLELOGRAM BOXES ARE STACKED IN TWO SPOTS ALONG THE SIDEWALK

SITTING FURNITURE

16 TRAPEZIUM BOXES ARE STACKED IN TWO SPOTS ALONG THE SIDEWALK

Fig.124 Rigid trapezium and parallelogram furniture for the "Gathering shell"





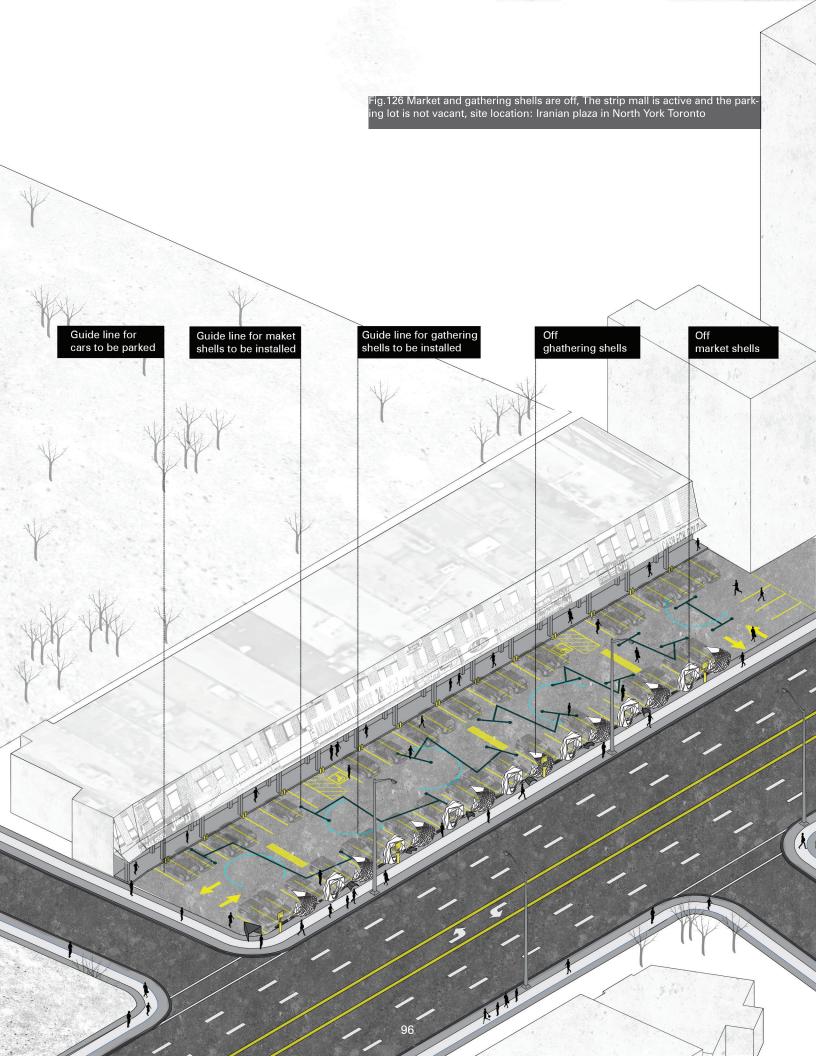




Different States of Expanding and Shrinking of Shells on the Site

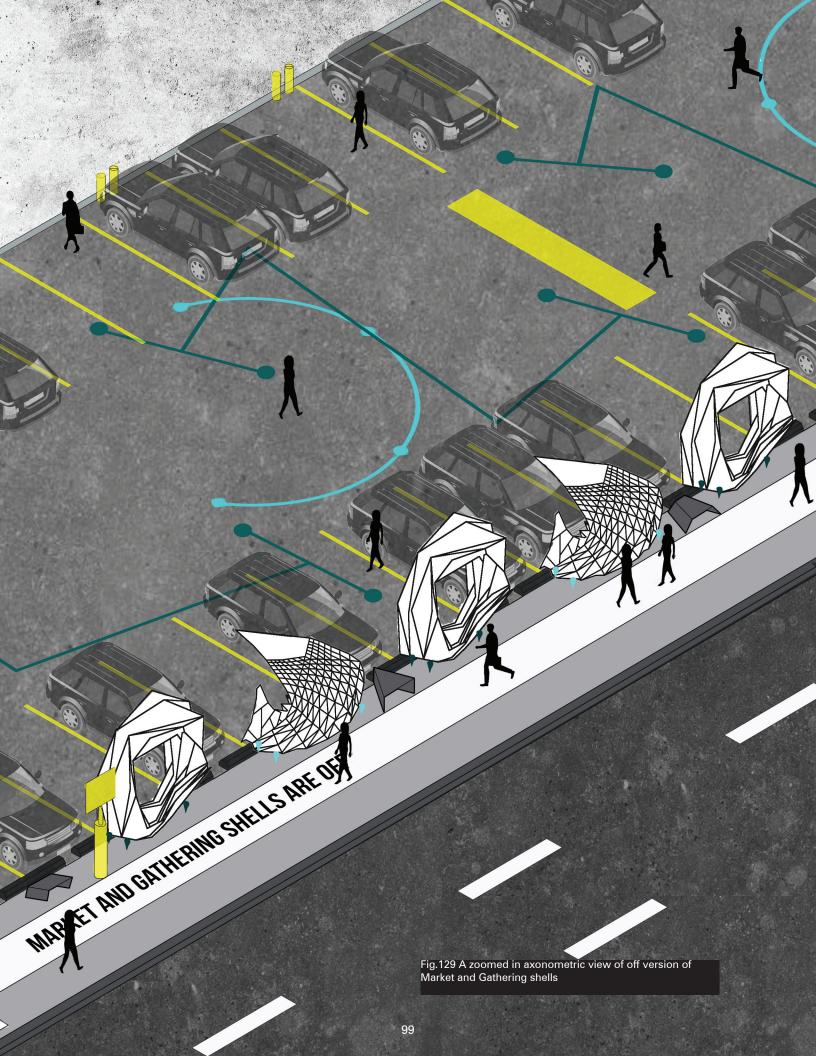
This part illustrates the different states of the shells on the Persian plaza site. To clarify the functional and formal behavior of the shells, I illustrate them as axonometric perspectives (Figures 126-131), plans (Figures 132-138), elevations (Figure 139), and sections (Figures 140-141), at different scales.

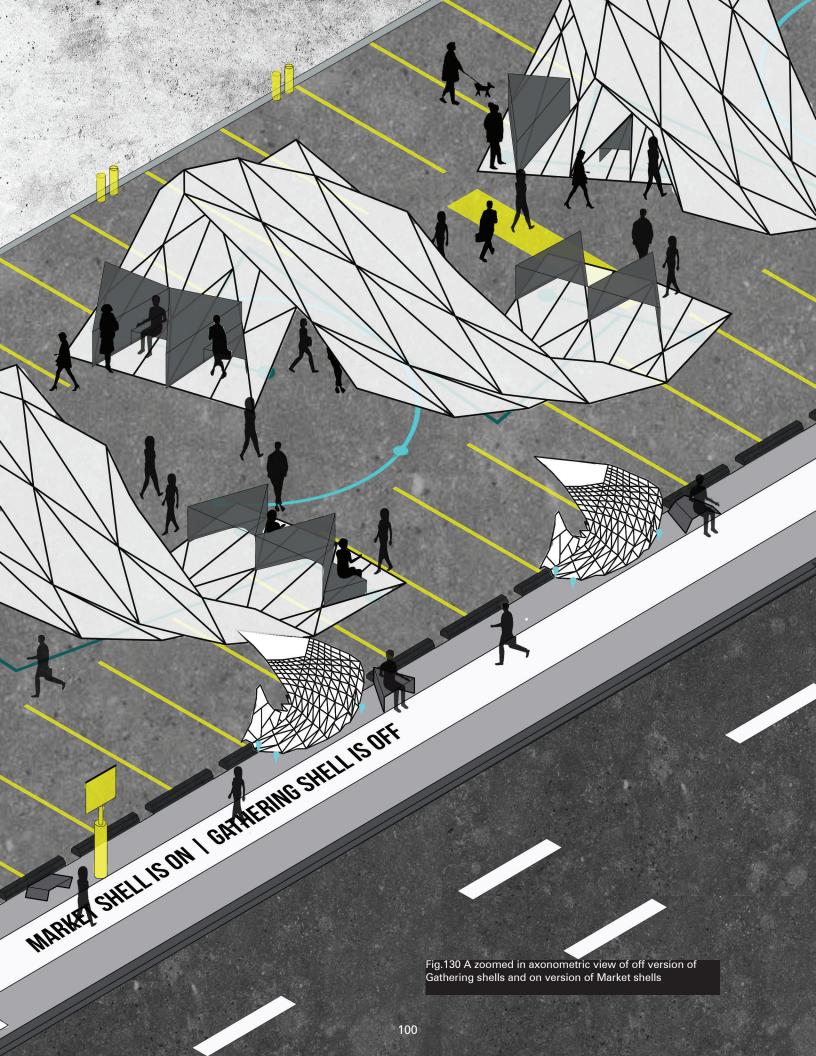
In addition to the yellow lines that delineate the car parking spots, there are two more guide lines in the middle of the parking lot. These are the guide lines for the shells to be installed when they are on (activated). The deployable shells are supposed to be on (activated) or off (deactivated) based on availability of space in parking area of the site. When the shells are off, they are folded so that they can be arranged between the side walk and concrete parking curbs. Hence, when the strip mall is activated, these deactivated shells would not block the pedestrian path of the sidewalk or the parking space of the cars (See Figures 138,141). It should be mentioned that these shells have the potential to be activated whenever there is car in the parking lot, so it is not necessary for these deployable shells to be activated whenever the parking is completely vacant of cars. That is why the shells are designed as an individual independent module so that they can be folded and DE folded based on the site conditions.

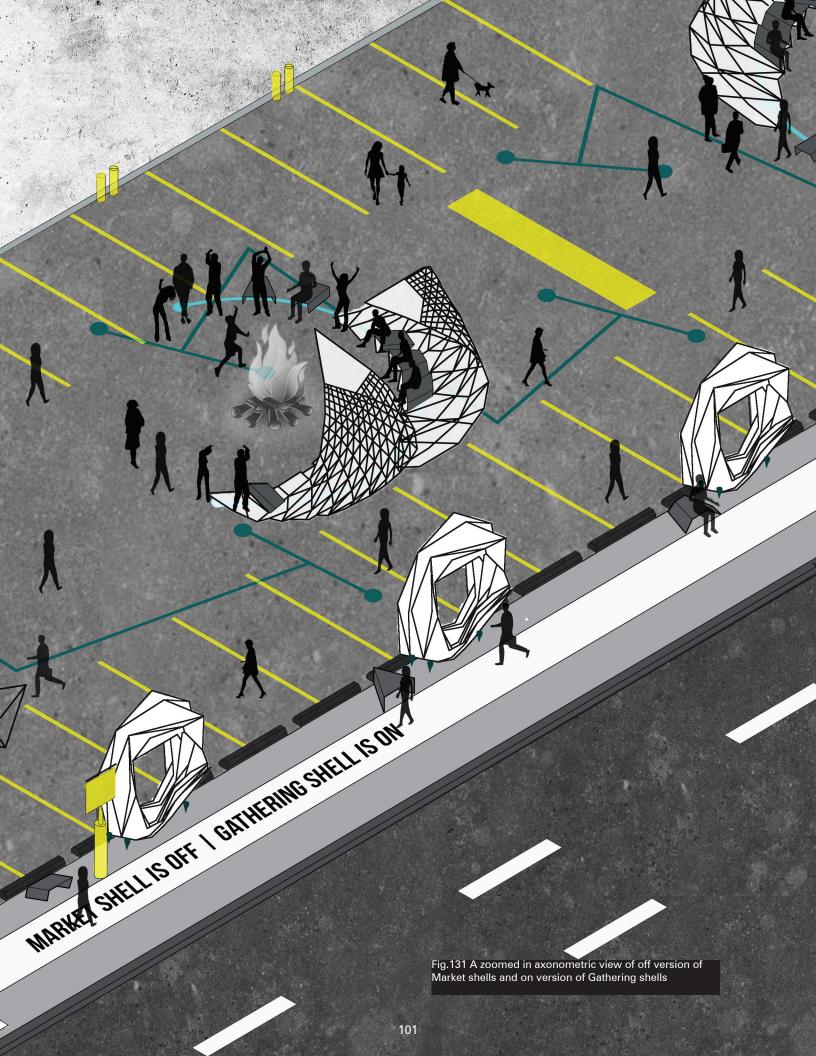




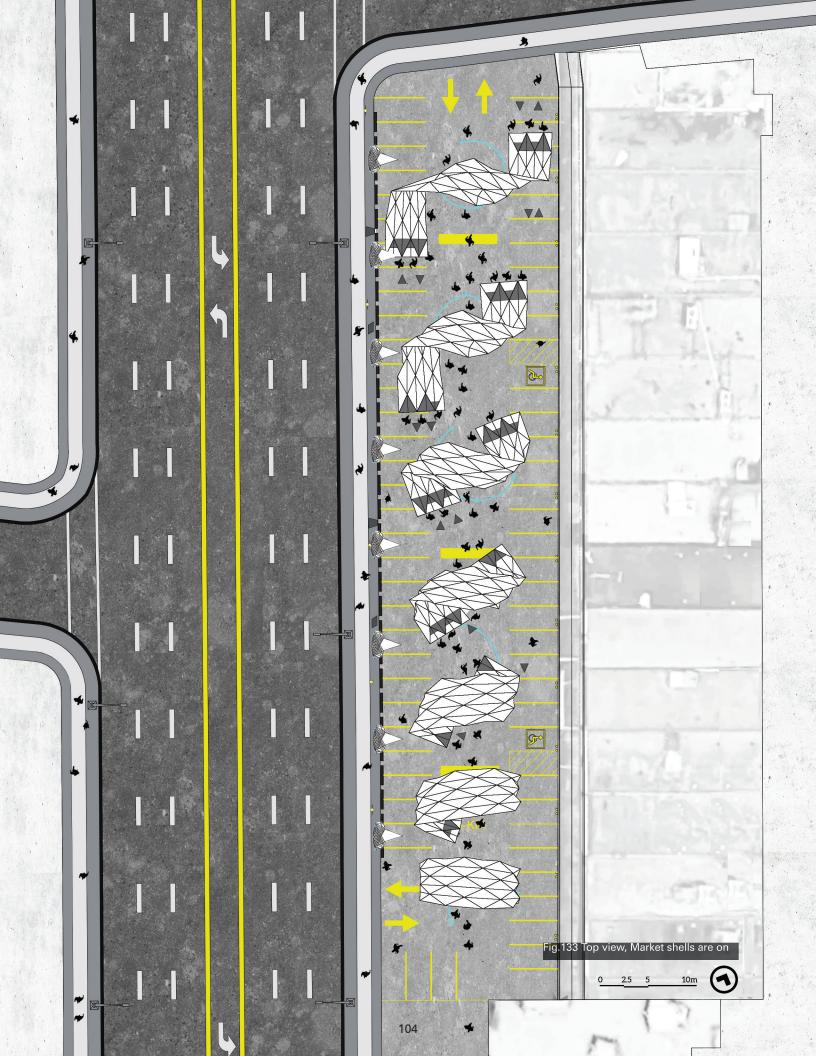


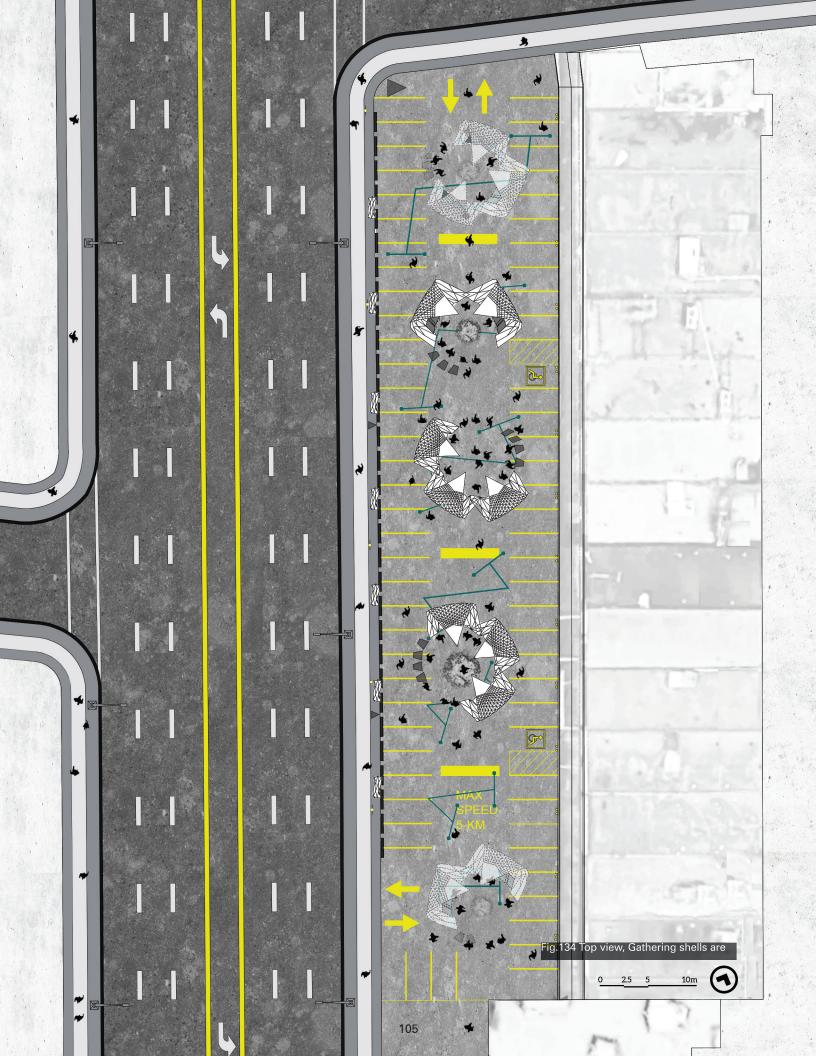




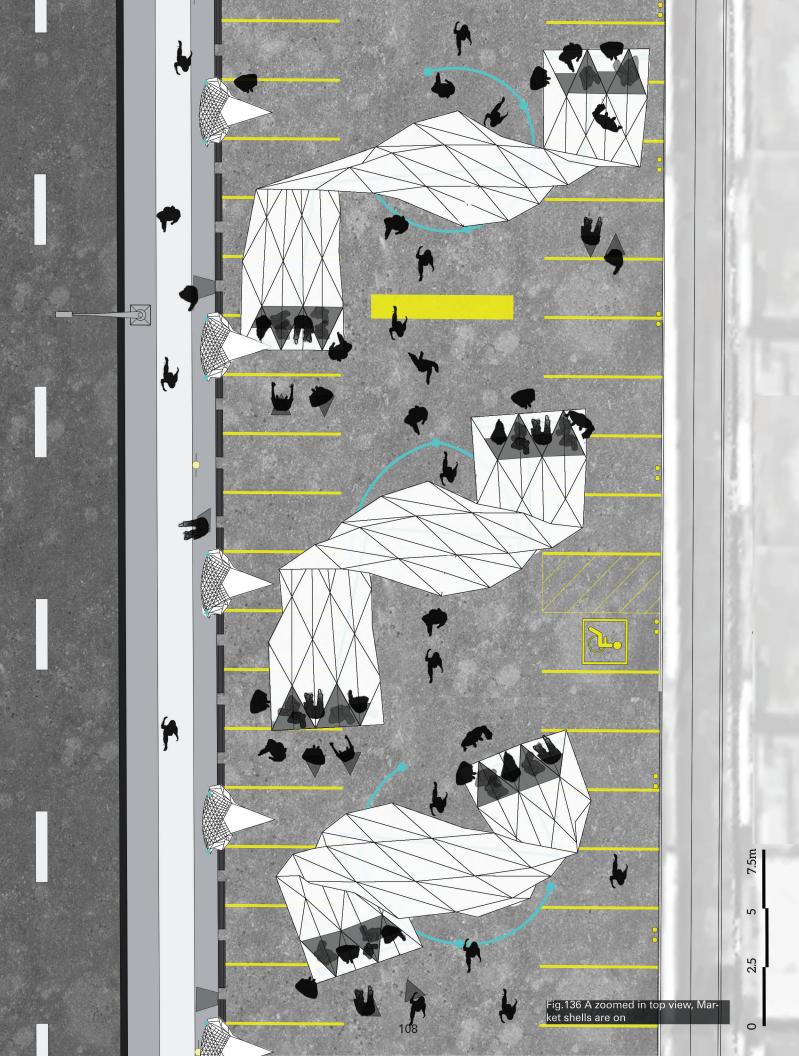




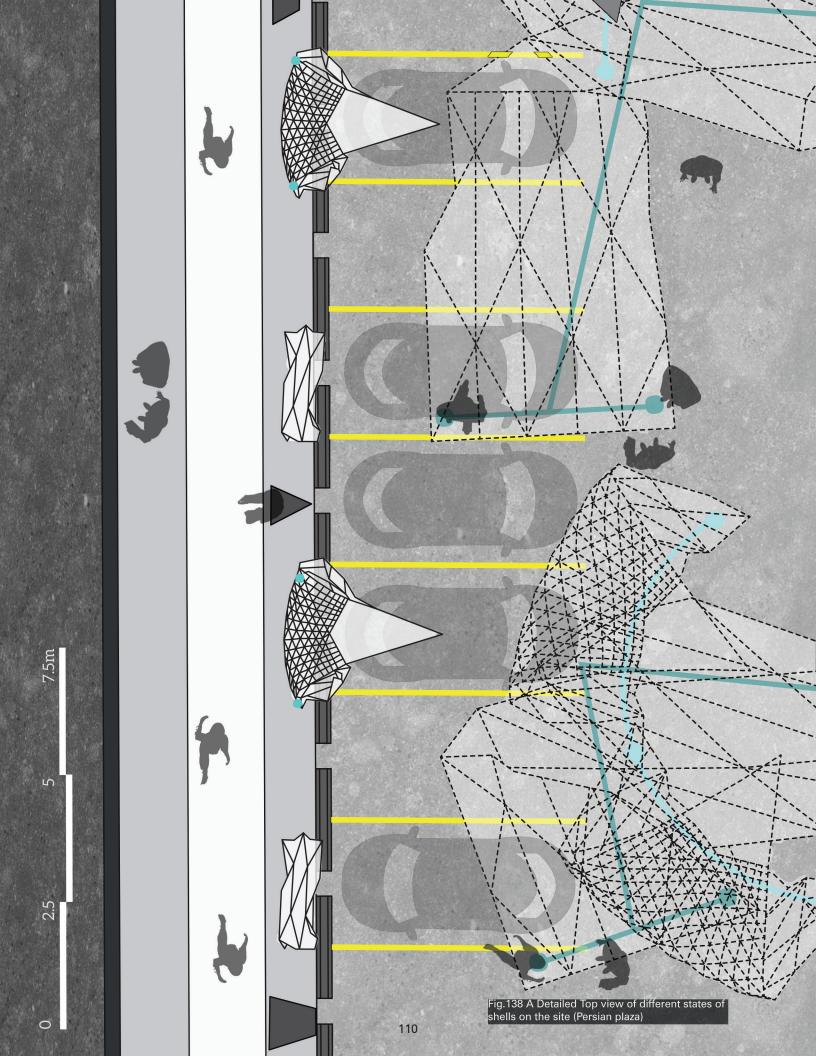




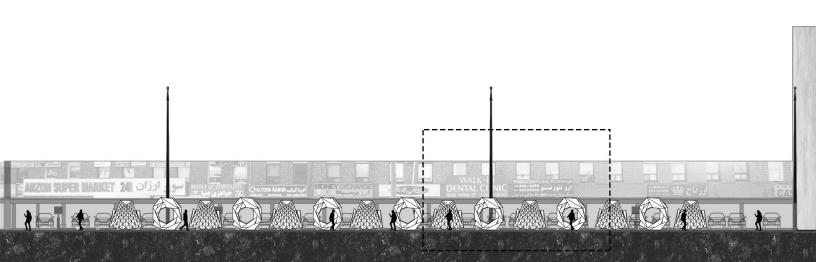




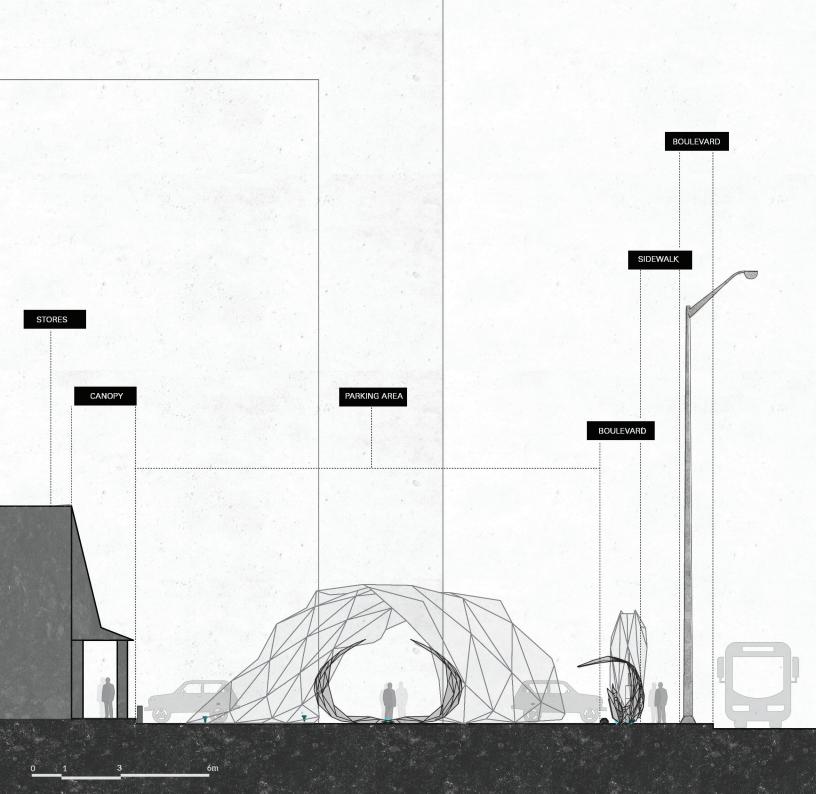








14m.



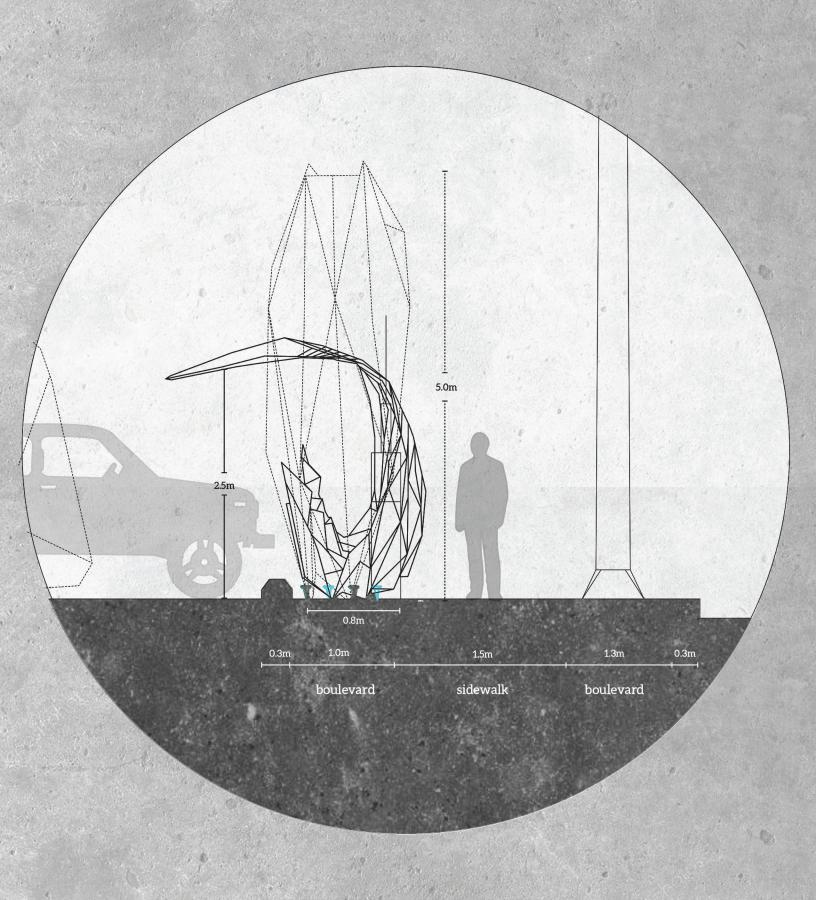


Fig.141 A Detailed sectional view of side walk demonstrating the off version of shells





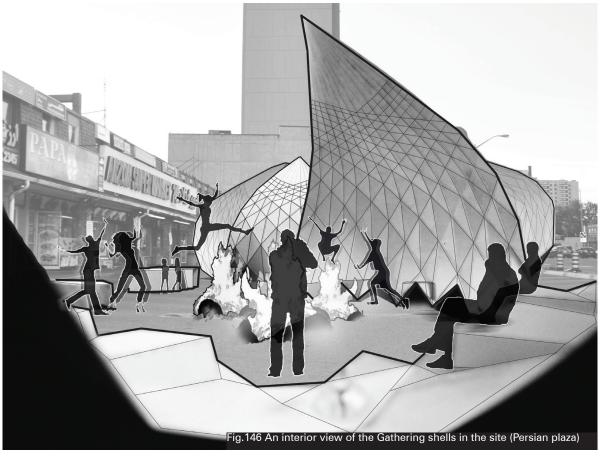
Q

5 7.5m

2.5 5

0





118

Fig.147 Top View of Gathering shells in the site (Persian plaza)

7.5m

2

2.5

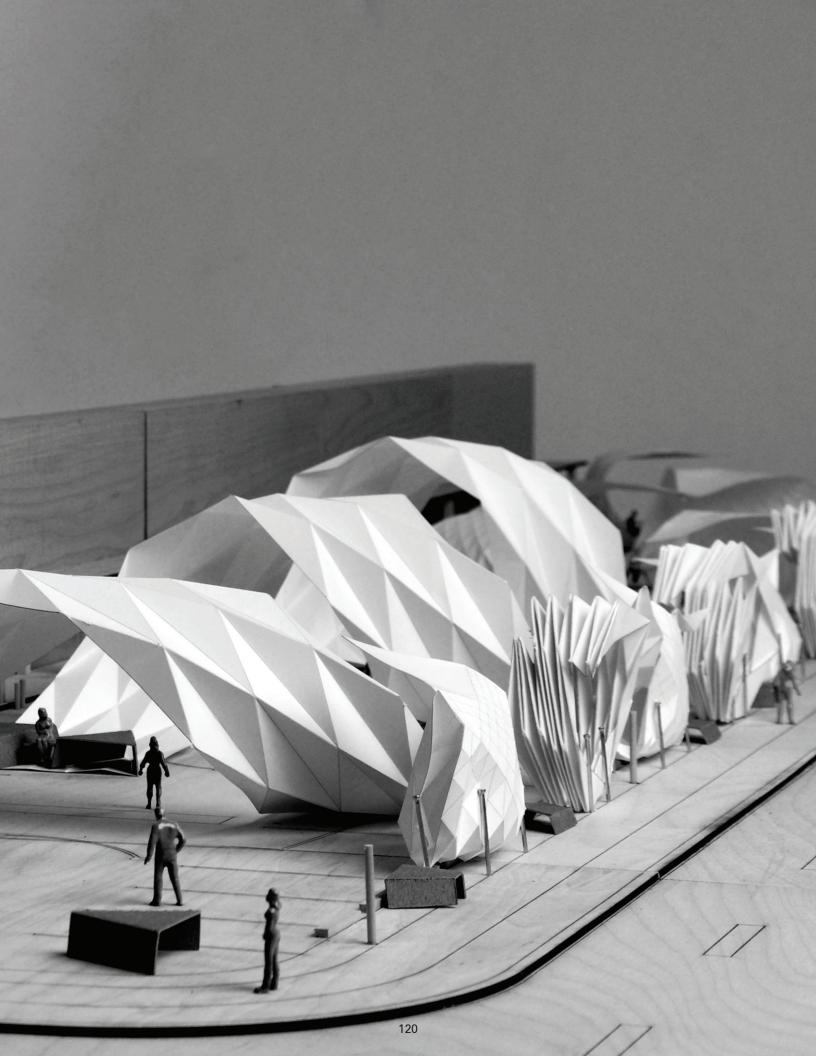
CONCLUSION

Overview of the Thesis Scope

Some of the many strip malls in Toronto act as centres of cultural activity, such as the Persian strip malls in North York. Criticism has been levied against the spatial quality of these commercial-cultural hubs. However, there is evidence to suggest that these strip malls have the capacity to be public gathering spaces. Therefore, in this thesis, I have proposed a design to expand the limited space of one of these Persian strip malls, called Iranian Plaza. to inform this design, I have analyzed different aspects of the site, deployable design concepts, and Persian architecture. After exploring different iterations of dynamic models which have the capacity to be changed based on limitations of the site, I developed two prototypes: "market shells" and "gathering shells," both inspired by Persian culture. These shells improve the spatial quality of the Iranian Plaza through the market and gathering zones that they create.

I predict that, if implemented, these shells could be the attractors for not only Persian people but also other communities to gather and celebrate this new spatial quality of the strip mall. In other words, these shells are representative of Persian culture but within a Western context, created through a modern kind of architecture, which is interactive architecture.

Fig. 148 Physical Model of the Market shells and the Gathering shells in the site (Persian plaza)

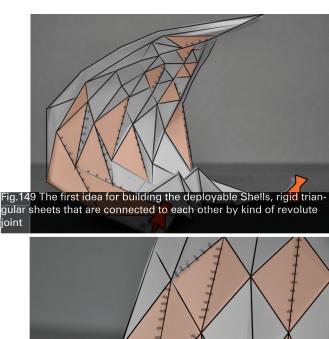


Future Developments

Although these deployable shells seem to have certain potentials in terms of being flexible enough to create different spatial states, there are some challenges regarding their material, stability, and structural techniques if they were to be realized. At this stage, I want to propose two different possible structural solutions to develop the designed shells in the real world.

The first idea is to think about triangular rigid sheets that are connected to each other through a kind of revolving joint, allowing the sheets to move 360 degrees around the joints. To fix these sheets in a stable state, there should be a condition for joints to be locked at a specific angle (See Figures 149-152).

The second idea is to think about an undulating space frame. This idea basically comes from the structural logic of an umbrella, where the foldable steel frames create a circular canopy whenever it is necessary. The same notion can be applied to the deployable shells in this thesis. These undulating steel frames could create the skeleton of the shells, which could be filled by a rigid material like wood that is connected to the steel frame (Figures 153-155).



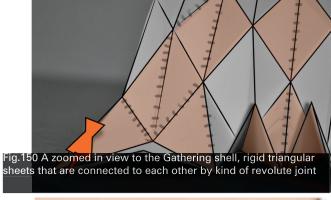




Fig.152 Assembling and folding of full scale structure of the thesis project: "Structural Folding: A parametric design method for origami architecture"

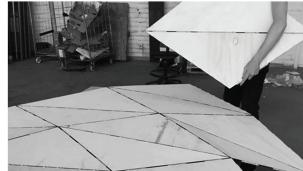


Fig.151 A Detailed view to the joint of the thesis project: "Structural Folding: A parametric design method for origami architecture"

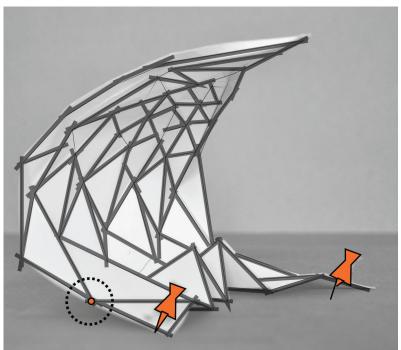


Fig.153 The second idea for building the deployable Shells, Deployable steel frame and rigid triangular sheets that are connected to the frame

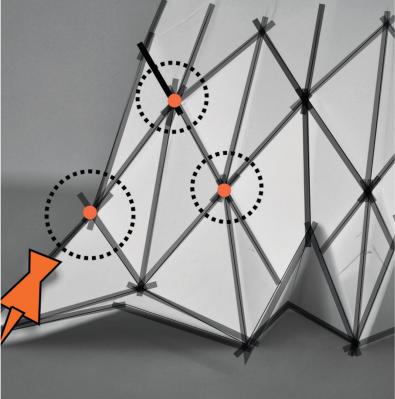


Fig.154 A zoomed in view to the Gathering shell, Deployable steel frame and rigid triangular sheets that are connected the frame

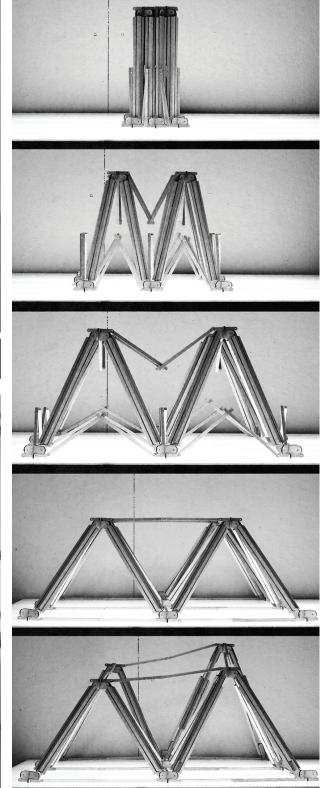


Fig.155 "02/20: UNDULATING SPACE FRAME" designed by Adam Achrati

these deployable shells would create if they were Despite the structural challenges that these deployable shells would create if they were to be developed in the future, "this thesis is an architectural practice to experiment with how to activate a strip mall in a Western context (Toronto) through interactive architecture and the formal language of culture."

In fact, by developing these individual deployable modules (Market and gathering shells), have defined a new special quality for the strip malls transferring the parking area of the strip malls to an active public space no matter the parking area is full of cars or vacant of cars. So, this thesis has proposed a new architectural prototype to redefine the strip malls to a public gathering space.





BIBLIOGRAPHY

- "Deployable Solar Array." Deployable Solar Array | Compliant Mechanisms. Accessed December 23, 2017. https://compliantmechanisms.byu.edu/node/892.
- "FESTIVALS EasyGoIRAN." EasyGoIRAN. Accessed December 23, 2017. https://easy-goiran.com/need-to-know/festivals/.
- "Iranian Fire Jumping Festival, Chaharshanbe Soori." Travel to Iran | Iran Travel agency | Iran Tour Operator | Irandoostan. March 07, 2017. Accessed December 23, 2017. http://irandoostan.com/iranian-fire-jumping-festival-chaharshanbe-soori/.
- "Iranian Plaza DemoSep24 2017." YouTube video, 1:01:06. Posted by "Babak Yazdi", September 24, 2017. Accessed December 22, 2017. https://www.youtube.com/watch?v=TIVdvuOSG5w.
- "KurzweilAI | Accelerating Intelligence." KurzweilAl Origami solves a space problem Comments. Accessed December 21, 2017. http://www.kurzweilai.net/origami-solves-a-space-problem#!prettyPhoto.
- "Shabe Eshgh by Nomad Dancers Persian dance." YouTube video, 4:12. Posted by "pghodsi", September 23, 2012. Accessed December 23, 2017. https://www.youtube.com/watch?v=3YKd9GAmN2I.
- "بازیهای آئینی گروه بین المللی یاقوت جام (حتن)." YouTube video, 5:56. Posted by "Omid Safaei", NJune 01, 2015. Accessed December 23, 2017. https://www.youtube.com/watch?v=vgHJtL-mmdE.
- "Demo in Iranian Plaza Toronto against recent Executions in Iran," YouTube video, 48:01, posted by "Babak Yazdi," October 27, 2013, https://youtu.be/BKiPisXwOV0.
- "DIY City 0.01a," Haque Design + Research, accessed December 5, 2017. http://www.haque.co.uk/diycity.php.
- "Folk Dance." Tallinn University. Tallinn, Estonia. (2011): 10-11.
- "Ghadeghan Iranian Plaza," YouTube video, 2:14, posted by "Babak Yazdi," July 29, 2013. https://youtu.be/dN9_OcVHiSo
- "Iranian Plaza," YouTube video, 1:45, posted by "Babak Yazdi," July 29, 2014. https://youtu.be/7vwwW1df4jA
- "Mohammad Ashrafi F Ashoora2017 Toronto." You Tube video, 2:14. Posted by "Babak Yazdi", Oct 1, 2017. Accessed December 22, 2017. "https://www.youtube.com/watch?v=vVb3M5tGnQA

- "OP Space," OTA+, accessed December 5, 2017. http://www.otaplus.com/project/op-space/.
- "Store Directory", Toronto Iranian Plaza پـــلازای ایرانیـــان در تورنتــو, http://www.torontoirani-anplaza.com/.
- "Toronto Iranians," YouTube video, 3:48, posted by "matin naderi," June 18, 2014. https://youtu.be/oYZTAxBqEqU
- Farshchi, Hamidreza, Ahmad Danaie Nia, and Ahmad Ashrafi, "The Geometric System of Single Impost Rasmi-bandi, Derived from Peripheral Circle," Maremat & Me'mari-e Iran Magazine (Fall & Winter 2016-2017): 10.
- Faryadi, Shahrzad. "Urban Representation of Multiculturalism in a Global City: Toronto's Iranian Community," Globalization Working Papers, Institute on Globalization & the Human Condition, McMaster University, 8, no. 4 (August 2008): 13-18. https://globalization.mcmaster.ca/research/publications/working-papers/2008/ighc-wps_08-4_faryadi.pdf
- Fox, Michael, and Miles Kemp. *Interactive Architecture*. New York: Princeton Architectural Press, 2009.
- Jackson, Paul. *Folding Techniques for Designers: From Sheet to Form*. London: Laurence King Publishing, 2011.
- Jett, Megan. "Polymorphic / Columbia University GSAPP," ArchDaily, September 13,
 2011. https://www.archdaily.com/168258/polymorphic-columbia-university-gsapp.
- Khorsandi, Shahrzad. "A Glimpse into Persian Dance Technique," DanceUs.org, accessed December 5, 2017. https://www.danceus.org/persian-dance/a-glimps-into-persian-dance-technique/.
- Lang, Robert J. *The Complete Book of Origami: Step-by-Step Instructions in Over 1000 Diagrams*. New York: Dover Publications, 1988.
- 1Linovski, Orly. "Beyond Aesthetics: Assessing the Value of Strip Mall Retail in Toronto," *Journal of Urban Design* 17, no. 1 (2012): 90-92.
- Moosavi, Mir Saeed. "Bazaar and its role in the development of Iranian traditional cities". Tabriz Azad University, Faculty of Art & Architecture, Iran, 1, 4, 5.
- Nejad Ebrahimi, Ahad, Minou Gharehbaglou, and Morteza Aliabadi. "Parametric Design pattern Language and Geometric Patterns in Historical Domes in Persian Architecture," Ciência e Técnica Vitivinícola 29, no. 7 (January 2014): 244-246.
- Parisi, Luciana. *Contagious Architecture: Computation, Aesthetics, and Space*. Cambridge, MA: MIT Press, 2013.

- Price, Massoume. "Culture of Iran: Festival of Fire," December 2001, accessed December 6, 2017. http://www.iranchamber.com/culture/articles/festival_of_fire.php; HI Tehran Hostel, "Chaharshanbe suri: Persian Festival of Fire | Rituals and routines," March 13, 2017, accessed December 6, 2017. https://www.hitehranhostel.com/chaharshanbe-su-ri/#.Wcg3CLKGP60.
- Vink, Luke, Viirj Kan, Ken Nakagaki, Daniel Leithinger, Sean Follmer, Philipp Schoessler, Amit Zoran, and Hiroshi Ishii. "TRANSFORM as Dynamic and Adaptive Furniture," MIT Media Lab, Tangible Media Group, accessed December 5, 2017. http://tangible.media.mit.edu/project/transform-as-dynamic-and-adaptive-furniture/.
- Welch, Adrian. "Al Bahar Towers: Abu Dhabi Buildings." E-architect. March 27, 2017. Accessed December 21, 2017. https://www.e-architect.co.uk/dubai/al-bahar-towers-abudhabi.

Fig.157 Front view of DE active shells

