Comparison of two fixture systems for window installation regarding their suitability for automation

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Introduction

- Value stream mapping in Sweden and Germany
- More or less automated equipment
- Window installation was idenitfied as the key to improve production efficiency.

Vertical window installation

Vertical window installation

Pre-fabricated window module

Pre-fabricated window module

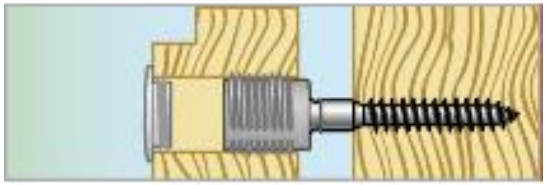
Equipment to pre-fabricate window module

Equipment to pre-fabricate window module

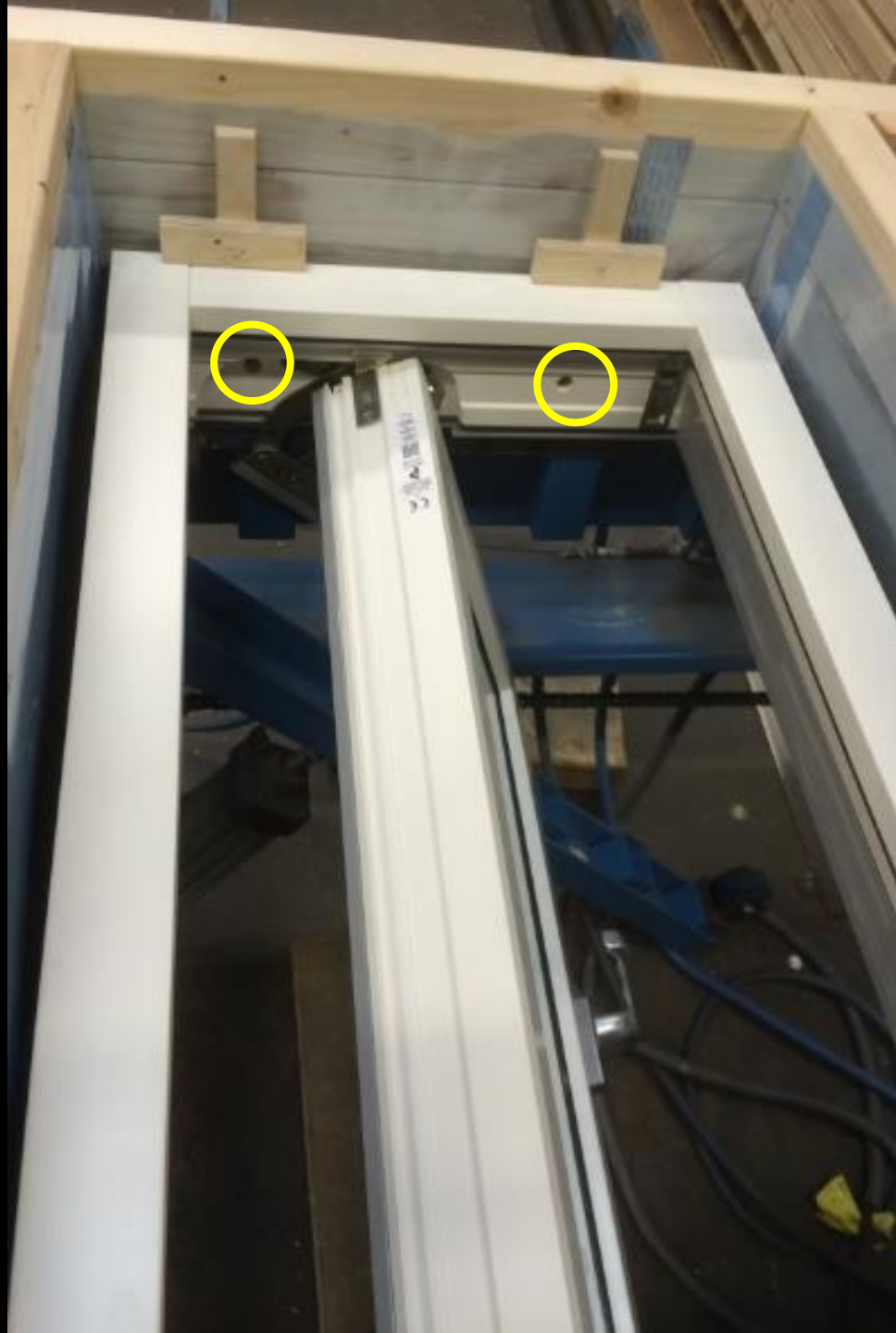
Equipment to pre-fabricate window module

Equipment to pre-fabricate window module

Adjufix fixture system (SWE)



Pre-drilled Adjufix wholes



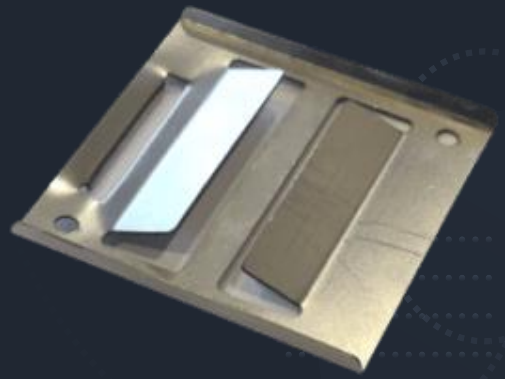
Unergonomic and risky (scratches etc.)

Placement of window modules in manual framingstation

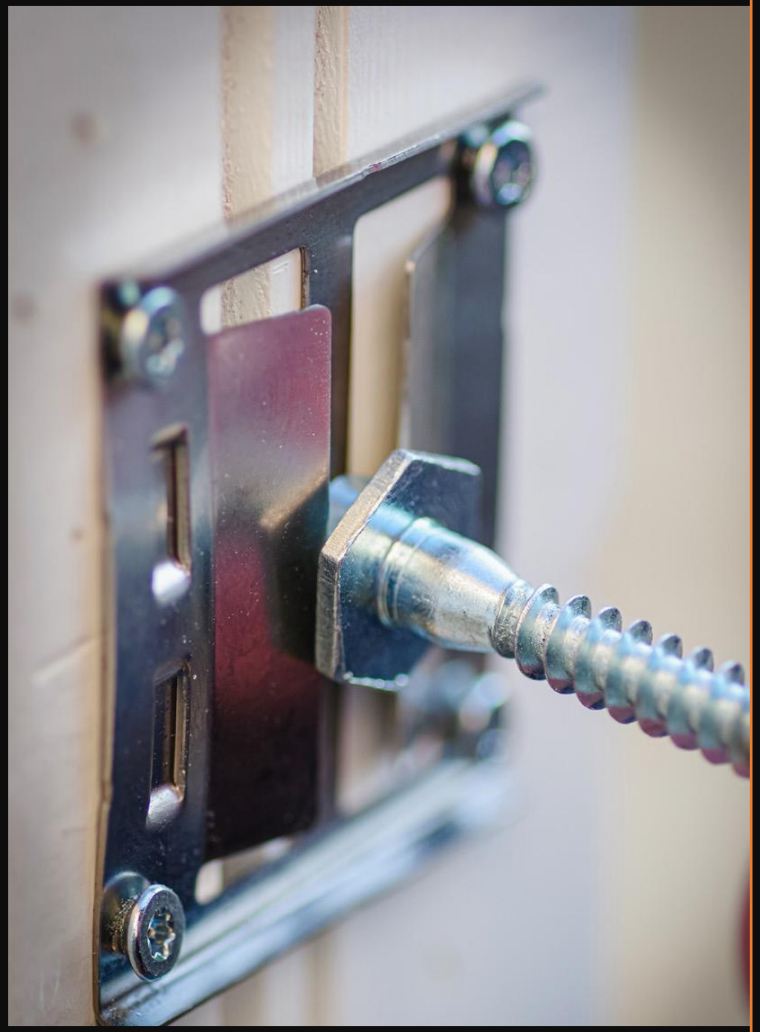
Screw (fixture system) for window installation (GER).

In GER and SWE, pads and wedges are use often. Here, the glas had to be devitrified from the window frame, so that the screw could be placed and the frame be fixed.

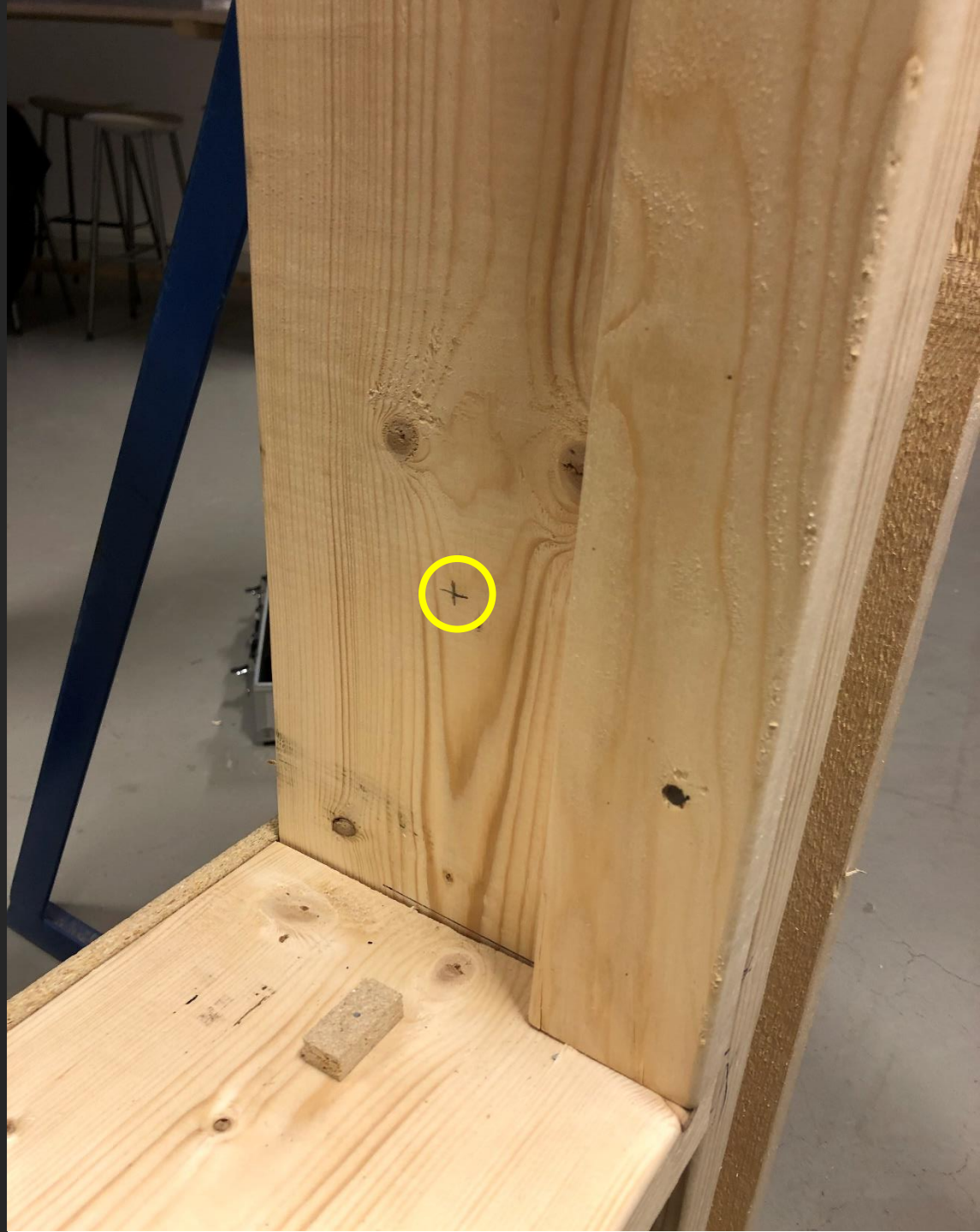
Click-In fixture system



How does it work?



Measuring and marking for the screw.



The window can easily be slided into the wall frame.

Click-In window installation in practice.

Data collection: requirements and procedure

- ”Normal” window: ca. 100x120 cm.
- Vertical installation.
- Pre-placed Adjufix shell.
- Pre-placed Click-In clips.
- Installation with qualified operators for the respective system.
- Working tasks were observed and agreed upon with with the operators.
- Six and seven measurements of all working tasks.

Comparing Adjufix and Click-In: vertical installation

	"Adjufix" fixture system	MA1	MA2	MA3	MA4	MA5	MA6	MA7
1	*placing wooden distance pieces*	23	25	26	26	32	25	23
2	*lifting and attaching window (tasks 2-4)*	39	51	59	58	124	51	44
3	*measuring lateral distance margins*							
4	*locking the window with wedges*							
5	*opening the window (tasks 5-6)*	79	112	93	91	128	112	82
6	*screwing frame screw anchor*							
7	*screwing frame screws (tasks 7-9)*	104	112	195	168	71	82	145
8	*control measuring/adjusting the window*							
9	*removing the wedges*							
10	*closing the window (tasks 10-11)*	17	29	68	119	18	29	40
11	*controlling open/close function*							
12	*sealing holes for frame screws*	40	31	31	24	22	21	26
	split-time working tasks "adjufix" only	302	360	472	486	395	320	360
	average split-time "adjufix" only	385						
13	*caulking with mineral wool strips*	209	219	245	241	192	219	201
14	*caulking with cellular plastic sealing tube*	160	142	143	151	155	142	125
15	*attaching elastic joint sealing*	190	264	245	282	201	264	223
	split-time common working tasks	559	625	633	674	548	625	549
	total assembly time "adjufix"	861	985	1105	1160	943	945	909
	average total assembly time "adjufix"	987						

	"Click-In" fixture system	MC1	MC2	MC3	MC4	MC5	MC6	MC7
1	*screwing click-in screws according to template*	53	42	40	41	37	35	27
2	*lifting and attaching window*	12	12	12	12	15	12	9
	split-time working tasks "click-in" only	65	54	52	53	52	47	36
	average split-time "click-in" only	51						
3	*caulking with mineral wool strips*	209	219	245	241	192	219	201
4	*caulking with cellular plastic sealing tube*	160	142	143	151	155	142	125
5	*attaching elastic joint sealing*	190	264	245	282	201	264	223
	split-time common working tasks	559	625	633	674	548	625	549
	total assembly time "click-in"	624	679	685	727	600	672	585
	average total assembly time "click-in"	653						

- Time saving: 308 sec (ca. 5 min.) per window.
- Ten working steps less = less risk.
- Adjufix working steps hard to automate!
- Click-In working steps easier to automate!
- Semi-automation most likely, yet, dependent on the existing production system!

Comparing Adjufix and Click-In: window module

	"Adjufix" fixture system prefabricated module	MP1	MP2	MP3	MP4	MP5
1	*adjusting window module working table*	88	94	90	45	48
2	*fetching window with vacuum lift*	298	280	312	254	241
3	*preparing for fixing 6 adjufix screws*	130	142	112	105	113
4	*tacking rubber strip inslulation*	62	56	60	58	52
5	*tacking rubber corners*	118	126	138	102	96
6	*placing supporting wood pieces*	20	22	23	20	21
7	*placing window on working table*	40	58	44	41	49
8	*attaching beams around the window*	286	269	305	251	232
9	*pressing and nailing beams to a frame*	334	348	482	304	294
10	*opening window with traverse crane*	60	55	65	58	56
11	*fastening adjufix screws*	129	114	121	115	115
12	*closing window*	32	37	40	29	31
13	*cutting extra wood pieces as filler*	59	55	64	51	49
14	*placing extra wood pieces*	74	89	93	68	66
15	*unfastening module from working table*	55	62	64	49	46
16	*lifting module with crane to palette*	86	98	96	67	62
	split-time working tasks "adjufix" module	351	348	338	307	315
	average split-time "adjufix" module	332				
	split-time common working tasks	1520	1557	1771	1310	1256
	tot. assembly time "adjufix" module	1871	1905	2109	1617	1570
	average tot.ass.time "adjufix" module	1814				

	"Click-In" fixture system	**MC1**	**MC2**	**MC3**	**MC4**	**MC5**	**MC6**	**MC7**
1	*screwing click-in screws according to template*	53	42	40	41	37	35	27
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It is hard to compare directly but it is indicated that time saving is about 15-20 minutes (900-1200 sek) per window.

Generally more complicated to automate! With the Click-In system, a window module is not needed at all!

Comparing (GER) screw and Click-In: vertical installation

	(GER) screw: relevant working steps in relation to Click-In: vertical installation	M1	M2	M3	M4	M5	M6	M7
1	*Pads and wedges (or tools like tighteners)*	315	310	345	280	395	330	248
2	*Opening or removing window blade*	155	140	114	190	142	138	149
3	*drilling*	336	370	240	250	244	180	198
4	*Placing four screws*							
5	*sounding, adjusting, remaining screws*	268	270	287	370	380	410	360
6	*Removing pads, wedges or tools*	44	80	75	80	62	90	63
7	*Blowing/cleaning chippings*	20	24	19	10	25	15	15
8	*Inserting/closing window*	68	79	71	66	89	65	66
9	*Tape on pad-/wedge wholes*	88	56	78	61	92	59	68
	Split-time working tasks (GER) screw	1294	1329	1229	1307	1429	1287	1167
	Average split-time	1292						

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Above are those working tasks, that would not be needed, if Click-In would be used.

- Time saving: 1241 sec (ca. 20 min.) per window.
- Seven working tasks less = less risk.
- ”(GER) screw” working steps harder to automate, especially *opening or removing the window blade*.

Conclusion/comments

- The Click-In system requires least working steps of the systems compared. This significantly reduces the total assembly time and the risk for material damages.
- In addition, the Click-In working steps are more ergonomic.
- The working steps for Click-In are more automation friendly than the steps for the other systems. Especially opening or removing the window blade would require immense efforts if being automated, thus development costs would be much higher.

Comments

A semi-automated approach could include

a) the automatic placement of the Click-In screws in the window opening (e.g.minor robot or mulitfunction bridge with integrated screwing function),

b) the automatic placement of the clip outside the window frame at the window manufacturer (robot cell),

c) the operator at the prefab line only needs to place the window in the window opening by means of a vacuum lift.

Window installation should not be regaded as a partial bottle-neck! It always depends on the entire production system.

There is no one best solution for all production systems, but at least we can state that independend of the production system, the Click-In system should make it possible to safe time and money!