Super-Welder Uprite Weld Rip Test Failure Reduction Project

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identify | innovate | implement

Have you seen this process in action?
It's not the best tool for every situation, but under the right circumstances, here's how it can bring significant savings!

$ 1.08M in Savings after 10 Weeks!!

The Project…

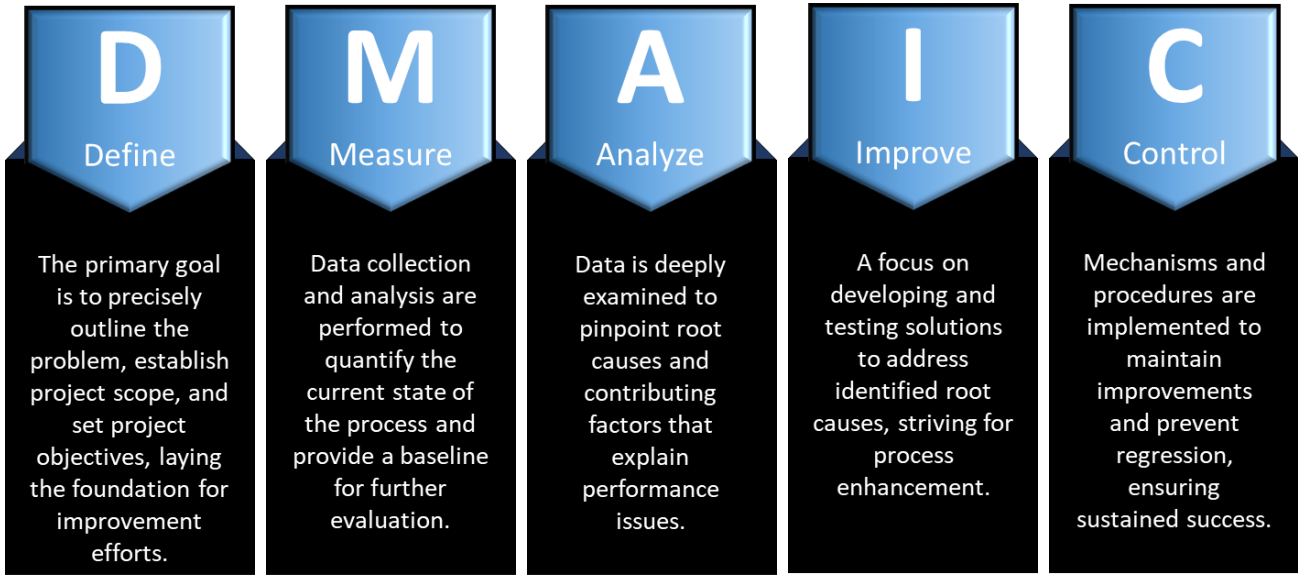
The Problem: Client was having to rework/reweld 25% of a specific product, costing unnecessary labor and welder time for the rework, but also taking production time from the welder doing the rework. It was also resulting in late / missed deliveries.

The Approach…Planning for Success…

The Project: Putting together a cross-functional/level team, led by Engineering, Create a Charter, and apply Lean Six Sigma protocol (DMAIC), and key tools / methods to conduct a detailed RC/CA (Root Cause/Corrective Action) process.

The Lean Six Sigma DMAIC Method

DMAIC (Define, Measure, Analyze, Improve, Control) steps enable a comprehensive RC/CA process, and enables optimizing critical factor performance to achieve overall performance goals. A Project Plan (Gantt) is also essential to ensure the project stays on track coupled with a project charter assures the agreement between all stakeholders on what needs to be accomplished.



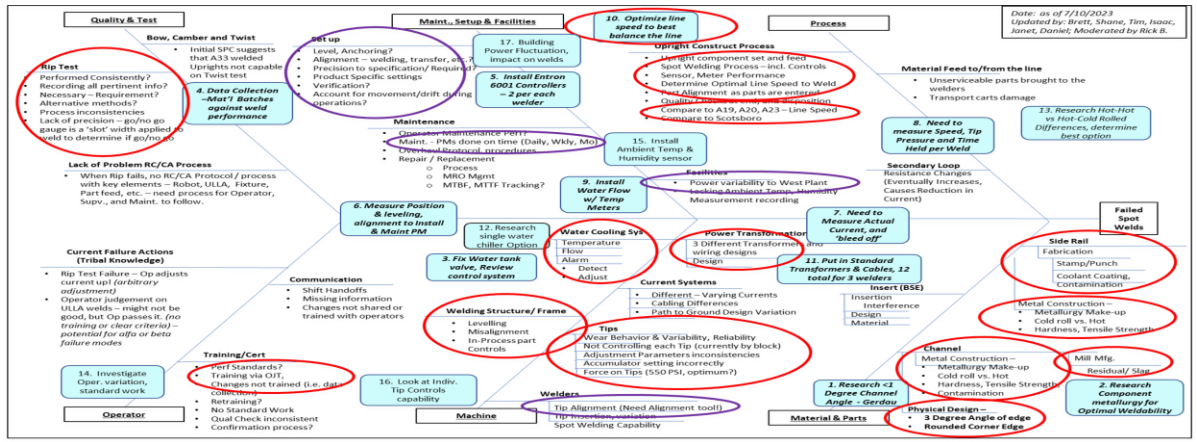
Assessing, Measuring the Problem…

Characterize/Stratify the rip test failures by welder, material, current settings, date/time, operator, tip wear, etc., looking for relationships, trends and possible correlations

Timestamp	Clock Number	Part Number	Channel Heat Lot #	Siderail Heat Lot #	Machine #	Parts welded at time of rig	Weld Count	Stage 1 (Front) Sch 1	Stage 1 (Front) Sch 2	Stage 2 (Rear) Sch 1	Stage 2 (Rear) Sch 2	Defective Weld Count Operator	Failure Type (4ROW, TOP WELD)	Defective Weld Count QC Initial	If Rip Fails - number of parts for reweld	Reject Tag	Rework Gauge 40135	Maintenance	Timestamp
4/26/2023 15:12	83404	U60		6101562	A028	500	17672	91	91	89		15	4ROW +TOP			43875		No	4/26/2023 15:12
5/2/2023 10:14	83404	U84	6101550		A033	200	3145	77	77	80		16	4ROW		95	43876		No	5/2/2023 10:14
5/2/2023 12:31	83404	U84	6101535		A030	400	7168	78	78	82		19	4ROW		86	43876		No	5/2/2023 12:31
5/2/2023 14:24	83404	U84	6101538		A030	600	9706	82	82	86		9	TOP WELD		100	43876		No	5/2/2023 14:24
5/2/2023 15:14	83404	U84	6101538		A028	200	8736	89	89	91		16	4ROW			43828		No	5/2/2023 15:14
5/3/2023 6:35	83404	U84	6101538		A028	100	1835	76	76	80		19	MAX					No	5/3/2023 6:35
5/3/2023 8:32	83404	USE60	6101544		A033	100	1800	78	78	81		19	4ROW		86	43878		No	5/3/2023 8:32
5/3/2023 11:24	83404	U84	6101538		A030	300	6800	80	80	84		13	4ROW		50	43879		No	5/3/2023 11:24
5/5/2023 8:12	83404	U72	6102574	832234790	A028	100	2341	82	82	86		19	MAX		37	43881		No	5/5/2023 8:12
5/5/2023 9:59	83404	U72	6102574	832234790	A028	300	4934	79	79	83		6	TOP WELD		72	43882		No	5/5/2023 9:59
5/5/2023 11:42	83404	U72	6402597	230220502	A033	200	1201	76	76	80		15	4ROW		53	43890		No	5/5/2023 11:42
5/5/2023 11:59	83404	U72	6101547	842230940	A028	500	8261	81	81	85		18	4ROW		97	43891		No	5/5/2023 11:59
5/8/2023 13:29	83404	U72	61012579	832234790	A033	100	5973	80	80	84		19	MAX		100	44068		No	5/8/2023 13:29
5/9/2023 9:46	83404	U72	6101622		A030	500	9448	77	77	81		18	MAX	TLC		43894		No	5/9/2023 9:46
5/9/2023 23:36	86804	U84	6101535	230220502	A030	300	20071	84	84	87	0	17	MAX	JC				No	5/9/2023 23:36
5/10/2023 6:05	83404	U84	6101592		A033	1	4020	76	76	80		17	MAX		78	44069		No	5/10/2023 6:05
5/10/2023 6:10	83404	U84	6101536		A030	25	1825	80	80	84		24	4ROW		23	44070		No	5/10/2023 6:10
5/10/2023 10:50	83404	U84	6101553	230220502	A030	400	9182	80	80	84		31	4ROW		119	44073		No	5/10/2023 10:50
5/10/2023 11:28	83404	U84	6101616	842230940	A028	500		83	83	87		20	4ROW		71	44074		No	5/10/2023 11:28
5/10/2023 13:44	83404	U84	6101539		A030	600	1768	77	77	80		30	MAX					No	5/10/2023 13:44
5/10/2023 14:29	85739	u84	6101539		A030	602	1800	79	79	83	0	34	MAX					No	5/10/2023 14:29
5/10/2023 15:37	85739	U84			A030	635	1900	79	79	82	0	21	MAX	jc				Yes	5/10/2023 15:37
5/10/2023 20:02	85739	U84			A028	150	13500	89	89	93	0	17	MAX					Yes	5/10/2023 20:02
5/11/2023 10:17	86787	u84	6101545		A030	500	8967	78	78	81		8	TOP WELD	GF	32	43897		No	5/11/2023 10:17
5/11/2023 14:38	86787	u84	6101565	832234790	A030	700	13869	81	81	82		9	4ROW	GF				No	5/11/2023 14:38
5/12/2023 3:18	10449	u84	6101655		A030	1	0	74	76	80		4	TOP WELD	TLC		42609		Yes	5/12/2023 3:18
5/12/2023 9:53	86787	u84	6101655		A030	1	442	77	77	80		12	4ROW	TLC		42606		No	5/12/2023 9:53
5/15/2023 6:43	86787	u84	6101532	230220502	A030	101	1850	77	77	81		31	4ROW	GF	34	43898		No	5/15/2023 6:43
5/15/2023 7:14	86787	u84	6101532	230220502	A030	104	2431	81	81	85		13	4ROW	GF				No	5/15/2023 7:14
5/15/2023 9:20	86787	u84	6101532	832230940	A030	300	5353	85	85	88		18	MAX	GF	75	43899		No	5/15/2023 9:20
5/16/2023 5:22	86984	U66	6101524		A033	7	NEW TIPS	76	76	80		8	ALL STAGE 1					Yes	5/16/2023 5:22
5/17/2023 6:20	83404	U60	6102717		A030	100	1601	76	76	80		10	4ROW	GF	139	44076		No	5/17/2023 6:20
5/17/2023 7:59	83404	U60	6101524	832234790	A030	200	2418	76	76	80		13	4ROW+TOP	GF	27	44077		No	5/17/2023 7:59
5/17/2023 10:15	83404	U60	6102714	832234790	A033	200	2608	78	78	82		8	4ROW	GF	78	44079		No	5/17/2023 10:15
5/17/2023 10:22	83404	U60	6103566	230220501	A030	600	8352	79	79	86		5	TOP WELD	GF	25	44080		No	5/17/2023 10:22
5/18/2023 13:06	83404	U72	6101626	12843405	A030	600	13596	81	81	85		16	MAX	GF	53	44082		No	5/18/2023 13:06
5/22/2023 14:21	86787	u66	6103561	832234790	A028	2905	200	78	78	82		10	TOP WELD	GF	56	44083		No	5/22/2023 14:21
5/22/2023 14:36	85739	U66			A028	210	3125	78	78	81	0	8	4ROW	GF				Yes	5/22/2023 14:36
5/22/2023 17:55	86225	U96	6102700		A028	100	5012	82	82	80		15	4ROW	JK	145	42610		No	5/22/2023 17:55
5/23/2023 6:45	86787	U66	6102697	832234790	A028	100	1500	76	76	80		7	4ROW, TOP	TLC	96	42618		No	5/23/2023 6:45
5/24/2023 8:51	86787	u102			A030	100	2352	76	76	80		9	TOP WELD	TLC	119	42624		No	5/24/2023 8:51
5/24/2023 9:18	86787	u102			A030	1st pallet	2325	76	76	80		14	TOP WELD					No	5/24/2023 9:18
5/24/2023 10:09	86787	U72		230220502	A028	225	3525	76	76	80		7	TOP WELD	TLC	187	42627		No	5/24/2023 10:09
5/24/2023 21:53	87491	102	230220502		A030	200	9151	81	81	83		11	4ROW	JK	41	42628		No	5/24/2023 21:53
5/25/2023 19:18	86225	U96	6102547	230220405	A030	100	10365	83	83	86		5	4ROW	JC	210	42630		No	5/25/2023 19:18
5/25/2023 20:09	87491	72	6102546	230220405	A028	200	7961	78	78	0		9	4ROW	JC				No	5/25/2023 20:09
5/25/2023 21:43	87491	72	6102546	230220405	A028	200	7961	78	78	0		16	4ROW	jc	102	42631		No	5/25/2023 21:43

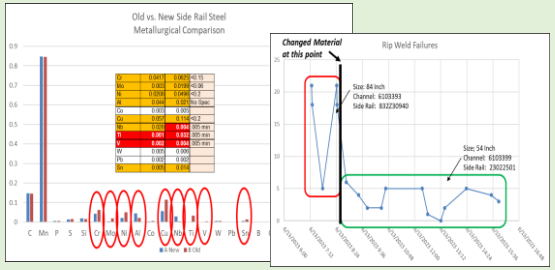
Considering all sources of variation – The Ishikawa (Cause & Effect) Diagram

From the team, identify CNX (Constants, Noise, Variables) sources for variation, determine priority to dive deeper, see if any are JDI (just do it) or require more analysis



Drilling Down… Setting up for the Designed Experiment…

Material Issues, and calculating CE (Carbon Equivalent)…

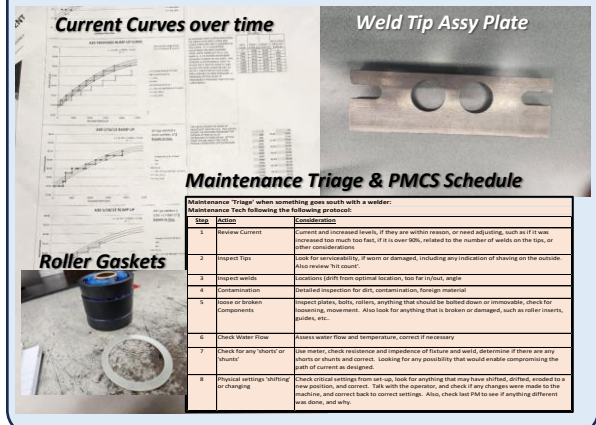


Key Points:
Measurements and Comparison:
- Channel CE: Mean = .44, SD = .008
- Nucor SR CE: Mean = .22, SD = .004
- Cliffs SR CE: Mean = .17, SD = .009

Interpretation:
1. The difference in CE impacts weld quality.
   a. Nucor Side Rail CE is closer to Gerdau Channel CE, so welds will be better.
   b. Cliffs Side Rail CE is Lower, and so further away from Gerdau Channel CE, so welds would be worse

Conclusions:
1. Reduce Channel CE if possible.
2. Use Side Rail closer to Channel CE, avoid lower CE Side Rail if possible.

Welding Schedule, settings, tips, components, alignment, maintenance and setup…



Maintenance Triage 'Triage' when something goes south with a welder:
Maintenance Tech following the following protocol:

Step	Action	Consideration
1	Review Current	Current and increased levels, if they are within reason, or need adjusting, such as if it was increased too much too fast, if it is over 90%, related to the number of welds on the tips, or other considerations
2	Inspect Tips	Look for serviceability, if worn or damaged, including any indication of shaving on the outside. Also review 'hit count'.
3	Inspect welds	Locations (drift from optimal location, too far in/out, angle
4	Contamination	Detailed inspection for dirt, contamination, foreign material
5	Loose or broken Components	Inspect plates, bolts, rollers, anything that should be bolted down or immovable, check for loosening, movement. Also look for anything that is broken or damaged, such as roller inserts, guides, etc.
6	Check Water Flow	Assess water flow and temperature, correct if necessary
7	Check for any 'shorts' or 'shunts'	Use meter, check resistence and impedence of fixture and weld, determine if there are any shorts or shunts and correct. Looking for any possibility that would enable compromising the path of current as designed.
8	Physical settings 'shifting' or changing	Check critical settings from set-up, look for anything that may have shifted, drifted, eroded to a new position, and correct. Talk with the operator, and check if any changes were made to the machine, and correct back to correct settings. Also, check last PM to see if anything different was done, and why.

Optimizing the Critical Few CTQs…

Product	Process	Equipment
Material type	Resistance	Weld tips
Material Chemistry	Amps	Transformers
Material Source	Setting Adjustments	Secondary Cables
	Weld failure locations	Weld Controllers

Heat: Q = i² x R x t

- *Very weld time*
  - *Low (12 cycles), high (18 cycles)*
- *Introduce a material heat-up (ramp) period*
  - *Low (no ramp), high (10 cycle ramp)*
- *Vary the 2 side rail materials*
  - *Low (Nucor), high (Cliffs)*

Factor	Factor Name	Level 1 Low(-)	Level 2 High(+)
1	Weld Time	12	18
2	Pre Heat	0	10
3	Material	Nucor 12843502	Cliffs 832Z34810

Critical to Quality (CTQ) Characteristics

Element	Characteristic	Description	Current Setting	Setting
Welder	Welding sequence, by each block weld	Squeeze - time it takes for the heads to come together and settle to a steady pressure of 500 PSI	15 cycles	Programmable
		Weld time - Time it takes to weld a spot weld	*15 cycles*	*Programmable*
		Pre-Weld time - Time to pre-heat prior to welding	*0 cycles*	*Programmable*
		Release	0 cycles	Programmable
		Current	*Amperes*	*Programmable*
Material	Steel Cha…			
	Material …			*…lified*
	Material T…			*…spring?*
Process	Component Feed and Handling by the welder	Stop	Dimensions	
		Feed by Operator, speed of the welder	Fit, timing	
		Grabbing rollers (upper and lower)	Fit	
	Mechanical Set up and alignment	Leveling	Horizontal error	
		Setup	Setting up tips, equipment	
		Alignment	Alignment of equipment, tips	
Testing	Rip Test	Rip Test weld assessment	Go / No Go Guage	Pass / Fail
		Rip Test equipment Calibration	Criteria for failure:	
		Wait time before testing	>15 total	
			< 4 > in a row	
			Top Weld Failure	

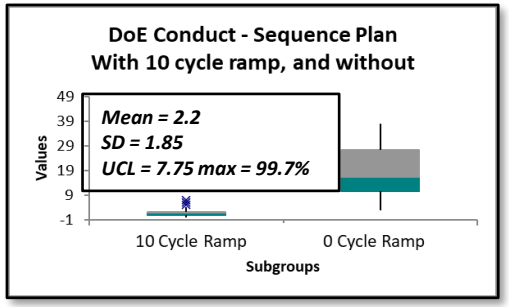
- *CTQ Matrix - Selection*
- *DoE Planning, Conduct, Outcome, Interpretation, applying the solution*

…then conducting the DoE, and the outcome:

Trials	Cum Coun	Weld Tim	Pre Hea	Material	Rip Weld Failures	1	2	3	4	5	6	7	8
3	3	12	10	Cliffs 832Z34810 (+)	1	0	1	0	0	0	0	0	0
4	4	12	10	Cliffs 832Z34810 (+)	2	0	0	1	0	0	0	0	1
7	7	18	10	Nucor 12843502 (-)	2	0	1	0	0	0	1	0	0
8	8	18	10	Nucor 12843502 (-)	0	0	0	0	0	0	0	0	0
3	11	12	10	Cliffs 832Z34810 (+)	2	0	0	0	1	0	1	0	0
4	12	12	10	Cliffs 832Z34810 (+)	3	2	0	0	1	0	0	0	0
7	15	18	10	Nucor 12843502 (-)	2	0	0	0	1	0	1	0	0
8	16	18	10	Nucor 12843502 (-)	0	0	0	0	0	0	0	0	0
3	19	12	10	Cliffs 832Z34810 (+)	2	1	0	0	1	0	0	0	0
4	20	12	10	Cliffs 832Z34810 (+)	6	0	1	0	2	0	1	1	1
7	23	18	10	Nucor 12843502 (-)	2	1	0	0	0	0	1	0	0
8	24	18	10	Nucor 12843502 (-)	1	0	0	0	0	1	0	0	0
3	27	12	10	Cliffs 832Z34810 (+)	5	0	0	0	1	0	1	0	3
4	28	12	10	Cliffs 832Z34810 (+)	1	0	0	0	0	0	0	0	1
7	31	18	10	Nucor 12843502 (-)	1	0	0	0	0	0	1	0	0
8	32	18	10	Nucor 12843502 (-)	1	0	0	1	0	0	0	0	0
3	35	12	10	Cliffs 832Z34810 (+)	3	1	0	0	1	0	1	0	0
4	36	12	10	Cliffs 832Z34810 (+)	7	2	1	0	3	0	0	0	1
7	39	18	10	Nucor 12843502 (-)	1	0	1	0	0	0	0	0	0
8	40	18	10	Nucor 12843502 (-)	2	0	0	1	0	0	1	0	0
					Pre-heat 10	7	5	3	11	0	10	1	7

Results… Applying the DoE settings…

The results of the DoE were atypical, in that the 10 cycle ramp overshadowed the other two variables. A t-Test was applied, to verify significance of the difference in rip weld failures.



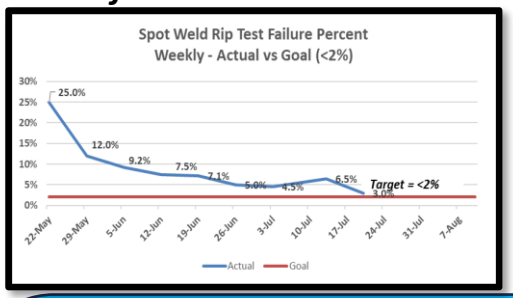
- *Several pallets of side rails that were 'on-hold – deemed unweldable' were then welded with the new settings. Results are shown below, 100% passed, all material was recovered.*

"On-Hold" Side Rail recovery - After DoE Settings applied - This material was rejected as unweld[illegible]...

Part Number	Channel Heat Lot #	Siderail Heat Lot #	Machine #	Parts welded at time of rip	Weld Count	Stage 1 (Front) Sch 10	Stage 1 (Front) Sch 20	Stage 2 (Rear) Sch 10	Stag[illegible] (Re[illegible] Sch	Defective Weld Count Operator
72	6103351	832Z34810	A030	304	10920	80	80	83		0
84	6102604	na	A033	1	5289	79	79	80		4
72	6103351	832z34810	A030	404	12195	80	80	83		1
84	6102604	na	A033	203	6021	79	79	81		6
84	6102604	NA	A033	303	6021	79	79	81		5
u84			A030	1	0	76	76	80	0	3
u84			A030	7	119	76	76	80	0	3
U120	6103346	NA	A030	1	280	76	76	80		0

- *Once all welders are aligned with new alignment tool, in both X & Y Axis, this should drop further.*

KPI Performance



The Results…

- **Reduced from 25% baseline uprite rework to sustainable 3% or less**
- **Total Cost & lost sales Avoidance for remainder of 2023: $1.08M**
- **Improved On-Time Delivery over 25%**
- **Annualized Savings of $2.4M**

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Here’s an inspiring case study that underscores the undeniable impact the Six Sigma methodology can have when paired with i3 Consulting's expertise.

In a world where efficiency and cost-effectiveness reign supreme, it is imperative to seize opportunities for savings and improvement. Our recent Six Sigma project, conducted in collaboration with an esteemed manufacturing client, not only showcases our commitment to excellence but also presents a compelling testament to what can be achieved when the right expertise meets a well-defined challenge.

This case study reveals that we helped our client save a staggering $1.08 million through a meticulously executed Six Sigma project. Now, you might be wondering how this could apply to your organization. The answer is simple: i3 Consulting stands ready to guide you on a similar journey towards success. We bring proven expertise in Six Sigma methodology, a track record of delivering tangible results, and a commitment to partnering with you every step of the way.

Our call to action for you today is this: seize the opportunity to transform your organization. Let's embark on a journey together, where data-driven decisions and process excellence become the pillars of your success. Imagine the possibilities when you harness the power of Six Sigma with i3 Consulting's guidance. Together, we can unlock savings, enhance efficiency, and propel your organization to new heights.

Don't miss out on the chance to achieve remarkable results, just as we have with our esteemed client. Contact us today, and let's begin shaping your own success story—one where substantial savings, operational excellence, and increased customer satisfaction are not just dreams but a tangible reality.

Thank you for your attention, and we look forward to partnering with you on your journey to excellence!

i3 Consulting

identify | innovate | implement

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