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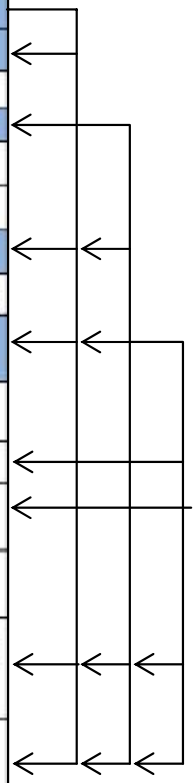
Hardwood Research Initiative

Jean McDonald

24 Avril 2012 / April 24th, 2012

Introduction

Secteur d'activité	Aspect		Projets
Marchés		1	Analyse du cycle de vie des produits
		2	Paramètres critiques de design lors de l'écoconception de produits d'apparence en bois
Analyse des besoins des utilisateurs		3	Définition des besoins des utilisateurs de la 2e et 3e transformation
		4	Liens entre les besoins des utilisateurs et la qualité des sciages requis
		5	Impact économique de la bioénergie et des bioproduits sur la récolte et la transformation des bois feuillus
Analyse des procédés de transformation	Procédés	6	Évaluation des procédés de débitage axés sur les besoins de la 2e et 3e transformation
		7	Meilleures pratiques contre les fentes à travers la chaîne de valeur
		8	Coloration et décoloration des produits de bois par la biotechnologie
	Technologies	9	Définition des technologies de transformation requises
		10	Applications de séchage de bois feuillus rentables pour la technologie de séchage haute fréquence en continu
Définition des besoins en approvisionnement		11	Identification des caractéristiques de billes requises pour répondre aux besoins des utilisateurs
Amélioration de la gestion de la récolte		12	Réduction des coûts de récolte liés à l'hétérogénéité des massifs forestiers en forêt feuillue
		13	Parcs de valorisation
Amélioration de la performance de la récolte	Traitements sylvicole	14	Traitements sylvicoles pour les aménagements extensifs (sans martelage)
	Protection de la forêt résiduelle	15	Augmentation de la productivité des peuplements aménagés intensivement
Connaissances des opportunités		16	Inventaire forestier capable de prédire les propriétés et la valeur économique des bois de feuillus dans l'est du Canada
		17	Impact des coupes partielles sur la qualité des tiges de la région acadienne



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Project 3
Identification of 2nd and 3rd manufactuing user needs

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Needs

- Better understand user needs
  - Lumber supply used
  - Components dimensions and qualities produced
- Oriented changes to introduce in primary manufacturing to better meet user needs

Approach

- Survey of 9 major manufacturing sectors
  - Flooring, kitchen cabinets, furniture, staircases, moldings, turning, coffins, doors and windows and pallets
- Information collected during individual meetings
  - 27 companies
  - Minimum of 3 per sector
  - Voluntary basis
- Synthesis of needs by sector

Results

- Exhaustive list of needs by sector
  - Lumber supply
    - Generally very high quality – 1 Common & Better
    - Exception - flooring, pallet and furniture sectors
  - Component dimensions produced
    - 4/4 and 5/4 thicknesses
    - Variable width from 1,5 à 4’’
    - Variable length from 10 à 96‘’
  - Components quality produced
    - Two main elements – color and knots
    - Other character marks
      - Considered as elements of coloration
      - Used in more permissive quality classes

Results

- Example – kitchen cabinet sector

Lumber supply

Species (%)	Grade	Sap/ Regular	Dimensions			Classified best face	Annual volume (%)	Notes
			Thickness	Width	Length			
Yellow birch 50-55%	Select	1 & 2 white or sap	4/4 to 95% 6/4 & 8/4 to 5%	Variable	6 to 8 feet 50 % 8 ft	No	30 à 35	90 % 1white 10 % 2 white
	1 Com.						65 à 70	--
Sugar maple 20-25 %	Select						65 à 70	90 % 1 white 10 % 2 white
	1 Com.						30 à 35	--
Cherry & Red oak	Select	Cherry 4 faces red					Na	--
	1 Com.						Na	--
Others 10 %	Select	Na				Na	Na	--

Component dimensions

Components	Grade	Species (%)	Thickness (in)	Width (in)	Length (in)	Target humidity (%)	Annual volume (% prod.)
Posts	Grade 1	Yellow birch (55) Sugar maple (25) Cherry & Red oak (10) Others (10)	¾ Small quantities of 13/16 - 7/8 1 – 1 1/8	1½ à 4 Mainly 2¼	8 to 84 in. 50% of 30 à 48	6 to 8	30
Crosspieces	Grade 2 Grade 3				7 to 24 in 50% of 12 to16		20
Panels	Grade 4			Lamellae of 1 à 3	5 to 81 in 50% of 27 to 45		50
Moldings	Grade 1		7/16 to 13/16 Mainly 13/16 et 3/4	Variables 2¼ to 5	96		Na

Result

- Example – Kitchen cabinet sector

Component qualities

Defect types	Precision	Grade 1 (clear)	Grade 2	Grade 3	Grade 4 (opaque)
Knots	--	UN	UN	UN	Best face UN Sometimes on reverse side max. 3/8 in
Pin knots	Max $^{1}/_{16}$ in	UN	UN	Generally UN but sometimes a little	A
Knots on edges	--	UN	UN	UN	UN
Coloration of clear areas (uniformity)	--	Skimmed*	Moderate*	Natural*	Natural*
Heartwood (or sap)	--	UN	UN	UN but sometimes on reverse side	A
Bark pockets	--	UN	UN	UN	UN
Mineral streaks (sugar maple and yellow birch)	--	Best face UN Sometimes on reverse side	Sometimes on best face and on reverse side	A	A
Gum/resin streaks (cherry)	--	Best face UN Sometimes on reverse side	Sometimes on best face and on reverse side	A	A
Green and brown vein (oak)	--	Best face UN Sometimes on reverse side	Sometimes on best face and on reverse side	A	A
Artificial stains (stickers, water rings, etc.)	--	UN	UN	A	A
Natural stains (greying, blue stain, etc.)	--	UN	UN	A	A

Thanks

- Industrial partners

  - Lapointe & Fils Ltée ;
  - AP Industries ;
  - Armoires de cuisines Denis Coutures (2002) Inc. ;
  - Boa-Franc S.E.N.C. ;
  - Bois BSL Inc ;
  - Bois Expansion ;
  - Bois Kennebec Ltée ;
  - Boiseries Rousseau ;
  - Charlebois & Fils Ltée ;
  - Cuisines Laurier Inc. ;
  - Distribution Option kit ;
  - Ébénisterie ST ;
  - Escaliers Gilles Grenier Inc. ;
  - Foresfloor ;
  - Industries JSP ;
  - L.C.N. Inc. ;
  - Menuiserie D'East Angus ;
  - Meuble Idéal Ltée ;
  - Meubles Villageois Inc. ;
  - Miralis Inc. ;
  - Planchers Mercier Inc. ;
  - Portes Saint-Georges Inc. ;
  - Produits Tremtech Inc. ;
  - Simard cuisine et salle de bains ;
  - Tournage de bois Dynastie;
  - Vic Royal Division de Fournitures funéraires Victoriaville Inc.

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Project 4
Linking user needs and required lumber quality

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Needs

- NHLA rules are the basis for transaction with the 2nd and 3rd transformation
  - Estimated yields per lumber quality class
  - Gap between anticipated and obtained products
    - Grading on the poor face
    - Defects treated the same way
- 2nd et 3rd manufacturing sector looking more and more for lumber adapted to their processes and products
  - Efficiency improvements
  - Lumber supply and production cost reductions

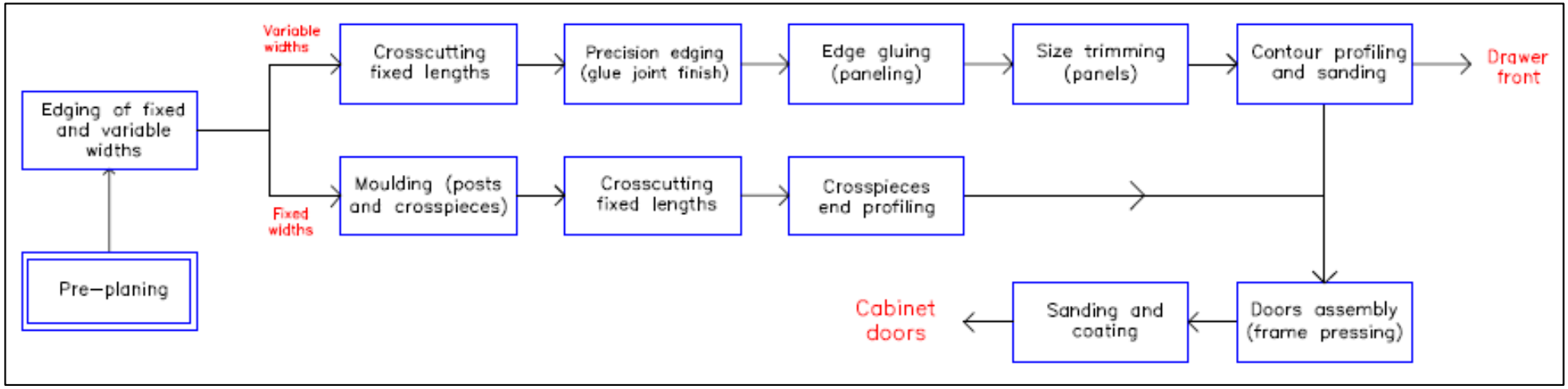
Approach

- Analyze the processes of components setting for different users
  - Manufacturing steps are numerous
  - Can influence the lumber process and selection
- Adapt the list of needs (project 3) depending on process requirements
- Propose groupings based on lumber size and quality required by user

Results

- Description of main manufacturing steps

Example – Kitchen cabinet sector



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Results

- Thickness target size calculation based on the main manufacturing steps

$$ÉCO = \frac{ÉFL + AS + AM + (FSD * VCS)}{(1 - RV)}$$

ÉCO =	Épaisseur cible vert brut optimale
ÉFL =	Épaisseur finale du composant après séchage et préparation
AS =	Allocation pour le sablage (si applicable)
AM =	Allocation pour le moulurage. Dans la plupart des cas, correspond à la différence entre l'épaisseur du sciage à la sortie du pré-rabotage et l'épaisseur à la sortie de la moulurière
FSD =	Facteur de sous-dimensionnement déterminé à l'aide des règles statistiques de la loi normale. Il réfère à une probabilité d'obtenir un nombre de mesures inférieures à l'épaisseur finale. Doit-être considéré comme un coefficient de sécurité car l'allocation pour le moulurage (AM) vient atténuer l'importance de ce facteur sur le calcul de l'épaisseur cible optimale.
VCS =	Variation combinée du sciage
RV =	Retrait volumétrique réfère à la réduction tangentielle de la dimension d'une pièce passant de l'état vert à une teneur en humidité finale minimale

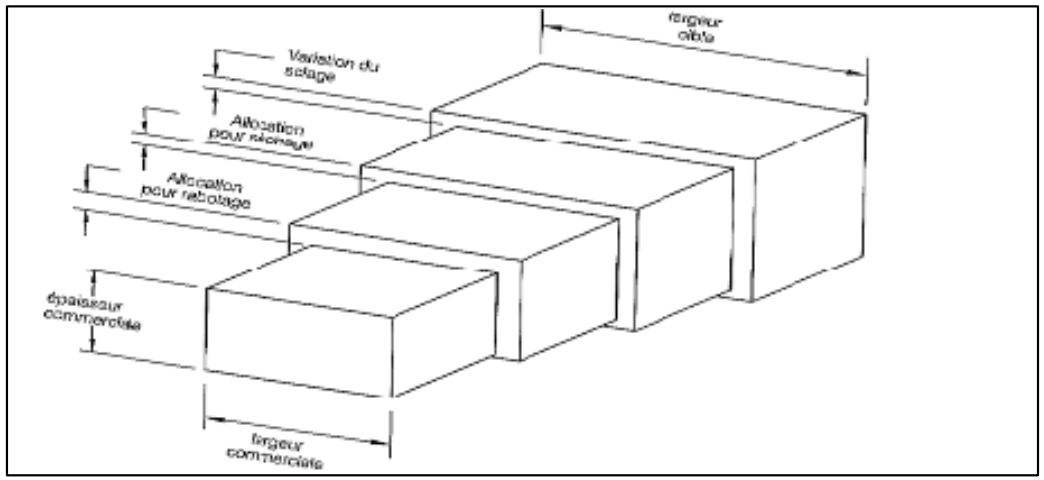
CALCUL DU RETRAIT VOLUMÉTRIQUE (RV)

$$RV = \frac{(30 - THM) * RTM}{30}$$

THM =	Teneur en humidité minimale des sciages
RTM =	Retrait tangentiel maximal de l'état vert à l'état sec

Results

- Lumber target thickness potential reduction of 1/16 inch at the sawmill
  - 4/4 lumber = 1,063 versus 1,125
  - 5/4 lumber = 1,326 versus 1,390



- Benefits for a sawmill that produces 5 MMbf/year
  - Lumber recovery increase by 3,8 %
  - Additional annual income of 130 000 $

Results

- Development of various grouping opportunities by sector
  - Dimensional offers better possibility than qualitative
  - 4/4 and 5/4 lumber thicknesses satisfy requirements of most users
  - Length grouping in relation to quality
    - 4 and 5 feet / 6 feet and more
  - Quality grouping is more difficult
    - Sorting based on colour
    - Grading according to best face
  - In-house grading rules
    - 4 feet lumber with clear cutting yielding > 75 %
    - Width less than 3'' ex: 2 ¾ for posts and crosspieces of 2 ¼

Conclusions

- Need to establish business relationships and ongoing dialogue between the 1st and 2nd transformation
- Vision system is essential to consider simultaneously size color and defects eligible

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Project 6

Evaluation of breakdown processes based on 2nd and 3rd manufacturing requirements

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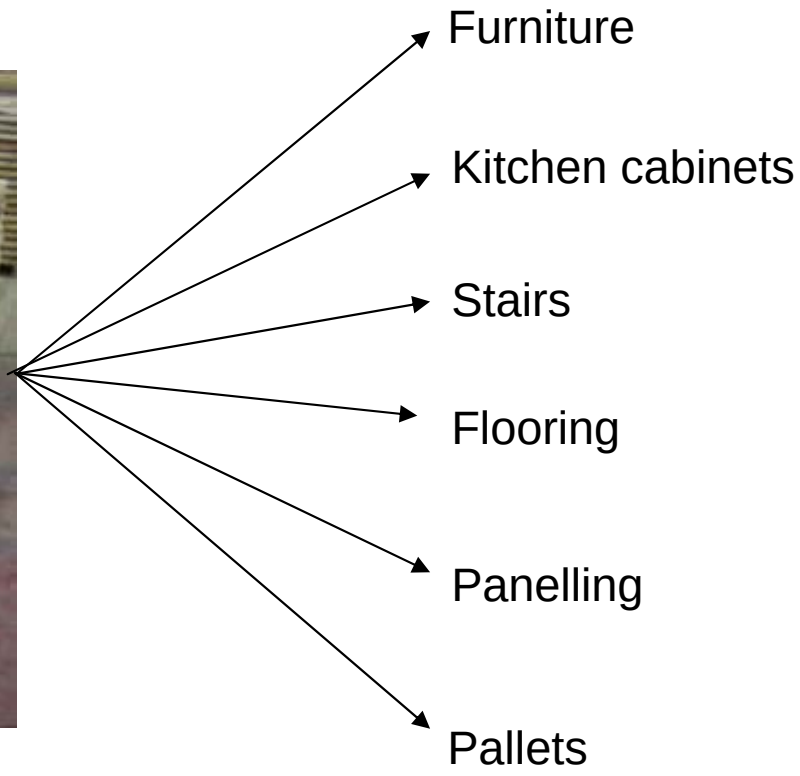
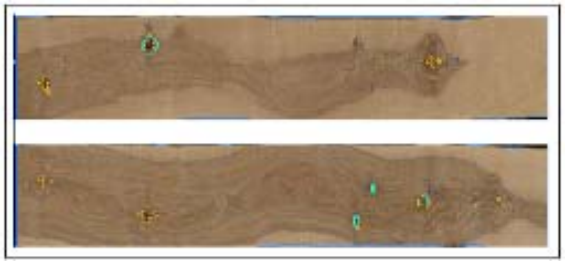
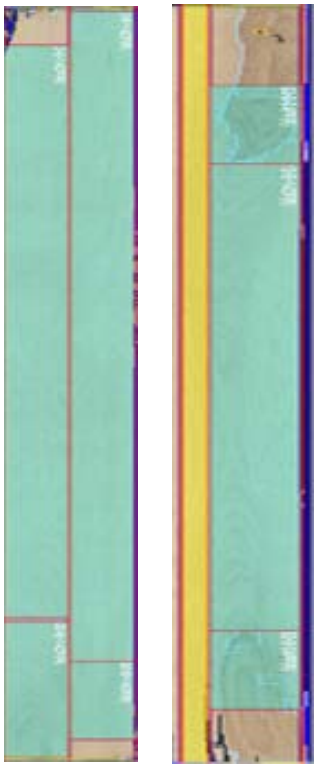
Needs

- Facilitate the adaptation of hardwood sawmills to the new reality
- Produce lumber according to specific needs of each user
  - Appropriate lumber to the right user



Approach





Results

- Base case scenario
  - Components average recovery before optimization

Lumber quality		Flooring	Stair	Kitchen cabinet	Molding	Furmiture	Panelling	Pallet
Select & Better	Sap	-	67,9 %	68,4 %	45,1 %	-	68,4 %	-
	Reg	-	64,3 %	-	-	-	-	-
1 Commun	Sap	-	61,5 %	65,2 %	28,9 %	66,0 %	63,7 %	-
	Reg	-	58,4 %	-	-	66,0 %	-	-
2 Commun	Sap	60,0 %	-	-	-	61,0 %	-	-
	Reg	54,4 %	-	-	-	59,2 %	-	-
3 Commun	Sap	50,3 %	-	-	-	49,5 %	-	-
	Reg	44,6 %	-	-	-	50,4 %	-	-
3B Commun		-	-	-	-	-	-	48,0 %
Average recovery		**53,4 %**	**61,5%**	**66,2 %**	**43,5 %**	**61,8 %**	**64,7%**	**48,0 %**
Average supply cost								
$/Mbf-lumber		**644 $**	**933 $**	**1 090 $**	**1 375 $**	**756 $**	**1 025 $**	**260 $**
$/Mbf-components		**1 206 $**	**1 517 $**	**1 645 $**	**3 164 $**	**1 224 $**	**1 585 $**	**541 $**

Results

- Optimization scenario 1
  - Best recovery in components

	Flooring	Stair	Kitchen cabinet	Molding	Furniture	Panelling	Pallet
Actual situation without sorting							
Average recovery (%)	53,4 %	61,5 %	66,2 %	43,5 %	61,8 %	64,7 %	48,0 %
$/Mbf – lumber	644 $	933 $	1 090 $	1 375 $	756 $	1 025 $	260 $
$/Mbf – components	1 206 $	1 517 $	1 645 $	3 164 $	1 224 $	1 585 $	541 $
Optimization according to best recovery							
Average recovery (%)	63,0 %	70,4 %	69,9 %	81,6 %	58,9 %	74,5 %	48,0 %
$/Mbf – lumber	655 $	1 106 $	1 024 $	1 360 $	672 $	1 141 $	260 $
$/Mbf – components	1 039 $	1 570 $	1 464 $	1 666 $	1 141 $	1 532 $	541 $
Difference based on actual situation							
Recovery gain or (lost)	**17,9 %**	**14,6 %**	**5,6 %**	**87,9 %**	**(4,6 %)**	**15,1 %**	**0,0 %**
Supply cost reduction or (increase)							
$/Mbf – lumber	**(10 $)**	**(173 $)**	**66 $**	**15 $**	**84 $**	**(116 $)**	**0 $**
$/Mbf – components	**167 $**	**(53 $)**	**181 $**	**1 498 $**	**83 $**	**53 $**	**0 $**

Results

- Optimization scenario 2
  - Best recovery in components including a minimum recovery

	flooring	Stair	Kitchen cabinet	Molding	furniture	Panelling	Pallet
Actual situation without sorting							
Average recovery (%)	53,4 %	61,5 %	66,2 %	43,5 $	61,8 $	64,7 $	48,0 $
$/Mbf – lumber	644 $	933 $	1 090 $	1 375 $	756 $	1 025 $	260 $
$/Mbf – components	1 206 $	1 517 $	1 645 $	3 164 $	1 224 $	1 585 $	541 $
Optimization according to best recovery including a minimum recovery							
Rendement moyen (%)	61,9 %	71,5 %	70,5 %	76,2 %	57,1 %	72,9 %	54,2 %
$/Mpmp de sciages	610 $	960 $	909 $	1 095 $	648 $	939 $	260 $
$/Mpmp de composants	985 $	1 343 $	1 289 $	1 436 $	1 135 $	1 288 $	479 $
Difference based on actual situation							
Recovery gain or (lost)	**15,9 %**	**16,4 %**	**6,4 %**	**75,4 %**	**(7,6 %)**	**12,8 %**	**12,9 %**
Supply cost reduction or (increase)							
$/Mbf – lumber	**34 $**	**(28 $)**	**181 $**	**280 $**	**108 $**	**86 $**	**0 $**
$/Mbf - components	**221 $**	**174 $**	**356 $**	**1 728 $**	**89 $**	**297 $**	**62 $**

Results

- Negligible impact on user productivity
- No significant difference in relation to sawing breakdown
- New outlets for low quality lumber
- This technology will eliminate the trimming and grading station at the sawmill

Conclusions

- Proposed changes will have a major impact on business relations
  - Fixing of lumber selling price
  - Constant information exchanges with users
    - Changing needs over time
  - New communication tools to interact with clients
    - WEB uses
  - Interdependence between different stakeholders
    - Commitment, cooperation and trust

Thanks

- Industrial partners
  - Centre de recherche industriel du Québec
  - Félix Huard Inc.

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Project 9

Definition of the manufacturing technologies required

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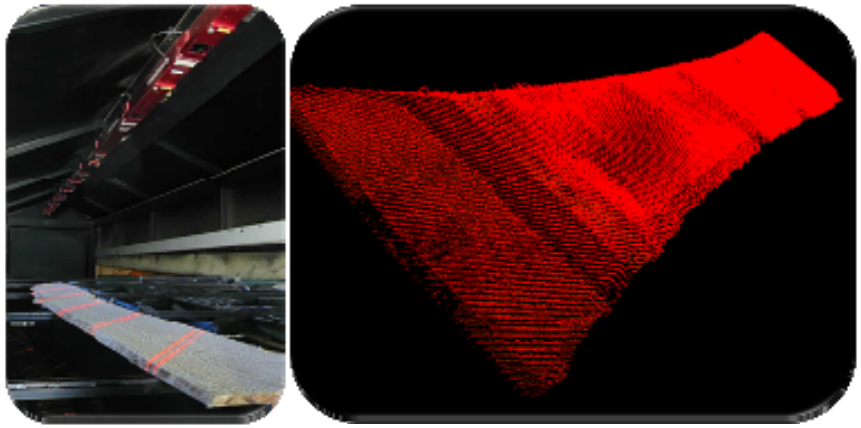
Needs

- Production oriented on the user needs will require changes to the sawing processes
  - Increased number of possible solutions
  - Unmanageable for a human
- Implementation of vision systems is essentiel
  - Technological advancement
    - 2008 Hardwood Initiative creation
  - Similar technologies
    - Cameras/lasers = geometric defects
    - Cameras/color = visual defects
  - Already implemented in some sawmills



Needs

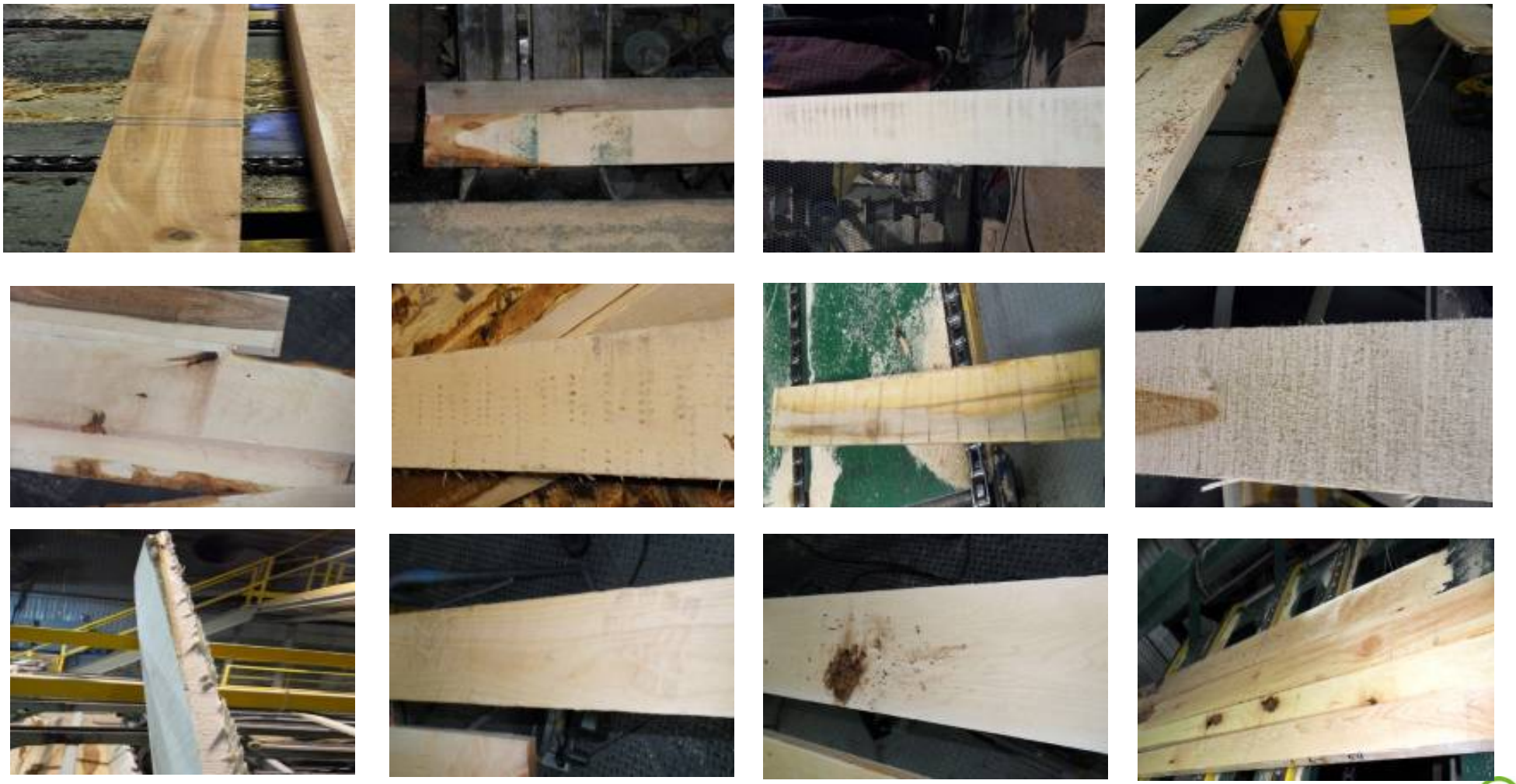
- Problems of false detections identified in project 6
  - Lumber oxydation
  - Presence of marks or impurities on lumber surface
- Acquire knownledge on false detection problems
  - Improve vision systems efficiency

Approach

- Tests in 3 sawmills that do not have a vision system
  - Source, frequency and impurity types
- Tests in 1 sawmill that has a vision system
  - Impact of oxydation and different types of impurities
- Identify possible solutions

Results

- Identify 12 different marks or impurities



Results

- Significant difference between sawmills

impurity types	Sawmill 1	Sawmill 2	Sawmill 3
Pieces frequency	17,2%	60,3%	80,2%
Chain marks	66,2 %	55,3 %	23,9 %
Presence of sawdust	24,7 %	26,3 %	27,0 %
Knots with bark/decay in contact with saw	2,6 %	15,8 %	11,7 %
Rubber belt marks	-	-	27,6 %
Oil marks from the carriage	-	2,6 %	1,8 %
Burns saws	6,5 %	-	-
Pressure rollers marks	-	-	2,5 %
Presence of splice on lumber edge	-	-	5,5 %
Excessive roughness	-	-	-
Foot prints	-	-	-
Various dirt marks	-	-	-
Presence of water on lumber	-	-	-

Results

- Monetary impact depending on impurety types
  - Gains of 9 $/Mbf to losses of 446 $/Mbf
- Annual potential losses associated to false detections

	Sawmill 1	Sawmill 2	Sawmill 3
Pourcentage of pieces that have been trimmed and/or classified incorrectly by a vision system	1,8 %	10,9 %	15,8 %
Potential monetary losses $/Mbf $/year	 11,40 $ 175 700 $	 33,98 $ 228 300 $	 26,21 $ 247 800 $

- Negligible impact associate with oxydation
  - Frozen wood
- List of corrective actions to eliminate or limite the marks and impurities

Conclusions

- Presence of impurities in all sawmills
- Equipments and sawing processes are not designed to reduce marks and impurities
- Vision systems use filters to improve the situation

Thanks

- Industrial partners
  - Scierie Préverco
  - Planchers Mercier
  - Bois Franc l'Islet Sud
  - Groupe Savoie

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Project 11

Log characterization in relation to user needs

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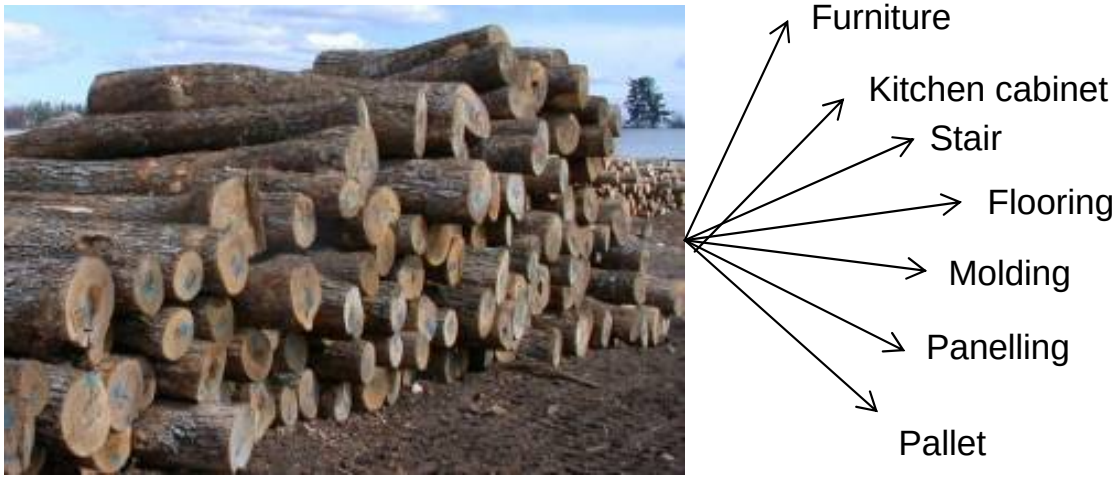
Needs

- Grading rules developed to predict lumber quality according to NHLA standards
  - B quality log = 40 % of 1 Common & Better
  - C quality log = 20 % de 1 Common & Better
- Proposed changes will reduce the actual rule efficiencies
  - Not design in this perspective
- Review the quantitative and qualitative grading criteria according to different users needs



Approach

- Merge data generated during project 6, 16 and 17
  - Homogeneous database of 240 yellow birch logs
- Use mathematical and statistical models to define the log quality criteria according to user needs
  - Correlation between variables prevent the use of conventional statistical analysis
  - Statistician from the Canadian Wood Fiber
  - JM Frayret, professor from the Polytechnique de Montréal and collaborator for the VCO network - CRSNG

Results

- Optimal selection criteria by users
  - Based on log supply cost per Mbf of components produced
  - Grading method efficiency range from 75 à 88%

SORTING CRITERIAS	FLOORING			CABINET		STAIRS		PANELLING		FURNITURE		MOLDING	PALLET	
Log position	Upper		Butt				Butt			Upper	Butt			
Minimal small end diameter	>= 32		< 32	26 à 32	>= 34	26 à 30	>= 32	26 à 32	>= 34	>= 26	>=38	>= 22	< 22	24 to 26
Number of clear faces	<=1	>=2	>= 3	4		4	>=3	4				4		
Heart size SED				< 45%		< 28%		< 45%				< 46%		>= 32%
Deduction			>= 12%							< 17%		< 7 %		

Results

- Recovery increase in bf of components produced / m^3 of logs

	Flooring	Stair	Kitchen cabinet	Molding	Furniture	Panelling	Pallet
Random logs distribution – before sorting	48.92	31.75	23.38	7.17	71.39	22.76	51.92
Logs selected according to optimum criteria	57.12	79.42	54.80	30.42	91.74	55.00	71.84
Volume recovery gain	**17 %**	**150 %**	**134 %**	**324 %**	**29 %**	**142 %**	**38 %**

- Resource cost reduction / Mbf of components produced

	Flooring	Stair	Kitchen cabinet	Molding	Furniture	Panelling	Pallet
Random logs distribution – before sorting	1436 $	2212 $	3004 $	9795 $	986 $	3086 $	1353 $
Logs selected according to optimum criteria	1199 $	959 $	1384 $	2437 $	818 $	1379 $	898 $
Resource cost reduction	**17 %**	**57 %**	**54 %**	**75 %**	**17 %**	**55 %**	**34 %**

Conclusions

- Opportunity of buying and/or slashing the logs according to major customers

- Results can be used to develop silvicultural strategies or merchandizing yard center