Composites Research Network: Key Findings from 2012 Outreach Activity

Executive Summary

Synopsis

Business and technology data was collected from participants in the composite materials industry in British Columbia, Alberta, Saskatchewan, and Manitoba during the summer of 2012, as a first step in mapping the activities and industry development needs of the entire community. This work is an activity of the Composites Research Network (CRN), led by The University of British Columbia. The network is a collaboration of academia and industry partners supporting the composites industry in Western Canada and beyond.

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CRN BACKGROUNDER

CRN was launched in January 2012 with a $9.8 million investment from Western Economic Diversification Canada (WEDC). Originally proposed and budgeted as a BC provincial network, the scope was expanded in response to WEDC interest in establishing a capability supplementing and extending existing expertise throughout Western Canada.

The vision of CRN is to establish a vibrant leading-edge composites industry in Western Canada, supported by CRN and partner organizations.

The mission of CRN is to create Knowledge in Practice Documents (KPDs) that enable effective and low-risk knowledge-based composites manufacturing and design.

The CRN aims to create a standardized up-to-date living knowledge base that can be easily and continuously updated and extended to all member organizations. The building block for the creation of this knowledge base is the Knowledge-in-Practice Document (KPD). KPDs are theory-based practical curricula that can be developed and customized for different user groups, with which trainers can be trained, who in turn can train sufficient numbers of engineers and technicians to supply and regenerate the workforce.

Core functions of the network are:

- **Bringing together academia and industry** to solve manufacturing and design challenges in composites materials.
- **Creating and promoting knowledge-to-practice documents** (KPDs).
- **Training new staff** in best practice application on a continuous basis.
- **Operating in all Technology Readiness Level (TRL) ranges** including basic research, program work, project work, and engineering implementation.

CRN is an initiative of The University of British Columbia (UBC) in collaboration with key stakeholders across the Western provinces of Canada and in concert with other national and international initiatives. Lead participants in the network are:

- Hub and main node: **BC, Lower Mainland**: UBC-Vancouver.
- Node: **BC, Okanagan**: UBC-Okanagan
- Node: **BC, Vancouver Island**: University of Victoria
- Node: **BC, Fraser Valley**: University of the Fraser Valley/City of Abbotsford
- Node: **Manitoba**: Composites Innovation Centre, Winnipeg
- Node (future): **Alberta**: TBD
- Node (future): **Saskatchewan**: TBD

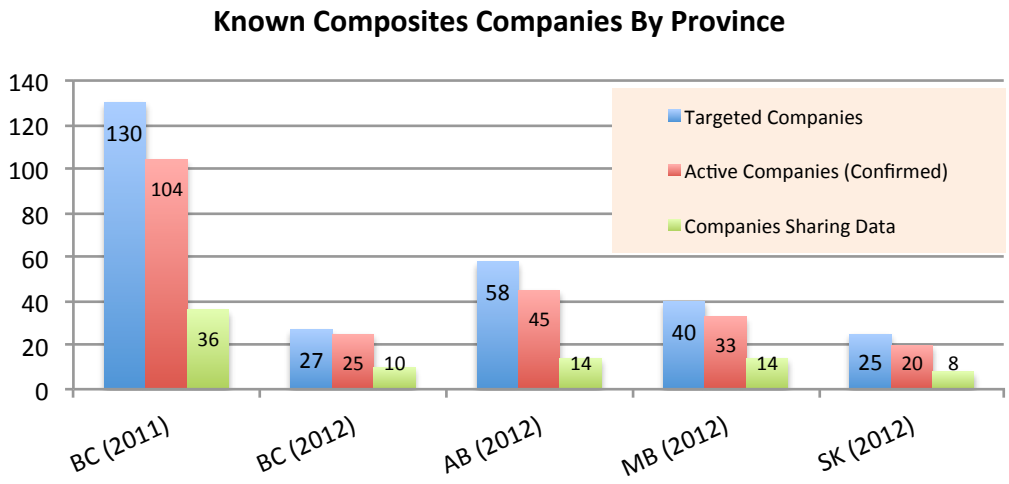
The proposing team, led by Prof. Anoush Poursartip at the University of British Columbia, with the support of NRC-IRAP, Industry Canada, and other governmental agencies, has collected extensive data on the industry needs and challenges in BC, through two web-based surveys in 2007 and 2011. Close associations with the Composites Innovation Center (CIC) in Winnipeg, Manitoba revealed the general relevance of the findings to the wider region, but comparable primary data in other provinces was lacking. Therefore, in order to extend its industry knowledge base across Western Canadian, and to help identify needs, strengths and key participant organizations that could help establish the network, a third industry survey was undertaken in 2012. This report summarizes the key findings, focused on understanding the industry, its current and future needs, and establishing themes to help direct the activities of CRN. Sharing this data with participants and the wider community is another goal supporting the development of a knowledgeable and responsive composites industry in Western Canada.

COMPOSITE INDUSTRY OVERVIEW

Information presented in this report has either been provided voluntarily in web-based surveys developed in this project, or has been collected from secondary public sources. Our data sets are inadequate to provide statistically relevant information on the exact size and health of the entire composites industry. However, we can provide insight into the industry based on our collective intelligence activities. Some highlights are:

- In early-2011, 104 active composite companies were identified and reviewed in BC. Together, these companies account for an estimated 4129 jobs and generate estimated revenues of around $563 million annually.
- In mid-2012, a further 123 companies were identified and reviewed across all four of the Western Provinces. Including data from the previous survey, the Western Canadian composite industry is estimated to provide 13,678 jobs and generate $2.36 billion in revenue.
- The active companies database currently comprises 129 companies in British Columbia, 45 companies in Alberta, 33 companies in Manitoba, and 20 companies in Saskatchewan (227 companies in total throughout the region). However, while BC is the largest regional contributor in terms of numbers of companies, Manitoba is larger in terms of jobs (5354) and revenue ($1.05 billion).
- Since 2011, 82 composite companies in Western Canada (representing 36% of the known industry) have shared data about their current status, needs and future development plans.

FIGURE 1



Unless otherwise identified, the data discussed in this document was collected from the responses of 46 companies in the summer of 2012. As indicated in **Figure 1** the companies were spread between the four Western Provinces.

INDUSTRY SNAPSHOT

- **INDUSTRY SIZE**. **Figure 2** shows four graphs developed from a combination of survey data (in 2011 and 2012) and desk research. Revenue and staff estimates were assigned for all known companies in terms of composite-related efforts[1]. Across all four provinces we estimate the composite industry accounts for 13,678 jobs and $2.36 billion dollars in revenue. Currently our confidence in these estimates in + or – 15% given that further companies likely remain to be discovered, particularly in Alberta and Saskatchewan. Though the majority of known companies appear to be based in British Columbia (129), on average they are relatively small (36 staff and $5.3 million in revenue) compared to the larger (153 staff and $30.26 million in revenue) but fewer (33) companies identified in Manitoba. The 44 Alberta companies identified were, on average, 67 staff and $11 million in revenue. The 20 Saskatchewan companies identified were of similar size to those in British Columbia (31 staff and $5.53 million in revenue). Revenue-per-employee ratios were used as a general reality check and while they varied significantly according to type and size of enterprise, an average value across the whole industry was determined at $170,797 per employee.

- **SUPPLY CHAIN**. **Figure 3** contains two representations; the first from our 2012 survey and the second from a combined data set of both our 2011 and 2012 surveys. The majority of respondent companies identified themselves as manufacturers (61.4% of the combined 2011 and 2012 survey data), 27.7% identified themselves as involved in repair, maintenance, and overhaul, and 22.9% as in design, research and consulting. Other categories (testing, materials supply, original equipment manufacturers, tooling/mold makers, distributors/suppliers/assemblers, and other activities) were chosen by below 15% of respondents. **Figure 4** summarizes the combination of the above supply chain data with secondary source-based assessments for non-responding active companies, to create a best-effort picture of the Western Canada supply chain by province. At present 59% of the known manufacturing base (as determined by numbers of active companies) is in BC. Alberta has its strongest representation in certification and testing (37%) and repair, maintenance, and overhaul (27%). Manitoba had its strongest representation in OEMs (40%), certification and testing (26%) and materials supply (25%).

- **APPLICATION DISTRIBUTION**. **Figure 5** contains two representations; the first from our 2012 survey and the second from a combined data set of both our 2011 and 2012 surveys. The most widely-serviced application is ground vehicles[2] (35.4% of the combined 2011 and 2012 survey data). Other prominent application choices were construction (31.7%) and marine (24.4%). Sporting goods, aerospace, and industrial products were chosen by around 22% of respondents. On average, respondents selected two application categories each, but some groups were far more diversified. For example 75% of companies involved in hot tubs and spas were also involved in ground vehicles,

1 For large or diversified companies, these estimates become challenging. Where possible we have erred on the side of caution.

2 **Application Categories.**
Ground Vehicles. (Do not include bicycles unless they are powered). Automotive components, recreation vehicles, mass transit, caravans, ambulances, motorcycles, scooters, railways, and other industrial vehicles.
Aerospace. Aircraft (civilian, defense and model) and aircraft components. Defence and space applications.
Marine. Powered commercial and pleasure craft. Components and other floating structures. Include sub-sea and surface products.
Sporting Goods. Mountain bikes, other recreational bicycles, kayaks/canoes, surfboards, snow boards, skis, golf clubs, fishing rods, tennis racquets and so on.
Hot Tubs and Spas. Shower units, baths, and other fittings.
Construction. Basic construction materials (paneling, sheet, and beam). Playground equipment, utility poles and conduits, and other infrastructure products.
Industrial Products. Corrosion products, tanks, piping, agricultural.
Alternative and Traditional Energy. Include turbines/blades for wind generators and electrical transmission components
Other. Includes biomedical and surveillance and security applications. (Please Specify).

sporting goods, and construction. Another strong overlap existed for construction companies that also selected ground vehicles (57%) and industrial products (50%). This data confirms that few, if any, companies rely on a single application field. Looking at all active company listings (the 227 companies identified in **Figure 1**) 80% of all marine activity and 72% of sporting goods is in BC (determined by numbers of active companies), which intuitively makes sense. AB accounts for 43% of energy application selections and 36% of industrial product selections. Manitoba has its strongest position in aerospace (26%) and ground vehicles (24%). Saskatchewan has its strongest representations in industrial products (23%), construction (14%) and infrastructure (14%).

- **AGE, FOCUS, MARKETS**. According to our 2012 survey data, 50% of respondent companies have been in business over 15 years. Less than 5% are new companies (under 5 years old). 78% were Canadian companies supplying principally domestic (30%) and both domestic and export (48%) markets. All had a component of activity in composites, with 87% stating that a significant number of areas of interest involved composite materials. These results mirrored results from the BC survey in 2011.

- **STAFF, REVENUE, and R&D EXPENDITURE.** Staff and revenue figures show similarities to many other industrial sectors in Canada. Over 70% of respondent companies have less than 50 staff and 45% have less than 10 staff. In terms of revenue 59% of respondent companies had revenues below $5 million. This data supports the picture, already determined for BC in 2011, that the industry largely consists of small and medium-sized enterprises, with a small but significant group of larger companies. Six companies (14% of respondents) reported revenue over $50 million (see **Figure 6**). In terms of R&D funding, a few (6) companies are focused on developing products and technologies and as a result are spending greater than 50% of revenue on R&D. But over 50% of companies undertake little or no R&D, which also reflects the earlier results from BC in 2011, and supports the already established need for industry support as envisioned in the CRN model.

- **TECHNOLOGY DEMAND.** We asked companies to tell us how mature their technologies and processes were, and if they were introducing novel or innovative designs, processes, or materials into their product lines. We also asked companies to tell us about the behavior of their customers towards new products and technology. 68% of respondents are introducing new designs, processes, or materials, but only 30% saw direct demand arising. The situation equates to a technology push scenario, where manufacturers are developing new solutions to customer requirements, but may also be developing them to improve productivity, efficiency, health and safety and so on. Essentially, the development of new technology is not directly driven by customer demand, but may be orchestrated in response to perceived business needs.

- **MATERIALS AND PROCESSES: CURRENT USE.** We asked companies to tell us about the materials and processes they were currently using, and the materials and processes they were considering using in the next five years. **Figure 7** and **Figure 8** show the responses of 40 companies across the region. These graphs help to show where the majority of companies are focusing their interests now, and where they may be seeking support in the next five years. General features of the current materials data confirms that thermosets are in wider use than thermoplastics, and that glass fibre (28 respondents) as woven fabrics (25 respondents) and chopped strand mats (20 respondents) are the most widely used reinforcements across all applications. In terms of current processes, once again thermosets dominate with hand lay-up/room temperature cure (19 respondents) and chopper gun spray (14 respondents) up being the most commonly identified. Resin transfer molding (12 respondents) and resin gun spray up (12 respondents) were also widely selected. This information tells us how the majority of industry operates today and this data can be helpful in directing CRN's attention to topics of common interest. The basic premise of CRN is that many companies can improve their existing productivity and

efficiency by accessing best practice information relating to their chosen materials and processes. Respondents generally chose more material options than processes.

- **MATERIALS AND PROCESSES: FUTURE USE. Figure 7** and **Figure 8** also show the responses of 40 companies across the region to questions about their anticipated future materials and process needs. From the point of view of CRN one could argue that topics that have the greatest levels of growth or increased interest are at least as important as those topics that are most widely used at present. Furthermore, new or previously untried processes or materials with small user bases would likely present the greatest challenges to companies seeking to enter or develop capability, and this kind of activity should be addressed in CRN's activities. While 81% of the collected data on materials and processes was related to current usage, the smaller volume of data on future use also provides useful insights and confirmations. Respondents were generally more selective in their choices for the future averaging around 3.5 for both processes and materials. We considered categories with the largest percentage growth rate, and also the categories with the largest numbers of respondents. In terms of future material needs, respondents were most focused on preforms, ceramic/clay nanoparticles, woven prepreg, and other natural fibres. Carbon fibre was also high up on the list in terms of the largest number of potential future users. In terms of future processes, compression molding with bulk molding compound (BMC), compression molding with sheet molding compound (SMC), resin transfer molding (RTM), molding with press, hand lay-up with oven cure, prepreg molding, and hand lay-up with autoclave topped the choices of respondents. **Figure 9** and **Figure 10** show these trends in more detail.

- **KPD NEEDS**. **Figure 11** tabulates respondent's choices with respect to potential KPD topics—basically a direct guide to topics that should reside in CRNs future knowledge base. 40 out of 46 respondents provided input, averaging 7.7 topics from 27 categories. This response rate shows a high level of interest in KPDs as a mechanism for knowledge transfer. The small numbers of choices under "other" categories also suggests that the questionnaire reasonably identified the most popular areas of interest. Topics that stood out were resin selection and fibre (and form) selection with 60% of respondents choosing these two. Other topics of high interest were cutting/machining/drilling, product design, process optimization, materials handling and storage, and fatigue and impact resistance. While these topics are themselves somewhat generic, the starting points for work in these areas could be guided by more detailed discussions with respondents who may directly and immediately benefit from the outcomes (industry partners/participants).

- **GROUPING RESPONDENTS BY APPLICATION**. It has already been noted that most companies in the composites field work in several complimentary application areas. This information helps us better understand the meaning of the application distributions in **Figure 5**. One can assume that, in terms of processes and materials, the products that manufacturing companies are making, are economically compatible. Some texture in responses to materials, process choices, and KPDs was evident when analyzed by application group. For example:
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    - Companies working in ground vehicles (17 respondents) chose natural fibres, unidirectional and woven prepreg, and preforms as their top materials growth areas. Compression molding BMC, SMC, molding with press, hand lay-up with autoclave and oven curing were the process areas most likely to see growth. 10 of these companies identified the top two KPD topics (resin selection and fibre (and form) selection) along side product design and infusion systems.
    - 12 responding companies working in construction identified PVC, phenolic matrix, ABS, CFRP, nanomaterials among their anticipated future interests. Process choices were similar to those of the ground vehicles group. 8 responding companies identified materials handling and storage as an additional area that KPDs could usefully address for them.

- The aerospace group had 9 respondents. Materials choices for the future were notably very limited (little or no change). Nanoparticles, natural fibres, chopped strand mats, unidirectional fibre, preforms and woven prepreg all had single choices (that is, no strong single focus of future activity). Process responses were a little more revealing. Hand lay-up with oven cure, BMC, SMC, RTM were all processes of future interest to several companies. Tooling design appeared at the top of the KPD list as did infusion systems, product design and process optimization.

SUMMARY AND CONCLUSIONS

The data gathered in 2012 from enterprises across Western Canada is a first step in identifying and engaging with the broader composites community. In the last few years we have reviewed close to 300 organizations, identified around 230 active in composites, and have collected direct data from 82 of them. Our attempts to date to identify and reach as many active companies as possible, whilst spirited, cannot be considered exhaustive. By way of example, we have surveyed the composites community in British Columbia three times since 2007. On each occasion there have been changes. In 2011 we observed that 16% of our know 2007 active companies had closed, merged, or otherwise changed business activities. In this survey we identified 25 active BC companies that were not previously know to us. Some are new and some we simply did not identify in previous efforts. The database development process is an iterative one, requiring regular updating, each bringing us closer to a true picture of the community. In this first Western Canadian effort we have identified a reasonably representative and responsive cross section of the community. But since most of our previous efforts have been focused on BC, it is reasonable to assume that our overall database is somewhat biased towards BC (and to a lesser extent, towards Manitoba). We might reasonably expect to see our active community in AB and SK expand by up to 20% in subsequent iterations. Even so, our database still suggests that BC has a very strong composites community (in terms of number of companies). In terms of employees and revenue BC and Manitoba are more closely matched.

Activities relating to the design, build, repair and maintenance of ground vehicles and construction products (closely followed by a range of other applications) underscore a mature and diversified industry. It is mostly composed of small companies with limited resources (a typical profile for many industries in Canada) accompanies by a few larger and better-resourced enterprises. What we can infer from our previous work in BC on process and material use (2007 was the last time we collected data) is that, in general, the results extend to Western Canada as a whole; not an unexpected result. However, in the 2007 survey (in BC), response rates on future use were 65% of existing use in materials and close to parity in processes. By comparison our latest survey indicates much lower future use responses, (40% - 50% of current use). One speculation might be that in 2007 there was a great deal of churn in the industry and business owners were prepared to consider a wide range of possible options to ensure survival. Whatever the reason, there seems less focus on making future improvements by way of introducing new process or materials than was apparent 5 years ago.

Materials and process trends continue to match the observed industry application focuses of ground vehicles, construction and marine, which tend to use thermoset matrix composites reinforced mainly by glass and in some cases carbon fibres. Thermoset matrix technology is generally stronger than thermoplastic options and better suited to higher temperature environments. The most popular thermoset matrix materials used in these applications are epoxy, polyurethane, polyester, and vinylester and our survey results reflect this observation. Summarizing the materials data, both thermoset and thermoplastic composites will continue to be used as each technology has specific applications which cannot be substituted by the other. Their relative importance will reflect the market-driven conditions expanding or diminishing demand for products that use them. Similarly, reinforcement materials selections will also respond to market-led forces and the strategic choices of manufacturers in their product portfolios.

In terms of processes, the predominant technologies (due to cost constraints and production volumes) are hand lay-up with oven cure, chopper gun spray lay-up, and resin gun spray lay-up (reflecting construction industry and ground vehicle practices). Vacuum assisted RTM (VARTM: in use by the marine and automotive industry), hand lay-up and oven, and hand lay-up and autoclave (primarily used by the aerospace industry) are also represented in the data. Despite the capital costs associated with hand lay-up and room temperature cure (which is labour intensive), the practice remains at the top of our process list. Noteworthy is the continued high interest shown in the future use of RTM. Although it has been available for decades, the capital investment required for equipment and tooling has limited widespread adoption. RTM is appropriate for mass production of composite parts, and the normal practice is to consider it for production runs greater than 100 parts per year (in the aerospace industry at least). A resurgence in interest in RTM appears to be in process throughout the composites industry, possibly driven by its application to new aircraft designs. This could be considered a possible direction for CRN activity in the future.

The KPD results, though generic, provide a useful indication of where companies across the spectrum of activities seek help. 40 out of 46 respondents provided input showing a high level of engagement in the fundamental ideas on which CRN is founded. 24 of these companies selected two common topics; resin selection and fibre (and form) selection. In practice, this one result implies that, across the whole region, 40 to 50 companies might be expected to eventually benefit from (and in many cases contribute to) the development of KPDs on these topics. Clearly, any work undertaken by CRN would be widely and rapidly applied through the KPD model to a significant cross-section of the composites industrial community.

The data collected in this (and previous) surveys of the composites industry provides valuable evidence supporting the view of a widely diversified industry that is seeking help to improve existing technologies and introduce new ones. The CRN has been conceived to precisely address such issues in an efficient collaborative process founded on the creation of Knowledge to Practice Documents (KPDs). This information has been shared throughout CRN and will be used to help direct programs and activities to the benefit of the industry.

THANKS AND ACKNOWLEDGEMENTS

CRN wishes to express sincere thanks to all the supporting organizations that have made this work possible; Western Economic Diversification, NRC-IRAP, Industry Canada, the University of British Columbia, and the Composites Innovation Centre. Many individuals too numerous to list at organizations across Western Canada have also contributed to the data gathering process. The greatest thanks are due to the 46 individuals who took the time to share their company views by responding to our web-survey. Many of the companies are noted below (11 participants chose not to be identified in the survey participants list):

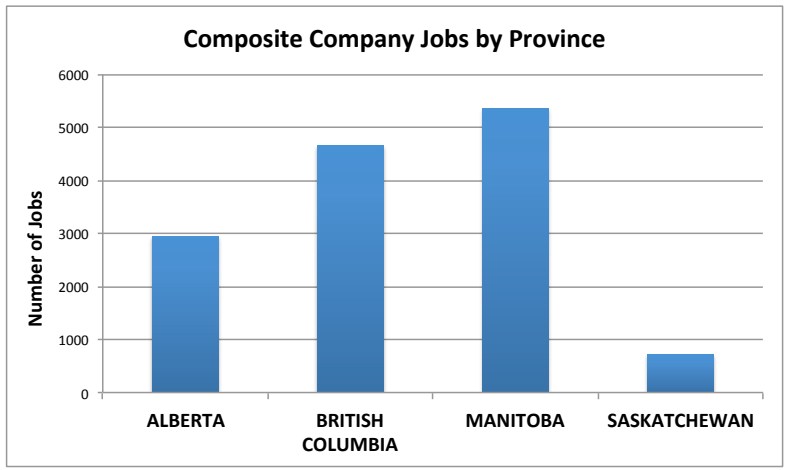
Organization	Province	Website	Activities
Alberta Innovates Bio Solutions	AB	http://bio.albertainnovates.ca/stratthemes	R&D, consulting and testing services for the composites and plastics industry.
Alta Injection Molding	AB	http://altainj.com	Custom injection manufacture mainly in engineered resin. The main areas of business are in military and medical fields. Oil and gas also.
ATR Manufacturing	AB	http://www.allterrainroad.com	All•Terrain•Road™ is a composite road mat system designed to provide stable and rugged access for heavy equipment to remote, inaccessible areas. ATR Manufacturing, Inc. designed the system for demanding use on muskeg and wetland, across difficult or environmentally sensitive terrain.
BP Composites Ltd.	AB	http://bpcomposites.com	Manufacturer of TUF-BAR GFRP fiberglass rebar and rock bolts.
Dynamic Composites	AB	http://www.dynamiccomposites.com	Design and manufacture of sporting goods products, marine, automotive and aircraft. Extensive experience with advanced materials.
Dynetek Industries	AB	http://www.dynetek.com/products.php	Design and manufacture of automotive pressure vessels ranging in size from 20-320 liters operating at pressures of 250-700 bar. These are made from wet filament wound carbon fiber overwrap over an aluminum liner.
Fiber-Werx International Inc.	AB	http://www.fiberwerx.ca	Custom fiberglass manufacturing and repair. Production methods include open face (chop & hand layup), vacuum infusion. CNC capabilities for master and mold production.
Motive Industries Inc.	AB	http://www.motiveind.com	Design and engineering services to transportation industry mostly toward automobiles. Composite parts design, prototyping and testing. Concept and production vehicle designs.
Polar Industrial Plastics	AB	http://www.polarplastics.com/frp.html	FRP Manufacturer of tanks, pipe, fittings, dual lamination capabilities and specialty items for the oil industry.

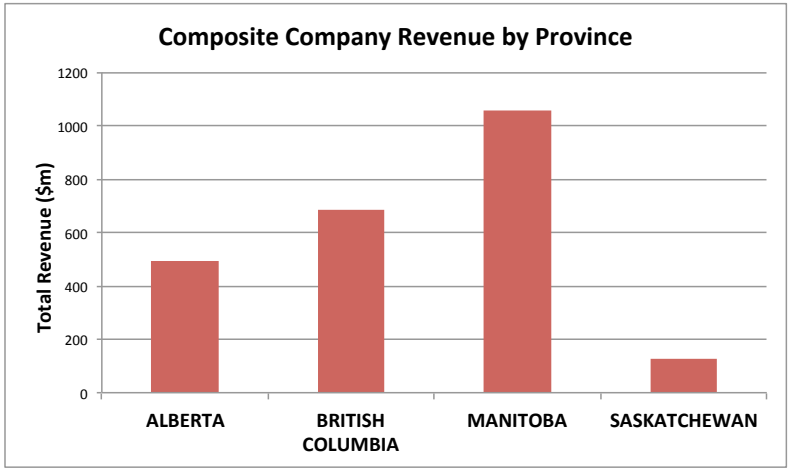
Organization	Province	Website	Activities
RS Technologies Inc.	AB	http://www.grouprsi.com	Manufacturer of composite utility poles using proprietary polyurethane resins and glass fiber. Also provide engineering and design support for the composite pole structures.
Sika Canada Inc. Western Region	AB	http://can.sika.com/en	Construction chemical manufacturer involved in structural strengthening of concrete, masonry, timber and steel structural elements. Providing surface mounted and near surface mounted, carbon plate and fabrics for flexural and shear, in both positive and negative moment applications. Adhesives for use with our strengthening systems, primarily for rehabilitation of structures.
ZCL Corrosion (was Triple M)	AB	http://www.triplemfiberglass.com	Manufacturer of fiberglass reinforced plastic and dual laminate underground and aboveground storage tanks, pipe, duct, roof systems. Markets include downstream petroleum (service stations and C stores), upstream petroleum (conventional oil and gas drilling), oil sands (both SAGD and mining), and industrial chemicals.
Applied Composite Technologies Inc.	BC	http://www.appliedcomposites.ca	Consulting in engineered wood products. Areas of interests and research involve: wood veneer modification, wood veneer densification, reinforcing wood veneer, products with fiberglass and polyester sheets, and wood pyrolysis to bio-carbon.
ArmorWorks	BC	http://www.armorworks.ca	Manufacturer of survivability products for the military and law enforcement. These include both hard and soft armor as well as energy attenuating seats.
Cobra Imaging	BC	http://www.cobraimaging.com	Decorative/protective coatings to make one substrates look like another (fibreglass surfaces can look like wood, metals, or something completely custom).
Lignol Energy Corp.	BC	http://www.lignol.ca	Developer of an integrated biorefinery process technology which separates biomass into constituent parts and then carries our value-added processing steps. One of the products is a pure form of lignin for which applications are being developed in a number of areas within the composites industry.
Performance POLY-TEK Custom Tooling	BC	http://performancepolytek.com/manufacturing.html	Composite manufacturing company, specializing in rigid and flexible tooling, custom production runs, hand lay, infusion, light RTM, using glass, carbon fiber, also offering thermoforming with a 6ft x 12ft sheet capacity
ACS-NAI Limited (EMTEQ Canada)	MB	http://www.acs-nai.com	TCCA approved design approval organization, approved maintenance organization and approved manufacturer. Certification services to aircraft operators/completion centres. design, certification and manufacture of aeronautical products.

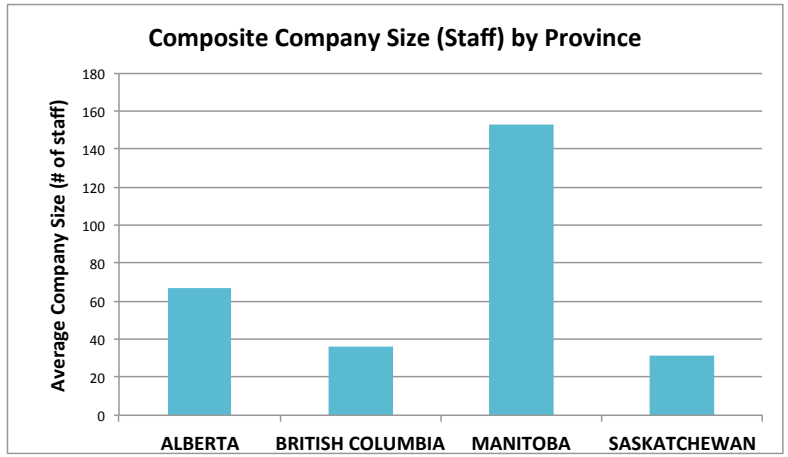
Organization	Province	Website	Activities
Buhler Industries	MB	http://www.buhlerindustries.com	Agricultural equipment manufacturer using many composite components.
Carlson Structural Composites	MB	http://www.carlsongrpco.com	Fiberglass reinforced polymer (FRP) components for OEMS of agricultural equipment, transportation and recreational vehicles. Also serves the industrial/custom fibreglass marketplace.
Eastside Composites	MB	http://www.theeastsidegroup.ca	Composite manufacturing as well as industrial liquid coatings; supplying components to a number of local OEM's as well as a number of proprietary products. Experience with multiple production methods and multiple substrates (carbon fiber, bio-fibers etc.).
Emerson Hemp Distribution Company	MB	http://www.emersonhemp.com	Consulting company for hemp fiber development and R&D on hemp fiber processing and product development. Amalgamation of Emerson Hemp Distribution and BioMass Fractionation
Frank Fair Industries	MB	http://www.mcicoach.net	Manufacturer of composite parts for ground transportation, and agriculture.
IMRIS	MB	http://www.imris.com	Medical device manufacturer, image guided therapy solutions.
MacDon Industries	MB	http://www.macdon.com	Manufacturer of agricultural harvesting equipment.
New Flyer Industries	MB	http://www.newflyer.com	Leading manufacturer of heavy-duty transit buses in Canada/US with manufacturing facilities Winnipeg, MB; St. Cloud, MN; and Crookston, MN.
Progress Plastics/CCP Composites	MB	http://www.ccpcomposites.ca/manitoba	Distributor of full line of fiberglass materials including polyester and vinyl ester resins, gel coats, reinforcements, structural adhesives and miscellaneous related products.
SWM International	MB	http://www.swmintl.com	World's largest purchaser and processor of linseed flax straw. Pulp grade flax tow for paper making operations in New Jersey and France. Launched FlaxStalk natural fibre solutions, a line of biomaterials from flax fibre, flax shive along with hemp fibre and hurd to supply the developing bio products industry.
Ag-West Bio	SK	http://www.agwest.sk.ca	Ag-West Bio Inc. is a catalyst for Saskatchewan's bio economy, helping to move research to market. A not-for-profit, member-based organization, Ag-West Bio is funded by Saskatchewan's Ministry of Agriculture and Agriculture & Agri-Food Canada's Growing Forward program.
BioLin Research Labs	SK	http://www.biolin.sk.ca	Processor of flax fibers and shives that have a range of different properties. R&D in areas of flax agronomy, harvest and processing methods, fiber and shive characterization, end use applications.

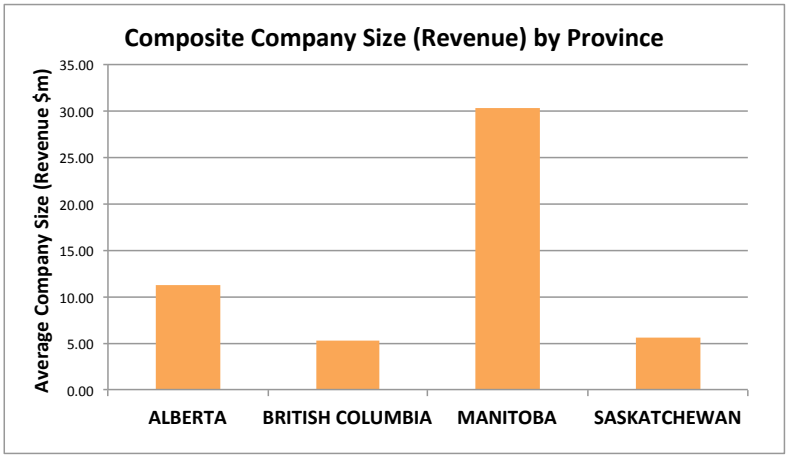
Organization	Province	Website	Activities
Estevan Plastic Products Ltd.	SK	http://www.estevanplastics.ca	Manufacturer of fiberglass products for the oil field. Pump jack belt guards, tank slimmers and tank floats, wellhead shelters, large volume tanks and acid tanks.
Genome Prairie	SK	http://www.genomeprairie.ca	Not-for-profit organization, developer, and funder of large-scale research projects across all sectors of the economy of Saskatchewan and Manitoba.
GP Fiberglass Ltd.	SK	http://www.gpfiberglass.com	Manufacturer of 30" diameter corrugated well casings, transformer bases, and aircraft warning markers.
Meldon Plastics 2006 Ltd.	SK	http://www.meldonplastics.com	Custom fiberglass manufacture and repair, retail sales of FRP materials, custom manufacture and repair in plastics, retail sales of HDPE, UHMW, PVC and Acrylic sheet.
Open Mind Developments	SK	http://www.pelacase.com	Manufacturer of eco-friendly plastic products made from Flaxstic. Flaxstic is a biocomposite consisting of biopolymers, flax fibre and flax shive.
Progressive Yard Works Ltd.	SK	http://www.progressiveyardworks.com also http://www.orcatrailers.com	Manufacturer of exceptional fiberglass products: Fiberglass water and septic tanks, custom FRP fabrication, fake rocks, fiberglass repairs. Also, Orca Trailers, fiberglass tooling, modular buildings, outhouses, toilets, indoors water storage.

FIGURE 2: INDUSTRY SIZE





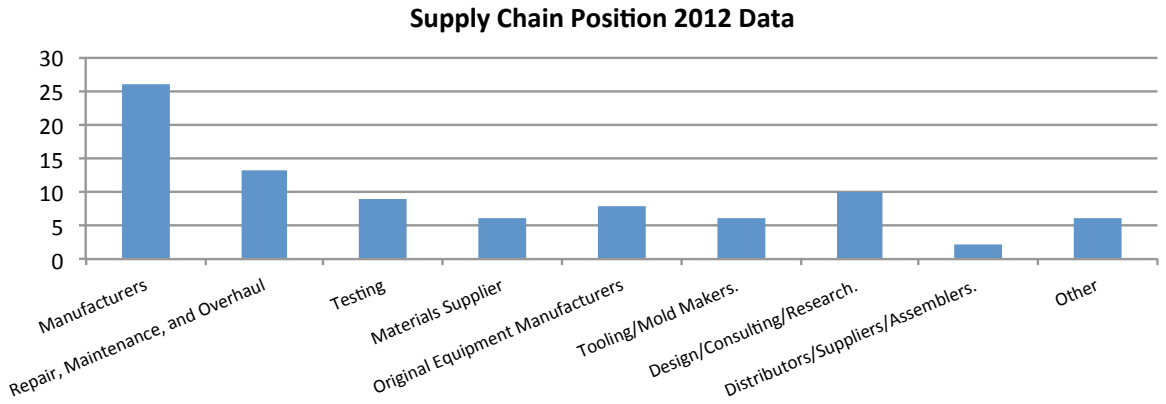


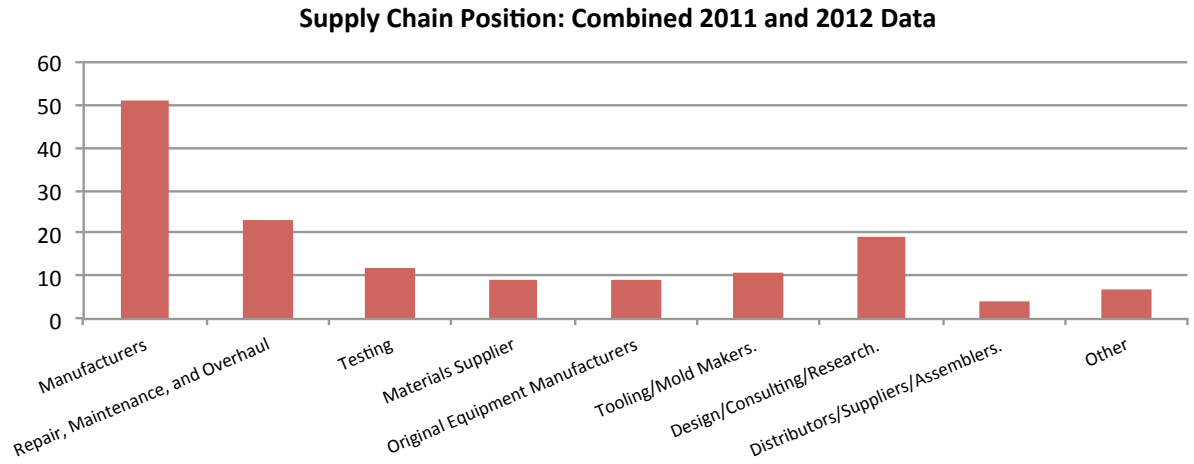


Survey data from 2011 and 2012 was combined with web-based research sources for non-responding companies to estimate staff and revenue for all currently known composites companies in Western Canada: N=227.

FIGURE 3: SUPPLY CHAIN DATA OF RESPONDENTS

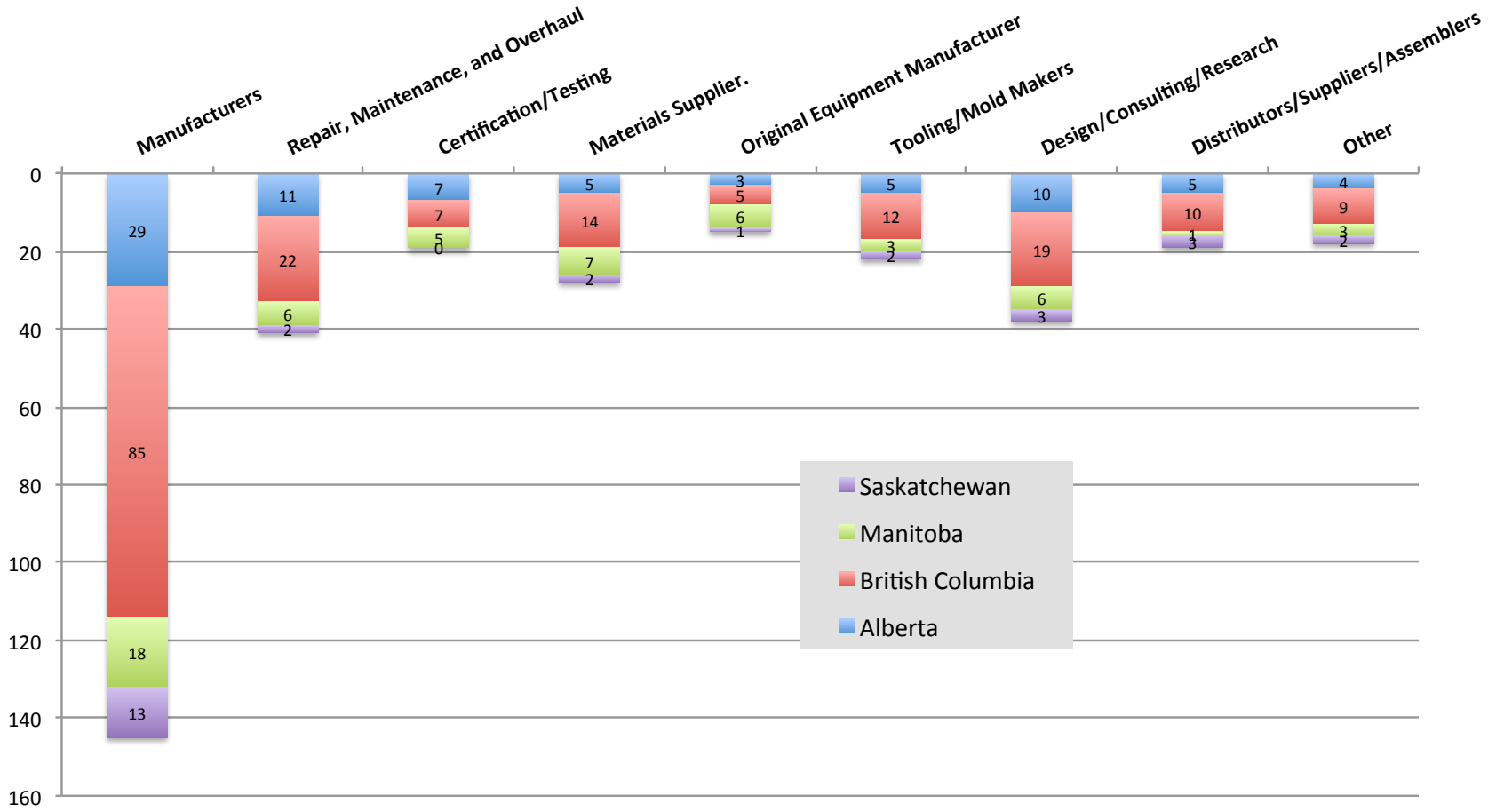
What our survey results tell us about supply chain representation





2012 supply chain position data: all 46 respondents answered this multi choice question. N=86. Average =1.9 choices per respondent for 9 categories. 2011/2012 combined supply chain data: 82 respondents answered this multi choice question. N =145. Average = 1.75 choices per respondent for 9 categories.

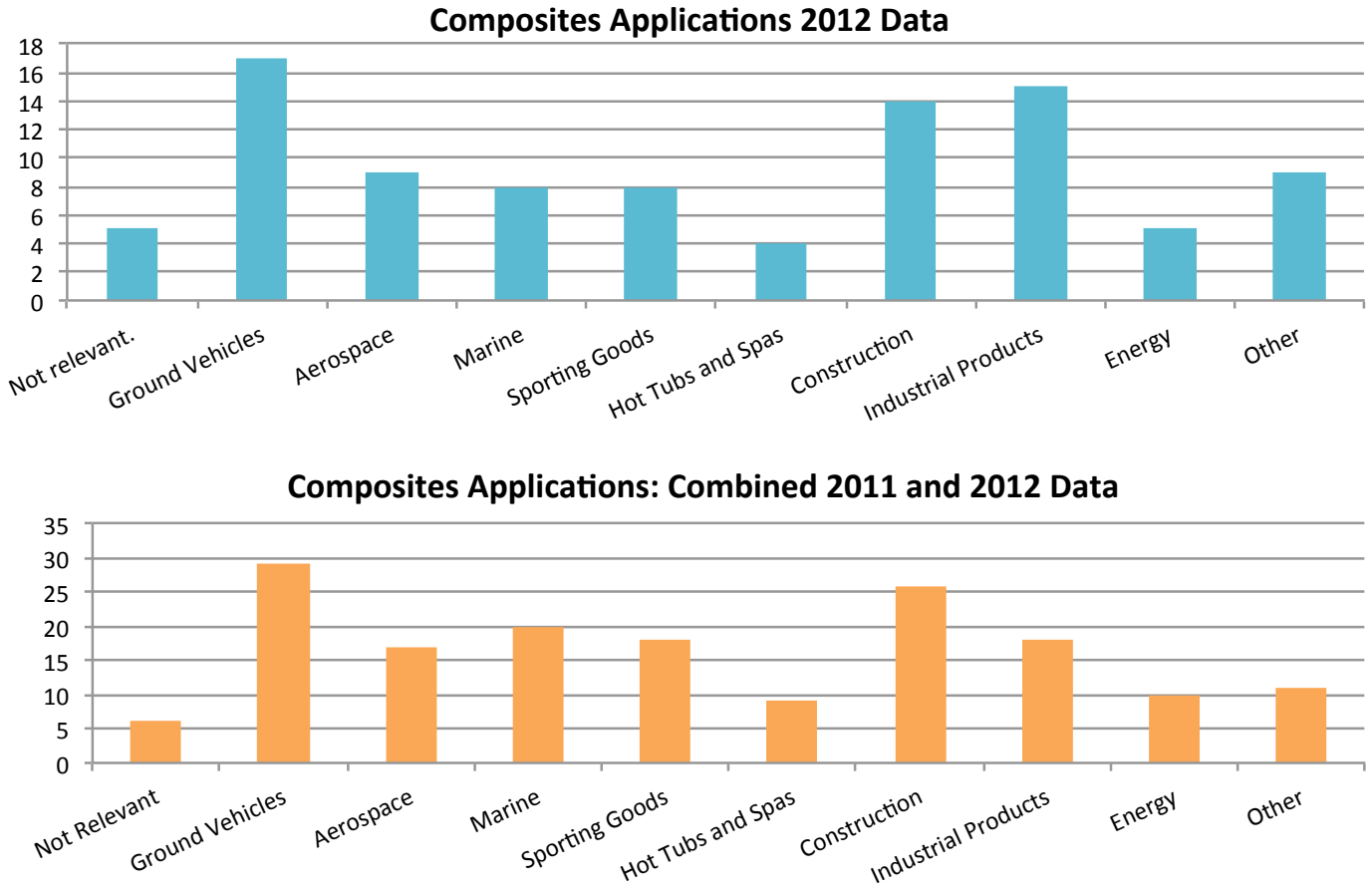
FIGURE 4: SUPPLY CHAIN DATA BY PROVINCE



Survey data was combined with web-based information sources for non-responding companies to tabulate supply chain data for all currently known composites companies in Western Canada: N=345. Average =1.5 choices per respondent for 9 categories.

FIGURE 5: APPLICATION DISTRIBUTION OF RESPONDENTS

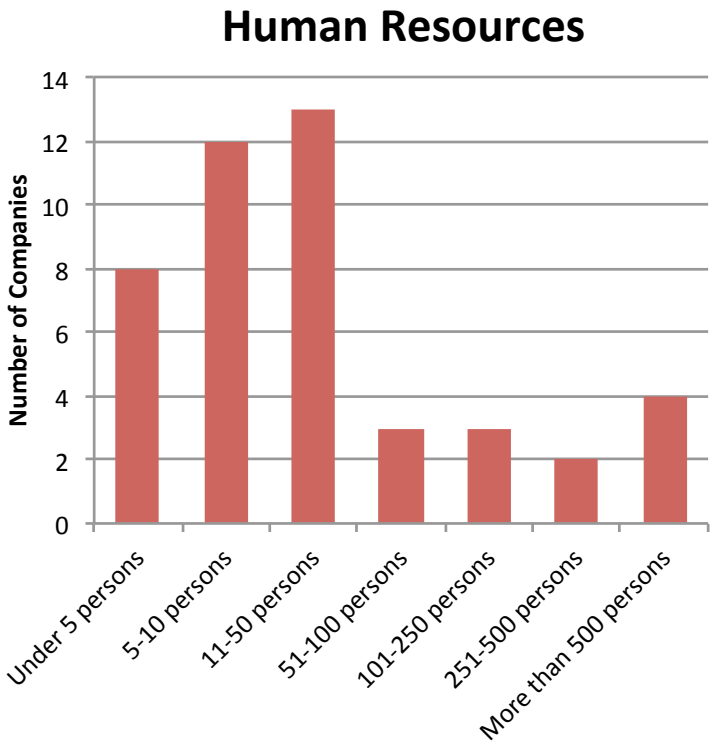
What our survey results tell us about application distribution

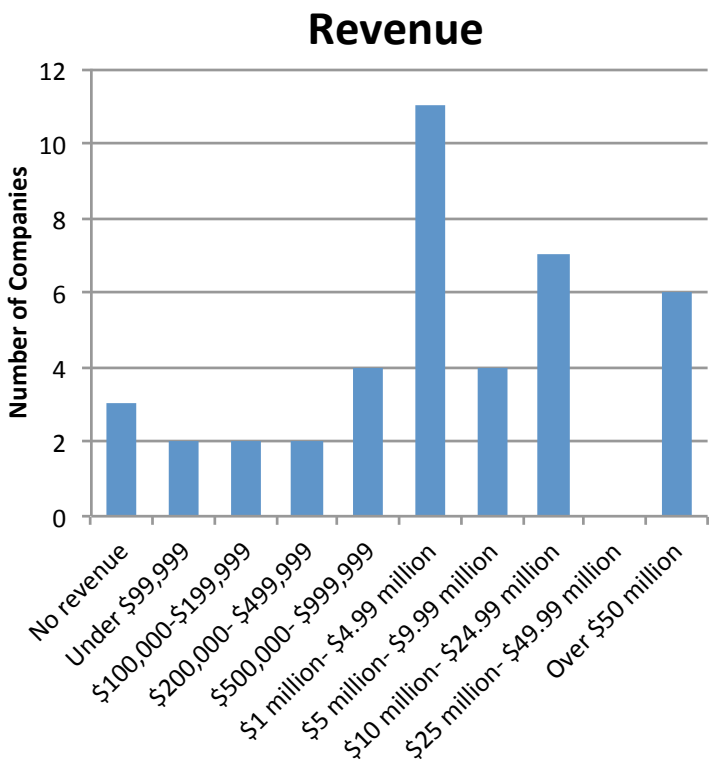


2012 applications data: 45 of 46 respondents answered this multi choice question. N=94. Average = 2.08 choices per respondent for 10 categories.
2011/2012 combined supply chain data: 81 respondents answered this multi choice question. N = 164. Average = 2.02 choices per respondent for 10 categories

FIGURE 6: HUMAN RESOURCES AND REVENUE

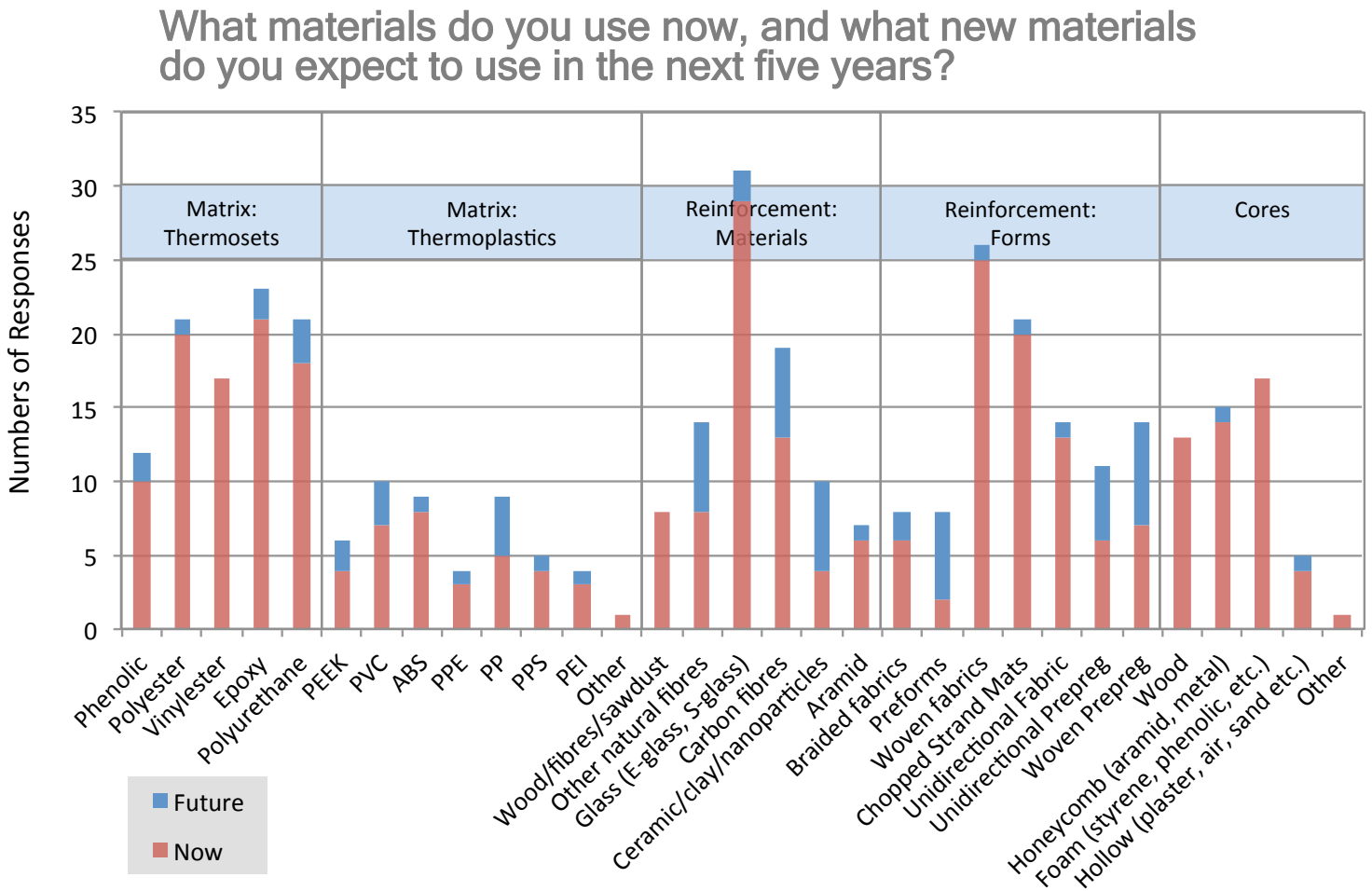
45% of companies have less than 10 staff





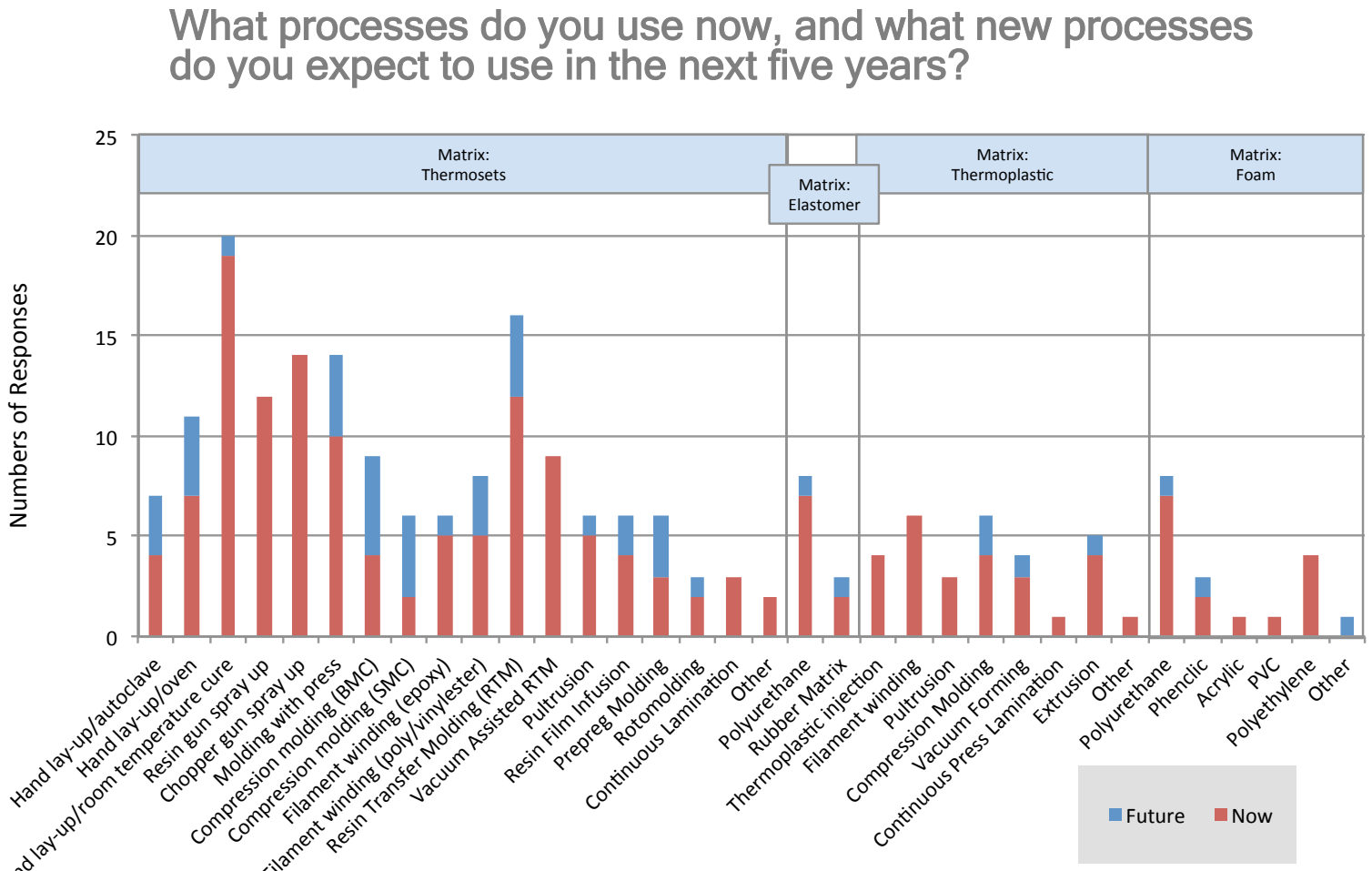
Human resources data: 45 of 46 respondents answered this single choice question. Revenue data: 41 of 46 respondents answered this single choice question.

FIGURE 7: MATERIALS USE NOW AND FUTURE



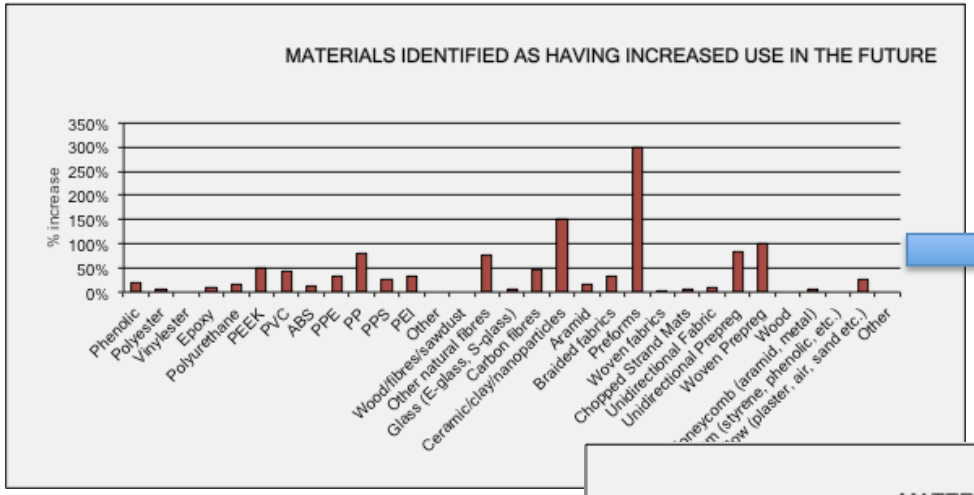
Materials use data *Now*: 40 of 46 respondents answered this multi choice question. N_{Now}= 317. Respondents averaged 7.9 choices.
Materials use data *Future*: 19 out of 46 companies answered this multi choice question. N_{Future} = 67. Respondents averaged 3.5 choices.
N_{total} = 384. There are 31 materials categories.

FIGURE 8: PROCESSES NOW AND FUTURE

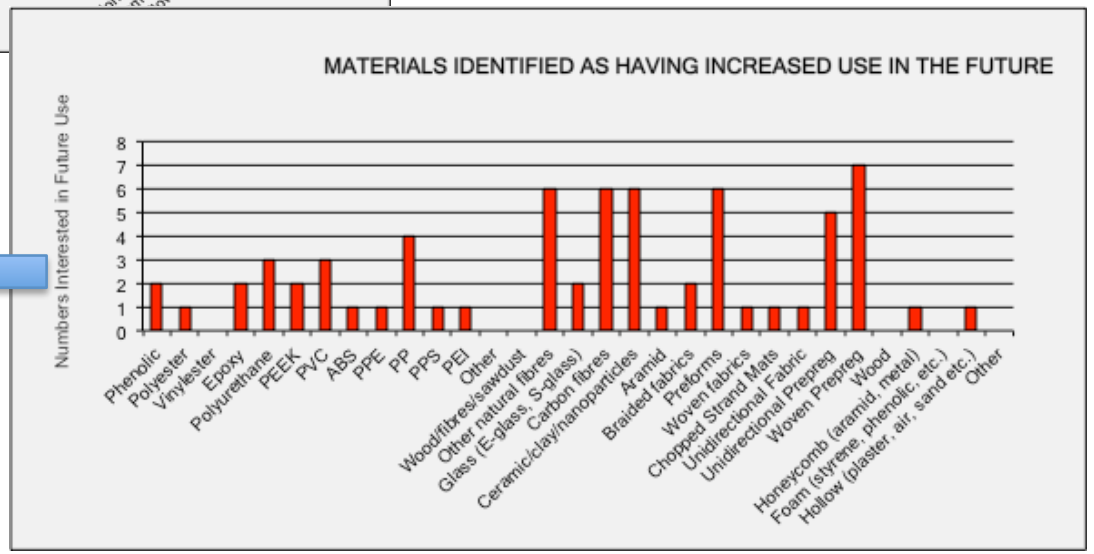


Processes *Now* data: 31 of 46 respondents answered this multi choice question. N_{Now}= 172 and respondents averaged 5.5 choices in the *Now* series
Processes *Future* data: 13 out of 46 companies answered this multi choice question. N_{Future} = 45 and respondents averaged 3.46 choices in the *Future* series. There are 34 process categories. N_{total} = 216.

FIGURE 9: FUTURE MATERIALS USE (DETAIL)



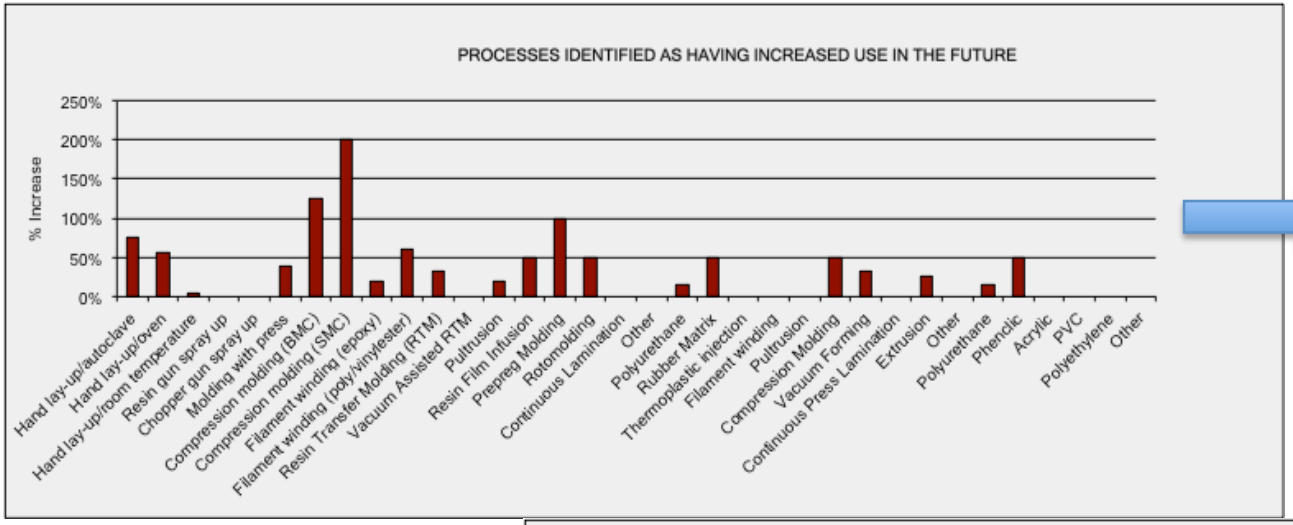
The largest growth rate areas are preforms, ceramic/clay nanoparticles, woven prepreg, and other natural fibers.



The largest numbers of new future users will likely be in woven prepreg, preforms, ceramic/clay nanoparticles, carbon fibers, and other natural fibers.

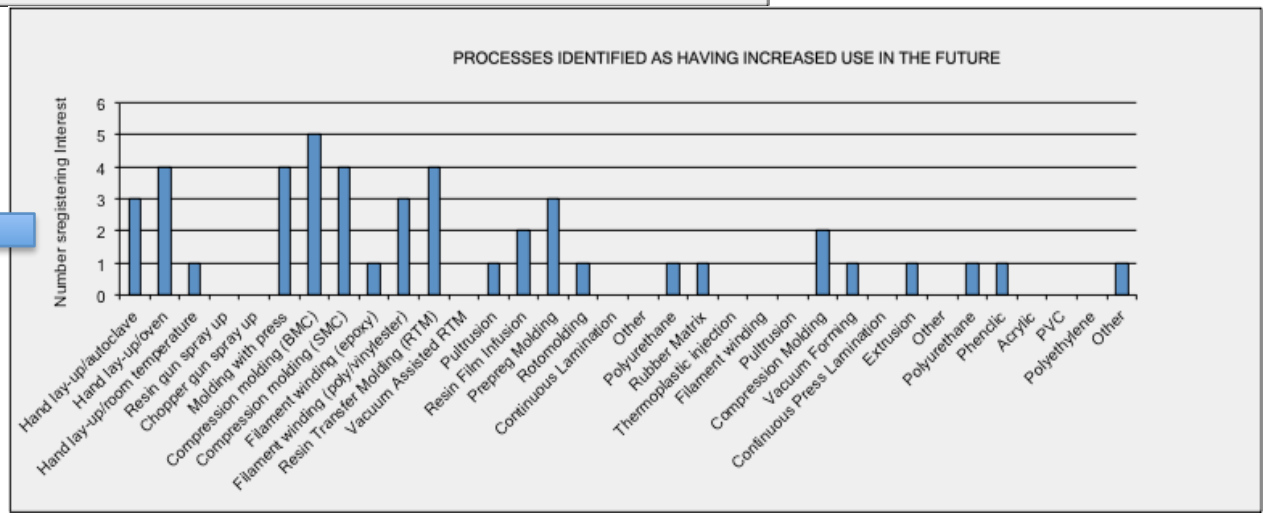
Future materials use data: 19 out of 46 companies answered this multi choice question. N = 67. There are 31 materials categories. Respondents averaged 3.5 choices each.

FIGURE 10: FUTURE PROCESS USE (DETAIL)



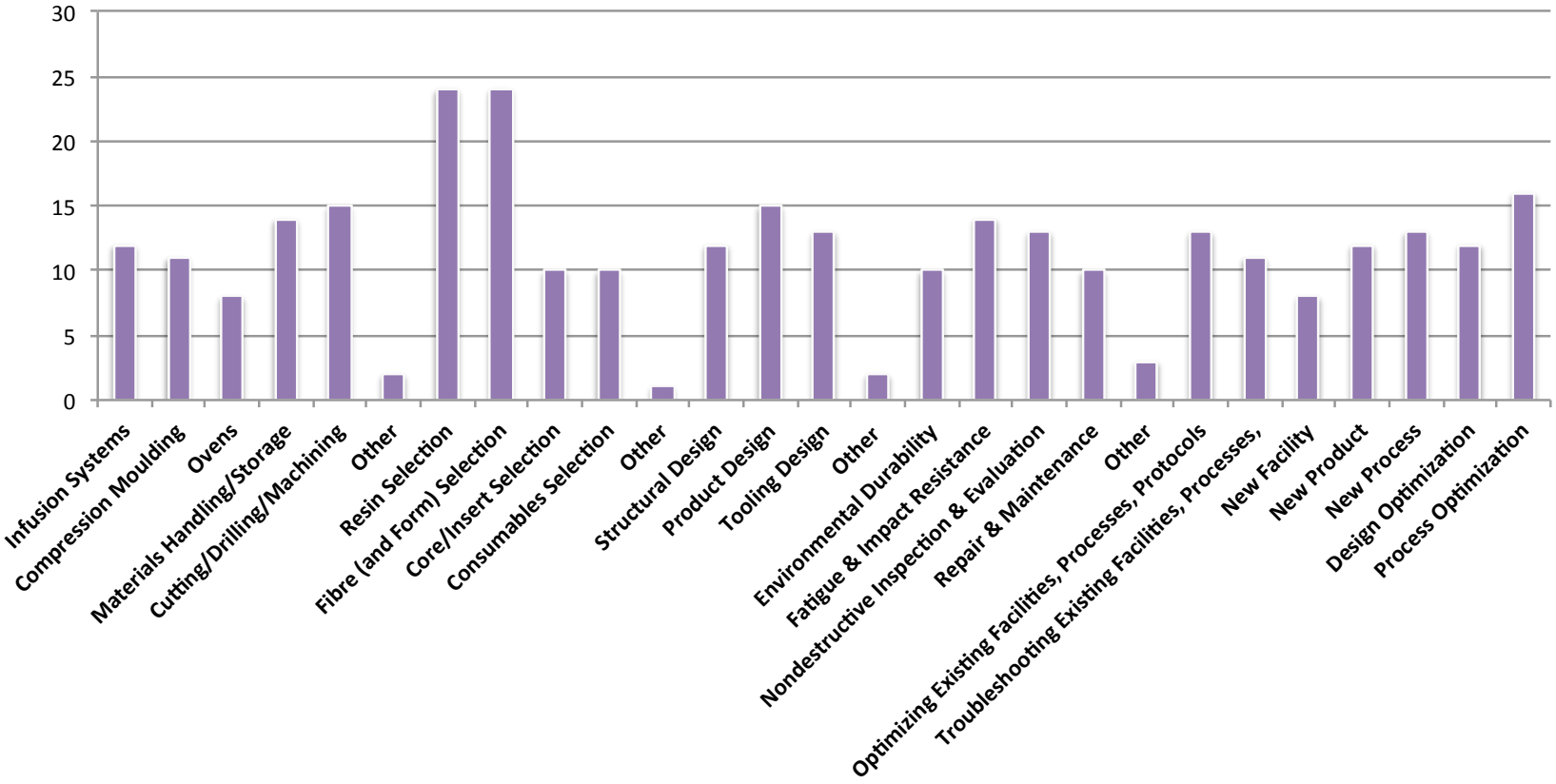
The largest growth rate areas are SMC, BMC, prepreg molding, and hand lay-up with autoclave.

The largest numbers of new future users will likely be in BMC, SMC, RTM, molding with press, and hand lay-up with oven cure.



Future process use data: 13 out of 46 companies answered this multi choice question. N = 45. There are 34 process categories. Respondents averaged 3.46 choices each.

FIGURE 11: KPD TOPICS



40 of 46 respondents answered this multi choice question. N=308. Average of 7.7 choices per respondent from 27 categories