



News From The Centres

ICBC

ICBC has now completed testing on the need to replace Child Restraint Systems following a low speed collision. This is a continuation of the presentation at last year's RCAR conference where ICBC and MPI showed the results of a joint study of damage to Child Seats after high speed (48km/hr and 56km/hr) barrier crashes. The new tests showed that lower speed crashes do not cause any damage to child seats. The tests were done using the crash pulse from the RCAR damageability tests—15km/hr with an offset barrier.



This project is a very good example of the possibilities of RCAR members sharing information with each other to further each other's research. In this research John Gane says he got help from a number of RCAR members, and without this help the work could not have been done.

Special points of interest:

- *News from 12 RCAR Centres.*
- *Regional initiatives and sharing of research results.*
- *A look at Intelligent Transport Systems and Telematics.*
- *News Sources, Book Review, and Forthcoming Events.*

Thatcham provided a series of crash pulses from RCAR tests which were used to tune the sled test device to simulate a RCAR crash, Cevvimap provided video images of RCAR crashes for the video, and NRMA provided images of a series of vehicles that were previously impacted by their pendulum at the same speed. These images are important for accident investigators to illustrate the type and amount of damage in these impacts, so they can determine in the field if the subject vehicle (and child seat) have been involved in a similar impact. MPI also provided the images of the high speed barrier crashes that were used in the original research on the subject. The final report will be presented at the RCAR 2000 Conference in Argentina.

NRMA

NRMA's "Impact" magazine (Issue 10 December 1999), which RCAR members will have received, announced a first in that NRMA "Times" are now on the Web. You can view them by going to the NRMA web site at www.nrma.com.au and then to the Insurance page. Once there select the Repair Data link under Technical Research Centre. It is great to see this project (details in the 1999 RCAR Projects Catalogue) is now on stream. Congratulations to NRMA.

NRMA is partner in the Australian New Car Assessment Program (ANCAP). In November 1999 six medium cars were tested and graded as follows: Subaru Liberty-4 Star; Volvo S40-4 Star; Mazda 626-3 Star; Holden Vectra-3 Star; Daewoo Leganza-2 Star; Hyundai Sonata (no airbag)-2 Star. Full details are at www.nrma.com.au/crashtests.

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Cesvimap

Cesvimap's December 1999 magazine has been circulated to RCAR members. It contains a variety of very useful information on polyester panel replacement, high yield spray guns, electronics in diesel engines, vehicle analysis, testing of OSA Spanesi Workbench, 3Ms paint ventilation system, and road safety work in tunnel safety. A report was issued on Cesvimap's new Plastic Repair Centre, which RCAR members will recall visiting at the time of the 1999 conference.

Recent issues of Cesvimap's repair manuals have included SEAT Alhambra, Peugeot Export, Toyota Landcruiser '90, Alfa Romeo 156 and two scooters: Italjet Formula 50cc and Aprilia SR50 LC.

Centro Zaragoza

Two magazines have been issued recently and circulated to members. Topics include: the alternative parts market, alternative parts certification, infrared, ECUs (can they be repaired?), emission legislation, "concentrate on your driving", "if you drink DON'T drive" and new vehicle launches (Peugeot 607, SMA Class Mercedes Benz, CL Coupé Mercedes Benz). Also a guest feature by Carmelo V Olmo (President of CETRAA), a test on Abratecmic's Abralon line of sanding and polishing disks, vocational training contract, news from Centro Zaragoza, and Step-by-Step—repair without dismantling.

Further subjects cover plastics and their repair, testing and inspection for certification, catalytic converters, investigation into the phases of an emergency stop, evolution of accident investigation, head restraints, a guest feature by Miguel Angel Cuerno (President of AECAR), Panel Bonding—3m 08115, Garma-Press, new vehicle launch (Seat Le*n), skills certificate, and Step-by-Step—colour preparation.

Cesvi Argentina

Cesvi Argentina has recently issued its magazine and circulated it to members. Topics covered are: Sata spray gun—Minijet, drying using infrared, insurance market—rules of the game change, interview with A Tsuneo Arima (President of Toyota Argentina), Fiesta LX, system for pricing spare parts, pneumatic tyres—the new protagonist, panel beater—Model 1000D "de Luxe".

IIHS

Two Status Reports have been issued in 2000: "New Record—90% Belt Use" and "Cosmetic Repair Parts Irrelevant to Safety". See comments on the latter under From The Secretary General – Page 6. This is seen as an important international milestone in the process of "injecting safety into the continuing debate about cosmetic crash parts". It also has some pretty interesting price comparisons for OE versus Aftermarket.

IIHS is also cooperating with ICBC and Thatcham to create a draft Static Head Restraint measuring protocol that will be put to RCAR members for discussion shortly.

KART and JKC

KART and JKC held a joint conference in Ichon, Korea (where KART's new facility is located), from 25-27 October 1999. Six members from JKC, including Director Mr Hiroshi Suenaga, attended this conference and made presentations on five different research results. Three research results from KART were also presented. All the conference proceedings were conducted in English. The presentations are summarised below.

Activities for Promoting Popularisation of JKC Repair Time Schedules.

Mr Hisashi Kusano of JKC explained the issuing status of JKC's Repair Time Schedules including the repair times of removal and refitting, refinishing and outer and inner body panel repairs, and also about how they are aiming to promote their usage in the market place including JKC's relationship with the repair industry, car manufacturers, insurance companies and electronic repair cost calculation system providers (Audatex Japan) with information about the regional penetration levels of JKC's schedules. In addition they maintain several committees to validate the results of the repair times.

Study of Japanese High Strength Body

Mr Masatoshi Saito of JKC explained the background of high strength body cars, and the history of Japanese car safety standards. Accordingly passenger cars' body panels were changed to be produced with high strength steel. The problem is that repairers are asking for more repair time with the high strength body panels than when they repair with traditional body panels. In order to establish the true facts, JKC studied how the high strength body car is damaged and how much its materials and repair time should be consumed compared with conventional cars. They crashed new and old model cars at 20km/hr to 40% offset barrier and repaired the damage for comparative analysis. Their conclusion is that there is no significant difference between the conventional and the high strength body panel cars in respect of damage levels, parts cost and repair times.

Research of Used Parts in Japan

Mr Shigeyuki Matsuura of JKC explained the situation concerning used parts, recycled parts and alternative parts in Japan in order to identify possible ways of lowering the parts cost. He surveyed each part's availability (bonnet, front fender, front and rear door and trunk lid) in the market with various sample cars., and he analysed their prices and quality. Overall the average availability was 65% and the used parts quality was acceptable. However there was one problem: when the availability was good then the replacement frequency was low and vice versa because more

News From The Centres

Damageability of the Low Speed Crash Test.

Mr Ichiro Fujino of JKC presented an analysis of test result from 38 cars crashed according to RCAR crash impact standard during the past 4 years. He explained how the damage differs according to good or poor design with the tested results. The conclusion is that the repair cost depends on damage depth which in turn depends on body structure (such as side member and bumper system, etc) and parts layout (various mechanical parts such as radiator, etc), and he introduced an ideal structure for good damageability and repairability. In addition JKC has a good and cooperative relationship with car manufacturers to improve their vehicle designs.

Measurement Data of Wheel Alignment of the New Car and Confirmation of the Difference Under the Measurement Conditions.

Mr Yoshimasa Uchida of JKC compared wheel alignment measuring data using static and drive-on type of 4 wheel alignment testers and also under various conditions such as "replacing wheel clamps", "after 3km driving", "use of different types of clamps", etc. The result was that the measured data was different from each tester, but he did not find any problems even if the measured data is slightly out of the tolerance recommended by car makers. However the real problem in Japan is that the 4 wheel alignment measurement charge shows so big a difference between CCK (Camber Caster Kingpin) gage and the 4 wheel alignment tester. In fact the latter one's charge is six to eight times higher than the former. Until now the insurers should have been paying a high price for the 4 wheel alignment testers. So JKC will continue their study to find out if it should be needed in every damage repair or not and, if it is not, then in which level of damage it is needed for correct and safe repairs.

Repair Time Schedules for Damaged Vehicles

Mr Byung Moon Yoo of KART explained the general situation in repair time schedules in Korea and what KART has been doing and plans to do in respect of the schedules for solving existing problems. KART has issued repair time schedules and refinishing cost guide (materials and times) for all domestic passenger car models, but they are not in use yet in the market because the repair industry has not accepted them. KART continues its efforts in various ways to encourage acceptance by the repairers.

Metal to Metal Adhesive Bonding

Mr Sang Don Lee of KART and 3M Korea jointly studied the panel bonding repair method of roof and rear quarter panel instead of the conventional welding method. This repair method is not accepted in Korea even though it is often used in North America and Europe. Results show that this new method gives very good repair quality and saves a lot of repair time. In the case of roof panel replacement the time saving was 6.1 hours. Crash tests for safety

Research on Repairability and Damageability of Light Weight Passenger Cars by Low Speed Crash Tests

Mr In Song Park of KART said that the Hyundai Atoz and Daewoo Matiz were crashed according to RCAR crash impact test standard. Both cars' engine capacities are 800cc. He analysed front and rear damage and repair cost of each car and compared them. As a result of this study KART made recommendations to the car manufacturers to help them to improve their car's design and these recommendations were accepted. In the case of Atoz, the major recommendations were front side member's design improvement, relocation of ABS hydraulic unit, rear side member and quarter panels' design improvement. In the Matiz front side member's design improvement and the relocation of fuel inlet hose were two of the recommendations made to Daewoo.

In addition, KART and JKC are planning to hold similar joint conferences annually in future and will take it in turns to host these. This year's conference will be in Japan.

JKC

In addition to the above report, a new Newsletter (No.55 January 2000) has been distributed by the Japanese non-life insurers. This is available on the Web at www.sonpo.or.jp. Also a Fact Book on Non-Life insurance in Japan 1998-1999 has been issued. PDF files for downloading are held at www.sonpo.or.jp/english/english.html.

Allianz

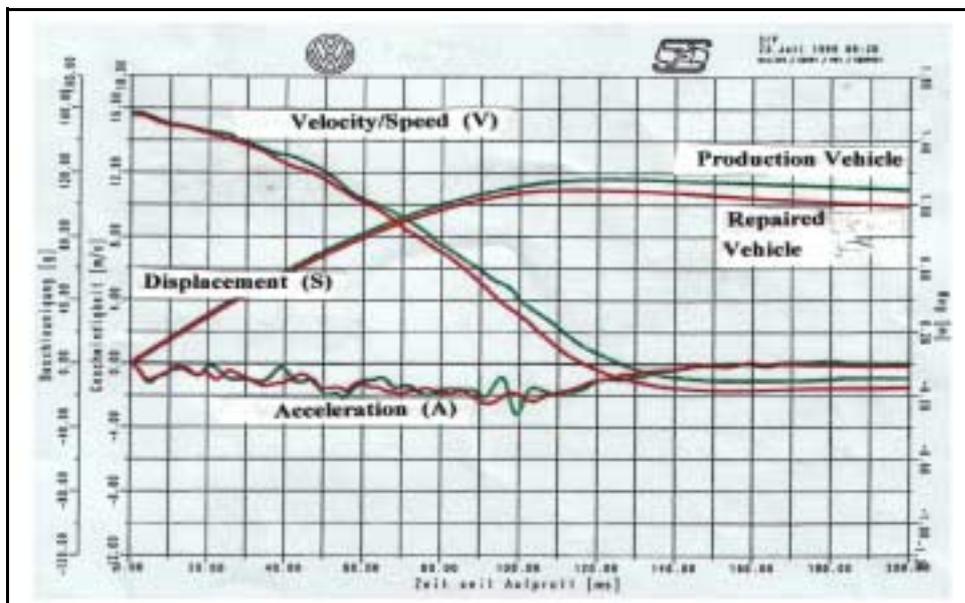
Technical news from Ismaning includes the following topics: repair data for the VW Gold and Bora covering removal and replacement of the radiator cover; identification (vehicle identification number—VIN) build up of data and origin of data for 17 digit identifier for VW cars and light commercial vehicles (LCVS); road tyre and performance data for VW Passat; crash repairs to front chassis legs (front rails or longitudinals) of passenger cars following impact; details of *PROFILE REPAIR* for caravans; information on automotive painting for Renault passenger cars.

Information was distributed on the construction of body panels for Mercedes-Benz S Class Coupé showing hybrid configuration of steel, aluminium, magnesium and other alloy body panels together with listing of Daimler Chrysler dealer/advice centres in Germany.

Allianz issued a Technical News Release on the repairability and damageability work carried out at Allianz Centre in conjunction with VW (statement issued by Dr.-Ing.Dieter Anselm in cooperation with Dipl.Ing. Gerhard Weber, VW AG). The work was carried out at Allianz with Ismaning on Golf TDI and Golf 1.6l and the very comprehensive research procedure covered 15km/hr testing, specification of damaged parts, repair of deformed chassis legs (front rails or longitudinals) and repair costs. VW then took the repaired vehicles, carried out a high speed (56km/hr) test comparing the pulse with a production vehicle. Correlation between "repaired" and "new production" was very good (see next page).

News From The Centres

Crash Pulse for 56km/h Test



For a full English translation of this very important work please contact the Secretary General. Also attached to this Newsletter is the year Book 1999 of the German Insurance Industry.

Thatcham

Thatcham, in conjunction with the Association of British Insurers, launched the new classification (rating) system for light commercial vehicles (LCVs) in February 2000. Vehicles will be impacted in the Crash Laboratory and Thatcham will be responsible for administering the system which has already gained good support from LCV manufacturers..

Thatcham, collaborating with IIHS and ICBC, is formulating a protocol for the static measurement of car head restraints. It is hoped that this will be presented as a draft Standard for the consideration of other RCAR members shortly.

Recent additions to the Method Repair Manuals available to repairers and insurance engineers include the following: Toyota Avenis 1998 4-door, 5-door and Estate; Ford Cougar Coupé 1998; Vauxhall Astra Van; Daewoo Matiz 1999; Hyundai Coupé; Volvo S80; together with a number of newsletters and an updated Paint Material Cost Guide—Stage 2 Compliant Products.

Euro-NCAP Super-Minis

Details of recently completed tests in Europe are as follows:

	Front & Side Impact	Pedestrian Test	Overall %
Fiat Punto 1.2	****	**	81
Volkswagon Lupo 1.0	****	**	81
MCC Smart	***	**	69
Hyundai Atoz	***	**	56
Vauxhall Corsa 1.0	***	**	56
Honda Logo	***	**	53

(Maximum ****)

NCAP Web Sites: www.nhtsa.dot.gov/cars/testing/ncap
www.fia.com/tourisme/crash/
 Plus RCAR Centres web sites at NRMA or IIHS

News From The Centres

State Farm

Following Wayne Sorenson's retirement we welcome Steven Stockton, Vice-President Strategic Resources who assumes overall responsibility for Research at State Farm.

Charlie Sollers has been active recently in chairing two meetings of the seven North American RCAR Centres. These meetings have been very useful in determining joint projects and agreeing to approach vehicle manufacturers in North America on a uniform basis.

The photo' below shows a part of the very impressive new training facility in Bloomington where State Farm assessors are trained in estimating techniques.



Tech-Cor

Tech-Cor recently issued the first of a revised series of periodicals to their field engineers. They issued their first "Information Bulletin" in 1978 and the new publication "Auto Research Technology", or ART, discusses emerging automotive technologies and their potential impact on the collision repair industry. This first issue of ART includes articles on making vehicles lighter covering both the use of aluminium and steel, a note on RCAR, and manufacturing process improvement and changes. In this latter area magnesium, plastics and carbon fibre materials are detailed with new technology covering multi-plex wiring, drive-by-wire systems and side air bags.

Tech-Cor also report the departure of Pam Overton, who moves back into All State Insurance but stays closely associated with Tech-Cor. Frank Manich has been appointed Vice-President Research. Best of luck, Pam, from your friends in RCAR and a very warm welcome to Frank.

From The Secretary General

I suspect we all have differing ideas on Newsletters. These will vary from a straightforward public relations exercise to a more serious reflection on the nature of our research work. Then, of course, there is the very important process of keeping in touch, helping each other and celebrating a sense of community between centres. Whatever it is, it must not be too intrusive... after all, we are very busy people and we need to be able to pick it up, use what is of interest and value, and then discard.

One could argue about the delivery means: should it be electronically distributed, eg on the web or by e-mail, or in hard copy? One could even question the need or right of the Secretary General to create the newsletter at all when each centre has such well-developed resources and some issue their own, high quality, glossy magazines. All these are important questions. However what I should like to do on your behalf is to set out my ideas, put them into practice so that you can make a judgement, and then together we can work to develop something that is valuable.

News from the Centres

In this issue I have started with news from the centres. Twelve of our twenty-three RCAR centres have featured and I very much hope that other centres will provide information on progress in the future. I also believe that the issue of the Projects Catalogue (in early April when I get back from Japan) will help in our ability to network. I have also included some dates for your diaries and a short article on major developments in automobile electronics.

Focus on Challenges

I believe it to be useful to have a focus in each Newsletter which defines a major area of interest for us all. Suggestions for the future are Information Technology in Research, materials development (aluminium, steel and composites), alternative parts, neck and head injury (whiplash related disorders), new welding techniques, training and the demonstration of the economic value of research being just a few topics for starters. Please let me have your ideas. I have written the first article on "*Intelligent Transport*

Systems and Telematics" but I am looking for volunteers for future topics...so beware!

Points of Interest

There were three particular areas that I did find interesting. The first was ICBC where John Gane, in addition to producing a very exciting picture, tells a story of cooperation between centres and the help he got from the international RCAR community. This is a very impressive reflection on the value of our organisation. The other two were where research was carried out in very important areas that have general application. On the one hand Dieter Anselm carried out some excellent research on the part replacement and repair of front rails (chassis legs or longitudinals) and in conjunction with a major automobile manufacturer, Volkswagon, carried out high speed impacts to prove that this type of repair, when carried out properly, does not compromise safety. *Please note Centres in countries where automobile manufacturers are reluctant to agree and approve this repair method!* Lastly, Brian O'Neill has conducted research to show that cosmetic parts do not affect vehicle safety. This is important since it updates IIHS's early work and that of Thatcham but employs the latest NCAP (high speed, offset deformable barrier) testing protocols.

Regional Networking

Let me finish with a comment on regional trends. As I was in the USA for NACE last November and at SAE this month, I was privileged to attend two meetings of the seven north American RCAR members. They met to talk about common problems and set up a joint project to use as a model to enable a strong message to be sent to automobile manufacturers in North America. I felt the meetings were extremely useful and I wish our North American friends good luck in developing the concept. A second area of regional cooperation is the conference held between KART and JKC reported in this Newsletter. I was very impressed that proceedings were in English and that the conference will become an annual event. I have also learnt from Antonio Estrada that Cesvi's have had a meeting in Spain to determine common testing, common approach and interchange of results.. He was very pleased to tell me that Cesvi

Handover of Secretary General

Hans Gustafsson, our retiring Secretary General, provided an excellent handover helped, I must say, by the marvels of e-mail attachments (what did we do before we had it?!) and culminating in a visit to Stockholm for the final handover. The picture right depicts the two Secretary Generals relaxing at the end of the handover. RCAR members will be delighted to learn that Hans has accepted the invitation of the Steering Committee, on behalf of the Members, to join us in Buenos Aires where I am sure we will give him a good send off to his retirement.



Intelligent Transport Systems and Telematics

Scene Setting

Attending the Society of Automobile Engineers (SAE) 2000 World Congress last week provided an excellent focus in reviewing progress of both Intelligent Transport Systems (ITS) and Telematics. SAE organised a conference within the congress to focus on Intelligent Vehicle Electronics and also set up their first Intelligent Vehicle Pavilion to showcase new technology in the area. Whilst RCAR members will be familiar with some of the technical issues, a number of themes are now emerging.

First there seems to be more of an understanding of the relationship between the environment and the vehicle. Whilst ITS embraces systems that link transport infrastructure and also vehicles using advanced communications, electronics and computer technology, telematics sits as a sub set of ITS. Telematics could be viewed as the products, services and supporting systems that deliver information, communications and entertainment to vehicles and mobile devices. However that is not the complete story since telematics does not cover the full range of technologies as defined and it may help to view the vehicle element of ITS as Intelligent Vehicle (IV). It should be noted that SAE has identified key IV functional areas that are prime candidates for development, namely basic vehicle, safety and security, information and entertainment.

Globalisation

The second theme is one of globalisation. It is recognised that development thus far has been in the three "islands" of USA, Europe and Japan. The concepts of ITS and the environmental dimension draws support and direction at a Governmental level. Whilst the principle motivation may vary in that Europe is driven more by congestion, Japan by technology and the USA by safety and security, there is a growing awareness that the vehicle is the common denominator. Auto manufacturers are global and certainly wish to avoid manufacturing cars with totally different sets of electronics for different countries.

Standards

The third theme is related to the two above in that, in agreeing definitions and working towards globalisation, there is a recognised need to create standards - standards that need to be as open as possible. The evolution of telematics is an interesting case in point. Here we have moved from the first generation (say mid-1990s) which was stand alone, non-compatible devices with single functionality (eg navigation, vehicle recovery, security systems,) to second generation (say 1997) where combined technologies are linked to a proprietary control and service centre. Here functionality is defined by the service supplier, eg Rescue, On Star with cellphone—GPS. Finally, in period 2000-2003 we enter third generation where the core element of the telematics process is a communications computer. Applications and services are lightweight JAVA agents downloaded onto the communications computer. Agents from different providers cooperate to provide a comprehensive suite of services for the user. For third generation standards are

vital and should be open and published. Service roaming should be built in (GSM), competition should be on the basis of quality/diversity/cost, and not technology. Other standards should be integrated so that parallel technology such as digital broadcasting can be enabled.

Integration

The fourth theme is that of integration. The third generation of telematics is a good example of integration and is of course mirrored in the general development of vehicle electronics. We talk in terms of "end to end" solutions for in vehicle communications and networking; multiplexed Controller Area Network (CAN) and Local Interconnect Network (LIN) solutions being examples of this integration process within the vehicle itself. However ITS will incorporate different transport infrastructures, the vehicle ceases to be an isolated unit and becomes part of an intermodal transport system.

When Will This Happen?

What then of timing? It is interesting to note that the sixth World Congress on ITS was held in Toronto in late 1999. A great deal of work has already been undertaken and some countries are planning the introduction of ITS in the next three to five years. Europe and Japan are well ahead; as an example, the Tokyo-Nagoya-Kobe highway is expected to incorporate elements of an automated highway in 2003. Certainly some of the elements of third generation telematics can be expected over the next two years. However, far more fundamental development and implementation will be later, probably over the period 2005-2015. The key drivers will be the needs of countries in relation to congestion and safety, governmental encouragement and funding and the perception of the rate of commercial return. In this latter area the Japanese Automobile Manufacturers Association (JAMA) estimates an annual domestic market value of US\$500 billion by 2015.

Insurance Factors

What effect will these developments have on the insurers that RCAR members support though their research? An extremely difficult question, but in seeking an answer consider the following four factors:

- The new ITS technology provides the insurer with the means to be far more in control. The vehicle through the telematic information provides the necessary data to consider insurance on a time, place, person basis or a sort of "pay as drive" based on a continual update risk analysis.
- The integration of the new technology leads to such complexity and increased cost of ownership that new patterns of ownership emerge. These are manufacturer based with "leased" use and packaged support service such as maintenance and insurance.
- Complexity of electronics leads to differing patterns of reinstatement such that the price of entry for independent repairers rises to a point where only dealer shops can operate. This leads to a skewing of the repair industry and passes control of claims/repair costs from insurer to vehicle manufacturer.

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News, News...

It is not possible, nor should it be the intention, in a Newsletter such as this to provide the latest automotive industry and related news. I suspect it would be out of date before the newsletter reached you. However there are some excellent sources available on the Web and members may find the following sites useful in staying in touch with the latest news.

www.ap.org
www.individual.com
www.automotive-online.co.uk
www.newspage.com
www.bloomberg.com
www.automotive.com
www.feer.com
www.jrm-software.co.uk
www.sillicon.com
www.koreaheadline.com
www.nytimes.com
www.slate.com
www.wired.com
cgi.zdnet.com
www.msnbc.com
cnn.com
www.interactive.wsj.com

Dates For Your Diary

Philippines Transportation Technology Conference/Workshop is to be held in Makati, Philippines on 10-14 April 2000.

Vehicle Safety 2000 international conference is to be held in London on 7-9 June 2000.

2000 FISITA World Automotive congress is to be held in Seoul, Korea, on 12-15 June 2000.

Automechanika is to be held in Frankfurt on 6-10 September 2000.
Details www.automechanika.com

Association for the Advancement of Automotive Medicine (AAAM) 44th Annual Conference is to be held in Chicago on 2-4 October 2000. Details: www.carcrash.org.

Annual RCAR Conference 2000 is to be held in Buenos Aires on 22-27 October 2000 and will be hosted by Cesvi Argentina.

STAPP, 44th Stapp Car Crash Conference is to be held in Renaissance Waverly Hotel, Atlanta, Georgia, on 6-8 November 2000.

Intelligent Transport Systems and Telematics (continued)

- The new ITS technology dramatically reduces the Personal/Bodily Injury element of claims to the benefit of the motorist, insurer and community.

There are many other factors. Suffice it to say that we are looking at major changes in the way vehicles are built and in the environment in which they will be operated. As research organisations concerned with the economic and safe design of future vehicles and the control of costs in the aftermarket, RCAR members clearly have a very important role to play. We need to continue to work with vehicle manufacturers maintaining our influence on both cost and complexity, providing advice and sharing the details of new developments. RCAR members certainly need to help each other, share information and present a common approach to vehicle manufacturers.

Further reading: Intelligent Vehicle Systems SAE publication SP-1538 March 2000 (Price: US\$87)

Book Review

Simultaneous Engineering for New Product Development: Manufacturing Applications

Author: Jack Ribbens
Publisher: Jack Wiley and Sons
Price: US\$80.00

This text was written primarily to help designers, engineers and technicians who are involved in advanced product programs that require input and experience from technical or non-technical fields, that are typically outside of their academic backgrounds or previous employment history. Frequently, these are business related issues that can greatly affect the design, execution and marketability of new programs, in spite of the product's technical excellence and profit contribution potential.

The book provides a practical method for studying all of the aspects to the problems associated with the new product development process, through the application of Simultaneous Engineering principles throughout the process.

The book analyses the following points: identifying and quantifying all design parameters, developing engineering targets, minimizing total time to market, and monitoring other life cycle cost issues. All of the above areas need to be addressed as early in a new program as possible and reviewed periodically all the way through the product's life cycle.

The first ten chapters provide a summary of the most important phases of the new product development process, with Simultaneous Engineering principles listed at each step. Five different industry case studies develop the entire process into a continuum showing where potential conflicts and oversights can be identified and managed appropriately. The cases mirror typical issues that occur in products designed to operate primarily in different aspects of the transportation field. Finally, simplified math models are presented, which show how simultaneous optimisation of all cost parameters could be accomplished, in a virtual design review format.

Available from: John Wiley, 605 Third Avenue, New York.

E-mail: tperlow@wiley.com or order from your bookshop.

ISBN 0-471-25265-4/344pp

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