KNEZICEK, T. Mining machinery integrated database for mine operations on bituminous deposits. *Application of Computers and Operations Research in the Minerals Industries,* South African Institute of Mining and Metallurgy, 2003.

Mining machinery integrated database for mine operations on bituminous deposits

T. KNEZICEK
Faculty of Mining, Geology and Civil Engineering, Tuzla, Bosnia and Herzegovina

Tuzla Coal Basin in Bosnia and Herzegovina is the largest coal area in the State. Regional mining industry sensed the need for mining machinery database development in order to achieve easier planning purposes and equipment selection for open cast mines in Tuzla Coal Basin. Several databases for mining machinery used on the bituminous deposits, i.e. on brown coal and lignite mines, were developed at the Faculty of Mining, Geology and Civil Engineering, Tuzla. System Development Method was used as the approach to the database development, generating relational structure of database. First database was established for trucks and was presented as simple table, drawn and filled on the paper sheet. In the next phase, data were stored in spreadsheet type software (Quattro Pro and Excel). Lately developed database is Bucket Wheel Excavator database designed in MS Access. Two concepts, spreadsheet and Access, were integrated into one large database, enabling manipulation of hundreds of data at one place. Required adaptations of existing database in MS Access, enables Access to be used as an integration resource. Database is designed to reserve free memory for input data for mining equipment not considered so far, such as spreaders, crushers, belt conveyors, tripper cars, etc. New, integrated database, at this stage, can be imported to any type of commercial or individual software where needed. Mining machinery integrated database for open cast mine operations is under going testing in a State company, Coal Mines Tuzla.

Keywords: Tuzla Coal Basin, machinery database, SDM, relational database

Introduction

Machinery database development is an essential field of interest for the mining industry. This is primarily related to the mining equipment databases. Tuzla Coal Basin in Bosnia and Herzegovina is one of the key coal and lignite producers in the State. The major bituminous consumer is Tuzla Thermal Power Station, but large amount of coal is being exported to the neighbouring countries. Recent conflicts in the State generated fall of equipment efficiency and cut of spare parts supply. In order to bridge this issue, Tuzla Coal Company accepted the approach of developing a series of mining machinery databases that will enable easier planning and equipment selection for open cast mines in Tuzla Coal Basin. First works on database development started at the University of Tuzla, Faculty of Mining, Geology and Civil Engineering[1]. Initial research showed that System Development Method (SDM) is the optimum method for development of mining equipment databases[2,3]. SDM is focused on relational type of databases and during designing process it was evident that SDM is applicable perfectly to the types of databases as equipment databases is. The SDM was utilized until database for bucket wheel excavators was developed. New development approach was the use of MS Access program. Most of the requirements in the database were possible to achieve and fulfil. The next step in developing an integrated database was discussion and adaptation firstly developed database which is a simple table filled on the paper sheet. Conversion was essential and additional efforts were put in re-typing data. Next phase was to change databases where data are stored in spread sheet form under Quattro Pro and Excel programs. Changes were adapted to Access database form where originally bucket wheel excavator database was developed.

Machinery database forms

Databases for surface mining equipment were developed in several stages, through various approaches. Development was reflection of knowledge base and technical availabilities in the past decade, taking into consideration three years of knowledge gap during the conflict in Bosnia and Herzegovina (1992 to 1995).

Drawn table database form

First database was developed at the Tuzla Faculty of Mining and Geology, University of Tuzla, during 1994. Database treated all types of trucks being used in surface mining, especially on bituminous deposits. Total 104 models of trucks from 17 manufacturers were analysed (MAG-FAUN, ATLAS, DART, EUCLID, GOODBARY, KRESS, RIMPULL, TEREX, UNITRIG, WABCO, CATERPILLAR, ISCO, INTERNATIO, KAMATSU, BELAZ, DJB, GM). For each model, 83 characteristics and parameters, plus 5 reserve fields, were designed. Characteristics and parameters included all available data that refer to truck performances, including locations in Bosnia and Herzegovina where agents or spare parts are available. Database is in the form of table drawn on large size paper sheet and is not open for new truck model adding. Later, all data were retyped and stored in Excel form.

DBASE database form

Database for hydraulic and electric shovels was developed in DBASE IV program during 1996 as a diploma work of Faruk Kasumovic[4] at the Faculty of Mining and Geology ,Tuzla. Database united two types of excavators, sharing the common performances. Part of the database related to hydraulic excavators included total 179 models of excavators made by more than 15 manufacturers. Hydraulic excavators were characterized by 239 parameters and characteristics. Electric shovels were represented by 25 models, made by 4 key manufacturers (BUCYRUS-ERIE, MARION, P&H, EKG). Electric shovels were represented by 169 parameters and characteristics. During database development, SDM technique was used to determine function models, definition of entities, attributes, and modules showing relationships between data in the database and external links. Difficulties and limitations during database development oriented future developments in different programs. Final output for entire database was presented in spreadsheet form.

Spreadsheet form

Spreadsheet form was used as a database from 1997[5]. Quattro Pro was used as a tool to develop database under the SDM methodology. Database includes 69 models of dozers made by 11 manufacturers, referring to 54 characteristics and parameters. Figure 1 shows a section of dozer database developed in Quattro Pro.

Database for loaders include 69 models produced by 15 manufactures and refers to 63 characteristics and parameters. This database was used as a pilot database for Kreka Coal Company for equipment selection working on bituminous deposits.

MS Excel was used as a base for scrapers and draglines. This database was developed in 2001, following SDM methodology. Included are 43 models of scrapers, referring to 28 characteristics and parameters and 52 models of draglines, referring to 41 characteristics and parameters[6]. Time limitations disabled compilation of larger number of machine types, but database is open for additional inputs in the models of machines, but not in the fields related to machine performances.

Access database form

Lately developed database[7] (year 2002) is a database named in local language 'Rotorni bager' (Bucket Wheel Excavator —BWE). BWE database is designed in Microsoft Access. This database contains 172 models of BWE, referring to 122 characteristics and parameters. Besides that, utilizing this database, in a simple way a specific model of BWE can be selected, where selection is based on the conditions established by the user. Also, calculation of machine capacities may be obtained directly in the database. Developed database can be linked through modules with elements of surface mine planning and design on continuous open pit mines. Established table links enable unified utilization of data in any place of the database, where is eliminated data multi-input. Advantages generated through the correct links among tables are emphasized in the elimination of multi-input, better efficiency, memory rationale, improved relationship client-server and easy use. This new approach in database design and development was result of advanced research related to Access opportunities.

Example of BWE selection screen is shown in Figure 2, while data links are showed in Figure 3.

Database integration

Various developing phases, styles and technical availabilities stimulated unification of all data within several databases. Initially, data from drawn table was converted into classical spreadsheet form (Excel). Also, all data from DBASE database and Quattro Pro were converted into a spreadsheet table. Essential adaptations prepared data to be further converted into Access form. Already developed Access database for bucket wheel excavators provided solid and safe base for conversion. New elements (still in developing phase) are various calculations that can be applied in Access. The major use will be calculation of machine capacities, digging resistance and several other parameters. Integrated database is framed under SDM

Type	Model	Engine hp	Weight lbs	Fuel tank gal	Coolant gal
Case	1450-B	140	29,890	65	14
Caterpillar	D6-D	140	31,500	78	10
Caterpillar	D7-G	200	44,300	115	12
Caterpillar	D8-H	268	61,950	170	-
Caterpillar	D8-K	300	70,500	170	32
Caterpillar	D8-L	335	79,360	199	-
Caterpillar	D9-L	460	111,910	255	34
Caterpillar	D10	700	190,300	382	52
Caterpillar	814	170	41,400	93	13
Caterpillar	824-C	310	69,621	158	23
Clark	280	274	69,890	145	-
Clark	380-B	473	122,950	240	-
Clark	380-B	572	128,460	240	-
Deere	850/6545	145	36,785	82	9
Fiat-allis	14-C	150	35,110	93	11
Fiat-allis	16-B	195	42,900	117	18
Fiat-allis	FD-20	223	54,013	124	17
Fiat-allis	FD-30	300	-	-	-
Fiat-allis	31	425	93,185	235	35
Fiat-allis	41-B	524	113,210	300	38

Figure 1. Section of dozer database

izbor bagera : Select Query

Ime firme	Naziv modela	Donji stroj	Pritisak na tlo,
KRUPP	C 100	Gusjenice	89632
KRUPP	C 300	Gusjenice	112385
KRUPP	C 500	Gusjenice	91011
KRUPP	SchRs	Gusjenice	100000
KRUPP	C 700	Gusjenice	103000
KRUPP	C 700 S	Gusjenice	99000
KRUPP	C 300 S	Gusjenice	0
O & K	SH 250	Gusjenice	127553
O & K	SH 400	Gusjenice	128242

Record: 1 of 178

Figure 2. BWE database Query section—selection of BWE

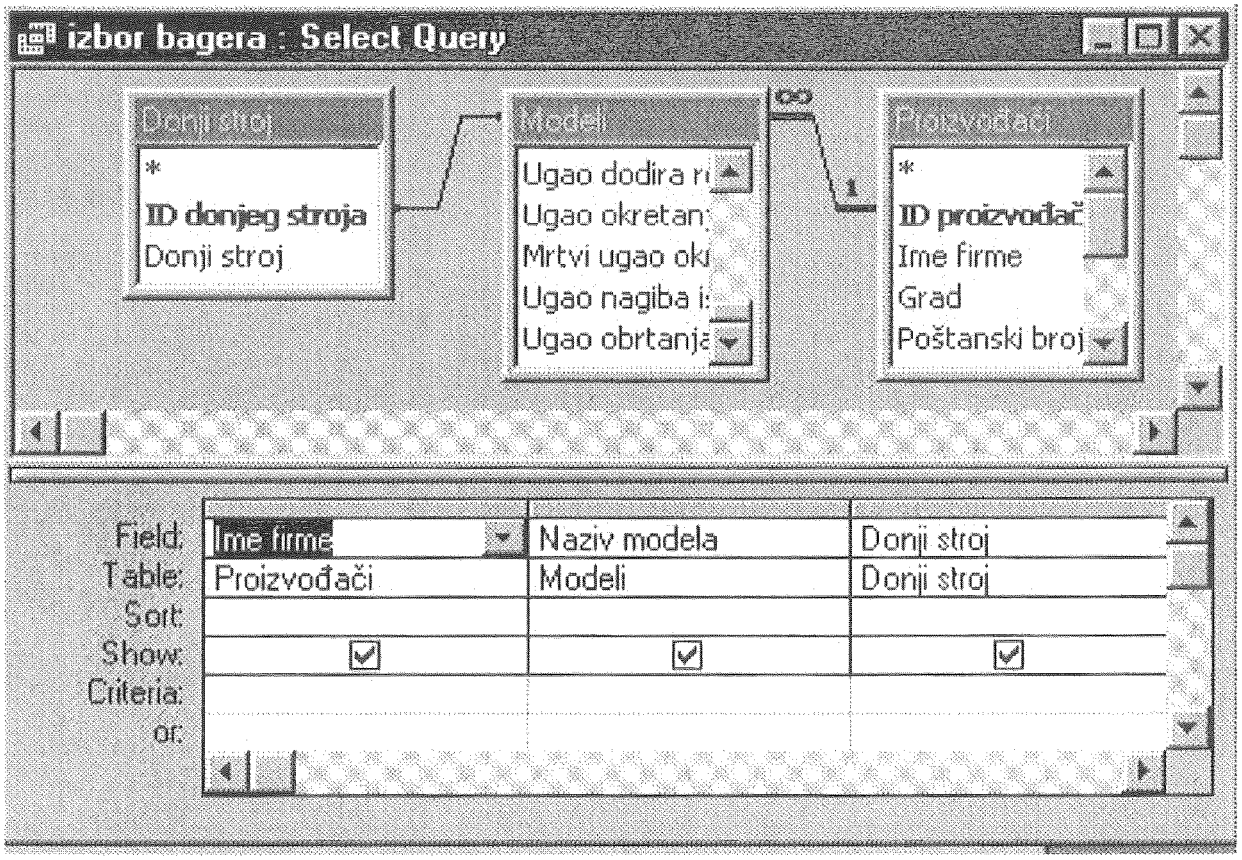

Figure 3. BWE database Query section—conditioning and links

methodology, but not dependent on it, i.e. can be designed in a different manner and provide various links between data within integrated database[8,9]. This approach will enable equipment selection and various calculations where there is more than one type of machine included. This is important for complex mining companies such as Kreka Coal Company which possesses a large number of machines in different locations and spare parts availabilities.

Conclusions

Successful database management and development is

primarily related to the need and database utilization. Dealing with mining machinery data is a sensitive issue while equipment selection is the objective. Extremely high cost of machines used in surface mining requires careful consideration in selection process. Any available data may help in decision-making process. Having all data in one site cuts the research time needed for detection of required performances. Achievement of having unified integrated mining machine database is direct benefit for the companies looking for additional equipment, specific spare parts or substitution of existing equipment. Access program, and database developed within Access is capable enough to satisfy all requirements that one company may have. This shows that relational database is the most suitable type of database for mining machinery data storage. Friendly user Access may be utilized in a number of working sites with very limited needs for user's training. That will enable large number of engineers discuss and analyse results of database processing.

References

1. LUKIC, Z. Organizacija i struktura podataka rudarske opreme—kamiona u bazama podataka, diploma work, University of Tuzla, 1994.
2. KNEZICEK, T., STEVIC, M., and ZIVKOVIC, S. Metodologija formiranja baza podataka u povrsinskoj eksploataciji mineralnih sirovina, '*Prvo bosanskohercegovacko Savjetovanje 'Elektroenergetski sistemi R BiH i rudarska djelatnost djelatnost u ratnim uvjetima, pravci i perspektive poslijeratnog razvoja'*, Tuzla 1994, pp. 211–223.
3. KNEZICEK, T. Databases in lignite opencast computerized mine designing, *Conference LIFE 2000, Lignite Innovations for Future Europe*, Freiberg, Germany, April 2000.
4. KASUMOVIC, F. Organizacija i struktura podataka rudarske opreme—bager kasikara u bazama podataka, diploma work, University of Tuzla, 1996.
5. JASAREVIC, L. Organizacija i struktura podataka rudarske opreme—buldozera i utovaraca u bazama podataka, diploma work, University of Tuzla, 1997.
6. HUSIC, E. Organizacija i struktura podataka rudarske opreme skrepera i dreglajna u bazama podataka, diploma work, University of Tuzla, 2001.
7. KNEZICEK, T. Veza tabela u sistemu upravljanja access bazom podataka 'Rotorni bager', *Zbornik radova RGGF*, Tuzla 2001, pp. 69–75.
8. KNEZICEK, T. Racunarska optimizacija izbora rudarske opreme u povrsinskoj eksploataciji ugljeva, *Savjetovanje o polozaju i perspektivama razvoja rudarstva u Bosni i Hercegovini*, Banovici 29–30 June 2000, pp. 131–140.
9. KNEZICEK, T. Databases optimization and comparison in mining equipment database development, *APCOM 2001*, Beijing, China, 2001, pp. 403–406.